UNIVERSITY COLLEGE LONDON

School of Slavonic and East European Studies

CHARLES UNIVERSITY IN PRAGUE

FACULTY OF SOCIAL SCIENCES

Institute of Economics Studies

Master thesis

2018 **Fei Song**

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Social Determinants of Life Expectancy in Transition Economies

Master thesis

Prague 2018

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Academic Year: 2017/2018

Bibliographic note

SONG, Fei. *Social determinants of life expectancy in transition economies.* 80 p. Mater thesis. Charles University, Faculty of Social Sciences, Institute of Economic Studies, Supervisor PhDr. Lucie Bryndová.

Abstract

This thesis investigates the impact of social determinants on life expectancy in 16 transition economies from 1995 to 2012 by a panel data regression analysis. The regression result suggests that, air quality, coverage for tertiary education, spending in health care have statistically positive associations with life expectancy. To be specific, 1 microgram per cubic meter reduction in PM 2.5 air pollution(mean annual exposure) is associated with a gain of 2.16 months of life expectancy at birth. 100 dollars increase in health expenditure per capita is associated with a gain of 2.4 months of life expectancy at birth. 10% points increase in the gross enrolment ratio for tertiary school is associated with a gain of 3.6 months of life expectancy. But the proxy variable of democracy(Unified Democracy Sores), Economic Freedom and out-of-pocket health expenditure are not significant factors of life expectancy.

Abstrakt

Tato práce zkoumá vliv sociálních determinant na délku života v 16 ekonomikách transformujících se od roku 1995 do roku 2012 pomocí regresní analýzy panelových dat. Výsledky regrese naznačují, že kvalita ovzduší, pokrytí terciárního vzdělávání, výdaje na zdravotní péči mají pozitivní a statistické sdružování s přírůstkem očekávané délky života. Jedná se konkrétně o to, že snížení znečištění ovzduší PM 2,5 (snížení průměrné roční expozice) o 1 mikrogram na metr krychlový je spojeno se ziskem 2,16 měsíce střední délky života při narození. Zvýšení výdajů na zdravotní péči o 100 dolarů na

jednoho obyvatele je spojeno se ziskem 2,4 měsíce očekávané délky života při narození. 10% zvýšení počtu hrubých studijních poměrů v terciárních školách je spojeno se ziskem 3,6 měsíce očekávané délky života. Zatímco zástupná proměnná demokracie (Unified Democracy Pores), ekonomická svoboda a vynaložené výdaje na zdravotní péči nejsou významnými faktory zdravotního stavu.

Klíčová slova

Zdraví, sociální determinanty, očekávaná délka života, přechodné ekonomiky

Keywords

Health, social determinants, life expectancy, transition economies

Range of thesis: 111202 symbols

Declaration of Authorship

1. The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

2. The author hereby declares that all the sources and literature used have been properly cited.

3. The author hereby declares that the thesis has not been used to obtain a different or the same degree.

Prague … 17 May 2018 Fei Song

Acknowledgments

I would like to thank all the people who have helped me to complete this thesis.

I would like to express my very great appreciation to my supervisor PhDr. Lucie Bryndová for her extraordinary support in the thesis process. Lucie recommended a lot of literature and data sources to me. I have a much deeper and more comprehensive understanding of health economics. Under her expert guidance, my analytical ability and critical thinking skills get improved substantially. My quest for knowledge about health economics is greatly satisfied with the help from Lucie.

I am thankful to my friends who supported me with their medical knowledge. I would also like to thank my friends who shared their personal experiences of medical treatment in different countries.

Last but not least, I would like to thank my parents for their support and encouragement throughout my study.

Institute of Economics Studies

Master thesis proposal

Research Field: Health Status and Social determinants of Health in Transition Economies

Research question: What are the significant social factors of life expectancy; How would political, economical and socioeconomic factors affect life expectancy.

Research Plan:

This study will follow the health status in 17 transition economies over the period from 1995 to 2012, and will investigate the impact of social determinants on health to see how these indicators influence the health status.

The social determinants would include political factor, economic factor, socioeconomic factor, environmental factor and health care-related factors.

Further actions will be suggested for the policy makers.

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1. Introduction

1.1 Purpose of thesis

This thesis aims to study the impact of social determinants on life expectancy in transition economies. Transition economies have gone through profound political and socioeconomic restructuring after the collapse of Soviet Union since 1991. Many countries experienced the transition from closed, totalitarian and centrally planned economies towards open, democratic, and market economies. Such transition has the profound effect on the lives of population significantly in many aspects. The economic transition improves the living conditions in many countries. Also, democratic transition gives people more political freedom and more chances to make their voice in the decision-making process.

Since the collapse of Soviet Union, these countries choose different development paths. Some countries took democratic transition while some countries confronted with obstacles towards democracy. After two decades, these countries have different levels of democracy and different levels of economic development. The transition from totalitarian communism to democratic capitalism provides a natural experiment to exam the effect of social determinants on population health. This research aims to develop an explanatory model to account for the factors that contribute to the life expectancy in these transition economies.

1.2 The research question of the study

This study plans to trace how the social determinants affect population health since their transition in 16 transition economies from 1995 to 2012. In this study, population health is measured by life expectancy at birth. The social determinants include the political factor, economic factor, socioeconomic factor, environmental factor and health care-related factors. To be specific, unified democracy score is used to measure democracy as the political factor; economic freedom is used as the economic factor, enrolment ratio for tertiary school is used to measure education level, PM 2.5 is used to measure air pollution as an environmental factor. Regarding health care related factors, the out-of-pocket health expenditure percentage in the total health spending is used to measure the access to health care. And the health expenditure per capita is used to measure the input into medical care for each person.

The 16 transition economies include:

- Baltics: Estonia, Latvia, Lithuania
- Central Europe: Czech Republic, Hungary, Poland, Slovak Republic, Slovenia
- CIS: Russian Federation, Belarus, Moldova, Ukraine,

- Southeast Europe EU members: Bulgaria, Croatia, Romania
- None-European Countries: People's Republic of China

According to the data in WHO, these countries have the similar or close level in many health aspects.

1.3 Current understanding of health

How to define "health"? Here I list two definitions of health.

1. Health is a state of complete physical, mental and social well being and not merely the absence of disease or infirmity (WHO Constitution).

2. The extent to which an individual or a group can realize aspirations and satisfy needs, and to change or cope with the environment. Health is a resource for everyday life, not the objective of living. (Health Promotion: A Discussion Document, Copenhagen: WHO 1984).

In this study, health can be understood as the second definition. Health is the resource for people to realize their aspirations in their life but not merely means the absence of disease. Health is contributed by many factors. People can acquire the resource through various health inputs.

1.4 Motivation

I choose to study social determinants of health for four reasons.

First, I get inspired from the book "The Great Escape: Health, Wealth and the origins of Inequality" by Angus Deaton(2015). There are some description and analysis of former communist countries about the changes of health status. Because of historical reasons, the former communist countries have different development paths with western developed countries. The author reviews the history of health status in the world and analyzes the different trend in some former communist countries. It is quite interesting that the stories can be told only from the plotting graphs. In his analysis, China appears as an outlier among the countries in the world. For example, China spends extremely less money into health care sector but its life expectancy is not extremely low as expected. At the opposite extreme, the United States spends almost the most money on health care sector but its life expectancy is not that long as expected. So I am curious about the reason behind. What's more, compared with western developed countries, China and former communist countries were all strongly influenced by the Soviet Union. To some extent, they have similar experiences and they then

choose their way in the transition period. So I was interested in analyzing these countries together.

Second, I am inspired by the model of health production by Grossman. His model provided a different view on health. Health could be influenced not only by lifestyle or genetic factors but also could be affected by many social factors. To achieve the expected health status, people should be aware of the need for the input for health. They can promote their health by doing more exercise, drinking less or studying more knowledge about health. This is also important for policymakers to improve population health.

Third, my personal experience motivated me to study this topic. I have experienced the health care systems in the United Kingdom and China respectively, so I have seen how physicians work in two countries. Moreover, many patients shared their personal experiences of medical treatment with me. They are from South Korea, Malaysia, the United Kingdom, Portugal, the Philippines and various regions in China. Some patients are over 90 years old and some patients are less than 30 years old. Life has its price in hospitals when people get sick. The costs and treatment vary across countries and regions. So I was motivated to figure out what makes the difference in life expectancy across countries.

1.5 Significance of study

First, there are few studies investigating the social determinants of health in transition economies. The studies that have the similar topic and similar scope as this one usually focus on Central and Eastern European countries or post-communist countries. Compared with previous studies, this research includes China with Central and Eastern European countries. Unlike other transition economies, China had a different historical relationship with the Soviet Union. Although China cannot be defined as the post-communist country, China once was strongly influenced by the Soviet Union, economically and politically. But there is no research comparing China with other countries that were under control by the Soviet Union. So this study plans to analyze the health status in all these countries with their political and economic context.

Second, this research includes more factor from more aspects. The previous studies of similar scope as this one mainly focus on the effect of socioeconomic factors on health status. But this research also includes health care related factors and environmental factors, such as the out-of-pocket health expenditure percentage in the total health spending, health expenditure per capita and air pollution.

1.6 Structure of thesis

Chapter 2 reviews the previous literature about the relationship between health and different social determinants respectively. The social determinants here include democracy, out-of-pocket expenditure, education, health literacy, income per capita, air pollution and health expenditure.

Chapter 3 reviews the background in these transition economies, including political transition, economic transition and health care system transition. This chapter also introduces the top causes of death in these transition economies.

Chapter 4 discusses the variables and methodology of the model. First, meta-analysis compromises the methods for contrasting and combines results from the previous regression analysis. Next part gives a detailed description of the logic diagram behind model estimation in this research. Then it discusses how to measure the independent variables and dependent variables and introduces the expected relationships between health and social determinants.

Chapter 5 gives the general description of data, including data quality, data resources and data availability. This part also discusses the correlation of variables. A detailed visual and descriptive analysis of data about each variable is followed. After some prior tests for the model estimation, the estimated model is shown in the last part of this chapter.

Chapter 6 reports and discusses the regression results of the model and the limitation of model estimation.

Chapter 7 explores the possible explanation for the outliers in this study, including China and Russia.

Chapter 8 provides some recommendations for promoting health in these countries.

The last chapter discusses the limitation of this study and concludes this study.

2. Literature review

2.1 Democracy and health

McKee and Nolte(2004) investigate the relationship between health and democratic political system in transition countries and they find that the countries who embrace democracy most enthusiastically achieved the most significant health improvements. They also conclude that the countries who are lacking democratic structures confront with the barrier to complete the public health policy. If the country lacks the mechanism for expression of popular discontent, the government is reluctant to respond to the health need. From 1989, the communist regime began to collapse and the establishment of the democratic

political system of the new governments varied from each other. The establishment of a fully functioning democracy involves many aspects, including democratic election, free press, independent legal system, freedom of expression, guaranteed rights for opposition parties and good control of corruption. Therefore the establishment of a fully functioning democracy took time to complete in the transition countries. "Several countries that emerged from the Soviet Union, such as Belarus, Turkmenistan, and Uzbekistan, are no closer now to having these conditions than they were in 1991."

McKee and Nolte(2004) also argue that the improvement of health may not only come from democracy. The opening of the economic market may also contribute to health improvement. For example, China, Russia and Ukraine proceed to open market in the absence of democracy. Thus, these countries provide examples to explore whether the health improvements can be achieved by the opening of the economic market in the absence of democracy.

Ruger(2005) explores the relationship between democracy and health in China. He analyzes three major public health events in China, including 1958-1961 famine, the SARS epidemic and the emerging threat of HIV. This research finds that, if the country does not have democratic institutions, especially press freedom and multiparty elections, the problems about public health cannot be reported by the press so that the truth could be hidden by interest groups, such as local officials, health care providers or pharmaceutical companies. If the problem cannot be solved in time, it could endanger public health.

Franco et al. (2004) conduct their study to detect the link between health and democracy by multiple linear regression analysis. In their model, the control variables include the wealth(GNP per capita), level of inequality(GINI Index) and the size of the public sector(total government expenditure). According to their regression results, they find that democracy has an independent positive association with health, after adjusted by control variables.

2.2 Out-of-pocket expenditure and health

The patients who have higher out-of-pocket expense may less likely have access to health care.

Falkingham(2004) examines the extent to which such payments act as barriers to health-care access in Tajikistan and find that private expenditure has significantly different

effects on health access across socioeconomic groups. The enormous out-of-pocket causes worse financial burden for household welfare especially for the poor household.

According to one OECD final report(2016) investigating the relationship between universal health coverage and health outcome, it find a clear negative correlation between out-of-pocket spending as a share of the current health expenditure and life expectancy in OECD and emerging economies, including Brazil, China, Colombia, Costa Rica, India, Indonesia and Russia.

Tambor et al. (2014) explore whether patients can afford to pay for outpatient and hospital services in six Central and Eastern European countries, including Bulgaria, Hungary, Lithuania, Poland, Romania and Ukraine. They find that patient in Bulgaria, Ukraine, Romania and Lithuania, often have to pay informal payments. Moreover, patients in Romania and Ukraine, are most often confronted with difficulties paying for health services. Especially in Ukraine, about 40% of Ukrainian payers need to borrow money or to sell their assets to pay for the hospital payments. They conclude that high out-of-pocket health expenditure mainly affects the patients who have low income.

According to another OECD report, Health at a Glance(2017), it is indicated that the share of out-of-pocket spending in total health spending did not have a significant association with life expectancy gains, mainly because of its tiny reduction over the time between 1995 and 2015 in all 35 OECD countries.

2.3 Education and health

Goldman and Smith (2002) indicate that education may improve self-management (and therefore the efficacy) of medical treatment, particularly for chronic diseases.

Education is considered as an important determinant of health. Education can contribute to the health output through two channels. On the one hand, education becomes a significant factor of individual income level with the transition from planned economy to market economy. In the market economy, labour needs to have a good command of knowledge or skills to find a job. With enough income, labour can pay for the clinic visiting, prescription and further treatment. Thus education can contribute to health output through the channel “income”. On the other hand, compared with uneducated people, educated people are more capable of understanding the disorder mechanism(Evan et al., 2001). Educated people translate medical information and health services into health more effectively. When they have free access to health care(physicians), educated people are more able to collect useful information and then make their rational choice to find a better physician for better treatment.

On the other hand, To measure education level, Evan et al. (2001) used a summary indicator of educational attainment—average years of schooling in the adult population.

Ross and Mirowski (1999) argue that people who are more educated are more likely to find the jobs with the higher wage. When they have more income, they have more choices in life. For example, they can afford to eat healthier food like seafood, vegetables and fruits, but not fatty food that is full of calories but little nutrition, like fried chips, hamburger and other junk food. When they feel depressed, they can also choose other activities like travelling or doing sports at higher costs but not just drinking cheap spirits or smoking cheap cigarettes. What's more, educated people are less likely to take risky occupations that can imperil their safety. They are more likely to take occupations that need their knowledge, analytical ability and skills but not strength. Moreover, when educated people earn a lot of money, they can afford to purchase their apartment or houses in the areas with high level of security. They can afford to make their homes more comfortable, buy more cleaning products and disinfection spray to keep their home clean and reduce the risk of infection via virus or bacteria.

There are many indicators to measure socioeconomic position. Daly et al. (2002) think that among all the indicators, education is the most stable measurement of socioeconomic status. Because usually, people finish their education in school in the twenties, which is early in their adulthood. Thus the relationship between education and health outcome is one way. Education background can influence health status through people's income and knowledge of health care. But when people get old, their health status at cannot change their education background. Therefore, using education as the measurement of socioeconomic status can reduce the risk of reverse causation.

Mall et al. investigate the changes in mortality in four Eastern European countries during the period from 1990 to 2000, including Estonia, Lithuania, Poland and Hungary. The authors compare these four countries to evaluate how the differences in people's socioeconomic can affect health status during the transition period. They find that the association between mortality and education in the two former Soviet republics diverges from the association between mortality and education in the two CEE countries. In the two Central European countries, Poland and Hungary, there is a convergence in all educational groups. No matter which educational group they are, mortality rates decreased or remained same. However, in the two former Soviet republics, Estonia and Lithuania, there is a divergence between the highly educated and the low educated. To be specific, mortality rates of the

highly educated group decreased while mortality rates of the low educated increased. This conclusion also applies in Russian Federation and the Czech Republic.

Susan et al. (2014) conclude that educational attainment is one of the best predictors of U.S. life expectancy. They also find three mechanisms to explain the relationship between education and health. The first important mechanism explains that the relationship between education and health may be explained by personality characteristics(Kern & Friedman, 2008). Their result shows conscientious individuals are more likely to complete advanced education, and also more likely to have good health habits, including the healthy diet and regular exercise. The second important mechanism indicates that higher education stimulates healthier activities. Higher educated people are less likely to smoke, less likely to be obese, less likely to be heavy drinkers, more likely to drive safely, and more likely to use preventive care (Cutler & Lleras-Muney, 2010). But their result does not support the first mechanism (hypothesis).

Muller (2002) conducts his research in the United States to investigate the relationship between education and health status. He finds that whether attending high school has the substantial impact on people's income. People who did not finish their study in high school are less likely to earn the high wage. Through this channel, high school education can be a powerful predictor of mortality among all the U.S. states.

According to the OECD report (2017), Health at a Glance 2017, in OECD countries, when education coverage increases 10%, life expectancy can increase 3.2 months.

2.4 Health literacy and health

As indicated by WHO(2013), health literacy affects health expenditure. If people just have inadequate health literacy, the country may spend more on health care system. For example, Canada spent more than 8 billion US dollars in 2009 for limited health literacy, which accounted for approximately 3% to 5% in the total health care budget in 2009. According to the statistics in the United States National Academy on an Aging Society, the United States spent considerable additional health expenditure on health care with about 73 billion US dollars for limited health literacy in 1998. Until now, there is no available data to do a comparative analysis for the health system in European countries yet. But still, it is expected that weak health literacy can lead to more health care costs in European welfare countries, which provide nearly universal access.

Measurement of health literacy is quite limited. Until now, the data of health literacy are only available in a few countries. As the data availability is quite limited, this research plan to use education as the proxy variable of health literacy. According to the report by European Health Literacy Project Consortium(HLS-EU Consortium, 2012), Education is considerably associated with health literacy. Higher educated individuals tend to have higher scores for the general-HL(Health Literacy) index. The survey of Adult Skills(2016) by the OECD Programme for the International Assessment of Adult Competencies (PIAAC) concludes that highly-educated and highly-skilled individuals are more likely to report better health than the less-educated and less-skilled, even when comparing individuals with similar background characteristics. This survey also indicates that education is associated with health in all countries even when controlling for cognitive ability. Regarding the reason that determines the association between literacy and health, this survey speculates that the relationship between literacy and health may be steeper in market-based for the provision of healthcare services. This maybe because market-based health care services provide more options to individuals but also requires more skills to acquire, process and react to information. Under this speculation, this research may further test the effect of health care system on health by dividing these countries into different groups according to their health care system. Health literacy may have a positive relationship with life expectancy. Although health literacy is roughly measured by the proxy variable education, promoting health literacy can have a positive impact on life expectancy.

2.5 Income per capita and Health

In most previous studies detecting the effect of social determinants on health, income per capita was included in their models. But there are also some different opinions about this.

For example, Evans et al. (2001) did not include income per capita as a variable in their research. They think adding income per capita could make the statistical estimation more complicated because income is highly correlated with health expenditure and education. Moreover, income does not contribute to health status directly. Income acts as a determinant of health through some other factors, such as education, housing, and food intake.

Mondal & Shitan (2013) indicate that individuals who are more educated are more likely to earn more wages. Thus they are more likely to afford better health care service and medical treatment.

2.6 Air pollution and health

Air pollution is a major health concern, linked to respiratory diseases, lung cancer and cardiovascular diseases. More generally, children and the elderly are particularly vulnerable to air pollution. The elderly are more susceptible to air pollution. Rabold & Mitzner (2008) find that the cardiac function can get worse for ageing population when they are exposed to the ambient fine-particulate air pollution for a long term. Pope et al. (2006) suggest that the PM 2.5 can severely threaten the elderly with underlying coronary artery or structural heart disease even for the short time exposure. If the government invest more to clean the air pollution, the expenditure of treatment for respiratory diseases, lung cancer and cardiovascular diseases may be saved. Moreover, better air quality is good for elderly health, which means cleaning air pollution can improve the human capital quality and years. Especially when the ageing problem is becoming the common problem for many countries, how to extend the healthy life years of the elderly population is getting more important.

According to the result from OECD(2017), air pollution was not significantly associated with life expectancy gains while there is clear evidence elsewhere of the adverse effects of air pollution on health (OECD 2016). In the research by James et al. (2017), to study the impact of environmental factors on the life expectancy, they use the share of the population exposed to fine particulates PM2.5 to measure the air pollution. As to the insignificant result, it is principally due to there being rather small decreases in air pollution over time in many OECD countries and because of the lagged effects of air pollution on health.

Chen et al. (2008) review the association between health and air pollution. They measure health in different ways, including the incidence and mortality from cancer, cardiovascular and respiratory diseases, and non-accidental death. According to their regression result, per a ten microg/m3 increase in the long-term exposure to PM2.5 can increase the risk of non-accidental mortality by 6%, controlling age, gender, and geographic region. Long-term exposure to PM 2.5 can increase the risk of cancer. Precisely, when the PM 2.5 increases ten microg/m3, the risk of mortality from lung cancer can go up about 15% to 20%. Similarly, when the PM 2.5 increases ten microg/m3, the risk of death from total cardiovascular mortality can go up about 12% to 14%.

Yu et al. (2013) explore the impact of air pollution on life expectancy in China by a quasi-experimental empirical approach. Their research is based on China's Huai River policy. According to this policy, the residents living in the north part of Huai River can be provided free heating via the provision of coal for boilers in winter, while the residents living in the

south part of Huai river cannot have such heating service. The authors compare the data in north part and south part of Huai River and find that the total suspended particulates (TSPs) air pollution substantially increased. Their regression result indicates that the ambient concentrations of TSPs in the north part of Huai River are about 55% higher than that in the south part of Huai River. Moreover, because of increased incidence of cardiorespiratory mortality, the life expectancy in the north part of Huai River is about five years and six months lower than the south part of Huai River. They also study the effect of TSPs on health in the long term and their result suggests that the long-term exposure to TSPs can have a harmful effect on life expectancy. An additional 100 μg/m3 of TSPs is associated with a reduction in life expectancy at birth of about three years.

In the United States, people also suffered air pollution. Since the 1970s, the government made substantial efforts to reduce air pollution and improve air quality. To explore whether the improvement in air quality has a measurable effect on life expectancy, Arden et al. (2009) investigate the relationship between fine-particulate air pollution and life expectancy in the United States during the 1980s and 1990s. They evaluate the association between reductions in air pollution and changes in life expectancy by regression analysis. In their model estimation, to adjust the influence of other factors, they use socioeconomic, demographic variables and the proxy variable for cigarette smoking as control variables. According to their result, a decrease of 10 μg per cubic meter in the concentration of fine particulate matter was associated with an estimated increase in mean (±SE) life expectancy of 0.61 ± 0.20 year (P=0.004). Their research concludes that life expectancy can be significantly improved if the government can devote to reduce the ambient fine-particulate air pollution.

2.7 Health expenditure and health

Japa et al. (2014) investigate the relationship between health expenditure per capita and life expectancy. The health expenditure is taken as the input of health care system and the life expectancy is used to measure the output of health care system. They collect the relative data in 175 countries in the world from 1995 to 2010 and divide these countries into four different groups according to the income level and geographic location. Their panel regression model does not include other control variables, such as education, lifestyle and income. Their result shows that health expenditure per capita is significant in every group countries but the coefficients of each group are quite different. Compare with developed

countries; developing countries can gain more longevity with the same amount increase in health expenditure per capita.

Wim et al. (2017) research the association between health expenditure and life expectancy at birth again but this time they include some control variables to get a more precise result. In their research, health care expenditure is measured as the percentage of the Gross Domestic Product (GDP) but not health expenditure per capita. Their data is collected from 31 countries in European countries and their study is a cross-sectional analysis. Regarding their control variables, expenditure on social protection and expenditure on education are used. Social welfare includes the coverage related to illness, disability, housing, unemployment and old age. And spending on education of a percentage of the GDP shows how the government allocate their resources to education. This expenditure includes the spending on schools, universities and other educational services. To measure the quality of health care system, they also use the number of curative beds, the number of long-term beds, the number of practising physicians, the number of general practitioners, and the number of nursing and care personnel per 100,000 inhabitants in 2013. These data are only available in Eurostat so if this study area is just in the European area, this study can be more precise. As their regression result indicate, health expenditure has a statistically significant correlation with life expectancy. However, they conclude that the longevity cannot explain by health care expenditure, and the causal link between health care expenditure and life expectancy is absent. The authors suggest that the policy makers should invest more in social protection, which has a more significant impact on longevity. This suggestion is concluded from the developed region so maybe in the developing regions, health care expenditure can have a more substantial effect on life expectancy.

Mihajlo et al. (2017) explores the relationship between the long-term health expenditure and life expectancy trend in Eastern European countries since 1989. In their research, the Eastern European countries are divided into three groups, including EU 2004, CIS and SEE. EU 2004 indicates the EU accession members as of 2004, including Czech Republic, Poland, Slovak, Slovenia, Hungary, Estonia, Latvia, Lithuania. These countries are the ones undergoing socioeconomic transition and their health care system are reformed rapidly with the investment from global financial institutions. CIS group include the Commonwealth of independent states, including Russian Federation, Ukraine, Belarus, Moldova, Georgia, Azerbaijan, Uzbekistan, Tajikistan and Kyrgyzstan. These countries have a slower pace to reform. SEE countries include Romania, Bulgaria, Albania, Serbia and Bosnia. Most of these countries catch up with EU 2004 member states with economic lags.

They collect data from European Health for All Database (HFA-DB) from 1989 to 2012 and they analyze these data using difference-in-difference (DiD) and data envelopment analysis (DEA). The authors use health expenditure per capita to measure health expenditure. They discuss that the increase in health expenditure appears to extend the longevity. SEE and CIS both have most rapid growth in health care expenditure, and similar longevity increase is recorded in both group. In their result, EU 2004 performs best in term of balancing the longevity increase and health expenditure growth. Longevity in SEE countries lags slightly behind with lower health care expenditure.

2.8 Health system efficiency and health

Evans et al. (2001) estimate the relationship between the level of population health and the inputs for health production. Their result shows the countries with the best level of health do not always have efficient health systems. They also find that health performance(efficiency) can be improved with health expenditure per capita(efficiency is positively related to health expenditure per capita), especially in the lower income countries.

3. Background

3.1 Political and economic transition

In the 1990s, the former Soviet Union and Eastern European states saw the political transition from socialism to capitalism and the consequent economic shift from planned economy to market economy.

Review of important timeline

1989, Berlin Wall fell

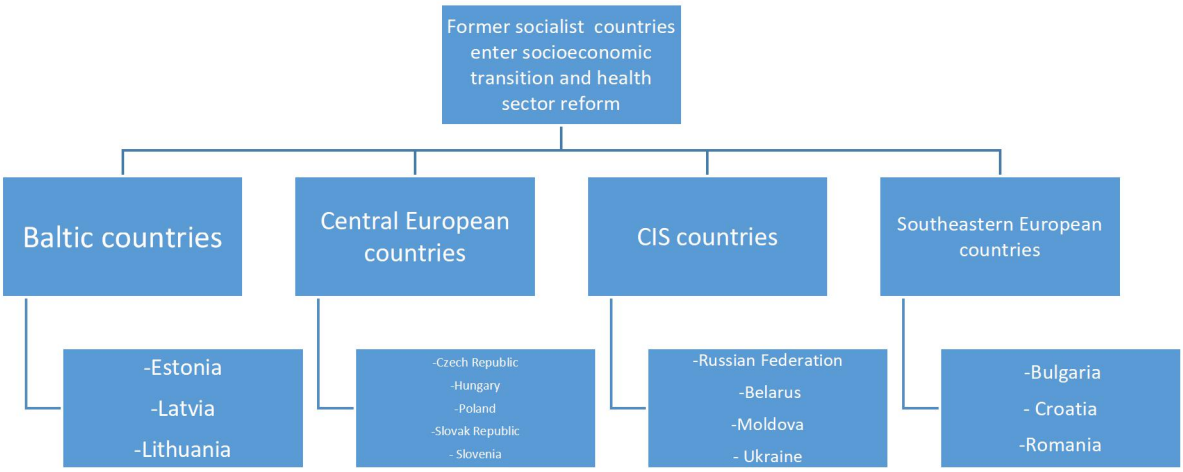
On 3 October 1990, West German and East German were reunified

On 21 December 1991, Commonwealth of Independent States (CIS) was established, in which most former Soviet Republics are included.

On 26 December 1991, Soviet Union was dissolved.

On 1 January 1993, "velvet divorce" of the Czech and Slovak Republics.

Figure 1. Former socialist countries



Since 1989, political changes took place rapidly throughout the quarter-century. After the Soviet Union collapsed, there is a striking divergence in political transition across these post-communist countries. Some countries began to integrate with Western Europe and their partnerships with the EU strengthened through the 1990s. These post-communist countries who joined European Union have made considerable progress in political transition and economic transition. These countries established market economies and democratic institutions. Their democratic institutions are similar to the institutions in Western European countries. Central European countries, including Czech Republic, Poland, Hungary, Slovenia, and Slovak, have a higher level in political and civil rights than other post-communist countries. Central European countries are followed by Baltic countries, including Estonia, Latvia and Lithuania. Southeast Europe EU countries, including Bulgaria, Croatia and Romania, have the similar level in political and civil rights with Baltic countries. While some CIS countries can be classified into the anti-democracy group, such as Moldova, Ukraine, Russia and Belarus. These countries have much lower level than Central European countries, Baltic countries and Southeast Europe EU countries. Parliamentary democracies

with prime ministers as heads of the government are established in some post-communist countries, such as Czech Republic, Hungary, Estonia and Latvia.

Regarding economic transition, there are four main ingredients of the transition process, including liberalization, macroeconomic stabilization, restructuring and privatization, legal and institutional reforms. Liberalization means the government need to give up the planned economy and let the market decide the price. Moreover, the government needs to lower the trade barrier to contact with the price structure of the world's market economies. Macroeconomic stabilization means that the government needs to bring the high inflation under control after liberalization. Restructuring and privatization indicate the process of transferring the ownership from the public into a private hand. In a planned economy, there is no free market to sell and purchase any goods. The consumers do not have the right or chance to choose the goods as their personal preference. Thus the public enterprises or national enterprises do not have the motivation to improve the quality of their products. As a result, the products made by these public enterprises or national enterprises cannot satisfy the market demand after liberalization. Therefore, the public enterprises or national enterprises are needed to be restructured to render them capable of producing goods that can be sold in the free market. The last part is legal and institutional reforms, which means the role of the government in the market economy needs to be redefined. What's more, the rule of law needs to be established and the government needs to make appropriate policies to complement reform.

At the start of the transition, most economists believe that liberalization and macroeconomic stabilisation should proceed quickly. In this way, the market mechanism can be activated to produce the price. Thus transition in most countries proceeds quickly. The price is rapidly liberated from the planned price to the market price. As the planned and artificial price does not reflect the demand and supply in the real market, the price in the planned economy is much lower than the price it should be. As a result, these countries suffered an immediate burst of inflation caused by pent-up demand, which once was strongly suppressed by the planned economy. In the early phase of transition, Central and Eastern European countries suffered averaged 450 percent inflation a year, Baltics suffered 900 percent inflation a year, and inflation in CIS countries was even more over 1000 percent. Until 1998, the annual inflation was lowered to single digits in Central and Eastern European countries and Baltics. In CIS countries, annual inflation was around 30 percent. Along with the burst of inflation, economic output fell in all these three groups. Before it bottomed out, economic output fell by 40 percent on average, which was far severer than expected by

economists. Such severe economic hardship lasted for five years. Economic output in Central and Eastern European countries and Baltics fell dramatically until 1993. For CIS countries, the collapse of gross domestic production stopped further decrease until 1995. But after 1995, CIS countries did not have good economic performance as Central and Eastern European countries and Baltics.

In China, reform process began in the late 1970s after the Culture Revolution. The government opened up and established a market-oriented economic system. Chinese government adopted a gradualist approach to stabilization. In the initial years, although the inflation rate did not rise above thirty percent, China still went through circles of low inflation. In sharp contrast to the experience in other post-communist countries in Europe, economic output remained positive after liberalization and stabilization programs. As the dominance of economy in China was agriculture, the new agriculture policies were adopted and this enormously stimulated productivity in agriculture. The growth in agriculture considerably contributed to the positive output after the economic transition.

3.2 Transition of health insurance system

For Central and Eastern European countries, including Estonia, Latvia, Lithuania, Czech Republic, Hungary, Poland, Slovak Republic and Slovenia, they went through the transition from Semashko system to social health insurance system.

Introduction of the Semashko system

According to the description from Sheiman (2013), Semashko system is a centralized health care system. In the first decade of Former Soviet Union, the Semashko system brought advantages in public health. In some ways, this is one of the first countries to achieve something close to universal coverage of basic health care service. This system provided an acceptable level of health care at that time, which is needed to treat some common disease and ensure comprehensive health care coverage for the public. The Semashko model provided a multi-tiered system of health care. Corresponding to the severity of the disease, there are five levels provide different health care, including district, central rayon, municipal, oblast and federal hospitals. A sound referral system connected these five levels of health care. Among these five levels of health care, district physician plays the most important role in the whole system. Because they are responsible for providing medical care of the population in his or her working area and they are also required to coordinate with upper levels of medical care so that they can integrate some medical services for their patients. From the economic perspective, the Semashko system is efficient and cost-saving. This

system provided universal coverage and made health care service free of charge to everyone.

This system works well until the 1970s. In the 1970s, the new medical technologies became available and better health care service began to be demanded by the public. From the 1970s, the health system began to emphasize the specialization in outpatient care. Thus the role of district physicians becomes less critical. District physicians do not have a responsibility to care the people who registered in their working area. As a result, the patients lose confidence in district physicians and they try to figure out a way to find a competent physician by themselves. So when patients want to get medical treatment, they tend to skip over district physicians and visit specialist directly, which substantially increases the demand for the specialist.

The mechanism of Semashko system is centrally planned. To be brief, the fund source is the general taxation from the population. The health care structure is tiered and hierarchical. Although it is said that, during that period, the number of hospital beds and the number of physicians are high, providers have low incentives to treat patients. Moreover, some scholars criticized that the number of hospital beds and the number of physicians are not the indicator of the effectiveness of the health care system. What's more, patients do not have many choices of providers.

After the Soviet Union collapsed, the health care system began to be reformed. The government has three strategies for reform. First, the health care system should be decentralized and privatized. Second, more money should be invested in health care sector. Third, the capacities are planned to be reduced. The power is given to the lower level: from national level to the regional level. Privatization is proceeded, especially for the dentists, pharmacies and ambulatory physicians. Physical chambers and health insurance companies are delegated. However, in several countries, the physicians are too influential so that the public health is ignored when the privatization is pushed.

The health care system in Estonia, Czech Republic, Hungary, Slovak Republic and Slovenia transformed from Semashko system to Bismarck system from 1991 to 1993. The health care system in Poland, Bulgaria, Lithuania and Romania transformed from Semashko system to Bismarck system latter, from 1998 to 1999. In Latvia, the health care system is still funded by the general taxation.

3.3 Top causes of death

According to the data from World Life Expectancy, the top 20 causes of death vary across these countries but the top three causes are common for most transition economies, including stroke, coronary heart disease, lung cancer. Except for these three top reasons, other causes of death are different across countries. In Slovenia where life expectancy is the highest among all these countries, the other top causes include colon-rectum cancers, influenza and pneumonia, lung disease, falls, breast cancer, liver disease and suicide. The Czech Republic has the second highest life expectancy among these countries. In the Czech Republic, the other top reasons include lung disease, colon-rectum cancers, diabetes mellitus, influenza and pneumonia, Alzheimers or Dementia, other injuries and pancreas cancer. Life expectancy in Estonia ranks as the third best. Other top causes of death in Estonia include hypertension, colon-rectum cancers, kidney disease, stomach cancer, prostate cancer, breast cancer and lung disease. In China, the other causes of death include lung disease, liver cancer, Alzheimer's, stomach cancer, road traffic accidents, hypertension, and influenza and pneumonia. In Russian Federation, the other top causes of death include inflammatory/heart, influenza and pneumonia, HIV/AIDS, breast cancer, colon-rectum cancers, pancreas cancer and suicide. Stroke, heart disease, hypertension are the disease of the circulatory system. Overall, circulatory disease and cancer are the most common cause of death in these countries.

Alcohol is also a common cause of death in transition countries. Except for China, Czech Republic, Slovakia, Romania and Bulgaria, other countries rank top 30 in the world. The age-adjusted death rate of alcohol in Russian Federation and Estonia is more than 10. The age-adjusted death rate of alcohol in other CIS countries and Baltics is more than between 3 to 10. China has the lowest age-adjusted death rate of alcohol among all the transition countries studied in this research.

Regarding all cancers, the age-adjusted death rate of all cancers in transition countries rank top in the world. Belarus, Ukraine, and Moldova are the exceptions. Other countries rank top 45 in the world. These countries have a high age-adjusted death rate of all cancers. Coronary heart disease is also a big challenge for most transition countries. Except for Poland and the Czech Republic, other countries rank top 43 in the world. Drug use is also a challenge for these countries, especially for CIS countries and Baltics. Ukraine, Russian Federation, Belarus and Estonia rank highest as top 4 in the world. Lung cancer is a common problem in these countries, except Ukraine, Belarus and Moldova. Parkinson’s disease is mainly the problem in the countries with long life expectancy. So for Central European countries, they

are struggling with Parkinson's disease. Stomach cancer is common in CIS countries, China and Baltics. Concerning stroke, Russia ranks high as 8 and China lists as 33. Central European countries are much better than CIS countries and Southeast EU countries. Suicide is also a common problem in CIS countries and Baltic countries. In CIS countries and Baltic countries, there are also many people died of violence. For CIS countries, HIV is a challenge for them. They rank behind African countries. Compare with other countries, and leukemia is a health problem especially for Baltics. Surprisingly, diabetes is not the big problem in these countries.

4. Variables and methodology

4.1 Meta-analysis

Safaei (2011) traces the population health in seven Central and Eastern European countries from 1990 to 2009. The seven Central and Eastern European countries went through political and economic restructuring after the Soviet Union collapsed, including Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia, and Slovenia. The political and socioeconomic transition have a strong influence on population health. As the data on lifestyle-related factors, such tobacco and alcohol consumption, is not available consistently, lifestyle-related factors are not included in the panel data model. Because of data unavailability, his model only uses real GDP per capita to measure the quality of material life, trade openness to measure the economic integration to the global economy, and democracy scores to measure the quality of political services. Mortality rates and life expectancy both for male and female are used as the independent variables in the model. Both fixed effects and random effects are applied in this panel regression model. According to the regression result, higher GDP per capita and a higher level of trade openness contribute are associated with higher life expectancy at birth. But democracy score does not have a statistically significant association with life expectancy at birth.

Bobak et al. (2007) also exam the association between health status and socioeconomic factors in 13 Countries from Central and Eastern Europe and the former Soviet Union because these countries have gone through profound economic and political transformation. They used the data from the New Europe Barometer surveys in 13 countries in 2004. The 13 countries include Estonia, Latvia, Lithuania, Czech Republic, Hungary, Poland, Slovak Republic, Slovenia, Russian Federation, Belarus, Ukraine, Bulgaria and

Romania. They use self-rated health status as the independent variable, which is reported by "very good, good, average, bad and very bad". Their research includes both individual socioeconomic factors and societal characteristics. Societal factors include GDP, Corruption Perception Index, GINI Index and homicide rate. Their cross-sectional regression result shows that GDP, corruption and homicide rate are associated with health status although their significance depends on whether individual socioeconomic factors are added to the model as control variables. Income inequality shows no association with health status.

OECD (2017) investigates the factors driving the life expectancy gains by a cross-county analysis in 35 OECD countries from between 1995 to 2015. This research includes four different types of variables: health system variables, life style factors, income and other socioeconomic factors and environmental variables.

Regarding health system variables, there are two variables included: a. Health care spending, measured by health expenditure per capita; b. financial protection, measured by the share of out-of-pocket expenditures in total health expenditure. Lifestyle factors include alcohol consumption in litres per capita, prevalence of daily smokers and health diet, measured by the share of the population consuming vegetables every day. In the vector of socioeconomic factors, there are four variables, including the net of total health expenditure, income measured by GDP per capita (constant PPP), education measured by the ratio of the population who have higher education background than primary school, and unemployment rate. Environment quality is measured by air pollution, the share of the population exposed to fine particulates PM 2.5.

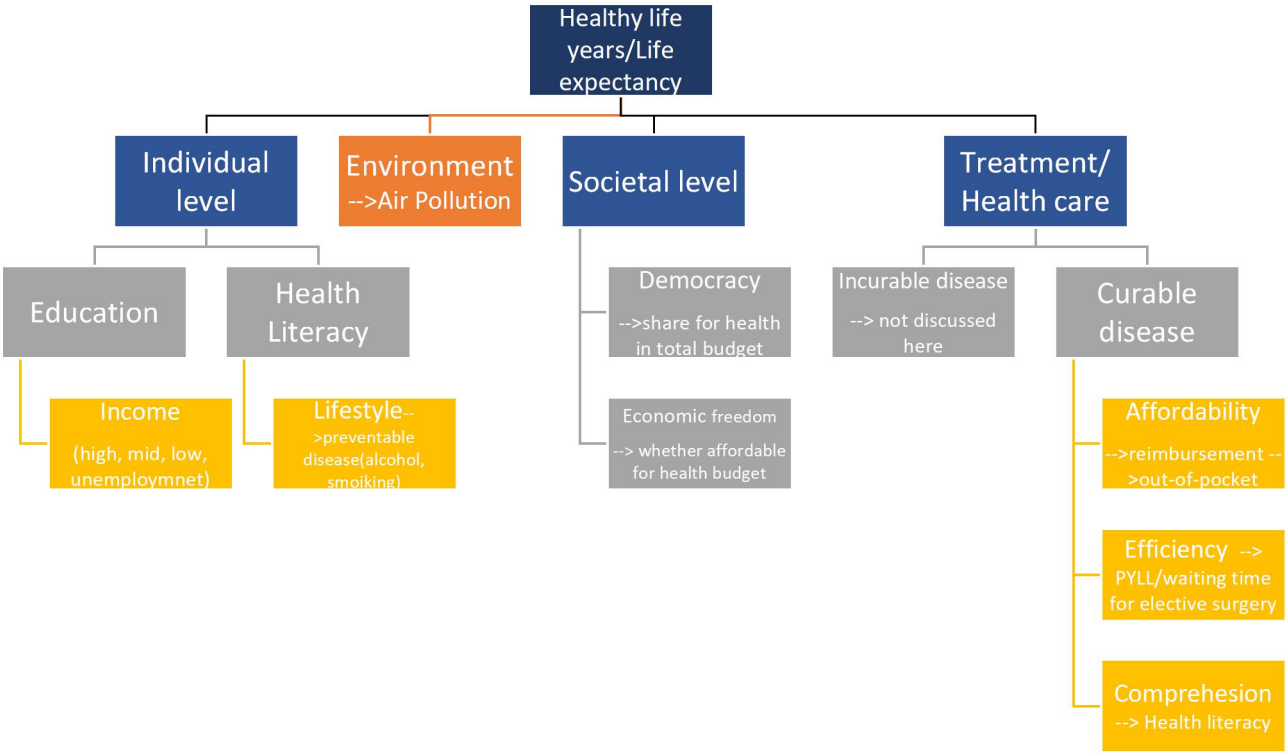
The result shows that health spending per capita, health lifestyle, income and education have a positive and significant relationship with life expectancy at birth. Life expectancy can increase 3.5 months if health expenditure per capita increases 10%. If people can reduce their smoking and alcohol amount by 10%, their life expectancy can increase 1.6 months and 1.0 month separately. What's more, socioeconomic factors also have a significant effect on health status. Life expectancy can increase 2.2 months if income can grow 10%. Compared with income, education background has a more significant influence on life expectancy. If the share of the population primary coverage can increase 10%, life expectancy would increase 3.2 months. Overall, health spending and education in primary school have a more significant effect on health than lifestyle factors. The out-of-pocket expense in total health and healthy diet has no significant relationship with life expectancy. This may be explained by the very limited reduction in the two variables. This is also one of the disadvantages of panel data regression analysis.

Table 1. Summary of meta-analysis

Independent Variables	Dependent Variables	Result	Source
Mortality rates, Life expectancy at birth, life expectancy at 45, life expectancy at 65, Suicide rates.	GDP per capita, Trade openness, Democracy scores.	Positive with LE, Positive with LE, Insignificant with LE.	Safaei, 2011
Self-rated health (very good, good, average, bad and very bad.)	GDP (PPP), Corruption index, GINI index, Homicide rate,	Positive, Negative, Not associated, Negative.	Bobak et al., 2007
Life expectancy at birth	Health spending per capita, Out-of-pocket spending, Smoking, Alcohol, Healthy diet, Income, Education, Unemployment, Air pollution.	Increase 3.5 months, Insignificant, Decrease 1.6 months, Decrease 1.0 month, Insignificant, Increase 2.2 months, Increase 3.2 months, Insignificant, Insignificant.	OECD, 2017

4.2 Explanation of health determinants(logic diagram)

Figure 2. The logic diagram of study



This diagram shows how the author of this research understands the health determinants from different levels or aspects. The health status can be measured as life expectancy or healthy life years. There are many factors can influence life expectancy or healthy life years. This research will focus on the factors of individual level, the factors of the societal level, factors related to medical treatment and environmental factors. The logic behind this is the timeline. To be specific, how people can fall ill, whether the patients can afford to visit physicians, and whether the physicians can heal the disease.

First, people can fall ill actively or passively. For example, people choose their life style actively. They can decide whether to smoke every day and how many cigarettes they smoke. They can also decide whether to drink alcohol and how much to drink. They can decide whether to take high-fat food or take more vegetables and fruits. People make their decisions based on their knowledge about healthy life styles. If they are informed that it is harmful to their health if they smoke a lot or drink a lot, they may reduce the frequencies or the amount of smoking or drinking. When the level of health literacy increases, people are more likely to be informed the unhealthy life styles, or people are more capable of self-study the healthy life styles. Therefore, health literacy is a quite important factor of health. However, the data of health literacy is only available in some western European countries. But as described in the literature review, education has a considerable association with health literacy. Therefore, health literacy is replaced by education variable to measure how the perception of health affect their choice of lifestyles.

People can also fall ill passively, which means the external factors can affect health. For example, environmental factors can make people exposed in some dangerous environment, including water pollution, air pollution and even nuclear radiation. In this research, air pollution is investigated to see how it can influence health status.

The genetic disease is not included in this research because people are unable to change it until now. People can be warned by their physicians to prevent some familial genetic disorders. However, in such situations, preventative measures can not 100% ensure they won't get familial genetic disorders.

Second, whether the patients can afford the medical treatment depends on how much they should pay for the treatment. The medical treatment process can include the clinical diagnosis, prescription, surgeries and inpatient health care. In the social health insurance system, the out-of-pocket health expenditure highly depends on how much the government can pay for the population. And this depends on whether the government has enough fiscal revenue to pay for health care. Even if the government has enough fiscal revenue to pay for health care, the government may be unwilling to cover all expenditure. For the post-communist countries, they transferred from planned economy to market economy. Market economy liberalizes the productivity and increases efficiency. With the growth of gross domestic productivity, the fiscal revenue gets increased, which means the government is more capable of paying the health care expenditure. Thus, in this research, Economic Freedom is used to measure the economic development level of each country during these years.

Democracy is also a significant determinant of health for the transition economies. After the Soviet Union collapsed, most of these post-communist countries transferred from centralized political system to democratic political system. From the speculation, the country with more public participation in politics may be willing to spend more budget on health care. This is because health care is related to people' well-being. If ordinary people can have their voice in the government in deciding how much of the fiscal budget can be allocated to the health sector, the out-of-pocket health expenditure is less likely to be the barrier for people to access medical care. Unfortunately, the Unified Democracy Scores cannot reflect such detailed information. But it can still be a good indicator for the general impression of some country's politics.

Concerning health care, Feldstein (2005) emphasizes that there are two approaches to analyze the medical care. The first way is to consider the medical care as the output. This means medical care is the output of health care industry and is produced by the actors in health care industry. The actors include physicians, hospitals, health insurance companies and other providers. To evaluate the efficiency of health care service, medical care should be viewed as output. The second way is to consider the medical care as the input. This means the medical care is one of the contributions to the public health. There are many different types of input to the public health, such as income, education, life styles and health care. If the quality of medical care can get improved, health status can get better, which means life expectancy can get extended by providing better medical care. Therefore, to explore how to allocate resources to improve health status, medical care should be viewed as the input.

In this research, the medical care is considered as the input to health status, like the other inputs mentioned above, including education, Economic Freedom, air quality and democratic political system. It has been discussed before how people can fall ill, whether the patients can afford to pay the expenditure for medical treatment. So when people fall sick and they need to see a doctor, they need to think about whether they can afford the expected health expenditure. If the out-of-pocket health expenditure cannot get in the way of medical care, for example, the patients are wealthy enough to cover all expected spending, or, fortunately, their government can reimburse the majority of the expense for medical treatment, then they will go to see the doctor and get the medical treatment. Then next, what will decide whether the patient can be cured or not? After all the laboratory results and other exams come out, the patient may be diagnosed with some disease. If the disease is incurable, the medical treatment cannot cure the patient, which means the role of health care is hardly to impose significant positive influence on his or her life years. If fortunately, the disease is curable, for

this patient, medical care plays a crucial role in his or her life. During diagnosis and treatment, the patients who have a better level of health literacy or who have a higher educational background, are more capable of understanding the mechanism of the disease. If the disease is complex, they are more capable of collecting more information from other channels to make their treatment decision, such as consulting with other physicians to confirm or consulting with other patients to learn some experiences for curing the disease.

The efficiency of health care system is also a quite important factor for the patients, especially for the patients who are suffering from the acute disease. For example, in Canada where people have national health insurance, sometimes patients with the non-emergent disease need to wait for, on average, 12.7 weeks for an MRI, which eliminates the chances for screening test method(Feldstein, 2005). There are some candidates for measuring the efficiency of health care system, such as potential years of life lost(more focus on preventable) and waiting time for selected surgery. Unfortunately, these two candidates both only available in 2014 or 2015 and only available in some western European countries. Thus, the efficiency of health care system won't be discussed in this research.

Overall, education, air pollution, democracy, economic freedom and out-of-pocket health expenditure(% of total expenditure on health) are most likely to be the independent variables in this research.

4.3 Candidates of the dependent variable

Candidate 1: Healthy Life Years

The Healthy Life Years (HLY) indicator (also called disability-free life expectancy) measures the number of remaining years that a person of a certain age is still supposed to live without disability. Healthy Life Years is a reliable indicator to monitor health as a productivity/economic factor. Healthy Life Years introduces the concept of quality of life. It is used to distinguish between years of life free of any activity limitation and years experienced with at least one activity limitation. The emphasis is not exclusively on the length of life, as is the case for life expectancy, but also on the quality of life. HLY is a functional health status measure that is increasingly used to complement the conventional life expectancy measures. Unfortunately, the data of HLY of European countries is only available from 2004 and HLY at the birth of all the countries from WHO is only available in 2000 and 2015. Therefore, HLY cannot be the dependent variable in this research because of data

unavailability. But HLY will be compared with LE to see the gap between these two indicators.

Candidate 2: Life Expectancy

Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.

Statistical Concept and Methodology: Life expectancy at birth used here is the average number of years a newborn is expected to live if mortality patterns at the time of its birth remain constant in the future. It reflects the overall mortality level of a population, and summarizes the mortality pattern that prevails across all age groups in a given year. It is calculated in a period life table which provides a snapshot of a population's mortality pattern at a given time. It, therefore, does not reflect the mortality pattern that a person experiences during his/her life, which can be calculated in a cohort life table. High mortality in young age groups significantly lowers the life expectancy at birth. But if a person survives his/her childhood of high mortality, he/she may live much longer. For example, in a population with a life expectancy at birth of 50, there may be few people dying at age 50. The life expectancy at birth may be low due to the high childhood mortality so that once a person survives his/her childhood, he/she may live much longer than 50 years.

Life expectancy of all countries is available from 1960 to 2015.

In this research, life expectancy at birth will be focused. Considering the health expenditure or health resources are mainly concentrated on the population aged 65 and above, life expectancy at 65 should have been paid more attention when discussing the effect of health resources or health expenditure. Unfortunately, the data of life expectancy at 65 is only available in OECD countries. Thus because the data is unavailable for all transition countries, life expectancy at 65 is not investigated in this research.

4.4 Independent Variables and data

4.4.1 How to measure democracy

Franco et al. (2004) use the freedom rating generated by the Freedom House for each country by data. As indicated in the survey methodology by Freedom House, there are two parts compose the freedom rating scores. The first one measures political right including three aspects: Electoral Process, Political Pluralism and Participation, and Functioning of Government. The second one measure civil liberties, which are grouped into four

subcategories: Freedom of Expression and Belief, Associational and Organizational Rights, Rule of Law, and Personal Autonomy and Individual Rights.

Borisova(2011) uses Polity IV democratization index from the Centre for Systemic Peace (CSP) to measure democracy level. This index is a combined Polity Score, which is computed by subtracting the AUTOC score from the DEMOC score; the resulting unified polity scale ranges from +10 (strongly democratic) to -10 (strongly autocratic). This index is derived from coding of the competitiveness of political participation, the regulation of participation, the openness and competitiveness of executive recruitment, and constraints on the chief executive.

Safaei(2012) obtain the democracy score from the Unified Democracy Scores (UDS) project' website. These scores are estimated by Pemstein et al. (2010) from other existing democracy scores which are claimed to be at least as reliable as other scores. The Unified Democracy Scores (UDS)1 covers the period 1946-2012. It incorporates recent updates to three of the ten original measures—Freedom House (2014), Polity IV (Marshall et al. 2012), and VanHanen (2012). Although he finds no significant role for democracy in life expectancy, it may be due to the openness variable sharing the effect of democracy in his regression model.

Democracy can also be measured by Voice and Accountability from Worldwide Governance Indicators. This index reflexes the extent to which a country's citizens can participate in selecting their government, freedom of expression, freedom of association, and a free media, ranging from -2.5 (weak) to 2.5 (strong) governance performance.

Considering the availability and quality of data, Unified Democracy Scores is used to measure democracy in this research. Unified Democracy Scores has a crucial advantage over other scores, such as Freedom House or Polity IV democracy rankings. Unified Democracy Scores are cardinal continuous scores rather than discrete ordinal ranks and, therefore, more suitable for regression analysis.

4.4.2 How to measure education

Previous empirical studies have selected different measurements for education, including

[1] Data can be checked in this website: www.unified-democracy-scores.org/uds.html

-educational attainment(percentage of the adult population, 25 to 64 years old, that has completed a certain level of education defined by ISCED system), which is used by Thornton (2002) and Self and Grabowski (2003)

-school expectancy(defined as the expected years of schooling under current conditions calculated through enrolment rates),

-average number of schooling, which is used by Or et al. (2005)

- primary school coverage, which is used by OECD, Health at a Glance(2017).

- expected years of schooling is used by Novak et al. (2014) to measure education level.

-the share of white-collar workers in the total workforce as a proxy for social and educational status, which is used by Or (2000) to solve the difficulty to get the time serious on the average number of schooling.

For all these measurements, each one has its drawbacks. In the OECD working paper (Joumard et al., 2008), the educational attainment level(share of the population that has attained at least upper secondary education) is considered as the best proxy for the contribution of human capital to health.

In the research on Brazil health by Mondal & Shitan (2013), they take the mean schooling years as the measurement of education and their regression result shows that higher level of education has a positive impact on life expectancy. However, the data of mean schooling years is not available in all required years, so it is not an appropriate candidate variable in this research.

Bayati et al. (2013) use Education index of HDI (Human Development Index) as a measure of education level since the data regarding other education criteria (e.g. adult literacy and mean years of school) were missing,

Novak et al. (2014) find that there is a statistically high significant relationship (higher the life expectancy at birth, the higher the expected years of schooling and vice versa).

Enrollment in different educational levels can use to investigate which level has the most potent effect on health status.

4.5 Expected relationships

Based on the literature review and economic theories about the relationship between dependent variable and independent variables, my hypothesis about the expected relationships is listed below. In the final model, GDP per capita is not included for two

reasons: first, considering the collinearity between GDP per capita and Health Expenditure per capita, one of these two indicators have to be dropped; second, the R Square of the model with Health Expenditure per capita is approximately 0.10 more than that of the model with GDP per capita.

Table 2. Expected relationships

Categories of Explanatory Variables	Proxy Variables	Hypothesis	Expected relationship	Speculation
Economic factor	Economic Freedom	Significant	Positive	A higher level of economic freedom can stimulate economic growth, which can cover the health care cost with more income.
Political factor	Unified Democracy Scores (UDS)	Significant	Positive	The country with a better level of democracy is more likely to satisfy public health need.
Educational factor	Tertiary gross enrolment	Significant	Positive	People who have tertiary education background are more likely to have a better understanding of disorder mechanism, more capable of being responsible for their health(better self-control) and more likely to have more income to pay treatment fee.
Environmental Factor	PM 2.5	Significant	Negative	Higher PM 2.5 means worse air quality, which makes people suffer more damage from air pollution, such as respiratory disease.
Individual access to health care (financial barriers)	Out-of-pocket health expenditure	Significant	Negative	The higher percentage of out-of-pocket health expenditure may discourage people from accessing curative care.

National input into health care	Health expenditure per capita	Significant	Positive	More input into health care can promote the public health status. This variable more functions like the control variable in the model and it can be replaced by GDP per capita.

4.6 Deal with missing observations

In the dataset, there are 256 missing observations of PM2.5 air pollution, mean annual exposure (micrograms per cubic meter) and about 15 missing observations of Gross enrolment ratio in tertiary level. PM 2.5 air pollution has many missing observations because the data is recorded every five years before 2010. After 2010, PM 2.5 air pollution is recorded every year. The 4-years gap in every five years from 1995 to 2010 is one of the limitations of this study, which means the changes during every five years can be missed. As the environmental indicator only has this variable as the proxy variable, it is less likely to drop this variable. To reduce the bias caused by the missing observations, a linear interpolation over time is created to fill the gap. The value of the linear interpolation is created as the time trend line(Meijering, 2002). The value is calculated by finding the closest values in the dataset and the total gap is divided by the number of years. The other 15 observations of Tertiary enrollment ratio are filled as the same method.

4.7 Advantages and disadvantages of panel data regression analysis

In this empirical study, panel data is used in the quantitative research because panel data model has its advantages. First, panel data model can control some unobserved variables that vary across countries but not over time, such as culture-related variables, medical care quality or efficiency that are caused by the health care system, and also life style related variables. Life styles involved the habit of smoking, the habit of drinking alcohol and diet habit. These habits cannot easily get changed within a short time. As Cífková et al. (2010) indicate, from 1985 to 2007, there is no change in smoking habit for females in the Czech Republic while there is a significant decrease for males. Second, panel data model can control

some variables that change over time but not across countries, such as international agreements about disease prevention and worldwide promotion of new medicine or treatment. Third, panel data can show more information by providing more observations. However, it also has some limitations. If the independent variables do not show variation over time within the countries, it could lead to insignificant result after regression.

5. Data and Model

5.1 General description of data

To compare the differences and similarities among these countries, they are divided into five groups according to the group division of post-communist European countries in the literature by IMF(2014), including

- Baltics: Estonia, Latvia, Lithuania
- Central Europe: Czech Republic, Hungary, Poland, Slovak Republic, Slovenia
- CIS: Russian Federation, Belarus, Moldova, Ukraine,
- Southeast Europe EU members: Bulgaria, Croatia, Romania
- None-European Countries: People's Republic of China

5.1.1 Summary of model information

Table 3. Summary of data

Data sources	**WB,**
Number of observations	16 transition economies
	- Baltics: Estonia, Latvia, Lithuania -Central Europe: Czech Republic, Hungary, Poland, Slovak Republic, Slovenia - CIS: Russian Federation, Belarus, Moldova, Ukraine, - Southeast Europe EU members: Bulgaria, Croatia, Romania - None-European Countries: People's Republic of China
Period	1995-2012 (over 17 years)
Dependent variable	Life Expectancy at birth
Independent variables	
External Independent variables (Socioeconomic factors)	*Economic factors:* GDP per capita, Economic Freedom *Political factors:*

	Democracy (Proxy: Unified Democracy Scores (UDS) *Socioeconomic factors:* Education (Proxy: Tertiary gross enrollment) *Environmental factors:* Air Pollution (Proxy: PM 2.5)
Internal Independent variables (Health care related factors)	Health expenditure per capita; Out-of-pocket health expenditure (% of total expenditure on health)

5.1.2 Description of Variables and Sources of Data

Table 4. Description of variables and sources of data

Variables	Source	Description
Life expectancy at birth, total (years)	World Bank. [2]	"Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life." (WB)
PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	Brauer, M. et al. 2016, for the Global Burden of Disease Study 2016.	"Population-weighted exposure to ambient PM2.5 pollution is defined as the average level of exposure of a nation's population to concentrations of suspended particles measuring less than 2.5 microns in aerodynamic diameter, which are capable of penetrating deep into the respiratory tract and causing severe health damage." (Brauer, et al., 2016)
Unified Democracy Scores (UDS)	Unified Democracy Scores (UDS) project's website	"Unified Democracy Scores (UDS) scores are estimated by Pemstein et al. (2010) from other existing democracy scores. UDS provides an approach to simultaneously leverage the measurement efforts of numerous scholars. UDS is at least as reliable as the most reliable component measure, such as Freedom House, Polity and PACL."

[2] The data of Life expectancy at birth from World Bank is derived from male and female life expectancy at birth from sources such as (1) United Nations Population Division. World Population Prospects, (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) United Nations Statistical Division. Population and Vital Statistics Report (various years), (5) U.S. Census Bureau: International Database, and (6) Secretariat of the Pacific Community: Statistics and Demography Programme.

Economic Freedom	The Heritage Foundation	"Economic freedom Index is measured in four aspects: 1) Rule of Law (property rights, government integrity, judicial effectiveness); 2) Government Size (government spending, tax burden, fiscal health); 3)Regulatory Efficiency (business freedom, labor freedom, monetary freedom); 4) Open Markets (trade freedom, investment freedom, financial freedom)"
Gross enrolment ratio, tertiary, both sexes (%)	United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics.	"Gross enrolment ratio for tertiary school is calculated by dividing the number of students enrolled in tertiary education regardless of age by the population of the age group which officially corresponds to tertiary education, and multiplying by 100." (UNESCO)
Out-of-pocket health expenditure (% of total expenditure on health)	World Health Organization Global Health Expenditure database	"Out of pocket expenditure is any direct outlay by households, including gratuities and in-kind payments, to health practitioners and suppliers of pharmaceuticals, therapeutic appliances, and other goods and services whose primary intent is to contribute to the restoration or enhancement of the health status of individuals or population groups. It is a part of private health expenditure. In general, low-income economies have a higher share of private health expenditure than do middle- and high-income countries, and out-of-pocket expenditure (direct payments by households to providers) makes up the largest proportion of private expenditures." (WHO)
Health expenditure per capita, PPP (constant 2011 international $)	World Health Organization Global Health Expenditure	"Total health expenditure is the sum of public and private health expenditures as a ratio of total population. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include the provision of water and sanitation. Data are in international dollars converted using 2011 purchasing power parity (PPP) rates." (WHO)

5.1.3 Data availability

Table 5. Data availability

Data	***Availability***
Life Expectancy	all have from 1960 to 2015
GDP per capita(PPP)	All available during 1990-2016 except Baltic, Moldova,

	Croatia, Slovenia unavailable from 1990-1994, Hungary 1991, Slovak 1991-1992[from 1995-2015]
Voice and Accountability	Almost all available from 1996 to 2016
Corruption index	Only from 1995 to 2016
Polity IV democratisation index	Almost all years to 2016
Unified Democracy Scores (UDS)	All available during 1946-2012 , continuous but insignificant previous model
Out-of-pocket health expenditure (% of total expenditure on health)	All available from 1995-2014
Gross enrolment ratio, secondary, both sexes (%)	All available from 1995-2014
Gross enrolment ratio, tertiary, both sexes (%)	All available from the 1970s until 2015
Health expenditure, public (% of GDP)	All available from 1995 to 2014. China is the worst (1-2-3), others 3-5, best 6
PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	1990, 1995, 2000, 2005, 2010-2015

5.2 Visual and descriptive analysis of data

5.2.1 General description of data

Figure 3. Summary of data

```
. sum
```

Variable	Obs	Mean	Std. Dev.	Min	Max
state	0				
idc	288	8.5	4.617796	1	16
year	288	2003.5	5.197158	1995	2012
LE	288	72.01363	3.184705	64.69073	80.12439
PM1	288	22.10435	9.64604	7.12166	58.22193
USD	288	.6550636	.6795772	-1.211585	1.55962
EcoFree	288	58.17951	9.127179	33	78
GDP	288	15306.7	7192.041	2268.499	31137.78
Primary	277	101.0284	5.72103	84.81215	124.666
Secondary	265	92.64019	9.608467	51.20373	110.7638
Tertiary	285	50.41444	20.21594	4.46107	90.43713
OOP_TOT	288	26.53562	12.24331	8.321381	59.96668
OOP_PRI	288	86.77795	14.79273	39.17667	100.0009
HEX_PC	288	826.5047	558.3934	64.34054	2616.847
PRI_HEX	288	2.031911	1.044726	.4758539	6.460319
PUB_HEX	288	4.53786	1.178072	1.621284	7.064964
TOT_HEX	288	6.578088	1.420592	3.214669	12.48972

Through this summary of data, it can be known that the mean value of life expectancy across these countries (China is included) from 1995 to 2012 is about 72 years old. The minimum value of life expectancy is approximately 65 years old and the maximum value of life expectancy is approximately 80 years old. The mean value of PM 2.5(proxy variable of air pollution) is 22 micrograms per cubic meter. Across this sample, the gap of PM 2.5 between the best and the worst is wide. The best value of PM 2.5 is about 7 micrograms per cubic meter while the worst value of PM 2.5 is more than 58 micrograms per cubic meter. In terms of proxy variable of democracy, Unified Score of Democracy, the mean value of Unified Score of Democracy is less than 1 unit, the worst is -1.2 units while the highest is about 1.55 units. The gap of Economic freedom between the highest (78) and the lowest(9.12) is not narrow. The average level of Economic Freedom is 58. The large standard deviation also exists in the gross enrollment ratio of tertiary, the highest ratio (90.43%) is almost 20 times more than the lowest ratio(4.43%). Health expenditure per capita varies most significantly. The gap between the least(64 dollars per capita) and the most(2616 dollars per capita) is about 558 times. In terms of out-of-pocket health expenditure, the luckiest patient only need to pay about 8.32% of the total health expenditure while the most unfortunate patients need to pay about 60% of the total health expenditure.

Figure 4. Correlation matrix of variables

```
.  correlate LE USD EcoFree Tertiary OOP_TOT HEX_PC
(obs=285)
```

	LE	USD	EcoFree	Tertiary	OOP_TOT	HEX_PC
LE	1.0000					
USD	0.4322	1.0000				
EcoFree	0.4837	0.6302	1.0000			
Tertiary	0.1579	0.2620	0.2856	1.0000		
OOP_TOT	-0.3804	-0.4271	-0.1522	-0.0866	1.0000	
HEX_PC	0.7512	0.5271	0.5035	0.5386	-0.4513	1.0000

According to the outcome of correlation of variables, Unified Democracy Scores, Economic Freedom, out-of-pocket health expenditure (% of total health expenditure) and health expenditure per capita are highly correlated with life expectancy at birth while enrolment ratio of tertiary education has a lower correlation with life expectancy at birth. This indicates that Unified Democracy Scores, Economic Freedom, out-of-pocket health expenditure (% of total health expenditure) and health expenditure per capita maybe the good explanatory variables of life expectancy. In the first column, Unified Democracy Scores,

Economic Freedom, enrolment ratio of tertiary education and health expenditure per capita all have positive covariances with life expectancy at birth, which indicates explained variable and explanatory variables move in the same direction. The countries who have higher Unified Democracy Scores, a higher level of Economic Freedom, higher enrolment ratio of tertiary education and more health expenditure per capita, are more likely to have a longer life expectancy. Out-of-pocket health expenditure (% of total health expenditure) has a negative covariance with the dependent variable, which means if out-of-pocket health expenditure (% of total health expenditure) increases, the life expectancy may get worse.

The covariances between independent variables are lower than the covariances between each independent variables and dependent variable. But covariance between Economic Freedom and Unified Democracy Scores is relatively higher than others. So the multicollinearity still needs to be further noticed and tested.

5.2.2 Analysis of line plots

Figure 5. Line Plots of PM 2.5

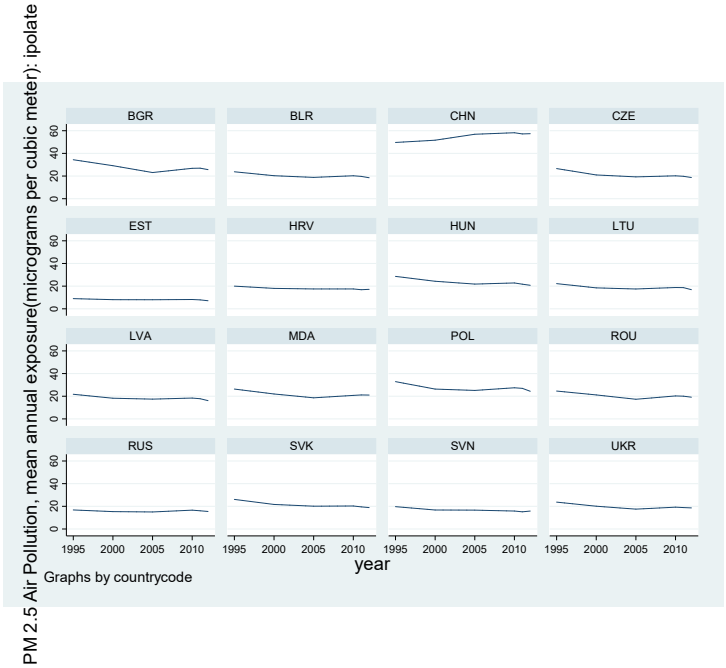


Figure 6. Box plots of PM 2.5

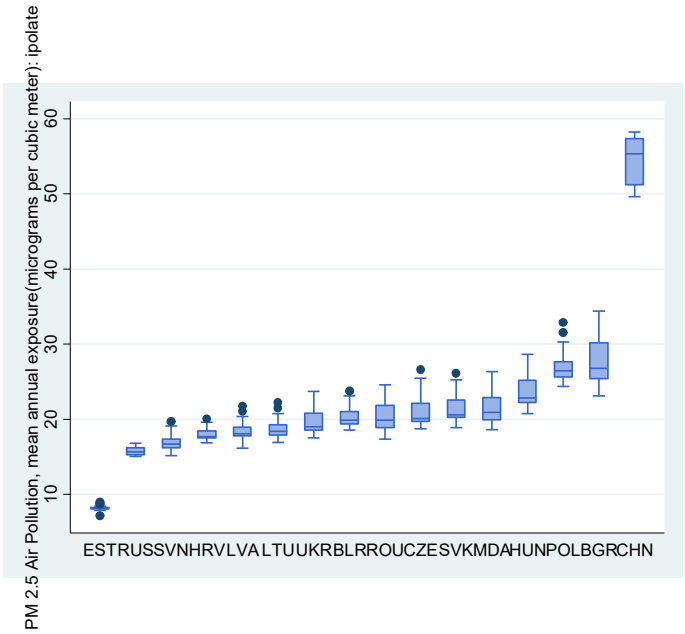
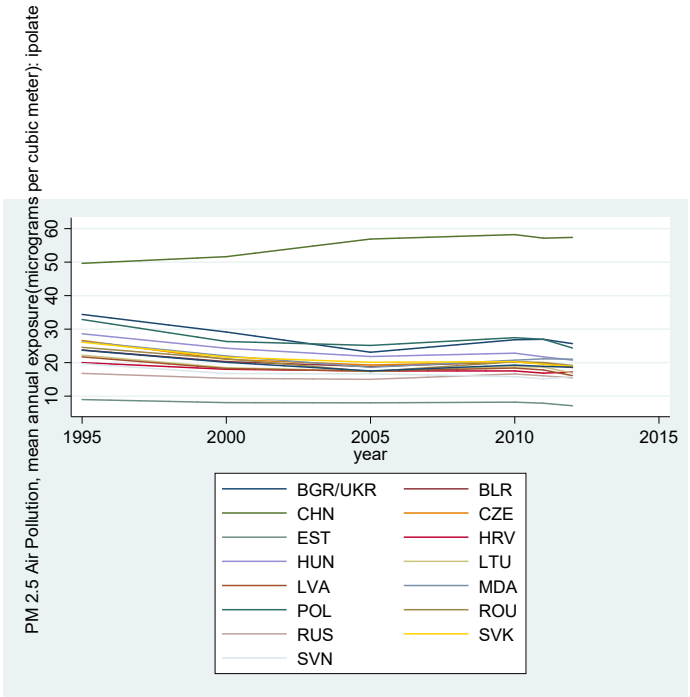


Figure 7. Overlaid line plots of PM 2.5



This figure plots PM 2.5 versus time for each country separately. PM 2.5 in most of these countries have been decreasing gradually from 1995 to 2012, although the reduction is slight. Almost PM 2.5 in all the states are lower than 30 micrograms per cubic meter except China. It is evident that air pollution in China is most serious, which keeps increasing from 50 micrograms per cubic meter to almost 60 micrograms per cubic meter. Compared with other countries, China has almost double air pollution. Among these countries, Estonia has the least air pollution level.

Figure 8. Line plots of Economic Freedom

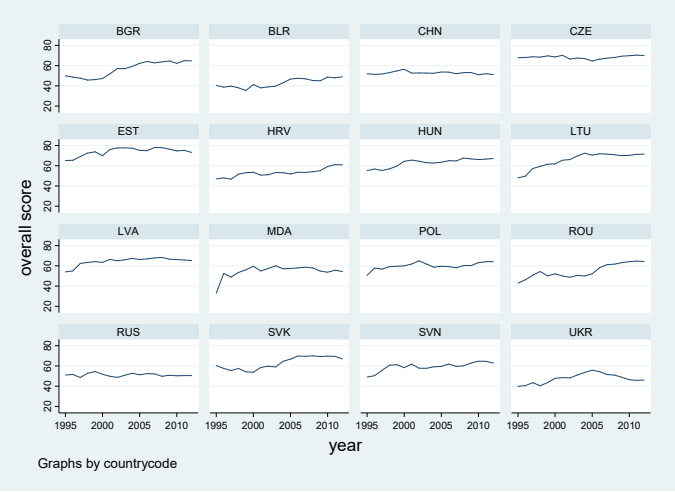


Figure 9. Overlaid line plots of Economic Freedom

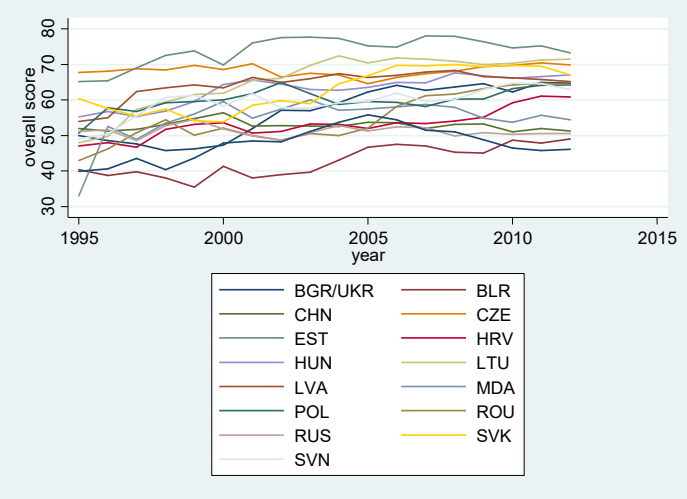
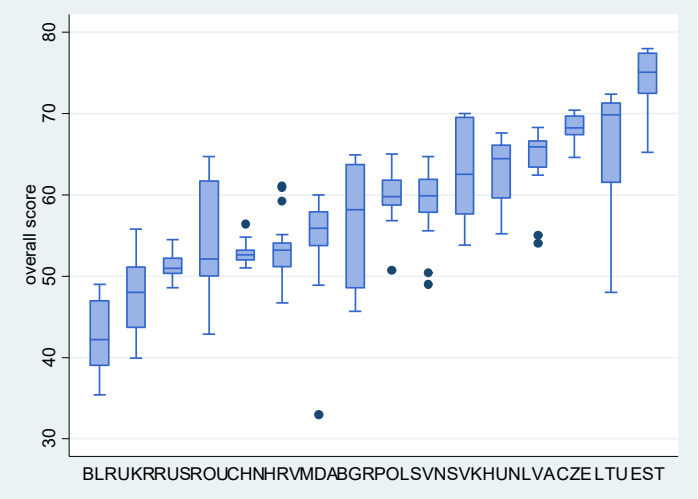


Figure 10. Box plots of Economic Freedom



Through the figure, Economic Freedom of all the countries fluctuates substantially from 1995 to 2012. Estonia has the highest score in Economic Freedom among these countries. CIS countries have the lowest score in Economic Freedom, at least including Belarus, Russian Federation and Ukraine. Baltics countries have a higher score in Economic Freedom than other countries.

Figure 11. Line plots of Health expenditure per capita

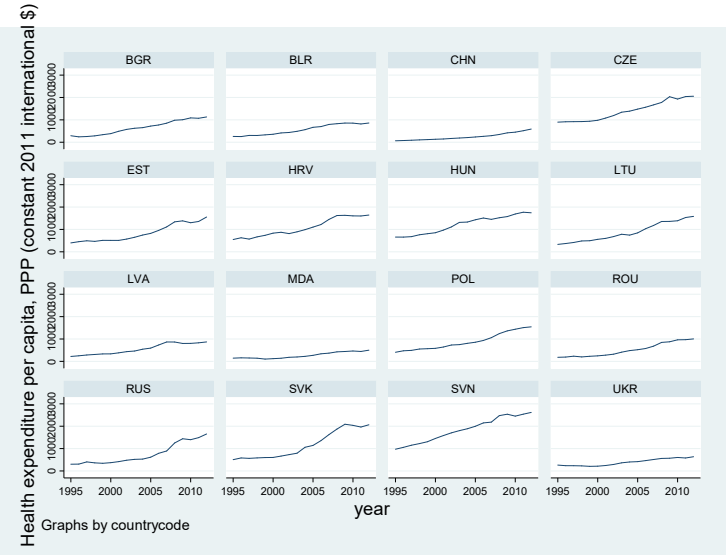


Figure 12. Overlaid line plots of health expenditure per capita

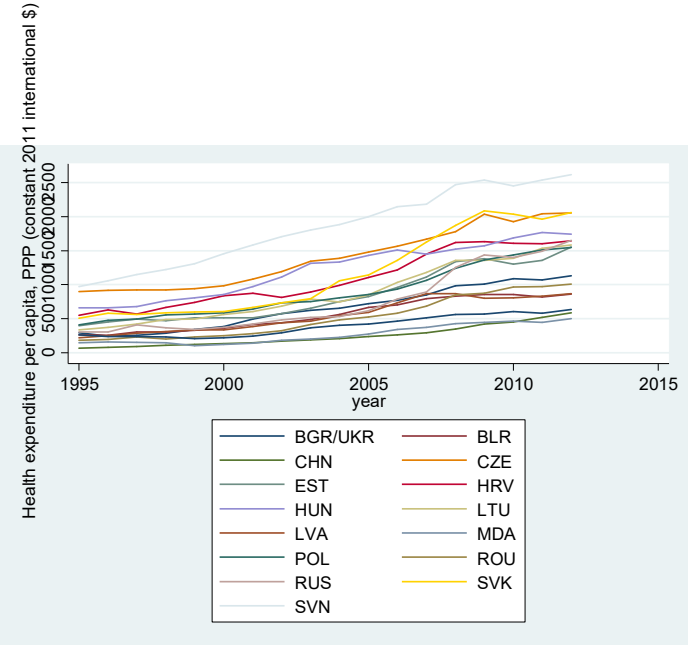
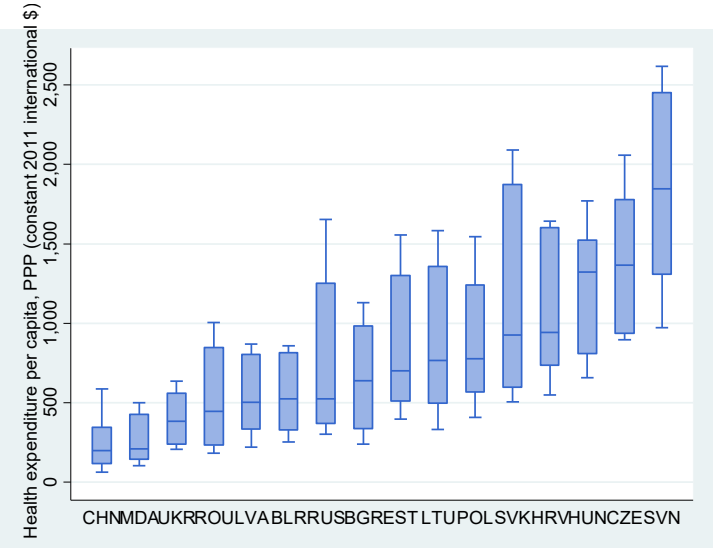


Figure 13. Box plots of health expenditure per capita



Combining these three graphs, it can be observed that the health expenditure per capita in all the countries are increasing substantially over time. Even in the countries with lowest health expenditure per capita, it still keeps the increasing trend over these years. Health expenditure per capita in half countries has increased more than 1000 dollars after 17 years. Most of these countries have a double-triple time of health expenditure per capita after 17 years. Slovenia has the highest health expenditure per capita, which even is still more than 500 dollars than that of the second highest country (Czech Republic). China, Moldova and Ukraine spend least on health expenditure for each person. In 2012, health expenditure per capita in China was only one-third of that in Russian Federation, one-fourth of that in the Czech Republic, and one-fifth of that in Slovenia. It seems that central European countries spend more money than others on health care. Baltics is the second group.

Figure 14. Line plots of out-of-pocket health expenditure

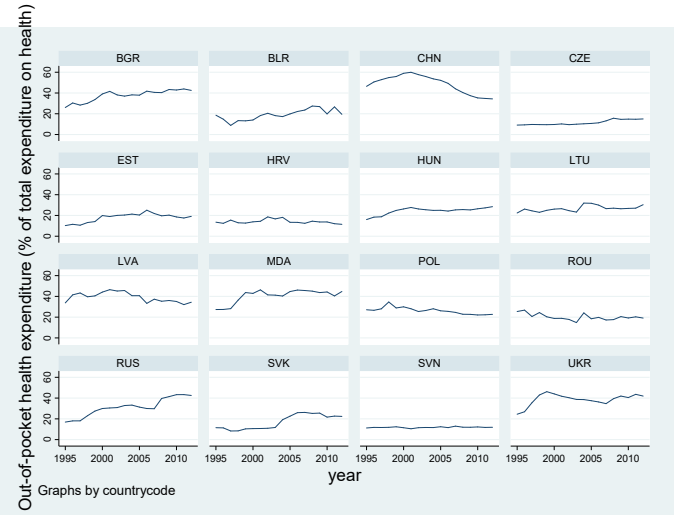


Figure 15. Overlaid line plots of out-of-pocket health expenditure

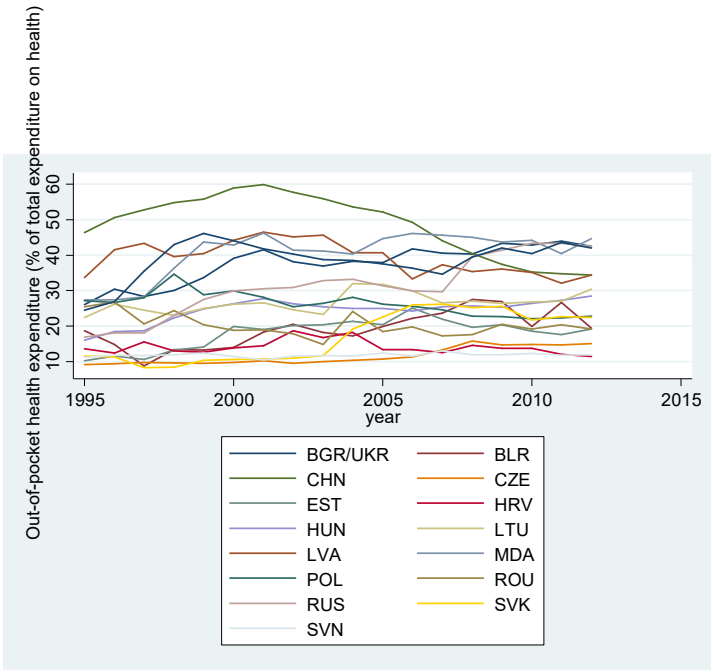
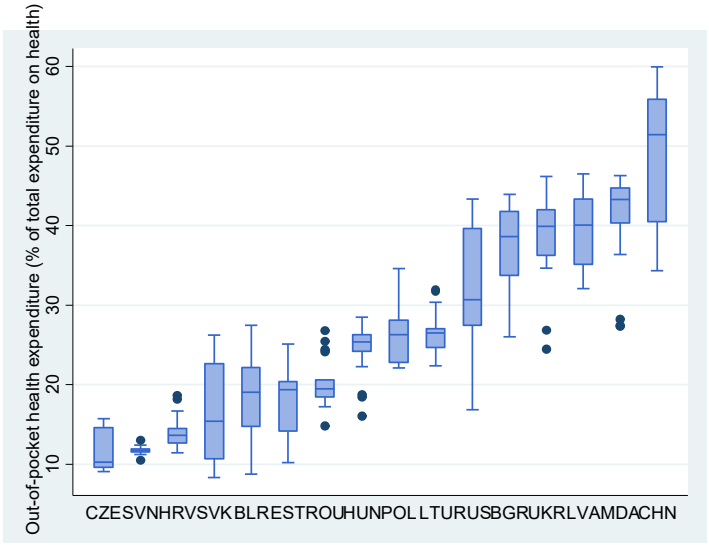


Figure 16. Box plots of out-of-pocket health expenditure



As the graph shows, the out-of-pocket health expenditure (% of total expenditure on health) across these countries fluctuate over time. The graph indicates there is no similar trend among these countries. Patients in China need to pay more money from their own pockets than patients in other countries. Although after 2000, the out-of-pocket health expenditure in China has decreased from 60% to less than 40%, its percentage is still in the top level with Moldova, Bulgaria, Ukraine and Russian Federation. It seems that the average level of CIS countries is second to China. Generally, Central European countries have the lowest out-of-pocket health expenditure percentage of total health expenditure. Patients in

Czech, Slovenia and Croatia only need to pay less than 10% of the overall health expenditure from their own pockets.

Figure 17. Summary of line plots of enrolment ratio for primary school, secondary school and tertiary school

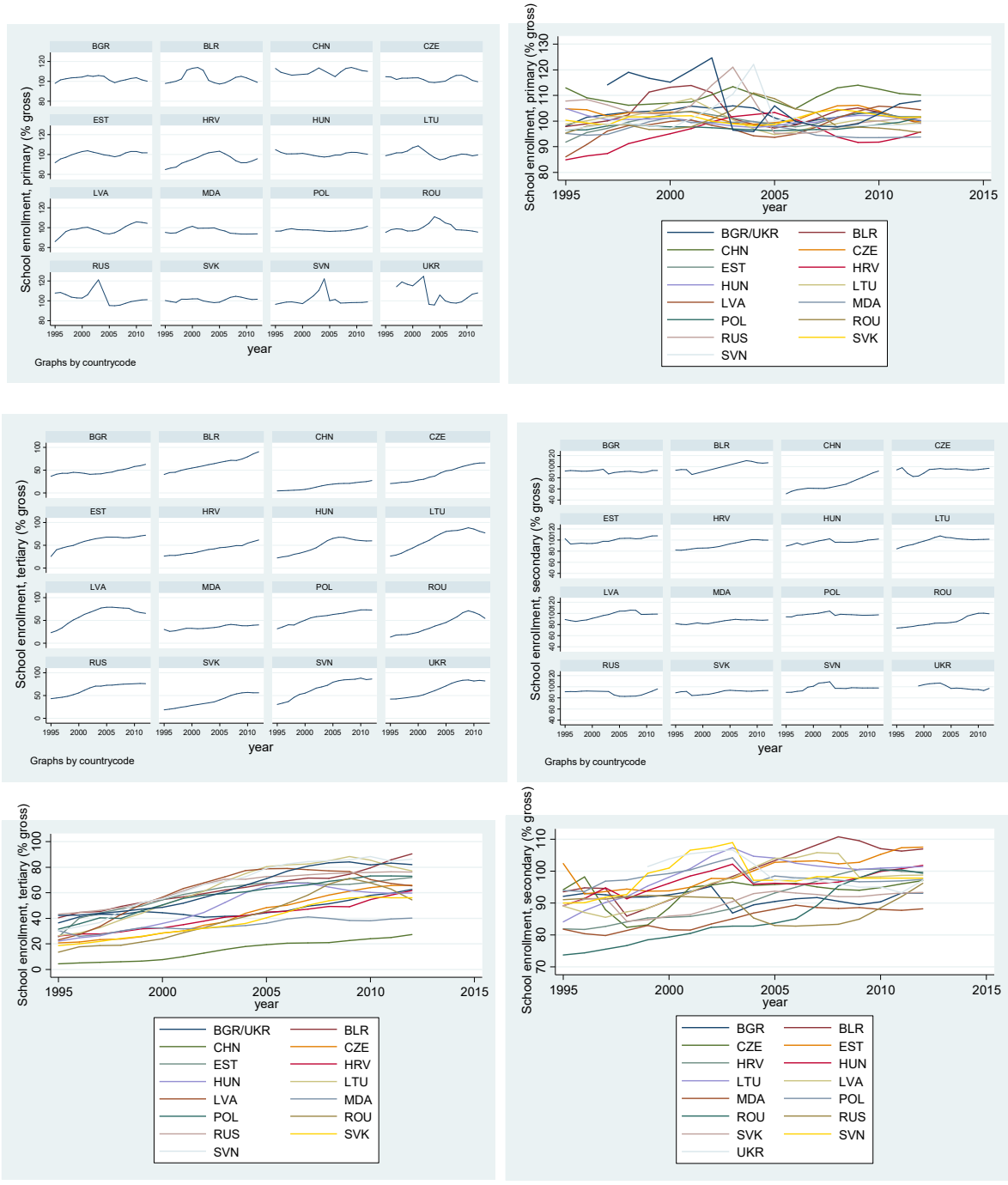
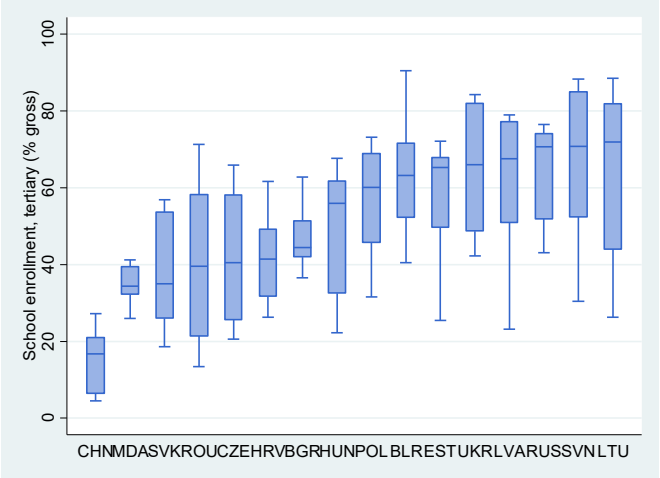


Figure 18. Box plots of enrolment ratio of tertiary school



In the original plan, there are three candidates for education proxy variables, including gross enrolment ratio for primary school, secondary school and tertiary school. However, the gross enrolment ratio for primary school and secondary school both fluctuate considerably over time. Only tertiary has a rising trend over these years. Therefore, gross enrolment ratio for tertiary school is used to be the proxy variable for education. It is worth mentioning that China only does well in primary education. Considering its population, there is still a long way to go to promote higher level education.

As the graph shows, gross enrolment ratio for tertiary school in all countries is rising considerably over time. In 1995, the average level of gross enrolment ratio for tertiary school in most countries was about 25%, which means nearly one out of four people got enrolled in tertiary education among the population whose age corresponds to tertiary education. After 17 years, the average level of gross enrolment ratio for tertiary school in most countries increases to approximately 65%, which means nearly three out of five people got enrolled in tertiary education among the population whose age corresponds to tertiary education. In some countries, the ratio turns down after 2008, such as Hungary, Latvia, Romania and Lithuania. These countries suffered a lot from the financial crisis. For example, Latvia cut its expenditure in the education system to manage the crisis, which could have a negative influence on education. Among these countries, China is an exception. There is a huge gap between China and other countries. Although gross enrolment ratio for tertiary school in China kept rising over time, the ratio in China in 2012 catches up with other countries in 1995.

Figure 19. Line plots of Unified Democracy Scores

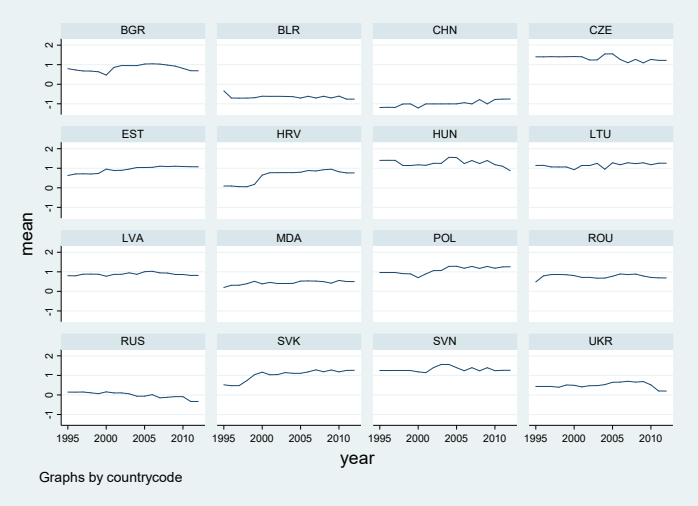


Figure 20. Overlaid line plots of Unified Democracy Scores

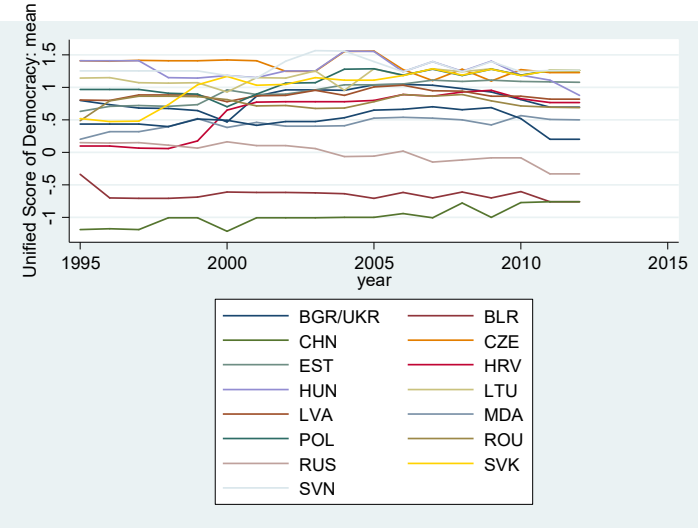
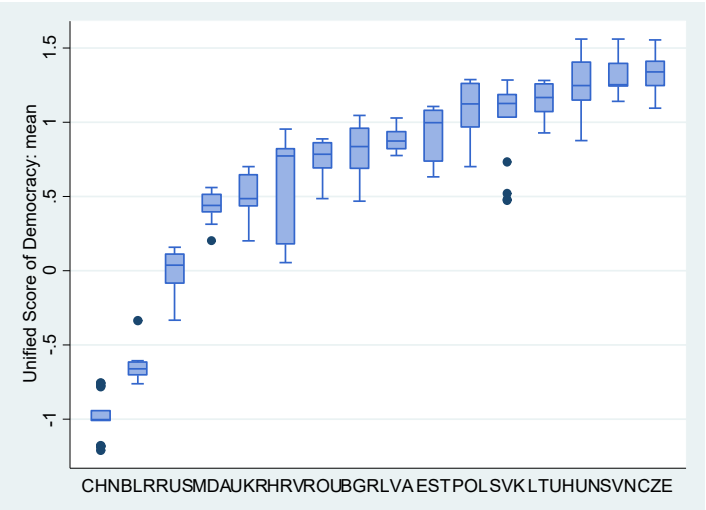


Figure 21. Box plots of Unified Democracy Scores



According to the graphs, the trend of Unified Democracy Scores (UDS) in most countries kept flat. Except for China and CIS countries, other countries have high Unified Democracy Scores, ranging from 0.5 to 1.5 scores. Among these countries, Central European countries and Baltics countries have the highest level of democracy, followed by Southeast Europe EU members. Compared with CIS countries, China has lower Unified Democracy Scores, which is also the worst score among all these countries. Unified Democracy Scores in Russian Federation was decreasing over time.

Figure 22. Line plots of life expectancy

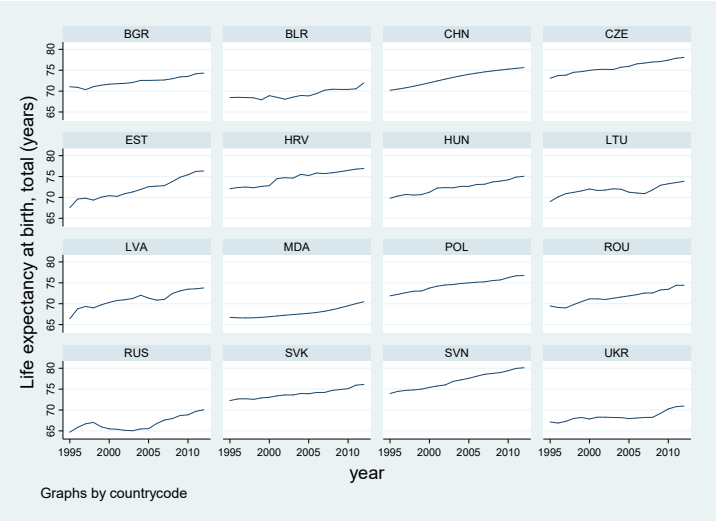


Figure 23. Overlaid line plots of life expectancy

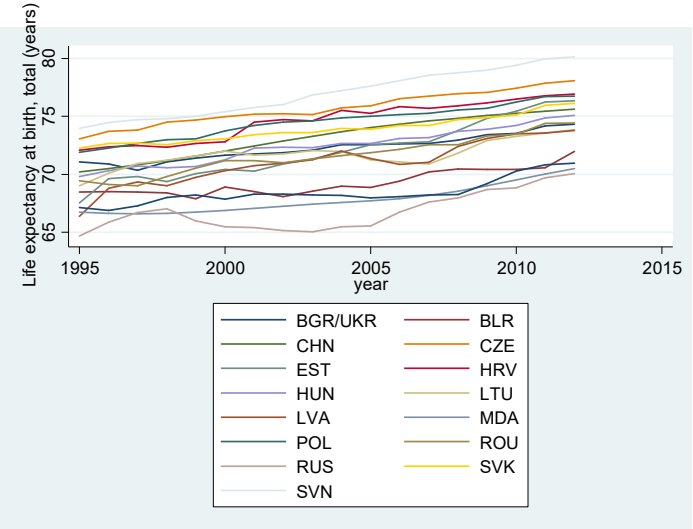
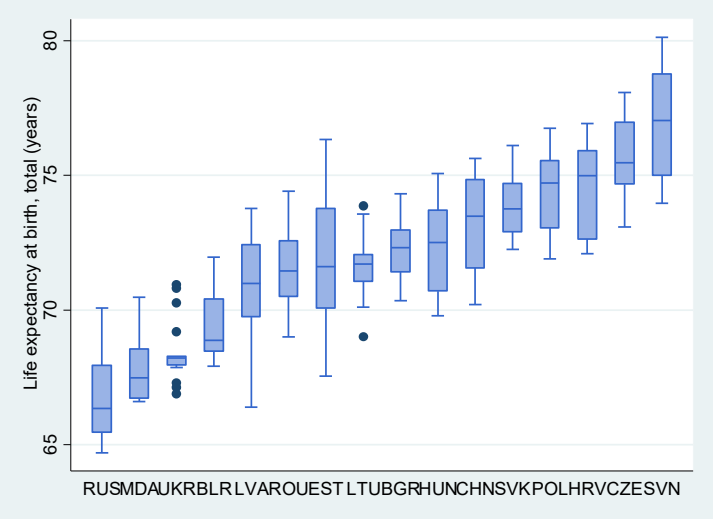


Figure 24. Box plots of life expectancy

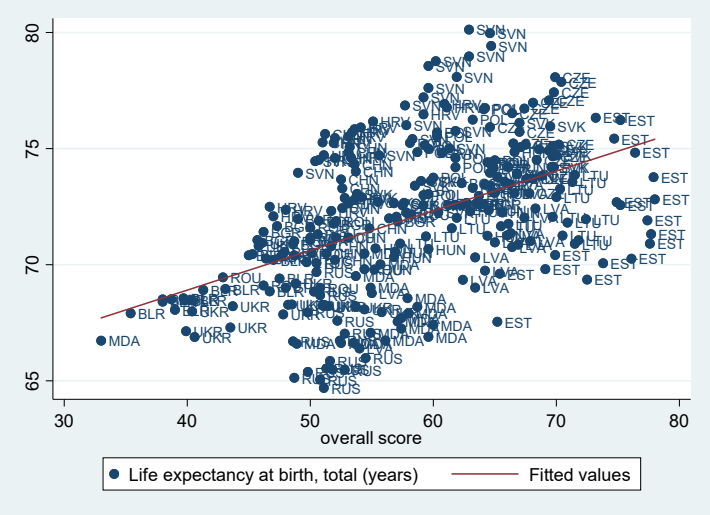


Life expectancy is the dependent variable in this research. As the graphs indicate, life expectancy in almost all the countries has increased in nearly five years over 17 years. Among these countries, Russian Federation is an exception as its life expectancy in Russian Federation turns down from 1998 and continue to decrease until 2005. The decrease in life expectancy from 1998 coincided with the economic crisis in 1998. In this economic crisis, Russian Federation experienced currency devaluation and increased poverty(Men et al., 2003).

Central European countries have higher life expectancy than other countries, from 1995(average life expectancy is above 70 years old) to 2012 (average life expectancy is above 75 years old). This advantage stays such high level throughout the whole period. Among Central European countries, Czech Republic has the higher life expectancy over other countries throughout 17 years, increasing from 74 years old to 80 years old. CIS countries, including Belarus, Ukraine, Moldova and Russian Federation (ranking from best to worst), have the shortest life expectancy, ranging from 64 to 72. Surprisingly, although China is the exception in the analysis of other variables, life expectancy in China has a close level and trend to life expectancy in Hungary, from 70 in 1995 to 75 in 2012. Although China has negative Unified Democracy Scores, highest out-of-pocket health expenditure percentage of total health expenditure, lowest gross enrolment ratio for tertiary school, lowest health expenditure per capita, its life expectancy is not the worst among all these countries. The reason why China is unique in this way will be explored in chapter 6.

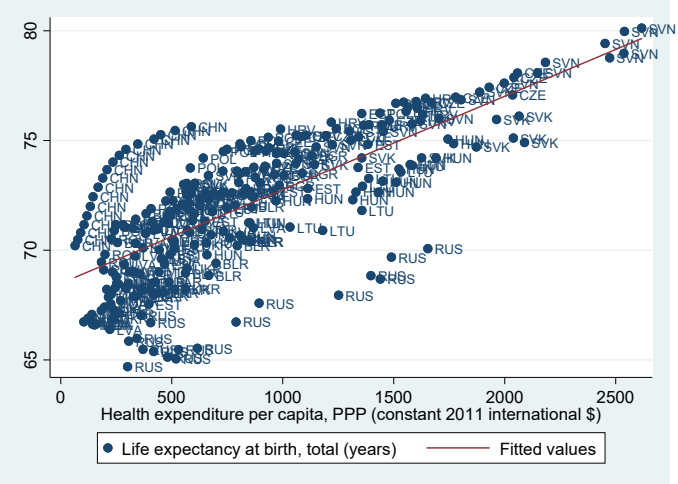
5.2.3 Analysis of scatter graph

Figure 25. Scatter plot between Economic Freedom and life expectancy



First, I regress life expectancy against Economic Freedom. The coefficient is 0.1809 and intercept is 61.34, both are significant with the significant level of 0.05. Adjusted R-square is 0.2673, which means about 26.73% of the variation in life expectancy can be explained by the variation in Economic Freedom. The scatterplot indicates a linear relationship between life expectancy against Economic Freedom.

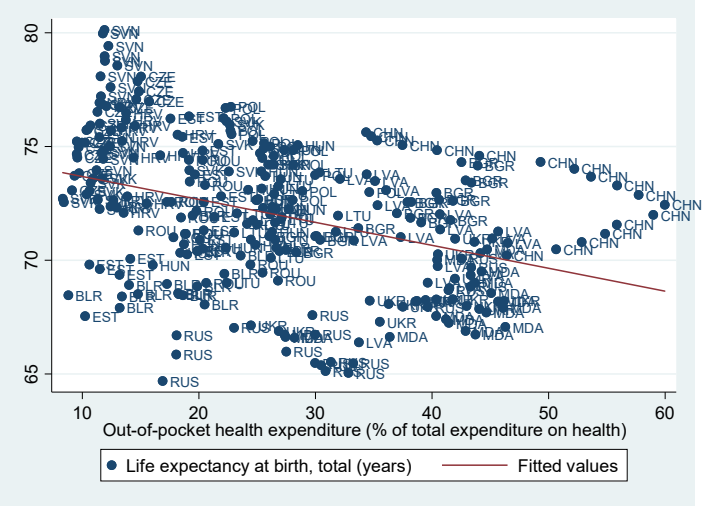
Figure 26. Scatter plot between health expenditure per capita and life expectancy



First, I regress life expectancy against health expenditure per capita, PPP. The coefficient is 0.0047 and intercept is 67.84, both are significant with the significant level of 0.05. Adjusted R-square is 0.6513, which means about 65.13% of the variation in life expectancy can be explained by the variation in health expenditure per capita. The scatterplot indicates a positive linear relationship between life expectancy against health expenditure per

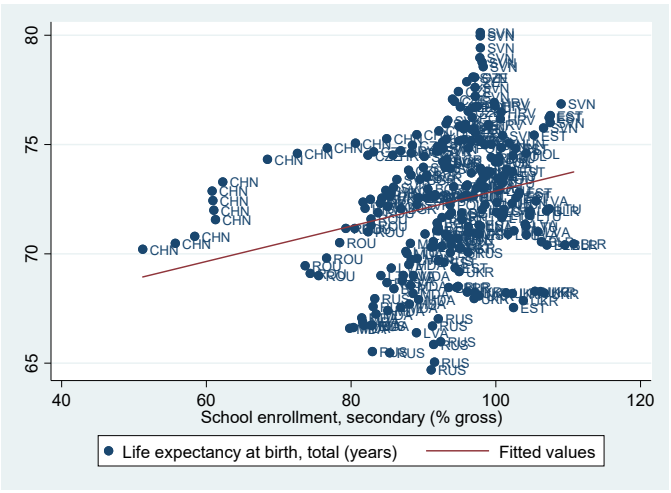
capita. China, as an outlier in the scatterplot, China has longer life expectancy with less health expenditure per capita. China has a similar level of life expectancy with Hungary, but Hungary invest two times health expenditure for individuals more than China. Russian Federation is also an outlier in the scatterplot, Russian Federation has shorter life expectancy with more health expenditure per capita.

Figure 27. Scatter plot between out-of-pocket health expenditure and life expectancy



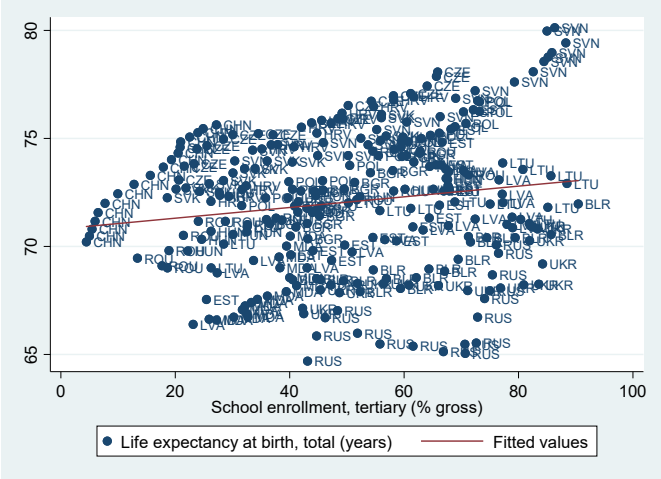
I regress life expectancy against out-of-pocket health expenditure (% of total expenditure on health). The coefficient is -0.1008 and intercept is 74.68, both are significant with the significant level of 0.05. Adjusted R-square is 0.1473, which means about 14.73% of the variation in life expectancy can be explained by the variation in out-of-pocket health expenditure(% of total expenditure on health). The scatterplot indicates a negative linear relationship between life expectancy against out-of-pocket health expenditure(% of total expenditure on health).

Figure 28. Scatter plot between secondary school enrolment rate and life expectancy



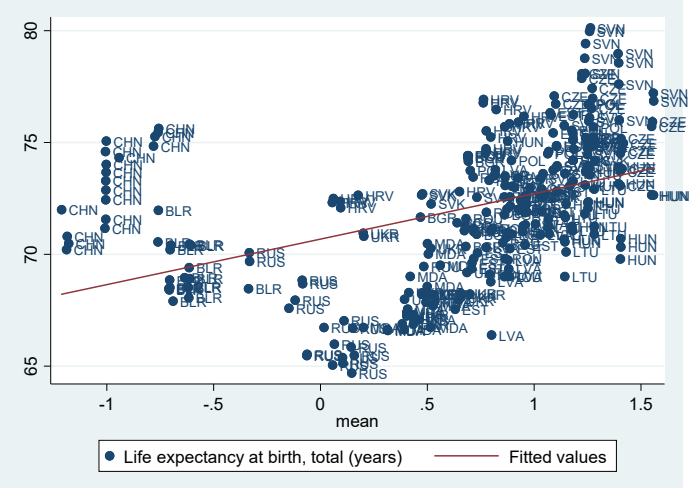
Through this scatterplot, it is clear that the gross secondary school enrolment ratio of most countries change slightly, which is less likely to explain the variation of life expectancy.

Figure 29. Scatter plot between tertiary school enrolment rate and life expectancy



I regress life expectancy against gross enrolment ratio for tertiary school. The coefficient is 0.0374 and intercept is 70.00, both are significant with the significant level of 0.05. Adjusted R-square is 0.0425, which means about 4.25% of the variation in life expectancy can be explained by the variation in gross enrolment ratio for tertiary school. The scatterplot indicates a positive linear relationship between life expectancy against total enrolment ratio for tertiary school.

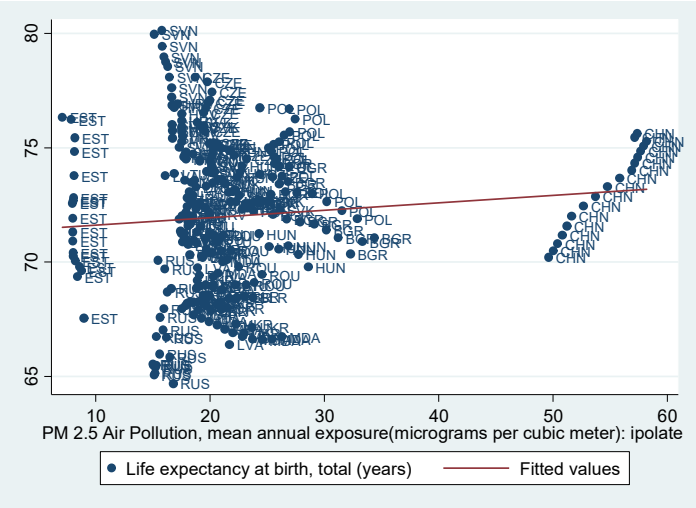
Figure 30. Scatter plot between Unified Democracy Scores and life expectancy



I regress life expectancy against Unified Democracy Scores. The coefficient is 3.78 and intercept is 69.04, both are significant with the significant level of 0.05. Adjusted R-square is 0.4042, which means about 40.42% of the variation in life expectancy can be

explained by the variation in Unified Democracy Scores. The scatterplot indicates a positive linear relationship between life expectancy against Unified Democracy Scores. From 1995 to 2012, Unified Democracy Score of China has never exceeded -0.5 when its life expectancy increases gradually. Unified Democracy Score of Belarus has never exceeded 0, and its life expectancy does not increase for five years as other countries. Russian Federation has better Unified Democracy Score than Belarus, but Russian people have shorter life expectancy than Belorussians. This could happen because of the extremely unhealthy life styles in Russian Federation. More intensive exploration about why Russian has shorter life expectancy will be analyzed later in chapter 6.

Figure 31. Scatter plot between PM 2.5 and life expectancy



I regress life expectancy against PM 2.5 air pollution. The coefficient is insignificant. Adjusted R-square is 0.0000, which means the variation in life expectancy cannot be explained by the variation in PM 2.5 air pollution in this research.

5.3 Problem of the outlier

China is defined as the post-communist country because China was once greatly influenced by Soviet Union development pattern. China is added to this research as this research also aims to compare the transitions between China and other post-communist countries. In the most previous studies, China is not included in the post-communist country group. In the analysis of the data, China is the outlier among all countries. Compare with other countries; China has much lower Unified Democracy Scores (UDS), less health expenditure per capita(less health care input), much worse PM 2.5, much lower tertiary gross enrolment rate and higher out-of-pocket health expenditure rate. But its life expectancy is not

that worse as those indicators show. It is speculated that maybe the factors that are not included in this research plays a more significant role in Chinese people health, such as some life style factors, including smoking, alcohol and diet. Because of its unique characteristics, China is excluded in the panel data regression. But it will be analyzed in the general comparison of independent variables with other countries together.

5.4 Prior tests for model estimation

The model is built by Stata 11. The independent variables do not have a strong correlation with each other(association). This model has also passed the collinearity test(VIF). Collinearity has been taken into consideration before specifying the model. Thus this model does not have collinearity problem. According to the test results, the model has the issues including cross-sectional heteroscedasticity and autocorrelation. To account for such issues, heteroscedasticity - and autocorrelation-consistent (clustered) standard errors(cluster-robust standard error) are used.

Breusch-Pagan Lagrange multiplier (LM) is used for the decision between simple pooled(OLS) regression or random effects regression. As the test result indicates, there are significant differences across countries. Thus only simple pooled regression is not enough for this model. To decide whether to use random effects regression or fixed effects regression, Hausman test is applied. Because of the Std. Err with vce(cluster state) is three times of std. Err without vce(cluster state), the normal Hausman Test for random effects or fixed effects is not fully effective in this model estimation. Thus the panel robust Hausman Test is applied, and the test result rejects the null hypothesis of random effect. Moreover, because of the difference between the two Std. Err, vce(cluster state) is used when the model is estimated.

Through further tests, the fixed time effects are needed. Therefore, in the final model, the fixed time effects is adopted to show the regression result.

5.5 Model estimation

The life expectancy production function used in this thesis uses the following form:

$$LE_{\text{it}} = \beta_1 PM_{it} + \beta_2 USD_{it} + \beta_3 EcoFree_{it} + \beta_4 Tertiary_{it} + \beta_5 OOP\_TOT_{it} + \beta_6 HEX\_PC_{it} + \alpha_i + \delta_t + \mu_{it}$$

Where the dependent variable LE_{it} is the health outcome, which means life expectancy at birth for the country i in the year t. PM is PM 2.5 air pollution, the proxy

variable for environmental factor. USD means the Unified Score of Democracy(Unified Democracy Score). EcoFree is the overall score of the indicator Economic Freedom Index. Tertiary represents the share of population attaining tertiary education. OOP_TOT is the share of out-of-pocket health spending in the total health expenditure. HEX_PC means health expenditure per capita, at constant 2011 international $ PPP. δ_t is the country-specific time trend. α_i is the intercept corresponding to country i. μ_{it} is the error term.

6. Discussion

6.1 Key findings

The total number of observations in this regression is 267. The standard Error is adjusted for 15 clusters in the country. The R Square is 0.3471.

Table 6. Regression results of model

Variable Category	Independent Variable	β	p-value
Environmental	**PM 2.5**	**-0. 1825**	**0.060**
Political	**Unified Score of Democracy**	**0.4807**	**0.551**
Economic	**Economic Freedom**	**-0.0237**	**0.149**
Educational	**Tertiary gross enrollment ratio**	**0.0318**	**0.022**
Access to healthcare	**Out-of-pocket**	**-0.0048**	**0.812**
Total input into healthcare	**Health expenditure per capita**	**0.0021**	**0.015**
	Constant	**73.6147**	**0.000**

The result from this analysis shows that better air quality, more coverage for higher education, more spending in health care over time have positive and statistically associations with life expectancy gains. In particular, one microgram per cubic meter reduction in PM 2.5 air pollution(mean annual exposure) is associated with a gain of 2.16 months of life expectancy at birth. 100 dollars increase in health expenditure per capita is associated with a gain of 2.4 months of life expectancy at birth. Ten percentage points increase in the gross enrolment ratio for tertiary school tertiary education is associated with a gain of 3.6 months of life expectancy.

The share of out-of-pocket health spending of total health expenditure has a negative but insignificant association with life expectancy at birth. This may be explained by the fluctuation of the share of out-of-pocket health spending in total health expenditure. The Unified Democracy Scores does not have a significant association with life expectancy. This is because of its very slight reduction of Unified Democracy Scores from 1995 to 2012. The

association between Economic Freedom and life expectancy is also not significant, mainly because of the fluctuation in Economic Freedom.

Surprisingly, the proxy variable of democracy(Unified Democracy Sores) and Economic Freedom both are not significant factors of health status. In my opinion, the result of this research does not mean that democracy and economic freedom cannot affect health status. Because the data of the two variables is not available between 1990 and 1995 in these transition economies, this panel data regression analysis is possible to miss the initial transition period. Most of these transition economies have finished their great political transition from centralisation to democracy during 1990 to 1995. Thus after 1995, the Unified Democracy Sores does not continue to rise as it has already reached the democratic scoreline. This explanation also applies to economic freedom. Most of these transition economies have finished their economic transition from planned economy to the market economy from 1990 to 1995. Therefore, the result of this research cannot prove that democracy and economic freedom do not have a positive impact on health status.

6.2 Limitation of the model

First, the period is only from 1995 to 2014, which misses the initial transition period. Thus the initial transition process or changes are not caught by this study but the initial period is the most important stage for these transition countries. Moreover, to use the data of Unified Democracy Score, the term has to be reduced to 2014 because Unified Democracy Score is only available until 2014. Otherwise, the period should last at least until 2015.

Second, in the CIS group, Georgia, Azerbaijan, Uzbekistan, Tajikistan and Kyrgyzstan are not included. Because these countries have quite different development paths if they are compared with the other countries, such as Russia Federation, Ukraine, Belarus and Moldova.

Third, the entire sample size is not large enough to satisfy an ideal panel data regression analysis, especially when the variables in different countries show a quite different trend. Sometimes, their trends show opposite directions, which can offset each other in the regression. This heteroscedasticity can cause some important variables to become insignificant.

6.3 Discussion about unexpected life expectancy in China

According to previous analysis, among all the countries studied in this research, China has the worst Unified Democracy Scores, highest out-of-pocket health expenditure percentage of total health expenditure, lowest gross enrolment ratio for tertiary school, lowest health expenditure per capita, but its life expectancy is not the worst among all these countries. Even though China has such pessimistic socioeconomic fundamentals, low health spending and unsatisfying health insurance coverage, life expectancy in China has a similar level as Hungary and Slovak throughout 1995 to 2012. This means, concerning life expectancy, China can be divided as into the Central Europe group. As analyzed in the previous chapter, socioeconomic factors in Central European countries perform best among all these countries. The unexpected outcome indicates that there may be other reasons to explain the health production.

Life style may be an important factor that makes the difference. Usually, life style includes smoking, drinking alcohol and diet.

According to the data from WHO, Eastern European countries dominate the cigarettes consumption in the world. Belarus, Russian Federation, Slovenia, China make the top 10. Czech Republic, Ukraine, Estonia and Hungary rank as top 20. So Chinese people do not consume fewer cigarettes than other post-communist countries. Therefore less smoking cannot explain the difference in life expectancy in China and other post-communist countries.

Alcohol is also a significant problem for most transition economies. As described in the previous chapter, regarding the death rate of alcohol, most transition economies rank as top 30 in the world, but China has the lowest age-adjusted death rate of alcohol among all the transition economies studied in this research. As the report(WHO, 2014) indicates, the harmful use of alcohol can result in harm to health. Alcohol is a casual factor in more than 200 disease and injury conditions(WHO, 1992). Drinking alcohol is associated with a risk of developing some health problems with alcohol dependence, such as liver cirrhosis, cancers and injuries (WHO, 2014; WHO, 2004; Baan et al., 2007; Shield, Parry & Rehm, 2013). The latest research finds the causal relationship between alcohol and incidence of infectious diseases such as tuberculosis and HIV/AIDS (Lönnroth et al., 2008; Rehm et al., 2009; Baliunas et al., 2010). In 2012, 5.9% of global death was attributed to alcohol. According to the data from WHO, the proportion of alcohol-attributable deaths relative to all deaths, like Alcohol-attributable fractions (AAFs)3, is highest in the WHO European Region. As alcohol

[3] Alcohol-attributable fractions (AAFs) for all-cause deaths

consumption in the European region is also the highest in this WHO region, this outcome is not that surprising. What's more, it is important to note that the high AAF figures in the European Region are almost entirely driven by Eastern European countries. Eastern European countries have both high-risk levels and patterns of alcohol consumption. Compared with other transition economies, alcohol consumption per capita in China is less than half of that in these countries. So maybe less alcohol could be one possible reason to explain the difference.

Figure 32. Alcohol consumption per capita in China, Czech Republic, Russia, Estonia and Romania

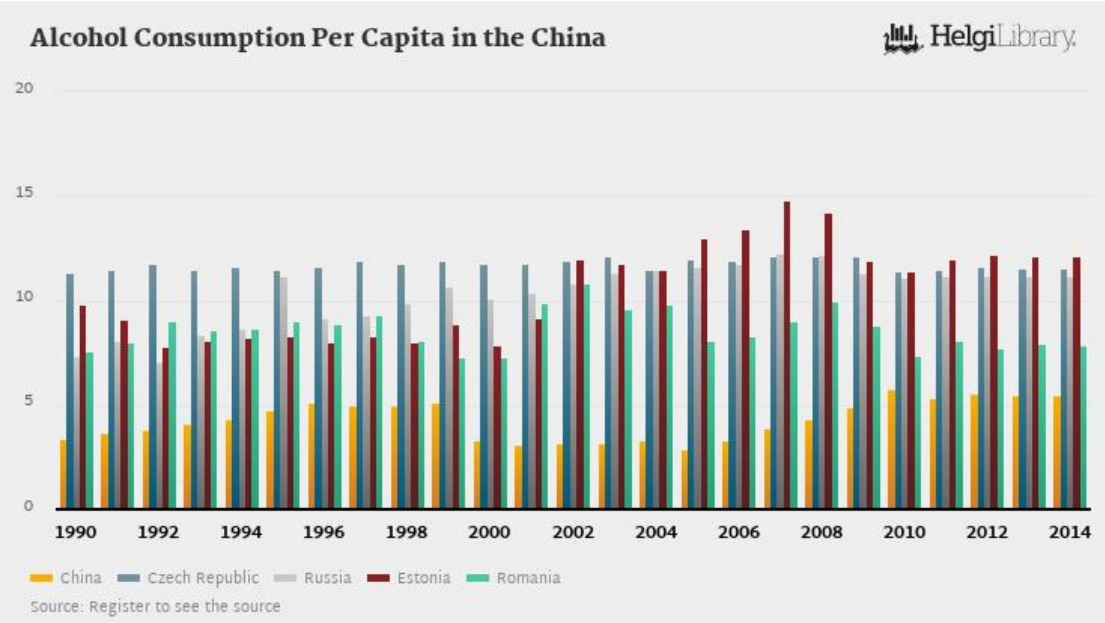
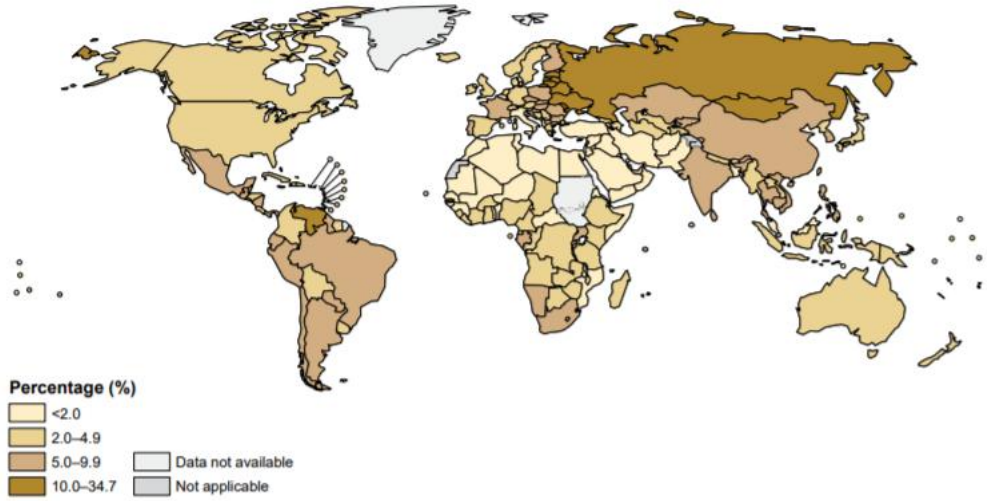


Figure 33. Alcohol-attributable fractions for all-cause deaths (AAFs; %; all ages), 2012



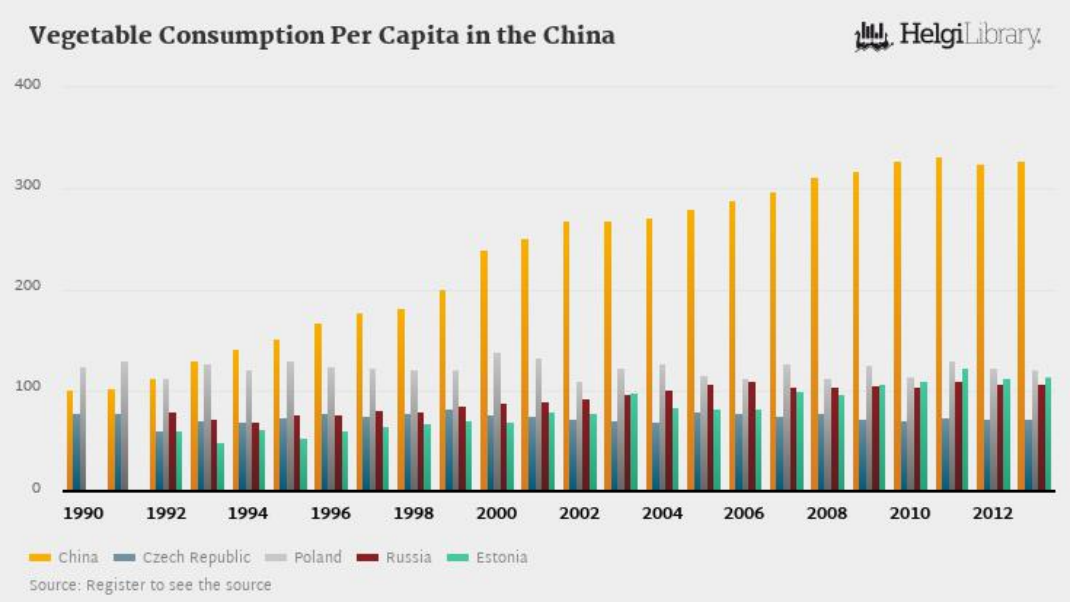
Obesity may also be another reason to explain the difference. According to the data in 2011 from the World Obesity, China has the lowest percentage of adults with obesity among all the transition economies that are studied in this research. Only 11.8% of men and 11.0% of women are obese in China. While obesity rate in other countries is over 16.7%. Romania (29.4% for men and 34.1% for women), Hungary(34.7% for men and 31.3% for women), Latvia(25.6% for men and 32.6% for women) and Moldova (17.8% for men and 28.5% for women) have the highest percentage of adults with obesity. As we all know, Hong Kong, Japan, Singapore and South Korea have high life expectancy in the world. These economies rank as 1, 2, 4 and 12 respectively. If you check the obesity rate in these economies, you will find these economies have meagre obesity rate. The obesity rate is only 3.30% in Japan, 5.80% in South Korea and 6.20% in Singapore. Peeters et al. (2003) find that obesity and overweight in adulthood are associated with the substantial decrease in life expectancy and also associated with the increase in early mortality. Moreover, Obesity in adulthood is a powerful predictor of death at older ages. Researchers from the National Cancer Institute (NCI) also find that people with class III4 (or extreme) Obesity had a dramatic reduction in life expectancy compared with people of normal weight. Statistical analyses of the pooled data indicated that the excess numbers of deaths in the class III obesity group were mostly due to heart disease, cancer and diabetes. According to the information provided by U.S. Department of Health and Human Services, many health problems are linked to obesity and overweight, type 2 diabetes, high blood pressure, heart disease, strokes, certain types of cancer, sleep apnea, osteoarthritis, fatty liver disease and kidney disease.

As indicated in the report by OECD (2016), nutrition is an important determinant of health. Inadequate consumption of fruit and vegetables is one factor that can play a role in increased morbidity. Proper nutrition assists in preventing many chronic conditions, including hypertension, cardiovascular disease, stroke, diabetes and certain cancers. Slavin and Lloyd (2012) argue that people can take dietary fibre from fruits and vegetables. The fibre intake is associated with lower incidence of cardiovascular disease and obesity. What's more, people can also take vitamins and minerals from fruits and vegetables, which are sources of phytochemicals that function as antioxidants, phytoestrogens, and anti-inflammatory agents and through other protective mechanisms (Slavin & Lloyd, 2012). As indicated by the WHO, fruit and vegetables are important components of a healthy diet, and their sufficient daily consumption could help prevent major diseases, such as cardiovascular diseases and certain

cancers. As the data from the WHO shows, approximately 16.0 million (1.0%) disability-adjusted life years (DALYs, a measure of the potential life lost due to premature mortality. And the years of productive life lost due to disability) and 1.7 million (2.8%) of deaths worldwide are attributable to low fruit and vegetable consumption. The WHO recommends a minimum of 400g of fruit and vegetables per day (excluding potatoes and other starchy tubers) for the prevention of chronic diseases such as heart disease, cancer, diabetes and obesity, as well as for the prevention and alleviation of several micronutrient deficiencies, especially in less developed countries.

Vegetable consumption per capita reached 328 kg in 2013 in China, according to Faostat. China has been ranked 1st within the group of 160 countries concerning vegetable consumption per capita; one places above the position from 1993 until now. After 1990, vegetable consumption per capita in China has exceeded 100g. From 2000, vegetable consumption per capita in China has exceeded 200g. It reached 300g since 2008. From the Figure 34, the average level of vegetable consumption per capita in other transition economies is less than 100g. This is one of the few advantages for China.

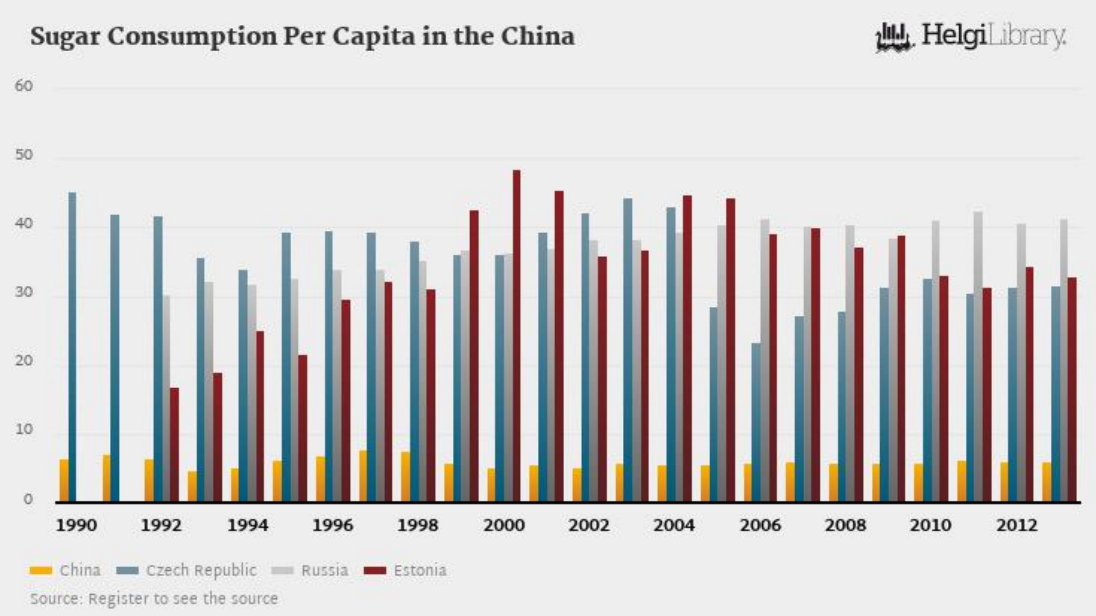
Figure 34. Vegetable consumption per capita in China, Czech Republic, Poland, Russia and Estonia.



Since 1990, sugar consumption per capita in China remained at approximately 6g. China has been ranked 148th within the group of 160 countries regarding sugar consumption per capita. While the average level of sugar consumption per capita in other transition

economies stays from 20g to 40g, which is three times or even seven times more than that in China. Therefore maybe less sugar intake is also one reason to explain the difference.

Figure 35. Sugar consumption per capita in China, Czech Republic, Russia and Estonia



Few of literature explores the impact of Chinese life style on their health. In East Asian regions, life expectancy in Hong Kong, Japan, South Korea and Singapore rank as top 10 in the world. As sometimes the data of Hong Kong is included into China, Japan replaces Hong Kong as the first place in the ranking. So actually scholars are more interested in Japan but not China. This also means most literature are discussing why Japanese people live longer.

As China shares some similar culture and dietary habits with Japan, here some similarities of life style will be emphasized, which may also contribute Chinese people's health.

First, they eat lots of vegetables, which means they are less likely to lack vitamins. Also, their staple food is rice that has low level of fat(0.8g/ 100g), zero cholesterol(0g/ 100g) and low level of sodium(116mg/ 100g). Eating rice has many benefits for health. Food that is low in fat and cholesterol can help to reduce the risk of arterial disease, heart disease and obesity. As we all know, sodium causes the arteries and veins to constrict, limiting blood flow. And when this occurs, the heart works extra hard to pump blood all over the body. As the heart works harder, pressure builds up in the veins, causing damage to the arterial wall. Eventually, elevated blood pressure could lead to atherosclerosis, heart attacks, and strokes. Thus eating rice with the low level of sodium won't aggravate the condition of those afflicted with hypertension or high blood pressure. What's more, they cook their food differently.

Chinese food involves a lot of steaming, slow cooking and boiling. These cooking ways need less oil, which also can help reduce the risk of obesity.

Second, retired Chinese people do their daily exercise. In the morning, the parks or squares are full of retired women who are practising Tai Chi or dancing in large groups. Retired men practice Tai Chi, play chess, read the paper or walk their caged birds. Meanwhile, they can seek friends in these activities. Tai Chi is considered as a preferred exercise for seniors to maintain health. People who regularly practice Tai Chi are less likely to suffer high blood pressure and are physically stronger. According to the research in the inactive group aged over 70 years old, Tai Chi can significantly improve functional balance, enhance physical performance, and reduce injurious falling (Li et al., 2005). Moreover, Tai Chi exercise training could decrease blood pressure and results in favourable lipid profile changes and improve subjects' anxiety status(Tsai et al. 2003).

Overall, healthy life style may be the explanation for the unexpected finding. Less alcohol, healthier diet, daily exercise for elderly people may be the reasons for the unexpected life expectancy in China.

6.4 Discussion about low life expectancy in Russia

Among these transition economies in this study, Russian Federation has the lowest life expectancy throughout the study period from 1995 to 2012, although social determinants of Russian Federation are not the worst. According to the analysis in this research, Russian Federation has the second best quality of air, and its gross enrolment for tertiary school is not bad. Health expenditure per capita in Russia is in the medium range, and its out-of-pocket health expenditure percentage in total health spending is at the high level. Moreover, the economic freedom level of Russia is one of the lowest, and the unified democracy score is also in low level. This part will discuss the possible explanations for the life expectancy in Russian Federation.

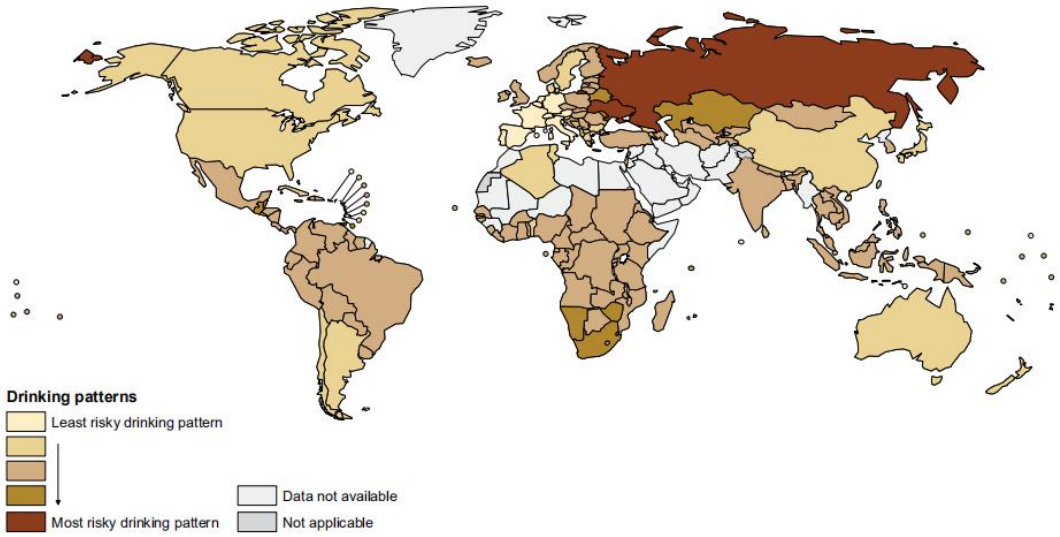
First, drinking alcohol is a significant reason for mortality among working-age male. Tomkins et al. (2012) conducted prospective research to study the effect of drinking alcohol on mortality. Their research is held in the city of Izhevsk, Russia. Their sample includes the data of mortality of 2000 men working in Izhevsk, aged from 25 years old to 54 years old. Eventually, they find that, compared with non-hazardous drinkers and people who abstain from alcohol, controlling age, smoking and education background, men who drank hazardously had a substantially higher mortality rate. To investigate the association between drinking alcohol and mortality, Zaridze et al. (2014) conducted their study in another three

cities in Russia, including Barnaul, Byisk, and Tomsk. They interviewed 200,000 adults in the three cities during 1999-2008 and followed these interviewees until 2010. Through their research, they collected data about the different cause of mortality. They find that people who consume more bottles of vodka per week have a higher risk of death. This finding applies to each age group. Eventually, they conclude that drinking vodka is a leading cause for high premature mortality in Russia, which strongly supports other evidence.

What's more, according to the global status report on alcohol and health (WHO, 2014), Russia and Ukraine have the highest patterns of drinking score(PDS) in the world, which means these two countries have the riskiest patterns of drinking. To measure the association between alcohol and health, patterns of drinking score (PDS) is a more accurate index than alcohol consumption per capita. Pattern of Drinking Score(PDS)[5] measures how people drink but not how much alcohol they drink. For example, drinking the same amount of alcohol with a meal is less harmful to health than drinking the same amount of alcohol without a meal. Thus different ways of drinking alcohol impose the different level of burden on health. There are five scales to measure Pattern of Drinking Score (PDS) from 1 to 5, where 1 means the least risky pattern of drinking alcohol and 5 indicates the riskiest way of drinking.

Controlling the amount of alcohol consumption, the burden of disease attributed to alcohol gets greater when Pattern of Drinking Score (PDS) increases.

Figure 36. Patterns of drinking score (15+ years), 2010



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[5] PDS is calculated based on the following drinking attributes: the consumed amount of alcohol every time; whether it happens during festive; the proportion of drunk times in all occasions; whether people drink alcohol daily or nearly daily; whether people drink alcohol with meals; whether people drink alcohol in public places. These attributes are weighted differently.

Source: WHO

Zaridze et al. (2009) also investigated how drinking influences health, whether there is any difference between male and female concerning the effects of alcohol consumption on mortality, and what specific reason for death after people drink alcohol. They find that, for male, there are three reasons to explain the death caused by alcohol, including accidents and violence, alcohol poisoning, and acute ischaemic heart disease. These three reasons are the primary determinants of mortality in Russia because their fluctuations have a similar trend as the fluctuation in mortality. In recent years, more than half of Russian people's death can be explained by alcohol, for those aged from 15 years old to 54 years old. They conclude that alcohol can explain the most of the considerable changes in mortality of Russian.

There are also some studies exploring the socioeconomic determinants of alcohol consumption in Russia. Tomkins (2007) find that hazardous drinking is associated with socioeconomic conditions, which means people who have less education and who are unemployed are more likely to hazardous drinking. Kossova et al. (2017) find that the macroeconomic factors are significantly related to consumption of various alcoholic beverages in Russia. To be specific, unemployment rate affects consumption of different types of alcoholic drinks in different ways. Unemployment has a negative association with consumption of vodka and beer but has a positive association with wine.

6.5 Recommendation

For Central and Eastern European countries, people should be encouraged to take healthier life style. Eating more vegetables and fruits, taking less fat and less sugar diet, smoking fewer cigarettes, drinking fewer spirits and taking daily exercise is good for people's health. In the long term, if the government can promote the healthy life style in primary school and secondary school, it may save a lot of health care costs for the government, which also means people may pay less tax for the health care expenditure or pay less health insurance premium in the future. As mentioned before, the enrolment ratio of primary school and secondary school in these countries stay at the high level. If the school can teach students the healthy life style since their childhood, it may be more effective because children are still developing their habits. It is more difficult to change the life style of the adults, as they have formed their life style. Moreover, promoting health life style through primary education and secondary education may be more cost-saving because it is kind of preventive measure to reduce some life style related diseases, such as circulatory disease, smoking-related

disease(lung cancer) and alcohol-related disease. If this is effective, a lot of medical treatment costs would be saved.

When it comes to the ageing problem, maybe China could provide some inspirations for other countries. In China, the elderly still take daily exercises, such as Tai Chi and Wu Qin Xi(Five-animal Exercise). These exercises have a slow pace, so they are suitable for the elderly. As most seniors take these physical activities in groups, so they can meet and chat with their friends every morning in the park, which can benefit their mental well-being. This almost costs almost nothing for the Chinese government because Chinese people have such traditional culture to self-care themselves when they get old. As described by WHO, physical inactivity is one of the leading risk factors for overweight, obesity and noncommunicable diseases and chronic conditions, including diabetes, hypertension, cardiovascular diseases, various forms of cancer, stress, depression and anxiety. Of the six WHO regions, the European Region is the most severely affected by noncommunicable diseases. Therefore, if the seniors can take some suitable exercise, it would benefit their health and save some health care costs. When the financing of health care is getting less in the ageing era, preventive measures would be helpful to save costs.

For China, the government should reduce air pollution and increase the share of health expenditure in GDP.

First, air pollution has been a severe problem since 2011. As GDP growth is the main criteria for local government officials, the local government officials have no motivation to reduce pollution. Although the environmental indicators have been included in the criteria to assess the performance of local government officials since last year, the effective solution for them is to shutter the steel companies and polluting power stations. Because the steel companies and polluting power stations are in Hebei province but not in Beijing, only Beijing does not need to suffer the economic loss. In my opinion, the government should develop public transport or encourage people to take public transport. But Beijing, the most air-polluted city, increases its public transport fee even higher than Shanghai. Ten years ago, to support the auto industry, the government encourage people to buy cars by providing subsidies for the consumers. However, the road capacity cannot hold so many cars, which leads to severe traffic congestion. As the cars get stuck in the traffic, they are just exhausting emissions on the roads, which substantially deteriorates air pollution. By this I mean, the government officials should consider the impact of their policy from the long-term

perspective. China is still a developing country so, during the development process, the government can refer to many experiences provided by other developed countries.

Second, the Chinese government should increase the share of public health expenditure of GDP. As mentioned before, China has the lowest health expenditure per capita. This is not only caused by the huge population. Among all the countries studied in this research, China has the lowest share of public health expenditure of GDP. Before 2008, the share of public health expenditure in GDP is only about 2%. After 2008, the share increases to 3%. By contrast, the average level in Central European countries is about 6%. Even the four CIS countries spend about 4% of GDP on public health expenditure. In a health system, if the payer(government) does not pay enough money for the whole system, it means either providers(hospitals) or consumers(patients) have to suffer the result. If the government wants to satisfy the needs of patients with low treatment costs, the providers have to suffer the low payments. In Chinese health care system, the physicians in the hospitals are suffering the low wage level. As there is no gatekeeper in Chinese health care system, patients go to the hospital when they get sick. So there are many patients in the hospitals, some patients have severe disease, but some patients do not need to visit hospitals. For physicians in the hospitals, because their working time is limited, they can only spend less than 3-5 minutes on each patient. Otherwise, they cannot finish their work on time. For example, the physicians in hospitals in Beijing can see almost 100 patients within one day. This is also because the best and the most medical care resources in China are concentrated in Beijing. So the patients there not only include local patients but also include patients who come from other provinces and even get some severe disease. In such circumstance, the physicians not only have high pressure from their daily work but also can only accept the underpaid salary. Therefore, the relationship between the physicians and patients is quite strained. To solve this problem, the government should consider whether to distribute more budget to health care sector.

6.6 Limitation of the study

First, this study mainly focuses on the socioeconomic factors, so the factors related to lifestyle is not included. Because according to the previous literature, lifestyle may account more share of the health than socioeconomic factors. But this research plans to explore the impact of transition on the public health, so it more focuses on the socioeconomic factors. Moreover, the culture related lifestyle does not change substantially, such as smoking habit, alcohol habit and diet components. To avoid lifestyle-related factors sharing the most

accountability from socioeconomic factors, lifestyle-related factors are not included. Maybe future studies can add some lifestyle-related factors into the model to compare the differences.

Second, this research aims to compare China and other transition economies, so China is included in the sample in the beginning. If this research just covers European countries, more precise and detailed data and indicators related to health care system can be collected from European health for all database, such as the indicators for health care system quality and health care system efficiency. But there will be no available data for China. Thus this research only includes the indicator for health care expenditure but no indicators for health care system quality and health care system efficiency. However, according to the plot graphs, China is a typical outliner in the graph. So actually the data of China has been deleted before the panel regression. But China is analyzed in a single chapter by plotted graphs and scattered graphs.

Third, life expectancy at 65 is not used as the dependent variable as planned in the beginning. This research plans to use both life expectancy at birth and life expectancy at 65 as the dependent variable separately to compare the coefficients of the two models. Because the majority of health expenditure is spent on the elderly. It is possible to compare the effect of health expenditure on different groups by doing this. However, the data of life expectancy at 65 is unavailable in the World Bank Data. Life expectancy at 65 is only available for European countries. As data of life expectancy at 65 in these transition economies is unavailable, life expectancy at 65 is not used as the second dependent variable in the model.

Fourth, in the beginning, corruption index is considered as a candidate for political variables. However, considering that corruption index may have collinearity with Unified Democracy Scores, corruption index is not included in the final model. Moreover, because this research does not investigate the relationship between life style related factors and life expectancy, it is not clear how to explain the regression result of corruption in this model, which does not include life style related factors. By which I mean, it is clear that corruption can affect health status through life style related factors, but it is difficult to explain how corruption affect life expectancy directly. In other words, it is difficult to explain how corruption can affect life expectancy through the variables in the model in this research, including education, economic freedom, out-of-pocket spending and health expenditure per capita. Healthy life style can have a positive impact on health. Less smoking, less alcohol, less-sugar and less-fat diet can reduce the possibility of some disease, such as lung cancer, hypertension, high cholesterol, diabetes, fatty liver and some other circulatory disease. But corruption can have a negative impact on health. For example, tobacco companies can offer a

bribe to the parliament members to stop more taxation on tobacco. As a result, the government fails to discourage people from smoking by the higher price of tobacco. In such circumstance, corruption needs to be added to the model to control the effect of the democratic institution on health because corruption could hinder democratic institution functioning in the right way.

Last but not least, the discussion about life expectancy in China is only from the social science perspective. The unexpectedly high life expectancy in China may be due to genetic reasons. The future studied can investigate this question further in different study areas because there are many social determinants affecting health status. Because South Korea, Japan and Singapore have similar dietary habits and culture with China, and these countries all have the high life expectancy, maybe scholars can research genetic similarities in East Asian countries to see whether East Asian people have longevity enabling genes.

7. Conclusion

This thesis studies the impact of social determinants on life expectancy in 16 transition economies from 1995 to 2012 by a panel data regression analysis. The independent variables involve factors in different aspects, including air pollution, economic freedom, democracy, education, out-of-pocket expenses and health expenditure.

The results of this study can be summarized as follows:

First, among all these transition economies, Central European countries have the highest level of democracy, the lowest financial barriers to access to health care and the highest level of health expenditure per capita. Moreover, Central European countries have the highest level of life expectancy. By contrast, CIS countries have the lowest level of democracy, the lowest score in economic freedom, high financial barriers to access to health care. Correspondingly, CIS countries have the lowest level of life expectancy.

Second, the regression result shows that air quality, coverage for tertiary education, spending in health care have positive and statistically associations with life expectancy gains. To be specific, one microgram per cubic meter reduction in PM 2.5 air pollution (mean annual exposure) is associated with a gain of 2.16 months of life expectancy at birth. 100 dollars increase in health expenditure per capita is associated with a gain of 2.4 months of life expectancy at birth. 10% points increase in the gross enrolment ratio for tertiary school is associated with a gain of 3.6 months of life expectancy. Surprisingly, the proxy variable of

democracy (Unified Democracy Sores) and Economic Freedom both are not significant factors of health status. This may be because these transition countries have finished their political and economic transition before 1995. So the changes in these two variables are slight throughout the study period. Additionally, the out-of-pocket health expenditure is not significant because out-of-pocket health expenditure in these countries fluctuates frequently and wildly.

Third, compared with other countries, China is an exception in all aspects. Although China has the worst unified democracy scores, the highest out-of-pocket health expenditure (% of total health expenditure), the lowest gross enrolment ratio for tertiary school, the lowest health expenditure per capita, but its life expectancy is not the worst among all these countries. Even though China has such pessimistic socioeconomic fundamentals, low health spending and unsatisfying health insurance coverage, life expectancy in China has a similar level as Hungary and Slovak throughout the period from 1995 to 2012.

Fourth, healthier life style may be the reasons for the unexpectedly high life expectancy in China. Less alcohol, healthier diet, daily exercise for seniors may be the reasons to explain the unexpected life expectancy in China. Here the healthier diet indicates more vegetables, less sugar and less fat. Strongly influenced by Chinese traditional culture, Chinese people are aware of the importance of daily exercise when they get old. The daily exercise is helpful to reduce the risk of some circulatory diseases.

Fifth, Russia is another exception among all these transition economies. Although Russia has the second best air quality, not bad enrolment ratio of tertiary school, and medium health expenditure per capita, Russia has the lowest life expectancy among all these transition economies. A lot of literature indicates that hazardous drinking is the major reason for the low life expectancy in Russia. Moreover, Russia has the riskiest pattern of drinking in the world. Hazardous drinking imposes a heavy burden on population health.

Last, promoting healthy lifestyle would be helpful to save health expenditure in the long term. Eating more vegetables and fruits, taking less fat and less sugar diet, smoking fewer cigarettes, drinking fewer spirits and taking daily exercise is good for population health. If the government can promote the healthy lifestyle in primary school and secondary school, it may save a lot of health care costs for the government in the long term. In the graying society, encouraging the elderly to take daily exercise or physical activities would contribute to reduce the risk of circulatory diseases.

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List of appendices

Appendix 1: Test results in Stata

Figure 1. Test result of collinearity

```
. vif
```

Variable	VIF	1/VIF
USD	2.94	0.340536
EcoFree	2.93	0.341140
HEX_PC	2.72	0.367919
Tertiary	2.30	0.435340
PM1	1.68	0.596551
OOP_TOT	1.67	0.597232
Mean VIF	2.37	

Figure 2. Test result for autocorrelation

```
Linear regression                               Number of obs     =        249
                                                F(6, 14)          =      31.05
                                                Prob > F          =     0.0000
                                                R-squared         =     0.2141
                                                Root MSE          =     .45746

                                   (Std. Err. adjusted for 15 clusters in state1)
------------------------------------------------------------------------------
             |               Robust
        D.LE |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         PM1 |
          D1. |  -.1083506   .0345747    -3.13   0.007    -.1825059   -.0341953
             |
         USD |
          D1. |  -.3480273   .2376258    -1.46   0.165    -.8576839    .1616294
             |
     EcoFree |
          D1. |   .0034752   .0116758     0.30   0.770    -.0215669    .0285174
             |
    Tertiary |
          D1. |   .0261503   .0127153     2.06   0.059    -.0011213    .0534219
             |
     OOP_TOT |
          D1. |   .0178111   .0150239     1.19   0.256    -.0144121    .0500342
             |
      HEX_PC |
          D1. |   .0014721   .0003545     4.15   0.001     .0007118    .0022325
------------------------------------------------------------------------------

Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,      14) =    122.863
           Prob > F =      0.0000
```

Figure 3. Panel Robust Hausman Test

```
. test mdPM1 mdUSD mdEcoFree mdTertiary mdOOP_TOT mdHEX_PC

 ( 1)  mdPM1 = 0
 ( 2)  mdUSD = 0
 ( 3)  mdEcoFree = 0
 ( 4)  mdTertiary = 0
 ( 5)  mdOOP_TOT = 0
 ( 6)  mdHEX_PC = 0

           chi2(  6) =   32.41
         Prob > chi2 =    0.0000
```

Figure 4. Test for heteroscedasticity for FE model

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (15)  =    2304.73
Prob>chi2 =      0.0000
```

Figure 5. Test for validity of time effects

```
. test year2 year3 year4 year5 year6 year7 year8 year9 year10 year11 year12 year13 year14 year15 y
> ear16 year17

 ( 1)  year2 = 0
 ( 2)  year3 = 0
 ( 3)  year4 = 0
 ( 4)  year5 = 0
 ( 5)  year6 = 0
 ( 6)  year7 = 0
 ( 7)  year8 = 0
 ( 8)  year9 = 0
 ( 9)  year10 = 0
 (10)  year11 = 0
 (11)  year12 = 0
 (12)  year13 = 0
 (13)  year14 = 0
 (14)  year15 = 0
 (15)  year16 = 0
 (16)  year17 = 0
       Constraint 8 dropped
       Constraint 12 dropped

       F( 14,    14) =   61.51
            Prob > F =    0.0000
```

Appendix 2: Figures about Alcohol-attributable fractions

Figure 1. Alcohol-attributable fractions (AAFs) for all-cause deaths by WHO region and the world, 2012

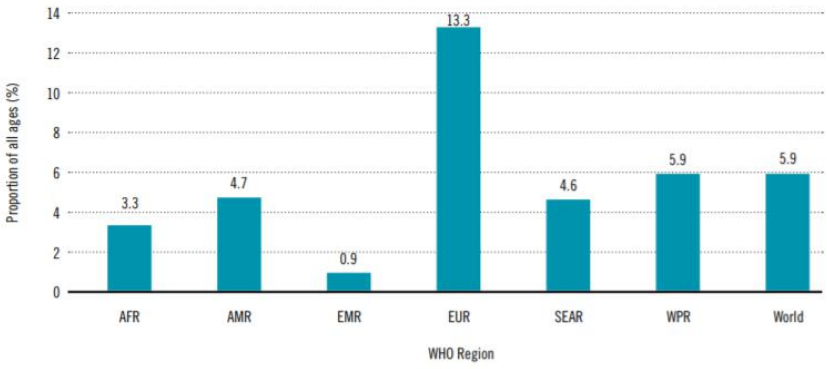

Figure 2. Alcohol-attributable fractions for all-cause deaths (AAFs; %; all ages), 2012