How does Economic Development affect Quality of Life in China and Taiwan in the past 40 years?

International Management

Submitted to Professor Ivo Ponocny

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Affidavit

I hereby affirm that this Bachelor's Thesis represents my own written work and that I have used no sources and aids other than those indicated. All passages quoted from publications or paraphrased from these sources are properly cited and attributed.

The thesis was not submitted in the same or in a substantially similar version, not even partially, to another examination board and was not published elsewhere.

July 17th 2020	Pin Fei Huang
Date	Signature

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List of Abbreviations

Carbon Dioxide	CO2
Consumer Price Index	CPI
Gross Domestic Product	GDP
Gross National Product	GNP
Gross National Income	GNI
Human Development Index	HDI
Organization for Economic Co-operation and Development	OECD
People's Republic of China	China, P.R.C.
Physical quality of life index	PQLI
Quality of life	QOL
Republic of China	Taiwan, R.O.C.
United Nation	UN
United Nations Development Programme	UNDP
World Trade Organization	WTO

1 Introduction

1.1 Statement of the problem

Economic development represents not only an increase in economic points of view but also a rise of economic and social development in the level of people's lives in the Republic of China (Taiwan) and later the People's Republic of China (China). This research seeks to understand the impact economic development can have on different aspects of quality of life (QOL) in Taiwan and China. After globalization spreads substantially in the 1970s, which helped the economy of Taiwan first and then China to grow, it is interesting to see how economic factors influenced people's lives in these countries. There are some debates if economic development can really affect QOL (Mikucka, Sarracino & Dubrow, 2017). Many researchers have argued over the question of economic development bringing changes for the QOL; some believe that there is no relationship between them vice versa (Mikucka et al., 2017; Wu, & Li, 2017; Appleton, & Song, 2008). In general, according to Wu and Li, 2017; Liao, Fu, and Yi, 2005, there is a connection between economic development and QOL.

1.1.2 Existing research on the problem

The problem is that over the years even though the income has increased in many countries, there is not enough evidence to demonstrate significant improvements in QOL according to the Easterlin paradox (Wu & Li, 2017). The application of the Easterlin Paradox theory only holds positive correlations in the lower income distribution to a certain level of income. Over this important point the income level does not seem to influence the QOL. Although economic indicators such as GDP per capita, Gini coefficient, GPI...etc. are some good examples to measure the QOL, they are not the only indicators since every individual perceives QOL differently (Long & Ji, 2019; Mikucka et al. 2017; Wu, & Li, 2017). Hajduová, Andrejovský, and Beslerová (2014) have demonstrated that GDP and living standard is not a linear relationship since GDP does not include people's perceptions of life. Moreover, using GDP to measure economic development has been a popular debate. Therefore, QOL is subjective according to some researchers (Hajduová, et al. 2014; Liao, et al. 2005; Chang, 2009). It is also critical to examine some other types of indicators, such as social indicators, health indicators and environmental indicators to evaluate QOL under the influences of the economic development. According to Mikucka et al. (2017), the relationship of QOL (e.g. well-being) has experienced the problem of methodological limitations. The QOL in both countries seems to increase as the economy grows, such as the GDP per capita, income, education, health...etc. have

significant improvements (Chan & Clark, 1994; Sen, 1981; Asadullah, Xiao, & Yeoh, 2018; Wu & Li, 2017).

1.1.3 Gaps in the literature

There are some research gaps in the findings. The small sample size can prevent researchers from receiving more accurate results and these studies do not provide further data after 2012, which suggests a gap of knowledge (Mikucka et al. 2017; Long & Ji, 2019; Ravallion & Lokshin, 2000). Moreover, these observations of research focus only on the average trend of life satisfaction and social capital. The reasons for declining accuracy of indicators have seemed not to be answered yet. According to the Easterlin Paradox theory, people stop feeling the increase in QOL at some level of income (Wu & Li, 2017); however, to what extent and what level of income in Taiwan and China do people stop feeling they are having a good life? Moreover, some of the data from the studies are not recent or there are limited data on the QOL for Taiwan (Hsiao & Hsiao, 1983; Yao, Cheng, & Cheng, 2009; Liao, 2009). The data of QOL of China seems to be recent, but there are also no older data from the 70s and 80s (Wu & Li, 2017; Appleton & Song, 2008). It would be interesting to find out the comparison of QOL of Chinese people before and after the economy surged. According to Liao (2009), QOL has two dimensions and it is difficult to only rely on one dimension to examine QOL. As the structure of people's lives is changing constantly and continuously, the perceptions of people towards things such as economic development, government policy, income...etc. might change compared to the past in the two dimensions of QOL (Ravallion & Lokshin, 2000; Liao, 2009). Moreover, there is some extent of the theories where they fail to cover different concerns of people's needs in life (Liao, 2009). It also means that some theories might be less affective when examining the concerns of QOL (Chan & Clark,1994; Liao, 2009). Ravallion and Lokshin (2000) point out that there might be some possibility of bias on QOL such as the issues of latent heterogeneity and different interpretation in their research.

1.2 Purpose of the study

The purpose of this research is to examine and compare how economic development influenced the QOL in China and Taiwan in the past 40 years. The aim is to identify some related indicators under the influences of economic and social development and perhaps to identify the effectiveness of these indicators, such as, can they correctly predict and examine the QOL in both countries from their results? In addition, to explore and discover the changes of the perception of QOL over the past 40 years and to compare the results of the two countries. As economic development and globalization

increase substantially, there is a variety of studies providing evidence about the relationship between the economic growth and the QOL (Wu, & Li, 2017; Liao et al., 2005). However, the measurement of economic development is difficult to achieve precisely according to Long and Ji (2019).

1.3 Research questions and hypothesis

This research aims to examine the changes in people's lives in Taiwan and China for the past 40 years under the effects of economic development. Since many scholars have done the similar studies about QOL with many different dimensions of indicators, it is still important to examine what are the most effective indicators that greatly influence Taiwan and China.
Hypothesis 1. *The quality of life in Taiwan and China has increased overall in the past 40 years for Taiwanese and Chinese citizens.*
Over these 40 years, many changes have happened internationally such as globalization (Mikucka et al. 2017; Wu & Li, 2017; Tsia & Chang, 1985). Globalization has improved technology which leads to an increase in QOL in both Taiwan and China (Yao, et al. 2009; Wu & Li,2017; Peniwati & Hsiao, 1987; Asadullah et al. 2018).

Hypothesis 2. *There is a significant effect of each economic indicator such as GDP on the quality of life in Taiwan and China over the past 40 years.*
According to the Easterlin Paradox and other literature reviews, there is some evidence demonstrating that the relationship between QOL and economic factors and the changes over time in economic growth and QOL is different (Mikucka et al. 2017), such as, QOL does not increase as the economy improves over time, which means that the economic situation does not have much influence on QOL (Mikucka et al. 2017; Wu & Li, 2017). In this research, the aim is to discover to what extent do economic indicators affect QOL.

Hypothesis 3. *The quality of life in one of the countries is higher in recent years.*
Lastly, to compare the recent QOL between Taiwan and China. Although Taiwan's economy grew substantially in the 1970s, the economy has not seemed to increase much recently although it is one of Four Asian Tigers (Sen, 1981; Hsiao & Hsiao, 1983; Chen, 2016). Second, it is interesting to observe some changes in recent years as China's economy has expanded substantially and is one of the largest economies in Asia (Lo & Li, 2011). Therefore, observation of the recent QOL in both places can reveal that there is a relationship between economic development and QOL.

1.4 Theoretical perspective

The theoretical perspective of this research is post-positivism, looking at the Easterlin paradox and Needs theory by Maslow to verify the findings. In the Easterlin paradox, happiness and income are positively correlated for some periods of time, however as people reach a certain amount of income, the perceived happiness does not increase as much (Di Tella & MacCulloch, 2007; Wu & Li, 2017; Ravallion & Lokshin, 2000). The Easterlin Paradox plays an important role in this research as the center of the problem that it aims to discover. This theory is relevant to this research because it examines and captures certain changes, such as in economic development, income level, and QOL and happiness. Especially when verifying Hypothesis 3, it might be interesting to find out if economic changes influence QOL more in either country, for example to discover after what level of income, people stop increasing in happiness. Using the Easterlin paradox also helps to examine if Taiwan and China also follow this trend.

Maslow's Needs theory is another theory used in this research. Needs theory is also known as Maslow's Hierarchy of Needs or livability theory. This theory is about the degree to which the provisions and requirements of the society fit with the needs and capacities of its members (Veenhoven, 1992). It is critical to discuss this because the needs of human and subjective feelings depend on the objective living condition which means that it has a lot of focus on the QOL (Liao, 2009). Moreover, Needs theory also demonstrates that happiness or life satisfaction depend to some degree on a country's economic condition. Therefore, it is greatly connected to the verifications and evaluations of hypotheses.

2 Literature Review

2.1 Historic and economic background of China and Taiwan after WWII

As the People's Republic of China (China) and the Republic of China (Taiwan) split after WWII, the significant difference of political styles between the two governments influenced economic development in the next 40 years. There are many arguments about whether Taiwan's economic development is a miracle or not (Chen, 2016; Chan & Clark, 1994; Tsia & Chang, 1985). Economic development has never been an easy topic since it involves such factors as politics, history, and other complicated factors. The success of Taiwan's economy is cumulative since policy makers have operated six long progressive economic plans from 1953 to 1981, which has led the focus of economy from agriculture to industrial, high-technology, and electronic industry and also from an importer to exporter (Chan & Clark, 1994; Tsia & Chang, 1985). According to WTO in 2006, Taiwan has even gained more power as an exporter and importer on the global level (Yao et al. 2009). Because of these reasons, the QOL in Taiwan has improved. During this period of time, Taiwan has operated under an authoritative and conservative government which has influenced the economic growth significantly for the 40 years after WWII with an annual growth rate of 6.9 percent (Chan & Clark, 1994; Scitovsky, 1985; Hsiao & Wang, 1983). Hsiao and Hsiao (1983) and Tsia and Chang (1985) have found out that the energy consumption in Taiwan such as hydropower, coal, petroleum and nuclear power...etc. were very high in the late the 1970s due to the government policy to enhance the industrialization in Taiwan.

On the other hand, in China, after suffering a terrible famine where there was a great loss in population and fertility in the late 1950's and beginning of the 1960s, the economy of China surged in the 1970s. The acceleration of industrial development for more than 30 years has outcompeted globally. This is due to intensive demographic and economic policies (Du & Yang 2014; Lo & Li, 2011). China has a comparative advantage of cheap labour, which reveals a positive correlation between labour productivity and industrialization from the 1970s to early the 1990s (Lo & Li, 2011). From the end of the 1970s to the early the 1990s, the total labour force and the average annual growth rate of employment are recorded as 3.60% and 3.63% respectively. The labour supply has been created quickly.

Industrialization in Taiwan developed and improved firstly in mid-the 1970s with foreign aid from the US (Scitovsky, 1985; Chen, 2016). China, on the other hand has also improved substantially (Chan & Clark,1994). Evidence has demonstrated that China's economy grew significantly starting in late the 1970s, where it was involved with globalization (Lo & Li, 2011). Under the

leading of Deng Xiaoping in the 1990s, the positive economic result of a nominal GDP demonstrated the success of China, which had become the second biggest world economy in the 2010s from the sixth place in 2000s internationally (Wu & Li 2017). However, the growth of China did not increase continuously, the finding shows that in the late 1990s the economic growth had not increased. China was in the period of capital-deopenning growth between 1993-2007, which was supposed to decrease allocative efficiency (Lo & Li 2011). However, this is not the case for China, instead, the labour productivity has surged again with an average annual growth rate of 9.15% between that period which confirms with the finding of Wu and Li, (2017). Also, Chan and Clark (1994) discovered that GDP growth in Taiwan and China were 9.9% and 6.9% respectively between 1965-1980. However, in 1980-1989 Taiwan's GDP growth declined 2% in contrast to China, where it surged to 9.7%. However, this phenomenon could not represent the QOL and human well-being in both places.

2.2 Quality of life and well-being

In general, QOL is the concept about people's well-being or welfare (Liao et al. 2005). QOL depends on social indicators that measure the level of living of one country's citizens and the progress of their living condition (Veenhoven, 1996). The measurement of QOL consists of two parts, subjective and objective dimensions (Veenhoven,1996; Liao,2009). Subjective QOL means the degree of individual appreciation of their life, that is their personal feeling or satisfaction towards their life (Veenhoven, 1996; Liao, 2009; Liao et al, 2005; Chan, Ofstedal & Hermalin, 2002). Therefore, there is no clear standard because everyone experiences things differently and their lifestyle is completely unique such as income, family size, health condition, interrelationship...etc. (Ravallion & Lokshin, 2000; Veenhoven, 1996; Liao, 2009; Chang, 2009; Chan et al., 2002). Subjective QOL includes life satisfaction, happiness, and evaluation of one’s life (Diener, Wolsic, & Fujita, 1995; Veenhoven, 1996; Liao et al., 2005). To evaluate from this perspective, the indicators are termed "soft" according to Liao (2009). These "soft" indicators play an important role in understanding the effect in the objective condition and government policies of well-being and usually measure the overall life satisfaction (Liao, 2009; Veenhoven,1996). Other focuses are satisfaction of interpersonal relationships, work, marriage, education...etc. (Liao et al., 2005; Liao, 2009).

On the other hand, objective QOL is the measurement on one's fulfillment of goals within the living conditions with observable indicators such as income and education (Veenhoven, 1996). Objective QOL is considered as "hard" indicators and it also includes education, welfare, economic condition, health,

government performance...etc. (Liao, 2009). These two dimensions are depending on each other and have influences over one another (Liao, 2009; Liao et al., 2005). They are both used to measure economic well-being as there are some overlapped variables such as education (Chan et al.,2002; Liao, 2009). Needs theory of Maslow demonstrates the common needs of human beings where the individual subjective perception is related to objective living conditions (Liao, 2009). Therefore, there is a correlation between economic development and QOL (Wu & Li, 2017; Liao et al. 2005; Liao, 2009). However, the limitation of Needs theory is that it does not consider different needs fulfillment in different areas (Liao, 2009).

2.3 The Quality of life in Taiwan

In the research of Liao et al. (2005, p.49), there were 1222 respondents in the Taiwan Social Trend Surveys, this a survey with a systematic sampling and collected in November 2000 (Table 1).

Table 1: Comparison of quality of life measures in Taiwan by Liao, Fu, & Yi (2005, p.49).

Comparison of quality of life measures

	Percentage			
Quality of life	Taiwan % (*n*)	Hong Kong % (*n*)	Pearson χ^2	d.f.
Individual level				
General happiness	(1216)	(1017)	83.0***	2
Not happy	26.5	22.3		
Pretty happy	52.0	68.5		
Very happy	21.5	9.1		
Satisfaction with personal life	(1210)	(1032)	20.46***	3
Very dissatisfied	3.2	4.7		
Somewhat dissatisfied	17.9	23.3		
Somewhat satisfied	66.2	63.7		
Very satisfied	12.6	8.4		
Society level				
Overall societal satisfaction	(1143)	(1014)	47.16***	3
Very dissatisfied	17.4	8.9		
Somewhat dissatisfied	37.7	34.0		
Somewhat satisfied	42.3	53.6		
Very satisfied	2.5	3.5		
Satisfaction with economy	(1152)	(1015)	78.16***	3
Very dissatisfied	28.5	13.3		
Somewhat dissatisfied	44.0	57.3		
Somewhat satisfied	26.4	27.9		
Very satisfied	1.1	1.5		
Satisfaction with security	(1190)	(1016)	716.93***	3
Very dissatisfied	44.1	4.7		
Somewhat dissatisfied	36.7	23.3		
Somewhat satisfied	18.6	65.6		
Very satisfied	0.6	6.3		

The survey was conducted by the Computer Assisted Telephone Interviewing System. The respondent rate of the data was about 41.2%. The question "Taking all things together, would you say you have a happy life these days?" was asked to measure general happiness. The rating was between 1 and 5, where 1 is not happy and 5 is very happy. The researchers also asked how

satisfied the respondents felt towards their personal life to examine the QOL, where 1 was very dissatisfied and 4 was very satisfied with their personal life. General happiness and life satisfaction are dependent variables that were measured in ordinal scale with ordinal regression to evaluate the QOL that people felt Liao et al. (2005, p.48). Meanwhile, the independent variable, the individual, was controlled. A little over 50% of 1216 respondents felt happy, more than 20% felt unhappy or very happy with their life (Liao et al., 2005). Most of them felt satisfied with their personal life. However, from the economic perspective, there were 44% who felt somewhat dissatisfied with the economic situation of Taiwan and only 1% of the respondents were very satisfied.

On the other hand, in the research of Yao et al. (2009, p.379), there were 1006 respondents from August 14 to 24, 2006, where the rating was between 1 to 5 for happiness (Table 2) and from 1 to 4 for enjoyment and achievement (Table 3&4). In this finding, 51% of the respondents were happy, 41% were neither happy nor unhappy and only 9% are not happy (Table 2).

Table 2: Level of happiness with demographic categories (%) in Taiwan by Yao, Cheng & Cheng (2009, p.388).

Levels of happiness with demographic categories (%)	Very happy (1)	Quite happy (2)	Neither happy nor unhappy	Not too happy (3)	Very unhappy (4)	Balanced (1 + 2) − (3 + 4)
Entire sample	17	34	41	7	2	+42
Gender						
Male	16	30	42	9	4	+33
Female	17	37	39	6	1	+47
Age						
20–29	16	42	36	5	1	+52
30–39	16	33	43	6	3	+40
40–49	15	30	42	11	2	+32
50–59	17	28	44	9	3	+33
60+	21	36	36	4	2	+51
Marriage						
Married	16	32	42	7	3	+38
Single	17	39	36	7	1	+48
Education						
Low	19	30	40	9	2	+38
Mid	14	33	43	8	3	+36
High	17	40	38	4	2	+51
Income						
Low	21	29	32	12	5	+33
Mid	15	33	45	6	2	+40
High	14	43	37	6	1	+50

Table 3: Levels of life enjoyment with demographic categories in Taiwan by Yao, Cheng, & Cheng (2009, p.389).

Levels of life enjoyment with demographic categories	Often (1)	Sometimes (2)	Rarely (3)	Never (4)	Balanced (1 + 2) − (3 + 4)
Entire sample	13	49	34	4	+24
Gender					
Male	15	47	35	4	+23
Female	11	51	34	4	+24
Age					
20–29	14	54	30	2	+36
30–39	13	48	36	3	+22
40–49	11	48	38	3	+18
50–59	13	46	35	6	+18
60+	16	44	33	8	+19
Marriage					
Married	12	47	37	5	+18
Single	16	53	28	2	+39
Education					
Low	15	41	39	6	+11
Mid	7	50	39	4	+14
High	18	57	24	1	+50
Income					
Low	14	42	38	6	+12
Mid	12	50	34	4	+24
High	15	49	34	3	+27

Table 4: Level of achievement with demographic categories in Taiwan by Yao, Cheng, & Cheng (2009, p.390).

Levels of achievement with demographic categories	Great deal (1)	Some (2)	Little (3)	None (4)	Balanced (1 + 2) − (3 + 4)
Entire sample	5	49	39	7	+8
Gender					
Male	5	49	37	8	+9
Female	4	49	41	6	+6
Age					
20–29	1	38	51	10	−22
30–39	5	46	42	7	+2
40–49	3	57	33	8	+19
50–59	8	54	34	3	+25
60+	10	56	26	9	+31
Marriage					
Married	6	53	35	7	+17
Single	1	37	52	9	−23
Education					
Low	7	50	34	9	+14
Med	3	48	41	7	+3
High	3	49	42	6	+4
Income					
Low	5	45	37	13	0
Mid	4	50	40	6	+8
High	5	50	40	5	+10

62% of respondents enjoyed their life but 38% of respondents did not (Table 3); 49% of the respondents did not feel accomplishment in life while 51% of people did (Table 4). To compare the enjoyment and the fulfillment of goals, more Taiwanese felt happy and enjoyed life rather than felt fulfilled in their

goals in life. Therefore, most Taiwanese felt somewhat happy, enjoyed their life and felt accomplishment in life, which was similar to the result of the Taiwan Social Trend Surveys (Liao et al. 2005). People who earned higher income and education tended to be happier than others, however the lower level educated were happier than the middle level.

2.3.1 Physical quality of life index in the 1970s to the 1980s in Taiwan

Chan and Clark (1994) and Peniwati and Hsiao (1987), chose to use PQLI as a measurement of well-being where indicated the level of a nation's average life expectancy, literacy, and infant mortality rate. The performance of PQLI of Taiwan in mid-the 1970s has outweighed China's performance by 17 out of 100 (Table 6). Moreover, Taiwan improved its QOL, that is as advanced as so-called developed countries. During this period, in spite of the fact that Taiwan's GDP growth rate has declined 2% between the period of 1965 to 1980 and the 1980s, the PQLI of Taiwan continued to grow over the next decade (Table 5). In 1982, it was 93 percent and in 1988 it was 95 percent compared to 1973, where it was only 89 percent (Table 5).

Table 5: Indicators of socioeconomic development in Taiwan by Chan & Clark (1994, p.129).

Indicators of socioeconomic development in Taiwan (source: Chan and Clark, 1992, pages 158–177).

	1952	1963	1973	1982	1988
GNP per capita ($)[a]	153	178	696	2650	6055
Agriculture, as a percentage of GDP	36	27	14	9	6
Investment, as a percentage of GDP	15	18	29	25	24
Exports, as a percentage of GDP	9	15	42	46	51
Industrial goods as a percentage of exports	8	41	85	92	95
PQLI index[b]	66	80	89	93	95
Income ratio[c]	20.5	5.3	4.5	4.3	4.9
Government budget as a percentage of GNP	21	19	20	26	24
Social welfare as a percentage of budget	6	8	11	15	18

[a] This figure understates economic growth in the 1950s and overstates it in the 1980s because of exchange rate fluctuations.

[b] Physical quality of life index based on relative standing in the world on literacy, infant mortality, and life expectancy with 100 as hypothetical 'perfect' score.

[c] Ratio of income of richest fifth of population to poorest fifth.

The basis of PQLI includes infant mortality rate, life expectancy, literacy rate and fertility rate. In Taiwan, the infant mortality rates improved after the 1970s compared to before, where in average there were only 24 deaths in a thousand (Tsia & Chang, 1985) (Table 7). In 1989, was even less, a great performance in comparison to some so-called developed countries, according to Chan and Clark (1994) with only 5 deaths out of a thousand (Table 6).

Table 6: Data for social economic and political indicators for selected nations by Chan & Clark (1994, p.130-131).

Socioeconomic and political indicators for selected nations (sources: CEPD, 1991, pages 2, 7, 29, 41, 62, 168, 173; DGBAS, 1989, pages 24, 155, 159; Morris, 1979, pages 138–144; World Bank, 1991, pages 204–269).

	GNP per capita 1989 ($)	GDP growth (%) 1965–80	GDP growth (%) 1980–89	Manufacturing (%)[a]	Central government budget (%)[a]	Budget balance (%)[a]
Low income						
Zaire	260	1.8	1.9	10	18.4	−6.8
India	340	3.6	5.3	18	17.7	−6.7
China	350	6.9	9.7	31		
Kenya	370	6.8	4.1	12	28.0	−4.4
Sri Lanka	430	4.0	4.0	16	29.8	−7.5
Middle income						
Philippines	710	5.9	0.7	22	15.7	−2.8
Turkey	1370	6.2	5.1	23	23.7	−4.6
Algeria	2230		3.5	14		
Venezuela	2450	3.7	1.0	28		
Brazil	2540	9.0	3.0	31	30.6	−14.9
South Korea	4400	9.9	9.7	26	18.0	0.2
Taiwan	7510	9.9	7.9	36	25.2	3.4
High income						
Australia	14360	4.0	3.5	15	27.0	0.5
United Kingdom	14610	2.9	2.6	20	34.6	1.3
Netherlands	15920	3.9	1.7	20	54.5	−4.5
France	17820	3.8	2.1	21	42.6	−1.9
Germany	20440	3.3	1.9	32	29.0	−0.1
United States	20910	2.7	3.3	17	23.0	−2.8
Sweden	21570		1.8	23	40.6	4.1
Japan	23810	6.6	4.0	30	16.5	−2.6
Switzerland	29880	5.7	2.1			

[a] As percentage of GNP in 1989.
[b] Physical quality of life index. 100 is the hypothetical 'perfect' score.
[c] 1989 infant mortality per thousand live births.

Table 6 (continued)

	PQLI[b]	Infant mortality[c]	Life expectancy 1985 (years)	Literacy 1985 (%)	Income ratio[d]	Fertility rate[e]
Low income						
Zaire	32	94	53	61		6.1
India	43	95	59	43	5.07	4.1
China	69	30	70	69		2.5
Kenya	39	68	59	59		6.7
Sri Lanka	82	20	71	87	11.69	2.5
Middle income						
Philippines	71	42	64	86	8.73	3.9
Turkey	55	61	66	74		3.6
Algeria	41	69	65	50		5.2
Venezuala	79	35	70	87	10.77	3.6
Brazil	68	59	66	78	26.08	3.3
South Korea	82	23	70		7.95[f]	1.8
Taiwan	86	5	73	93	4.94	1.9
High income						
Australia	93	8	77	⩾95	9.59	1.9
United Kingdom	94	9	76	⩾95	6.81	1.8
Netherlands	96	7	77	⩾95	5.64	1.5
France	94	7	77	⩾95	6.48	1.8
Germany	93	8	75	⩾95	5.69	1.4
United States	94	10	76	⩾95	8.91	1.9
Sweden	97	6	77	⩾95	4.61	2.0
Japan	96	4	79	⩾95	4.31	1.7
Switzerland	95	7	78	⩾95	8.56	1.6

[d] Ratio of richest to poorest fifths of the populations in the mid-1980s.
[e] Number of children per average woman in 1989.
[f] This figure applies to the mid-1970s.

Table 7: Data for Infant mortality rates and average life expectancy in Taiwan by Tsia & Chang (1985, p.240).

Infant Mortality Rates and Average Life Expectancy

Year	Infant Mortality Rate (deaths/1,000)	Average Life Expectancy (years)
1952	91.2	58.6
1954	64.5	62.1
1956	54.2	62.6
1958	46.8	64.3
1960	42.2	64.5
1962	40.4	65.3
1964	31.9	66.5
1966	32.3	66.9
1968	30.9	66.9
1970	26.5	68.7
1972	24.4	69.4
1974	24.6	69.4
1976	23.1	70.5
1978	24.1	70.8
1979	24.1	70.7

Source: Statistical Data Book for the Conference on Social Report of the Republic of China, Ming-teh Foundation, 1981, Table 5.

Life expectancy also has risen from age 68.7 in 1970, to age 72 in 1977 and to age 73 in 1985. These numbers are almost as high as some so-called developed countries (Tsia & Chang, 1985; Chan, & Clark, 1994; Sen, 1981) (Table 6&7). In 1995, the life expectancy was about 74.5 according to Chan et al. (2002, p.269). The literacy rate in 1977 was 82% and also increased to 93% in 1985 (Chan & Clark, 1994; Sen, 1981) (Table 6). The fertility rate in 1989 in Taiwan was found to be the same as Australia and the United States, with the average woman having two children according to Chan & Clark (1994) (Table 6).

2.3.2 Income Distribution in Taiwan

Gross National Product (GNP) is an economic development indicator that measures and estimates total gross domestic and foreign output in a given period produced by a country. It is also related to Gross Domestic Product (GDP) (Hsiao & Hsiao, 1983). GDP measures a country's economic activity and is the final output of a country in terms of monetary values. The GNP per capita of Taiwan in 1977 was around US$1170 (Hsiao & Hsiao, 1983, p. 47). The rank of Taiwan was positioned in the top half of 126 countries by World Bank (Hsiao & Hsiao, 1983, p.47) and top half in 100 countries (Sen, 1981, p. 291). It increased from the 1960s to the 1980s (Scitovsky, 1985; Chan & Clark, 1994) (Table 7). The annual growth rate of GNP between 1970-1995 is 8.4%, which was considered high at that time (Chan et al., 2002, p.268). Although Chan and Clark (1994) indicated that the GDP rate has decreased, Tsia and Chang (1985) had the opposite result and some other studies have discovered that there was still rapid growth in the 1980s in Taiwan. In addition, the

national income increased to US$29,600 per capita as Taiwan specialized in high-tech industry in 2007 (Yao et al., 2009, p.378; Chan & Clark, 1994; Chen, 2016). The income distribution was evenly distributed with US$2,570 for GDP per capita by the end of 1981 meanwhile the economy continues to expand (Scitovsky, 1985, p.216; Chen, 2016, p.516).Taiwan's income inequality situation is quite impressive at that time because normally when an economy starts to grow rapidly, income inequality tends to be worse. However, this was not the case in Taiwan, thanks to the governmental operation of equalization in land, income, wage, factor price...etc. The real income per capita of the 1990s is approximately US$8000 and had a good performance where it was five times more than the 1960s in comparison (Deininger & Squire, 1996, p.587).

2.4 Quality of life in China

Economic growth does not only bring improvement in the numbers of economic indicators, but also improvements in health quality, education systems, city development and increase in revenue (Long & Ji, 2019). Some studies find out that income inequality prevents people from developing a better subjective wellbeing as lower income people feel upset to see others earn more income than they do (Wu & Li, 2017). However, some studies discover the opposite, where there is no relation between income inequality and QOL. For example, some researchers disagree with the idea that economic factors could have a strong effect on happiness in China (Asadullah et al. 2018). Moreover, according to the Easterlin paradox, even though an increase in economic development brings the improvement of physical and tangible observables, the intangible observables such as QOL and happiness do not increase much. Wu and Li (2017) revealed that life satisfaction in China is not consistent in the 1990s while there was an economic growth in GDP per capita. In fact, the subjective well-being decreased in all income level groups as the income inequality continuously increased in the 1990s (Hilke, Jan, Christian & Hao, 2009; Wu & Li, 2017). Hilke et al. (2009) suggest that there is a decrease in happiness from 1990 to 2000 as the perception of happiness declines from 28% to 12%. There is also a fall in life satisfaction.

Figure 1. *Scale of life satisfaction.*

Figure 1. Scale of life satisfaction in China by World values survey from Appleton & Song (2008, p.2328).

Figure 1 shows that around 40% of respondents are satisfied with their life and very little of them are very dissatisfied or very satisfied (Appleton & Song, 2008, p.2328).

Table 8: Mean life satisfaction in selected countries by Appleton & Song (2008, p.2328).

Mean life satisfaction in selected countries

Country	Average life satisfaction
Denmark	8.16
Switzerland	8.02
Sweden	7.77
US	7.67
Australia	7.58
Britain	7.46
Brazil	7.15
Taiwan	6.89
China 1995	6.83
Nigeria	6.82
France	6.78
South Korea	6.69
Japan	6.61
India	6.53
Urban China 2002[a]	6.47
Peru	6.36
South Africa	6.08
Russia	4.45
Ukraine	3.95

Sources: Selected from Frey and Stutzer (2002).
Note: This is a scale between 1 and 10, 1 = lowest score of satisfaction, and 10 = highest.
[1] Denotes authors' calculation from this sample.

Table 9: Changes in reported happiness over time in China by World values survey from Appleton & Song (2008, p.2328).

Changes in reported happiness over time in China, World values survey

	1990	1995	2000
Very happy	27.5	22.7	11.5
Quite happy	39.1	60.9	66.3
Not very happy	28.6	14.1	19.0
Not at all happy	2.1	1.7	2.8
Do not know	2.1	0.6	0.4
No answer	0.6	0.0	0.0

Source: Online analysis of World values survey data at http://www.worldvaluessurvey.org/.

Table 8 demonstrates the comparison of mean of life satisfaction between China and other countries. The life satisfaction of China in 1995 scores 6.83 out of 10, where 10 indicates most satisfaction in life. The data from Table 9 records the years 1990, 1995 and 2000, where there is an increase in happiness between 1990 and 1995. However, in 2000, the happiness factor slumps, especially the level of very happy.

2.4.1 Income Distribution in China

The GDP of China in 2000 is almost five times more than GDP in 1990, moreover in 2010 it is 7.5 times more according to Wu and Li (2017, p.50). Between 1980 and 2010, the income per capita and economic growth has significantly increased, where it is four times more than before (Asadullah, et al. 2018, p.83). According to the Chinese Household Income Project surveys, between 1988 to 2002, the income per capita in more developed cities has an average yearly growth rate of 4.47% (Appleton & Song, 2008, p.2326). In the research of Appleton & Song (2008, p.2328), the survey was conducted in 2002 with the question: ”Considering all aspects of your life, how satisfied are you?” to identify the level of QOL of 7000 respondents, where 1 is very dissatisfied and 5 is very satisfied (Figure 1). The research was constructed under the empirical method to analyze the data of life satisfaction. In other research, the yearly growth of 4.42% between 1995 and 2002 in income per capita was found (*ibid.*). Apart from the increase in GDP and income, China's economic condition is different from Taiwan, China follows the trend as mentioned before. The income inequality and unemployment rate continue to increase (Asadullah et al. 2018). The Gini coefficient of China detected the increase from 0.448 to 0.481 from 2001 to 2010, meanwhile life satisfaction also increased in 35.4% of the respondents from 2003 to 2008 in China (Wu & Li, 2017, p.53). The Gini coefficient is a measurement which captures income

distribution, where 1 indicates there is a high uneven income distribution and 0 means an even income distribution. According to UN, above 0.6 is indicated as a very high uneven income distribution and 0.2 to 0.29 is considered to be the opposite. There is an uncertain relationship between income inequality and happiness in China. In some points-of-view, the income inequality affects QOL since the negative effects on economic conditions lead to crime, financial difficulties, and psychological issues of people (Long & Ji, 2019). According to the World Value Survey data, the happiness of Chinese citizens did not increase for over 20 years, moreover there is a decreasing trend even though income continues to increase (Asadullah et al. 2018, p.84).

3 Methodology

This research follows the post-positivist paradigm, where it is a quantitative based study that has used and collected secondary data to observe changes and results. The reason for choosing post-positivist orientation is because this view is based on the foundation of true knowledge as science and its methods, measurements and procedures are useful to examine the social world (Chilisa & Kawulich, 2012). Moreover, in post-positivism the empirical experienced knowledge highlights the facts and behavioral causes. In addition, this view provides the ability to verify or falsify theories involved with empirical observations. Secondary data analysis is the method using data from previous researchers' primary work, individuals are not present during the process of collecting data and then this data is analyzed (Johnston, 2014; Church, 2005). The analysis is based on published data or original data such as official statistics, administrative records, or data collected by organizations or governments (Church, 2005; Hox, & Boeije 2005). Secondary data analysis includes procedural and evaluative steps, but in a more flexible way (Johnston, 2014).

In this research, the dependent variables are socio-economic indicators, such as GDP, life ladder, and HDI...etc. These indicators are used to examine any change of QOL in Taiwan and China. Using the existing data from secondary sources is a benefit for this research because of limited time and resources (Johnston, 2014). Since the data collection is mostly correct, precise, and real-life orientated, it is quite convenient and useful (Hox & Boeije 2005). However, there are some limitations, such as knowing the exact time of the data collection and understanding the whole processes and conditions, since researchers are not present (Johnston, 2014). For example, the data from Appleton and Song (2008) is collected in 2002 and Liao et al. (2005) is collected in November 2000. Since the researchers only mentioned the year or month when they collected the data, but they did not specifically record or mentioned how long was the process of data collection.

3.1 Data collection

There are many secondary data from difference sources. First, participants and respondents of QOL are from Taiwan and China, however the samplings vary from research to research. Reading and comparing statistical work and identifying what is related, useful and meaningful can be time-consuming. The first step is to collect and organize data that is about economic development, then to interpret the economic changes and process over the 40 years in Taiwan and China. After this, the significance of the growth or decline is examined and reasons to explain the phenomenon are look for. Basically, the

historical economic development is discussed. Therefore, using the economic indicators such as GDP and GNI data that are collected by the national government or organizations to interpret the findings is considered to be accurate and detailed. Secondly, dependent socio-economic variables and social indicators of QOL are collected. In this case, defining QOL and identity, and some related variables such as life ladder, HDI, democratic quality, social support...etc. For Taiwan, surveys as secondary data on indicators like happiness and life satisfaction in 2000s can be found (Yao et al. 2009; Liao et al. 2005). However, there is no older data from these researchers. On the other hand, PQLI is used as an indicator in research of Chan and Clark (1994) and Peniwati and Hsiao (1987). But these data are old and outdated, therefore it is hard to observe later trends. For China, life satisfaction and happiness are observed in the 1990s and 2000s (Asadullah et al. 2018; Wu & Li, 2017). The Easterlin paradox is used to describe the effect of income on QOL. However, some data is not recent or there is no older data, suggesting that there is a need to look for more data to cover these gaps. Since it is difficult and there is limited time and resources, it is convenient to use secondary data to find out the national life satisfaction in both places.

Therefore, in this research, most of economic indicators are collected from the national statistics websites of Taiwan and China (data source can be found in the Reference section) and are used in the conduction of empirical tests. Economic indicators are easily found and have a long data set. However, there is not enough data found for social indicators. HDI and life ladder are the two that have the most complete data set found (data source can be found in the Reference section) and are used also in the empirical tests. However, there is also no older data from the 1970s. The reason for collecting data from these sources is to maintain consistency and keep the data set within similar calculations where they could contribute and produce the most accurate result.

3.2 Data analysis

The method applied to analyze the secondary data will be a quantitative approach. First, data from economic perspective such as income distribution and GDP in Taiwan and China is collected. This secondary data demonstrates an increase in economic development in both places from the 1970s. However, China had a more significant growth in the late 1990s and 2000s (Lo & Li, 2011). Next, the measurements on QOL in Taiwan is introduced. The overall QOL in Taiwan demonstrates that most Taiwanese feel satisfied in life which is applied to verify H1. The QOL in China also has had a significant increase, where it is justified by H1. There is growth in the economy in Taiwan and China, which has improved QOL in both places. Therefore, this demonstrates and verifies H2 if there is a significant effect of economic factors such as GDP

on the QOL in Taiwan and China over the past 40 years. This secondary data demonstrates that the QOL in both places and identified socio-economic indicators have correlated and improved respectively.

3.2.1 Time series analysis, forecasting and correlation

This report is conducted with time series analysis within SPSS software where it is also being called as "longitudinal studies". Using time series analysis generates graphs which demonstrate and observe different seasons of various lengths (Gould, Koehler, Vahid-Araghi, Snyder, Ord & Hyndman, 2005). Time series analysis collects and examines past data, and this is able to help in interpreting the distinct structure which contains inherent characteristics (Adhikari & Agrawal, 2013). Moreover, after the observation of this data, SPSS forecasting can generate a forecast on the incoming time period within the time series analysis, which means that this is based on past data to forecast the future. There are some other time series analysis and models like Brown's and Holt's linear trend. Brown's and Holt's linear trends are both suitable for linear trends but not seasonality and their relevant smoothing parameters are level and trend ("Time Series", 1994). There is no constraint in Holt's linear trend by other values. However, Brown's linear trend is not as general as Holt's linear trend; for larger series, it takes more processes to compute estimates. In Brown's linear trend, the assumption of level and trend is the same. Choosing the right type of the model is crucial for the success of the time series analysis. ARIMA model parameters predict the past values or residuals in a linear way. There are different types of model under ARIMA model parameters which are moving average and autoregressive moving average. The convenience and characteristics of ARIMA model parameters are that ARIMA model parameters are flexible and simple for understanding diverse time series analysis. In forecasting the equation of ARIMA, the model parameters p, d, and q represent different meanings, where p means the number of autoregressive, d is the number of nonseasonal difference requirement for stationary and lastly q means the forecast error of lag in the prediction equation (Nau, 2019). After conducting time series and forecasting analysis are completed, correlations will be conducted. It means once the secondary data has been detrended and the noise residuals obtained, the correlations are then based on these noise residuals. Afterwards, one-tailed tests will be conducted. The one-tailed p-values will be chosen in this study.

4 Results

4.1 Time series and forecasting results of China

The result of the times series graph shows that when *GDP per capita in current US dollars* increases, the social indicator, *HDI*, also increases (Figure 2).

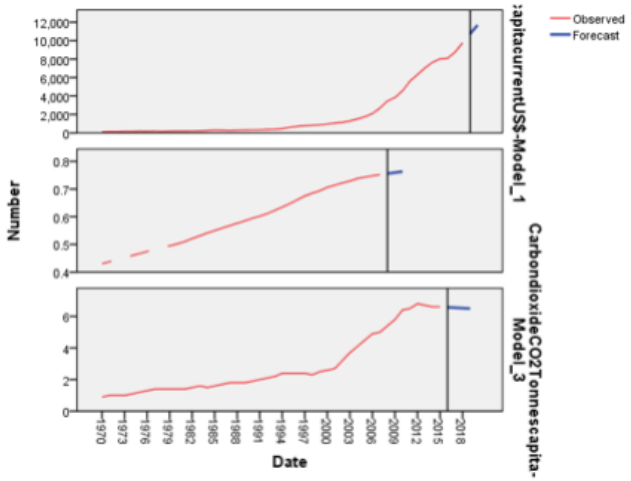

Figure 2. GDP per capita in current US dollar, HDI and CO2 emissions from fossil fuels.

GDP per capita in current US dollars and *CO2 emissions from fuel fuels* both follow Brown's linear trend, and ARIMA model parameters are (0,2,0) for HDI. Moreover, *GDP per capita in current US dollars* and *CO2 emissions from fossil fuels* experience similar ups and downs according to the graph (Figure 2). With the exponential smoothing model parameters, the alpha and trend of *GDP per capita in current US dollars* are almost 1, which indicates that the current smoothed point is set in current time (Table 10).

Table 10: Exponential smoothing model parameters of GDP per capita in current US dollars and CO2 emissions from fossil fuels.

	Exponential Smoothing Model Parameters				
Model Type	Model			Estimate	Sig.
	GDP per capita	No Transformation	Alpha (Level and Trend)	0.94	0
	Carbon dioxide	No Transformation	Alpha (Level and Trend)	0.769	0

For *life ladder*, Holt's linear trend was chosen. *Life ladder* and *GDP per capita in current US dollars* are both ascending according to the forecasting result (Figure 3).

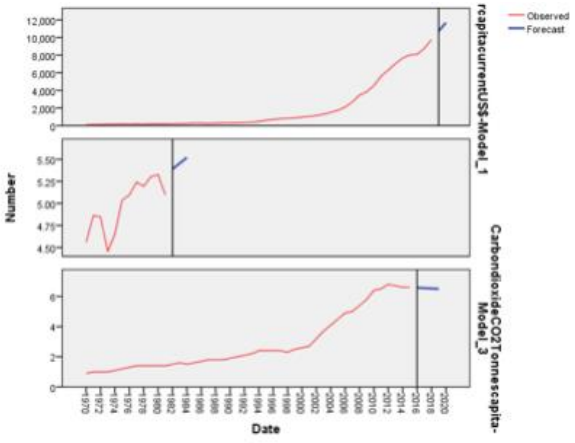

Figure 3. GDP per capita in current US dollars, life ladder and CO2 emissions from fossil fuels.

Life ladder has an alpha of about 0.2, which means that the current smooth point is based on the past smoothed value and since the gamma is extremally small, which confirms with this result (Table 11). *GDP per capita in current US dollars* and *life ladder* do not have significant p-values.

Table 11: Exponential smoothing model parameters of GDP per capita in current US dollars, life ladder and CO2 emissions from fossil fuels.

Exponential Smoothing Model Parameters				
Model			Estimate	Sig.
GDP per capita (current US$)-Model_1	No Transformation	Alpha (Level and Trend)	0.94	0
life ladder (WHR)-Model_2	No Transformation	Alpha (Level)	0.191	0.393
		Gamma (Trend)	9.728E-07	1
Carbon dioxide (Tonnes/capita)-Model_3	No Transformation	Alpha (Level and Trend)	0.769	0

ARIMA model parameters are (2,2,0) that was chosen for *GDP in current US dollars.* In ARIMA model parameters, *GDP in current US dollars* has a significant p-value < 0.05 and it is AR lag 2 (Table 12).

Table 12: ARIMA model parameters of GDP in current US Dollars and HDI.

ARIMA Model Parameters					
				Estimate	Sig.
GDP in currentUS$-Model_1	No Transformation	AR	Lag 2	-0.475	0.009
		Difference		2	
HDI Model_2	No Transformation	Constant		0	0.685
		Difference		2	

GDP in current US dollars and *HDI* both have upwards slopes. *HDI* seems not to be consistent with *GDP in current US dollars* (Figure 4).

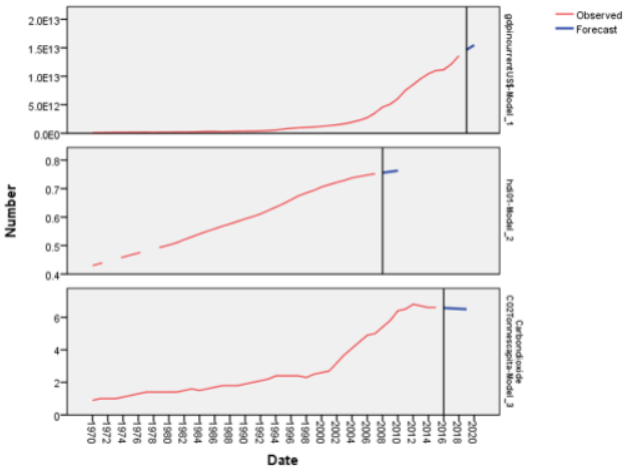

Figure 4. GDP in current US dollars, HDI and CO2 emissions from fossil fuels.

Next, *GNI per capita* and *life ladder* follow Brown's and Holt's linear trend respectively. *Life ladder* has decreased in recent years, but the forecasting demonstrates that it will increase similarly as *GNI per capita* will increase as well (Figure 5).

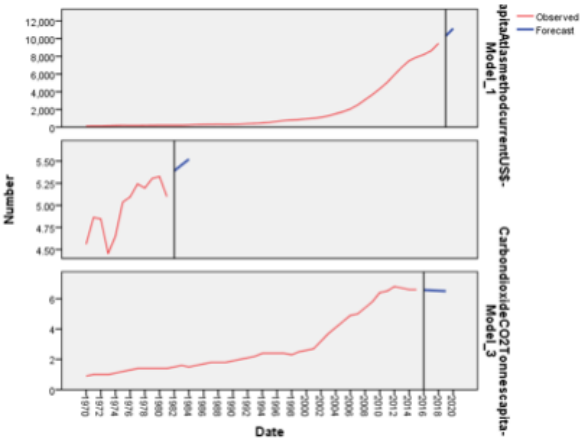

Figure 5. GNI per capita, life ladder and CO2 emissions from fossil fuels.

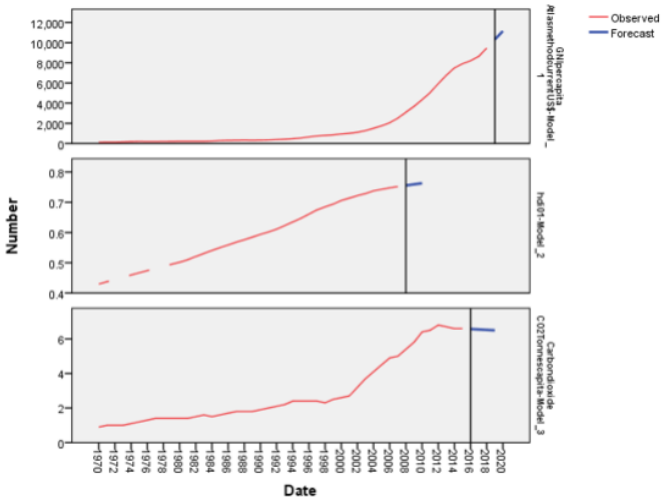

Figure 6. GNI per capita, HDI and CO2 emissions from fossil fuels.

GNI per capita has surged more than *HDI* (Figure 6). There are significant p-values in *GNI per capita* and *life ladder* in exponential smoothing model parameters and *HDI* in ARIMA model parameters (Table 13).

Table 13: Exponential smoothing model parameters of GNI per capita, life ladder and CO2 emissions from fossil fuels.

Exponential Smoothing Model Parameters				
Model			Estimate	Sig.
GNI per capita, Atlas method (current US$)-Model_1	No Transformation	Alpha (Level and Trend)	1	0
life ladder (WHR)-Model_2	No Transformation	Alpha (Level)	0.191	0.393
		Gamma (Trend)	9.73E-07	1
Carbon dioxide (Tonnes/capita) -Model_3	No Transformation	Alpha (Level and Trend)	0.769	0

4.2 Time series and forecasting results of Taiwan

The result of *GDP per capita in current US dollars* and different *HDI* demonstrate some increases, especially in the recent years (Figure 7,8,9). *GNI in US dollars, national income in US dollars* and different *HDI* have the same results. Therefore, the results are not presented here.

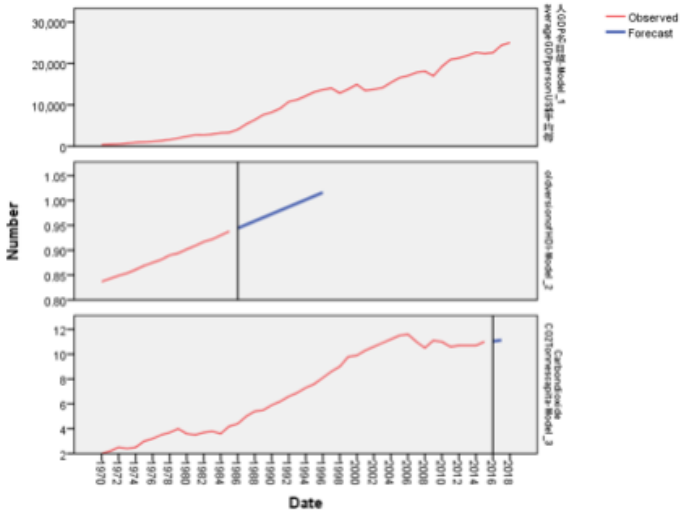

Figure 7. GDP per capita in US dollars, old HDI and CO2 emissions from fossil fuels.

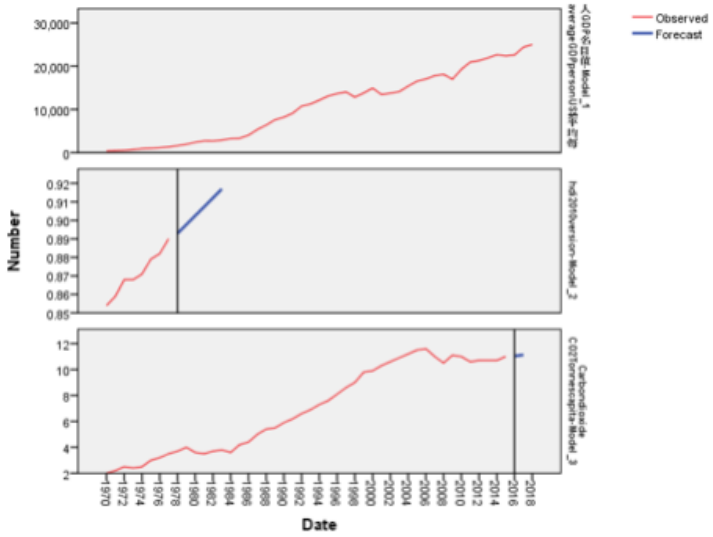

Figure 8. GDP per capita in US dollars, HDI 2010 and CO2 emissions from fossil fuels.

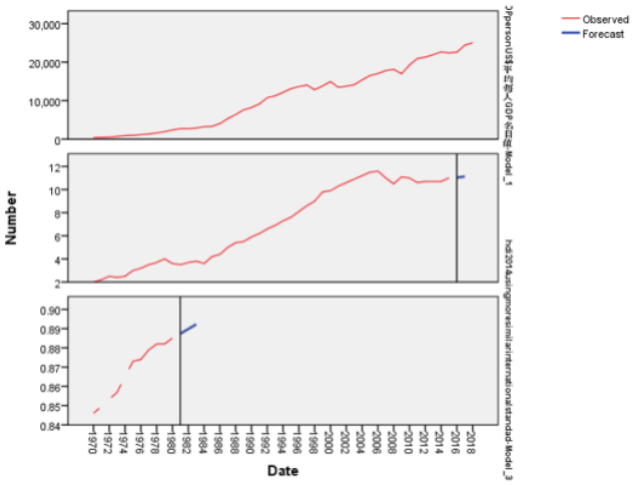

Figure 9. GDP per capita in US dollars, HDI 2014 and CO2 emissions from fossil fuels.

For *GDP per capita in US dollars, old version HDI* and *HDI version 2010*, Holt's linear trend is the chosen model, and Brown's linear trend is the chosen model for *CO2 emissions from fossil fuels*. However, ARIMA model parameters are (0,1,0) for *HDI version 2014*. Moving on to the next social indicator, ARIMA model parameters are (0,1,0) for *life ladder*. *GDP per capita in US dollars, GNI in US dollars, national income in US dollars* and *life ladder* both have increasing signs in the recent years (Figure 10,11,12).

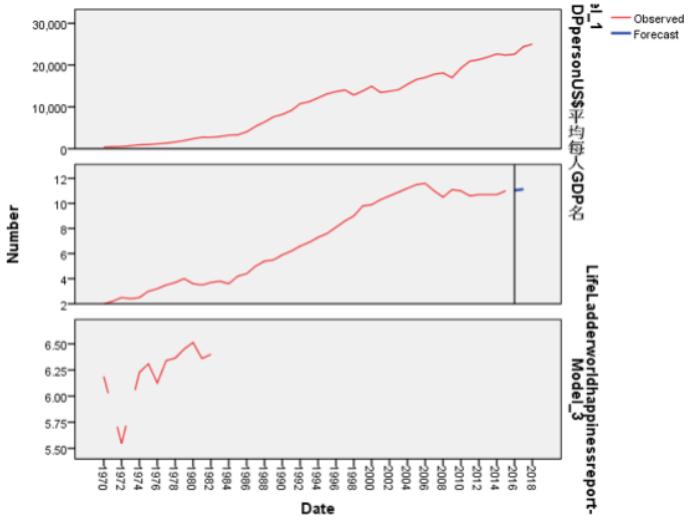

Figure 10. GDP per capita in US dollars, life ladder and CO2 emissions from fossil fuels.

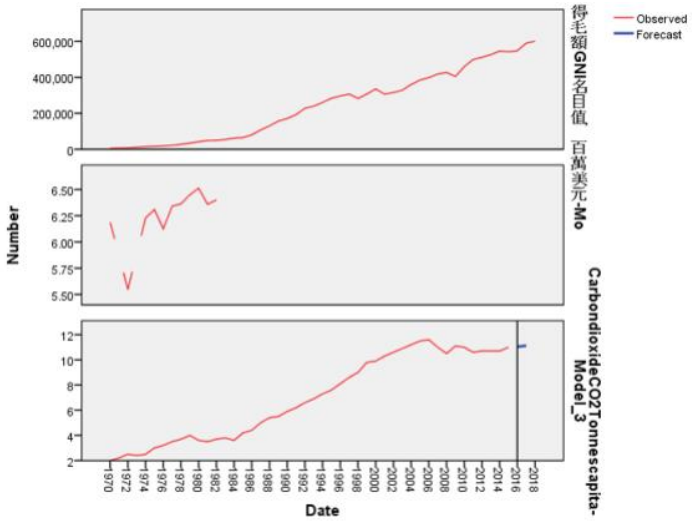

Figure 11. GNI in US dollars, life ladder and CO2 emissions from fossil fuels.

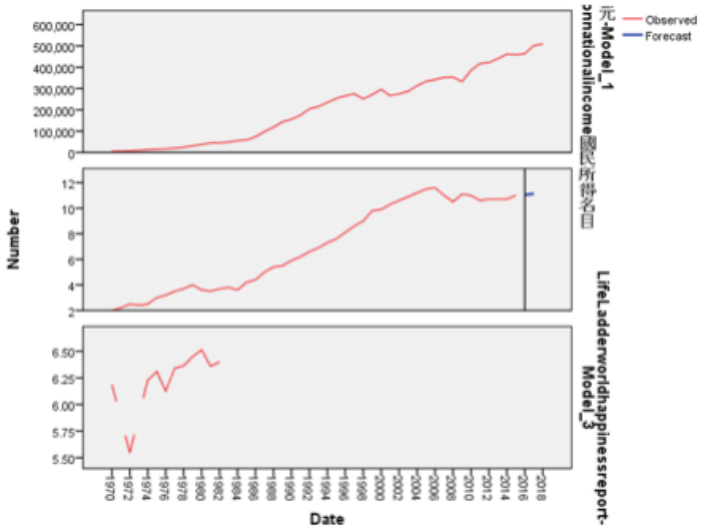

Figure 12. National income in US dollars, life ladder and CO2 emissions from fossil fuels.

GDP per capita in US dollars and *life ladder* have no significant p-values in exponential smoothing model parameters and ARIMA model parameters respectively. *GNI in US dollars* and *life ladder* do not have significant p-values in exponential smoothing model parameters as well. *GNI in US dollars* follows Holt's linear trend; the result of it with different *HDI* also have some increases. Next, *national income in US dollars* follows Holt's linear trend. Regarding the exponential smoothing model parameters, the alpha and gamma of *old version HDI* have significant p-values. In ARIMA model parameters, *HDI version 2014* has a p-value of 0.051. The results of other social indicators including *life ladder* are like what have completed above, which the p-value > 0.05 after conducting SPSS forecasting.

4.3 Correlations between economic indicators and social indicators for China

For China, *GDP per capita in current US dollars* and *HDI* have a negative and small correlation about 0.5 (Table 14). The one-tailed p-value is about 0.4, which is insignificant. *HDI* and *CO2 emissions from fossil fuels* do not correlate well since the value is close to 0.16 which is very small; this correlation has no significant one-tailed p-value (Table 14).

Table 14: The correlation of GDP per capita in current US dollars, HDI and CO2 emissions from fossil fuels and one-tailed p-values.

Correlations: GDP per capita/HDI/Co2				
		Noise residual from GDP/capita currentUS$ -Model_1	Noise residual from HDI -Model_2	Noise residual from CO2 -Model_3
Noise residual from GDP/capita currentUS$ -Model_1	Pearson Correlation	1	-0.049	.264*
	Sig. (1-tailed)		0.406	0.038
Noise residual from HDI -Model_2	Pearson Correlation	-0.049	1	0.157
	Sig. (1-tailed)	0.406		0.227
Noise residual from CO2-Model_3	Pearson Correlation	.264*	0.157	1
	Sig. (1-tailed)	0.038	0.227	
* Correlation is significant at the 0.05 level (1-tailed).				

On the other hand, the result of *GDP per capita in current US dollars* and *life ladder* has a negative correlation of 0.009 and it is insignificant as the one-tailed p-value > 0.05 (Table 15). *Life ladder* and *CO2 emissions from fossil fuels* have an insignificant one-tailed p-value and the correlation is negative and small that is about -0.3. *GDP per capita in current US dollars* and *CO2 emissions from fossil fuels* have a small correlation. The value of correlation is close to 0.3 and the one-tailed p-value < 0.05 (Table 15).

Table 15: The correlation of GDP per capita in current US dollars, life ladder and CO2 emissions from fossil fuels and one-tailed p-values.

Correlations: GDP per capita /Life ladder/co2				
		Noise residual from GDP/capita currentUS$ -Model_	Noise residual from life ladder(WHR)-Model_	Noise residual from CO2-Model_3
Noise residual from GDP per capita currentUS$ -Model_	Pearson Correlation	1	-0.009	.264*
	Sig. (1-tailed)		0.489	0.038
Noise residual from life ladder(WHR)-Model_2	Pearson Correlation	-0.009	1	-0.321
	Sig. (1-tailed)	0.489		0.168
Noise residual from CO2-Model_3	Pearson Correlation	.264*	-0.321	1
	Sig. (1-tailed)	0.038	0.168	

Moving on to the next economic indicator which is *GDP in current US dollars* and *life ladder* have a small negative correlation. However, the one-tailed p-value is insignificant (Table 16). The correlation result of *GDP in current US dollars* and *CO2 emissions from fossil fuels* is 0.225 which is weak. The one-tailed p-value is close to 0.07, which is insignificant (Table 16).

Table 16: The correlation of GDP in current US dollars, life ladder and CO2 emissions from fossil fuels and one-tailed p-values.

Correlations: GDP/ life ladder/ co2				
		Noise residual from GDP in current US$-Model_1	Noise residual from life ladder(WHR)-Model_2	Noise residual from CO2-Model_3
Noise residual from GDP in current US$-Model_1	Pearson Correlation	1	-0.068	0.225
	Sig. (1-tailed)		0.417	0.068
Noise residual from life ladder(WHR)-Model_2	Pearson Correlation	-0.068	1	-0.321
	Sig. (1-tailed)	0.417		0.168
Noise residual from CO2-Model_3	Pearson Correlation	0.225	-0.321	1
	Sig. (1-tailed)	0.068	0.168	

Table 17: The correlation of GDP in current US dollars, HDI and CO2 emissions from fossil fuels and one-tailed p-values.

Correlations GDP/HDI/CO2				
		Noise residual from GDP in current US$-Model_1	Noise residual from HDI -Model_2	Noise residual from CO2-Model_3
Noise residual from GDP in current US$-Model_1	Pearson Correlation	1	0.005	0.225
	Sig. (1-tailed)		0.49	0.068
Noise residual from HDI -Model_2	Pearson Correlation	0.005	1	0.157
	Sig. (1-tailed)	0.49		0.227
Noise residual from CO2-Model_3	Pearson Correlation	0.225	0.157	1
	Sig. (1-tailed)	0.068	0.227	

Next, the correlation of *GDP in current US dollars* and *HDI* is weak and not significant as the one-tailed p-value > 0.05(Table 17). *GNI per capita* and *life ladder* have a small and negative correlation but it is insignificant since the one-tailed p-value > 0.05 (Tables 18). *GNI per capita* and *CO2 emissions from fossil fuels* have a weak correlation and it is insignificant because the one-tailed p-value is about 0.3 (Table 18). *Life ladder* and *CO2 emission from fossil fuels* have a negative and insignificant because the one-tailed p-value > 0.05. *GNI per capita* and *HDI* do not seem to correlate since the correlation value is small and the one-tailed p-value is insignificant. (Table 19)

Table 18: The correlation of GNI per capita, life ladder and CO2 emissions from fossil fuels and one-tailed p-values.

Correlations: GNI per capita/life ladder/co2				
		Noise residual from GNI/capita currentUS$ -Model_1	Noise residual from life ladder(WHR)-Model_2	Noise residual from CO2 -Model_3
Noise residual from GNI/capita currentUS$-Model_1	Pearson Correlation	1	-0.025	0.073
	Sig. (1-tailed)		0.47	0.316
Noise residual from life ladder(WHR)-Model_2	Pearson Correlation	-0.025	1	-0.321
	Sig. (1-tailed)	0.47		0.168
Noise residual from CO2-Model_3	Pearson Correlation	0.073	-0.321	1
	Sig. (1-tailed)	0.316	0.168	

Table 19: The correlation of GNI per capita, HDI and CO2 emissions from fossil fuels and one-tailed p-values.

Correlations:GNI per capita/HDI/CO2				
		Noise residual from GNI/capita currentUS$ -Model_1	Noise residual from HDI-Model_2	Noise residual from CO2-Model_3
Noise residual from GNI/capita currentUS$ -Model_1	Pearson Correlation	1	0.214	0.073
	Sig. (1-tailed)		0.147	0.316
Noise residual from HDI-Model_2	Pearson Correlation	0.214	1	0.157
	Sig. (1-tailed)	0.147		0.227
Noise residual from CO2-Model_3	Pearson Correlation	0.073	0.157	1
	Sig. (1-tailed)	0.316	0.227	

4.4 Correlations between economic indicators and social indicators for Taiwan

GDP per capita in US dollars and *life ladder* have a negative correlation about 0.3, however this result is not significant since the one-tailed p-value > 0.05 (Table 20). *GDP per capita in US dollars* and *CO2 emissions from fossil fuels* have a correlation approximately 0.4 and the one-tailed p-value is 0.002 which is significant (Table 20). The correlation of *life ladder* and *CO2 emissions from fossil fuels* is strong since the result is close to 0.8 and the one-tailed p-value < 0.05.

Table 20: The correlation of GDP per capita in US dollars, life ladder and CO2 emissions from fossil fuels and one-tailed p-values.

Correlations: GDP per capita/life ladder/co2				
		Noise residual from GDP/capita in US$-Model_1	Noise residual from Life Ladder (WHR)-Model_2	Noise residual from CO2-Model_5
Noise residual from GDP/capita in US$-Model_1	Pearson Correlation	1	-0.27	.414**
	Sig. (1-tailed)		0.259	0.002
Noise residual from Life Ladder (WHR)-Model_2	Pearson Correlation	-0.27	1	.792*
	Sig. (1-tailed)	0.259		0.03
Noise residual from CO2-Model_5	Pearson Correlation	.414**	.792*	1
	Sig. (1-tailed)	0.002	0.03	
** Correlation is significant at the 0.01 level (1-tailed).				
* Correlation is significant at the 0.05 level (1-tailed).				

GDP per capita in US dollars and *old version HDI* or *HDI version 2010* does not correlate well. Because the correlations are both around 0.3, and the results do not lead to significant one-tailed p-values. However, *GDP per capita in US dollars* and *HDI version 2014* have a correlation about -0.5 but it is insignificant due to the one-tailed p-value > 0.05 (Tables 21). *Old version HDI* and *CO2 emissions from fossil fuels* have a correlation about 0.6 and it has a significant one-tailed p-value. However, *HDI version 2014* and *CO2 emissions from fossil fuels* have a moderate correlation approximately -0.7, but it is not significant as the one-tailed p-value > 0.05 (Tables 21).

Table 21: The correlation of GDP per capita in US dollars, HDI 2014 and CO2 emissions from fossil fuels and one-tailed p-values.

Correlations: GDP per capita/ HDI 2014				
		Noise residual from GDP/capita US$-Model_1	Noise residual from HDI (2014 version)-Model_4	Noise residual from CO2-Model_5
Noise residual from GDP/capita US$-Model_1	Pearson Correlation	1	-0.545	.414**
	Sig. (1-tailed)		0.171	0.002
Noise residual from HDI (2014 version)-Model_4	Pearson Correlation	-0.545	1	-0.688
	Sig. (1-tailed)	0.171		0.1
Noise residual from CO2-Model_5	Pearson Correlation	.414**	-0.688	1
	Sig. (1-tailed)	0.002	0.1	
** Correlation is significant at the 0.01 level (1-tailed).				

Next, the economic indicator that is applied to correlate with social indicators, is *GDP in US dollars. GDP in US dollars* and *life ladder* have a negative and weak correlation since the value is around -0.3. The correlation is not significant because the one-tailed p-value > 0.05. The correlation of *GDP in US dollars* and *CO2 emissions from fossil fuels* is weak; however, it has a

significant p-value < 0.05. The correlation of *GDP in US dollars* and *old version HDI* is small. The value of correlation is close to 0.3 and the one-tailed p-value > 0.05. *GDP in US dollars* and *HDI version 2010* have a weak correlation and the one-tailed p-value < 0.05. *GDP in US dollars* and *HDI version 2014* have a negative but insignificant correlation about 0.5 since the one-tailed p-value > 0.05.

4.5 Time series and correlations for China when adding independent variables

GDP in current US dollars is chosen as an independent variable, *HDI* and *fertility rate* are dependent variables. For *HDI*, Brown's linear trend and ARIMA model parameters are (0,1,0) for *fertility rate*. *HDI* is statistically significant (p<0.001) in ARIMA model parameters and the *fertility rate* has a significant p-value < 0.05 in exponential smoothing parameters. As *HDI* is increasing, the *fertility rate* is decreasing according to the SPSS forecasting (Figure 13). The dependent variables have a correlation value that is -0.225 and the one-tailed p-value > 0.05.

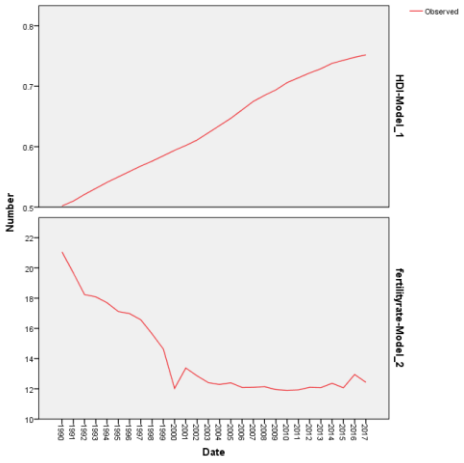

Figure 13. GDP in current US dollars as the independent variable, HDI and fertility rate as dependent variables.

Next, *fertility rate* is substituted with *life expectancy*. ARIMA model parameters are (1,3,0) for *life expectancy*; there is a lag 1 and its significant p-value < 0.001. The forecasts of both variables have similar curve lines (Figure14).

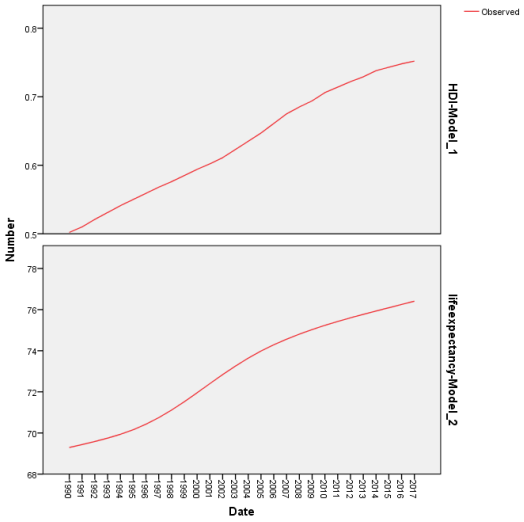

Figure 14. GDP in current US dollars as the independent variable, HDI and life expectancy as dependent variables.

There is also no significant one-tailed p-values in the correlation between the dependent variables. The correlation value is quite small that is about 0.04 and is insignificant as p-value < 0.05. Replacing *GDP in current US dollars* with other economic indicators such as *GNI per capita* or *household consumption* have similar results.

Moving on, *HDI* is chosen as the independent variable and *life expectancy* and *fertility rate* are dependent variables. The forecast demonstrates that as *fertility rate* decreases, *life expectancy* increases (Figure 15). The dependent variables do not correlate and the one-tailed p-value > 0.05.

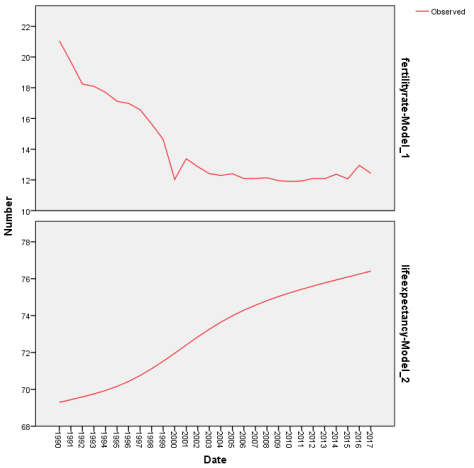

Figure 15. HDI as the independent variable, fertility rate and life expectancy as dependent variables.

On the other hand, the next social indicator is *life ladder*. *GDP per capita in current US dollars* is the independent variable, *life ladder* and *fertility rate* are dependent variables. *Life ladder* follows Holt's linear trend and ARIMA model parameters are (0,0,0) for *fertility rate*. The p-value > 0.05 for *life ladder* in exponential smoothing model parameters. The p-value < 0.001 for *fertility rate*; *GDP per capita in current US dollars* has a p-value < 0.05 and its numerator is lag 0 in ARIMA model parameters. *Life ladder* and *fertility rate* have a small correlation since it is about 0.206. The one-tailed p-value of this correlation > 0.05. When using *GNI per capita*, *GDP in current US dollars*, and *household consumption* as the independent variables to analyze data, Holt's linear trend is the chosen model for *life ladder* and *fertility rate*. There is no significant one-tailed p-value in both dependent variables when applying Holt's linear trend. Therefore, the results are not reported here. The forecasts of *life ladder* and *fertility rate* are irregular and there is a small similarity in the ups and downs (Figure 16).

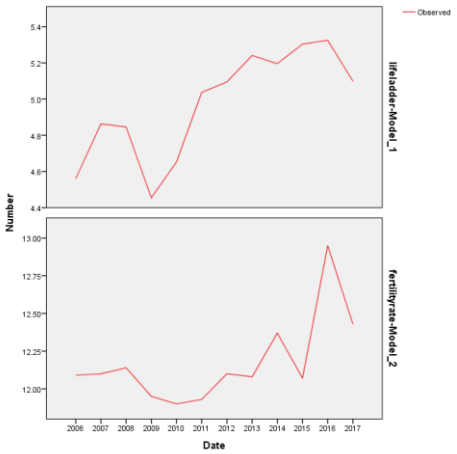

Figure 16. GDP per capita in current US dollars as the independent variable, life ladder and fertility rate as dependent variables.

Next, *economic active population* is applied as the independent variable and *household consumption* is added to the dependent variables to. The chosen ARIMA model parameters of *household consumption* are (0,1,0). The p-value of *household consumption* < 0.001. The correlation between these dependent variables is weak and the one-tailed p-value > 0.05 which is insignificant (Table 22).

Table 22: The correlation of life ladder, household consumption and fertility rate and one-tailed p-values.

Correlations				
		Noise residual from life ladder-Model_1	Noise residual from household consumption in yuan-Model_2	Noise residual from fertility rate-Model_3
Noise residual from life ladder-Model_1	Pearson Correlation	1	0.372	0.062
	Sig. (1-tailed)		0.13	0.424
Noise residual from household consumption in yuan-Model_2	Pearson Correlation	0.372	1	0.034
	Sig. (1-tailed)	0.13		0.46
Noise residual from fertility rate-Model_3	Pearson Correlation	0.062	0.034	1
	Sig. (1-tailed)	0.424	0.46	

Next, *life expectancy* and *life ladder* are dependent variables and *GDP per capita in current US dollars* is the independent variable. ARIMA model parameters are (0,3,0) for *life expectancy*. In the ARIMA model parameters, *life expectancy* has a p-value < 0.05; the numerators of *GDP per capita in current US dollars* are lag 0 and 2 that have p-values < 0.05. The result of significant p-value for lag 2 is interesting, which will be discussed later in discussion section. As *life expectancy* increases, *life ladder* has experienced a similar curve (Figure 17). The correlation between these dependent variables is moderate but the one-tailed p-value > 0.05.

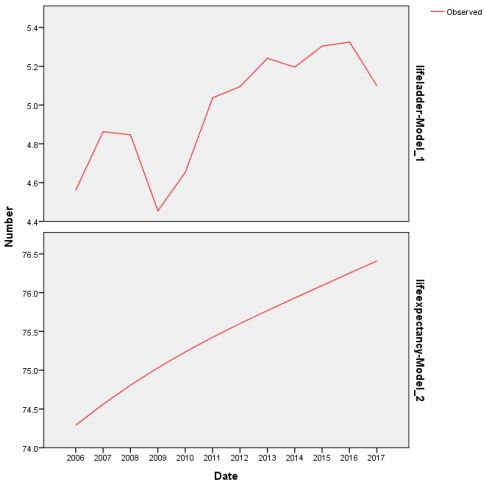

Figure 17. GDP per capita as the independent variable, life ladder and life expectancy as dependent variables.

Using *GDP in current US dollars* as the independent variable has the same results as before, which the numerators are lag 0 and 2 and they have significant p-values in ARIMA (0,3,0). However, using *GNI per capita* and *household consumption* are different, the p-value of *life expectancy* changes from 0.001 to 0.01. Using *economic active population* as the independent variable and adding *household consumption* as a dependent variable to run the data has a similar result as before. There is no correlation between these dependent variables as the one-tailed p-values > 0.05 (Table 23).

Table 23: The correlation of life ladder, life expectancy and household consumption and one-tailed p-values.

Correlations				
		Noise residual from life ladder-Model_1	Noise residual from life expectancy-Model_2	Noise residual from household consumption in yuan-Model_3
Noise residual from life ladder-Model_1	Pearson Correlation	1	0.423	0.372
	Sig. (1-tailed)		0.128	0.13
Noise residual from life expectancy-Model_2	Pearson Correlation	0.423	1	0.163
	Sig. (1-tailed)	0.128		0.337
Noise residual from household consumption in yuan-Model_3	Pearson Correlation	0.372	0.163	1
	Sig. (1-tailed)	0.13	0.337	

Next, *social support* is chosen to be the independent variable, *life ladder*, *life expectancy* and *fertility rate* are dependent variables. Holt's linear trend is the chosen model for *life ladder* and *fertility rate*; ARIMA model parameters are (0,3,0) for *life expectancy*. The result of *life expectancy* is same as above, which has a significant p-value of 0.01. *Life ladder* and *fertility rate* have no significant p-values and because p-values are about 0.4 and 0.9 respectively. There is no correlation between these dependent variables since the one-tailed p-value > 0.05 (Table 24).

Table 24: The correlation of life ladder, fertility rate and life expectancy and one-tailed p-values.

Correlations				
		Noise residual from life ladder-Model_1	Noise residual from fertility rate-Model_2	Noise residual from life expectancy-Model_3
Noise residual from life ladder-Model_1	Pearson Correlation	1	0.062	0.423
	Sig. (1-tailed)		0.424	0.128
Noise residual from fertility rate-Model_2	Pearson Correlation	0.062	1	0.124
	Sig. (1-tailed)	0.424		0.376
Noise residual from life expectancy-Model_3	Pearson Correlation	0.423	0.124	1
	Sig. (1-tailed)	0.128	0.376	

Lastly, *life ladder* is applied as the independent variable, *life expectancy*, *social support* and *fertility rate* are dependent variables. ARIMA model parameters are (0,0,0) for *social support* and the others remain the same. The p-value of *social support* < 0.001. The forecast of these dependent variables differs greatly from each other (Figure 18).

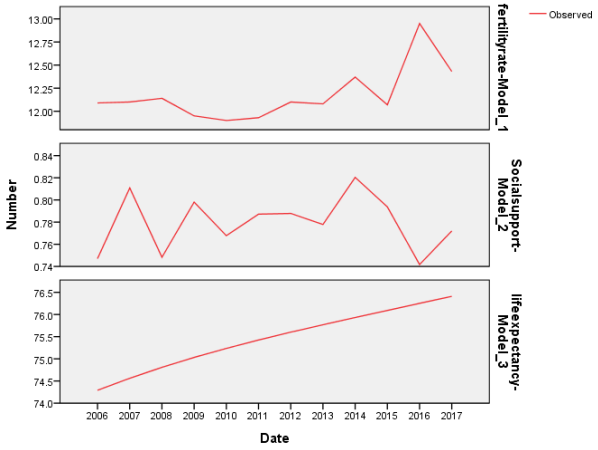

Figure 18. Life ladder as the independent variable, fertility rate, social support and life expectancy as dependent variables.

The correlations between these dependent variables have no significant one-tailed p-values. However, there is one difference compared to above, which is the correlation of *social support* and *fertility rate* because it has a negative value (Table 25).

Table 25: The correlation of fertility rate, social support and life expectancy and one-tailed p-values.

Correlations

		Noise residual from fertility rate-Model_1	Noise residual from Social support-Model_2	Noise residual from life expectancy-Model_3
Noise residual from fertility rate-Model_1	Pearson Correlation	1	-0.448	0.124
	Sig. (1-tailed)		0.072	0.376
Noise residual from Social support-Model_2	Pearson Correlation	-0.448	1	0.431
	Sig. (1-tailed)	0.072		0.124
Noise residual from life expectancy-Model_3	Pearson Correlation	0.124	0.431	1
	Sig. (1-tailed)	0.376	0.124	

4.6 Time series and correlations for Taiwan when adding independent variables

First, *GDP in US dollars* is chosen as the independent variable, *life ladder*, *life expectancy* and *CO2 emissions from fossil fuels* are the dependent variables. *Life ladder* and *life expectancy* follow Holt's linear trend. ARIMA model parameters are (0,0,0) that is chosen for *CO2 emissions from fossil fuels*. The results of forecasting for *life ladder* and *life expectancy* both have upwards slopes (Figure 19).

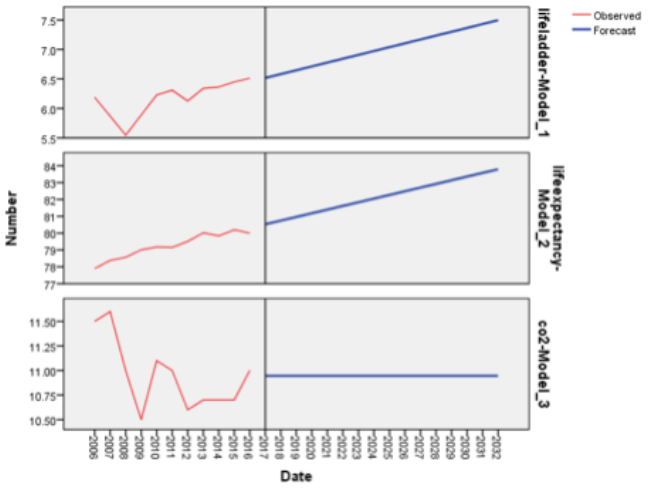

Figure 19. GDP in US dollars as the independent variables, life ladder, life expectancy and CO2 emissions from fossil fuels as dependent variables.

The p-values of these dependent variables > 0.05 and the p-value of independent variable is almost 1 in exponential smoothing model parameters. *CO2 emissions from fossil fuels* in ARIMA model parameters has a p-value < 0.001. The estimates of alpha and gamma of *life ladder* are 0.007 and almost 1 respectively; the estimates of alpha and gamma of *life expectancy* are close to 2 and close 0 respectively. The correlation of *life ladder* and *life expectancy* is negative with small values (Table 26). The one-tailed p-value > 0.05. The correlation of *life expectancy* and *CO2 emissions from fossil fuels* has the same result. *Life ladder* and *CO2 emissions from fossil fuels* have a small correlation but the p-value > 0.05.

Table 26: The correlation of life ladder, life expectancy and CO2 emissions from fossil fuels and one-tailed p-values.

Correlations				
		Noise residual from lifeladder-Model_1	Noise residual from lifeexpectancy-Model_2	Noise residual from co2-Model_3
Noise residual from life ladder-Model_1	Pearson Correlation	1	-0.317	0.358
	Sig. (1-tailed)		0.171	0.14
Noise residual from life expectancy-Model_2	Pearson Correlation	-0.317	1	-0.309
	Sig. (1-tailed)	0.171		0.178
Noise residual from co2-Model_3	Pearson Correlation	0.358	-0.309	1
	Sig. (1-tailed)	0.14	0.178	

Next, there are two methods to observe the forecasts of *total births in a year*, *school enrolment rate* and *social support* as dependent variables. First method is to remove the variable, *democratic quality*, and the second method is to keep all variables at the same length, which is for the year 2016. In the first method, *total births in a year* and *life ladder* are dependent variables and *GDP in US dollars* is the independent variable. *Life ladder* follows the model, simple. For, *total births in a year*, ARIMA model parameters are (0,0,0) is chosen. The alpha of *life ladder* is 1 and has a significant p-value of 0.005. The *total births in a year* has a p-value < 0.001. The correlation between *life*

ladder and *total births in a year* about -0.5. The one-tailed p-value is 0.05, which it is not expected. Replacing *total births in a year* with *school enrolment rate*. ARIMA model parameters are (0,1,0) is chosen for *school enrolment rate*. In ARIMA model, *GDP in US dollars* is delayed, the numerators are lag 0 and 1 and they have p-values of 0.029 and 0.001 respectively. The correlation of *school enrolment rate* and *life ladder* is -0.154. The one-tailed p-value > 0.05, therefore the correlation is insignificant. Then, *social support* is applied to be the dependent variable and simple is the chosen model. The p-value of *social support* is 0.05 in exponential smoothing model parameters. The correlation of *social support* and *life ladder* has a value is about 0.46 and one-tailed p-value is > 0.05. SPSS forecast is not able to forecast *total births in a year*, *school enrolment rate*, *social support*, and *life ladder* well without *democratic quality* because SPSS forecasting does not exceed naïve models. Therefore, the results are not reported here.

Moving on to the second method, keeping *democratic quality* as a variable in the dataset for the year 2016 to analyze data. *Life ladder* and *total births in a year* are dependent variables and *GDP in US dollars* is the independent variable. Holt's linear trend is chosen for *life ladder* and ARIMA model parameters are (0,0,0) for *total births in a year*. *Total births in a year* has a significant p-value < 0.05; *GDP in US dollars* is lag 0 and the significant p-value is 0.051. The correlation has a negative and small value about 0.49. The one-tailed p-value is > 0.05. Next, ARIMA model parameters are (0,1,0) for *school enrolment rate*. *GDP in US dollars* has similar results, but the p-values are slightly different (Table 27).

Table 27: ARIMA model parameters of school enrolment rate and GDP in US dollars.

ARIMA Model Parameters						
					Estimate	Sig.
Enrolment rate age 6-21 (%)-Model_2	Enrolment rate age 6-21 (%)	No Transformation	Difference		1	
	gdp	No Transformation	Delay		2	
			Numerator	Lag 0	-1.68E-06	0.019
				Lag 1	3.96E-06	0
			Difference		1	

The one-tailed p-values > 0.05 in these dependent variables. However, in this second method, the value of correlation is positive that is about 0.2. Lastly, ARIMA model parameters of *social support* are (0,0,0). *Social support* has a p-value < 0.001; *GDP in US dollars* is delayed, and its numerator is lag 0, which the p-value < 0.001. The correlation between these dependent variables is small which less is than 0.08 and the one-tailed p-value > 0.05. Substituting *GDP in US dollars* with other economic indicators such as *GNI*, *GDP per capita in US dollars* and *national income* demonstrate similar forecasting, exponential smoothing model parameters and ARIMA model parameters. SPSS forecasting is not able to forecast *total births in a year*,

school enrolment rate, *social support*, *democratic quality*, therefore the forecasting results are not reported here.

Perception of corruption is chosen as the independent variable; *life ladder* and *democratic quality* are dependent variables. The ARIMA model parameters of *democratic quality* are (0,1,0) and it has a p-value of 0.059. The forecasts of these two variables have positive slopes (Figure 20).

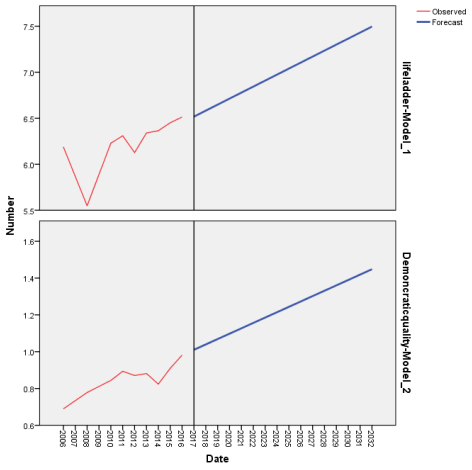

Figure 20. Perception of corruption as the independent variable, life ladder and democratic quality as dependent variables.

The correlation of *democratic quality* and *life ladder* is about 0.035 and the one-tailed p-value > 0.05 which is insignificant. Next, replacing *democratic quality* with *confidence in national government* to run the analyze. The ARIMA model parameters of *confidence in national government* is (0,0,0); it has a p-value < 0.001, *perception of corruption* has a p-value of 0.001. The one-tailed p-value > 0.05, therefore they are not reported here. *Democratic quality* is the independent variable, *freedom to make life choices* and *life ladder* are dependent variables. *Freedom to make life choices* follows Holt's linear trend. The alpha and gamma of *freedom to make life choices* are about 0.1 and almost 0 (Table 28).

Table 28: Exponential smoothing model parameters of freedom to make life choices.

Exponential Smoothing Model Parameters				
Model			Estimate	Sig.
life ladder -Model_1	No Transformation	Alpha (Level)	0.007	0.97
		Gamma (Trend)	0.989	0.977
Freedom to make life choices-Model_2	No Transformation	Alpha (Level)	0.1	0.559
		Gamma (Trend)	9.83E-06	1

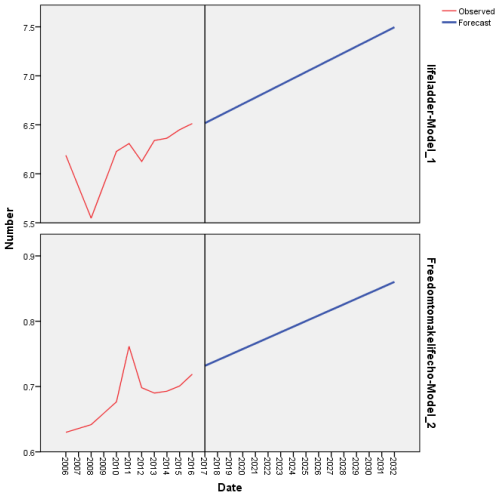

Figure 21. Democratic quality as the independent variable, life ladder and freedom to make life choices as dependent variables.

The forecast also has a positive slope (Figure 21). The value of correlation is about 0.3 for *freedom to make life choices* and *life ladder*, which is weak. The one-tailed p-value > 0.05. *Life ladder* is applied to be the independent variable, *life expectancy* and *total births in a year* are dependent variables. The ARIMA model parameters of *total births in a year* is (0,0,0). The p-value of *total births in year* > 0.05. SPSS forecasting has not discovered any significant p-value in this forecasting model and proposes a naïve model. The correlation of *life expectancy and total births in a year* -0.345 and the one-tailed p-value > 0.05, which is insignificant.

Moving on to next social indicator *old version HDI*, it is applied here because it has the most complete dataset. *HDI* and *CO2 emissions from fossil fuels* are dependent variables and *GDP in US dollars* is the independent variable. *HDI* follows Holt's linear trend, and ARIMA model parameters of *life expectancy* and *CO2 emissions from fossil fuels* are both (0,1,0). *HDI* has the same result as above, which the p-values of alpha and gamma < 0.05. *CO2 emissions from fossil fuels* and *life expectancy* have p-values < 0.001. The forecast of *HDI*, *life expectancy* and *CO2 emissions from fossil fuels* are both increasing (Figure 22).

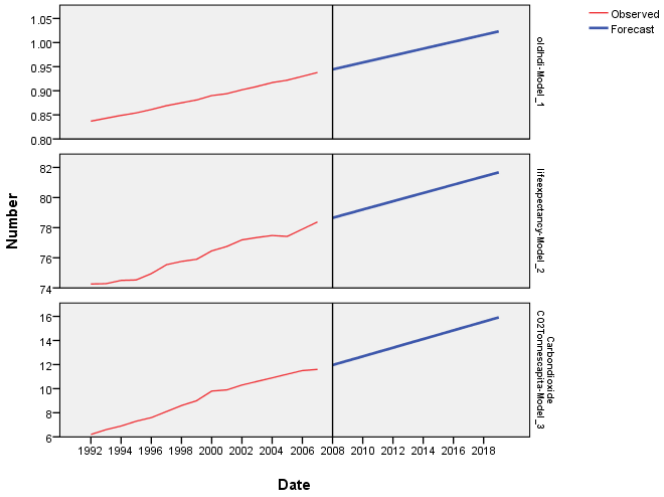

Figure 22. GDP in US dollars as the independent variable, HDI, life expectancy and CO2 emissions from fossil fuels as dependent variables.

HDI and *life expectancy* have a weak correlation and its one-tailed p-value < 0.05. The same result can be found for *HDI* and *CO2 emissions from fossil fuels* (Table 29). The one-tailed p-value of *life expectancy and CO2 emissions from fossil fuels* > 0.05 and the correlation is weak.

Table 29: The correlation of old version HDI, life expectancy and CO2 emissions from fossil fuels and one-tailed p-values.

Correlations

		Noise residual from old version HDI-Model_1	Noise residual from life expectancy-Model_2	Noise residual from Carbon dioxide CO2-Model_3
Noise residual from old version HDI-Model_1	Pearson Correlation	1	.551*	.551*
	Sig. (1-tailed)		0.017	0.017
Noise residual from life expectancy-Model_2	Pearson Correlation	.551*	1	0.211
	Sig. (1-tailed)	0.017		0.225
Noise residual from Carbon dioxide CO2-Model_3	Pearson Correlation	.551*	0.211	1
	Sig. (1-tailed)	0.017	0.225	

* Correlation is significant at the 0.05 level (1-tailed).

When replacing *life expectancy* with *total births in a year*, Holt's linear trend is chosen for it. The p-value > 0.05 for *total births in a year* (Table 30).

Table 30: Exponential smoothing model parameters of old version HDI and total births in a year.

Exponential Smoothing Model Parameters

Model			Estimate	Sig.
old version hdi-Model_1	No Transformation	Alpha (Level)	0.268	0.016
		Gamma (Trend)	0.653	0.031
Total births per year-Model_2	No Transformation	Alpha (Level)	0.101	0.23
		Gamma (Trend)	1.75E-05	1

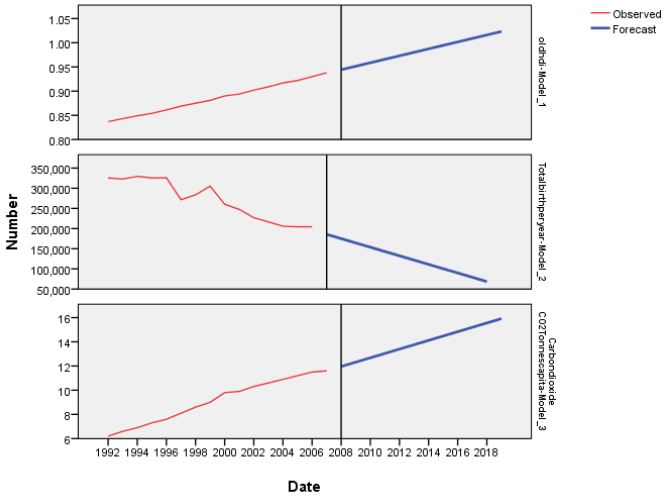

Figure 23. GDP in US dollars as the independent variable, HDI, total births in a year and CO2 emissions from fossil fuels as dependent variables.

The forecasting result of *total births in a year* demonstrates that it has a negative slope (Figure 23). There is correlation between *total births in a year* and *HDI* or between *CO2 emissions from fossil fuels* because the p-values are > 0.05 (Table 31).

Table 31: The correlation of old version HDI, total births in a year and CO2 emissions from fossil fuels and one-tailed p-values.

Correlations				
		Noise residual from old version HDI-Model_1	Noise residual from Total births per year-Model_2	Noise residual from Carbon dioxide CO2-Model_3
Noise residual from old version HDI-Model_1	Pearson Correlation	1	0.352	.551*
	Sig. (1-tailed)		0.099	0.017
Noise residual from Total births per year-Model_2	Pearson Correlation	0.352	1	0.389
	Sig. (1-tailed)	0.099		0.076
Noise residual from Carbon dioxide CO2-Model_3	Pearson Correlation	.551*	0.389	1
	Sig. (1-tailed)	0.017	0.076	
* Correlation is significant at the 0.05 level (1-tailed).				

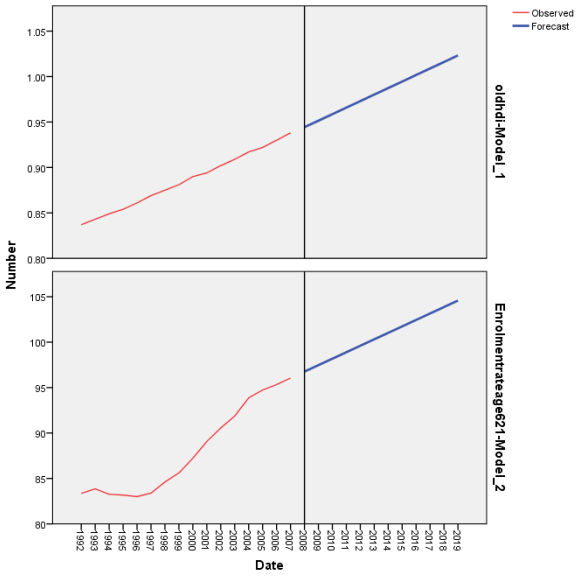

Figure 24. GDP as the independent variable, HDI and school enrolment rate age 6-21 as dependent variables.

Brown's linear trend is chosen when replacing *total births in a year* with *school enrolment rate*. *School enrolment rate* has a p-value <0.001. *School enrolment rate* and *HDI* both have positive slopes (Figure 24). The correlation between these dependent variables is 0.43 which is weak. But the one-tailed p-value < 0.05. Using *HDI* is applied to be the independent variable, *school enrolment rate* and *total births in a year* are dependent variables to run the data analysis. The forecast demonstrates *school enrolment rate* is increasing but the *total births in a year* has a negative slope (Figure 25). The correlation of these dependent variables is weak, and the value is about 0.2. The one-tailed p-value > 0.05, which is insignificant. The forecast demonstrates that *life expectancy* has a positive slope, but *total births in a year* is the opposite (Figure 26). The correlation between these dependent variables is 0.69, which is strong. The one-tailed p-value is < 0.05, which is significant.

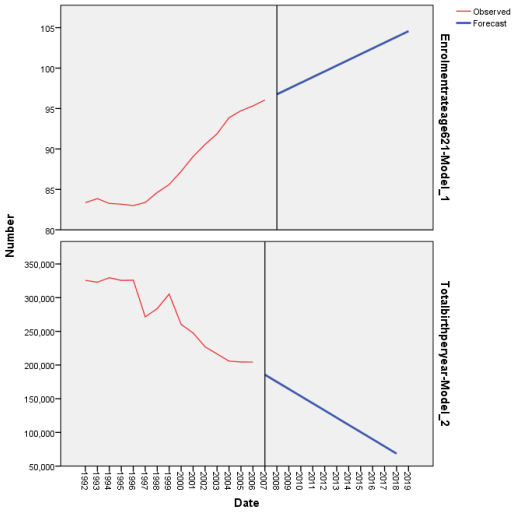

Figure 25. Old version HDI as the independent variable, total births and school enrolment rate age 6-21 as dependent variables.

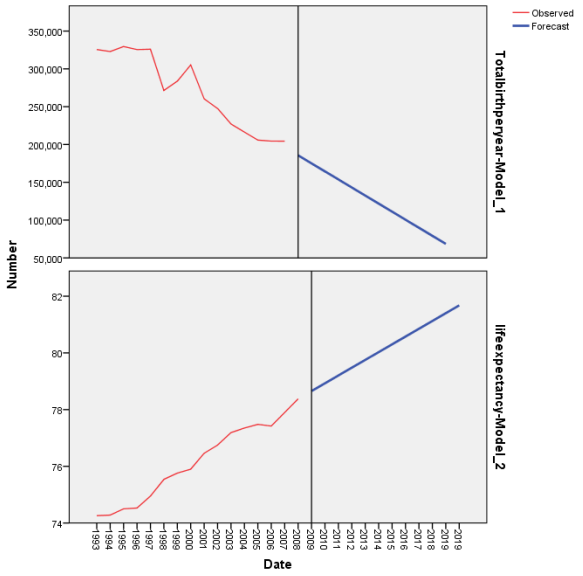

Figure 26. Old version HDI as the independent variable, total births in a year and life expectancy as dependent variables.

5 Discussion

5.1 Comparison of time series results without independent variables between China and Taiwan

The purpose of this paper is to attempt to discover economic development affects QOL in China and Taiwan for the past 40 years. The time series analysis results of most economic indicators are insignificant with social indicators for China. However, *GDP in US dollars* is significant and has an AR lag 2, which means that the p is the order of the autoregressive model in ARIMA (p,d,q,). Lag 2 means the deviation from the series should be considered regarding the second values in the past. In other words, the effect on GDP is delayed by 2 years. The forecasts of economic and social indicators demonstrate some growths over the past 40 years. Most of the economic indicators have surges around the beginning of the 2000s, same as C*O2 emissions from fossil fuels*, and *HDI* has only grown gradually over time. The economic indicators will increase more than *HDI* according to the forecasts. On the other hand, the availability of the data for *life ladder* is from 2006; life ladder decreased in 2009 after the Financial Crisis in 2008 and increased again in 2010. But there are even no decreases in *HDI*. Therefore, it is suspected that the social indicators are not influenced by the economic indicators, however, they both increased overall because of some other factors.

For Taiwan, there are no significant changes in the economic indicators and social indicators. The *old version HDI* used life expectancy (starting with age 0), adult literacy rate, gross school enrolment rate and purchasing power parity as indexes in the calculation of HDI. In *HDI version 2010*, life expectancy and purchasing power parity remains the same; average years in school and expected years in school are considered as indexes. *HDI version 2014* has some calculation changes in 2005, 2008 and 2010 to 2012. The data value of different HDI does not seem to be affected by the Financial Crisis in 2008. The forecast of the *old version HDI* has grown gradually and steadily compared to *HDI version 2010* and *2014*. Overall, they all have some certain degrees of increase. However, *life ladder* dropped in 2008 and increased after 2010. On the other hand, SPSS forecasting is not able to predict *life ladder* due to the limit of the data collected. *CO2 emissions from fossil fuels* have been increasing. However, it has not been increasing a lot recently like before.

According to SPSS forecasting results, Hypothesis 1, QOL in Taiwan and China should have increased during the past 40 years but it has not been confirmed because the data of social indicators are only available for the past 30 years. Therefore, the data does not allow for this conclusion. Since the data of *HDI* of China and Taiwan have a set of continuous data for almost 30 years,

HDI has improved as the economic indicators grew during these past 30 years. The data of *life ladder* of China only spans 11 years. Even though there are ups and downs during these 11 years, SPSS forecasting shows an increase. On the other hand, Taiwan also experienced similar fluctuations as China. However, there are no SPSS forecasting results of Taiwan, even when the data from 2006 to 2017 is separated and run with economic indicators, the forecasting result demonstrates a horizontal line for each year. Therefore, it is difficult to examine if *life ladder* has increased with the economic indicators. But since *HDI* of Taiwan has a longer and more continuous length of data, QOL in Taiwan has increased for the past 30 years, but not 40 years, which is the same as China.

5.2 Comparison of correlations without independent variables between China and Taiwan

For China, *HDI* and most economic indicators have small and insignificant one-tailed correlations, especially with *GDP per capita in current US dollars*, which has a negative value. *GDP in current US dollars* and *HDI* can be interpreted so that there is no correlation between them because the value of correlation is very small, and it has an insignificant p-value. On the other hand, *life ladder* with all economic indicators have negative small correlations. These values are also extremely small as well, which can be interpreted as no correlation and since p-values > 0.05. Therefore, as economic indicators grow, social indicators do not seem to be improving as much. Moreover, the negative values of correlations imply that as economic indicators increase, the social indicators decrease, or vice versa. But since the correlation values are not significant, there is not sufficient evidence to prove and conclude that there are linear relationships between the economic indicators and social indicators yet. However, the correlations of *CO2 emissions from fossil fuels* and *GDP per capita in current US dollars* and *GDP in current US dollars* are significant, but they are very weak correlations. This means when economic indicators grew, *CO2 emissions from fossil fuels* increased a little, which is reasonable. However, since the concept of sustainability has been more widely accepted and adapted in the government regulations in recent years, the correlations between *CO2 emissions from fossil fuels* and *GDP per capita in current US dollars* and *GDP in current US dollars* being small is reasonable. Moreover, other economic indicators do not demonstrate higher and significant correlations.

For Taiwan, the similar results on correlations can be observed. Interestingly, *HDI version 2014* is the only one that has negative correlations with economic indicators compared to the other versions of HDI. *Life ladder* also has negative values with economic indicators which also means two variables go two

separate directions. Next, the correlation values of *CO2 emissions from fossil fuels* and economic indicators are almost moderate, which means there is a higher correlation compared to China. In contrast to China, the correlations between social indicators and *CO2 emissions from fossil fuels* of Taiwan are significant and almost moderate. For examples, social indicators like *Old version HDI* and *life ladder* have strong correlations with *CO2 emissions from fossil fuels*. According to these results, Hypothesis 2, there is a significant effect of economic indicators, such as GDP on QOL in Taiwan and China over the past 40 years, but it could not be investigated because there is not enough data and moreover there is no strong or moderate correlation between economic indicators and social indicators.

5.3 Comparison of time series and correlation results with independent variables in the past 30 years

For China, when economic indicators were applied as the independent variables, *HDI* increased with them but the *fertility rate* decreased according to SPSS forecasting. The *fertility rate* in 1970s was high because the leaders, Mao and others, encouraged citizens to have more births during the Fourth Five-year plan. However, starting from the 1980s, the leaders, Deng and others, promoted and enacted the One-child policy due to overpopulation and a high fertility rate from the last decade in China. But this policy was unable to reduce the high population. Therefore, in the 1990s, the One-child policy has become stricter, which resulted in a more influential decrease in fertility rate. However, there is a weak correlation between *HDI* and the *fertility rate* which means women might not want to have more babies even though QOL was enhanced. Therefore, there might be some other reasons that can explain this phenomenon. On the other hand, *life expectancy* has become longer, and it has a similar curve as *HDI*. However, there is a weak correlation between these two. But as the medical treatment continually improved, so did the average age of the population. There is a small correlation between *fertility rate* and *life expectancy*. In the forecasting of *fertility rate*, there was a drop in the year 1998 which was a tiger year in Chinese zodiac. The tiger year usually gives an ominous feeling and impression in Chinese culture, which is one of the superstitions from older generations. Then in 2012, there was a small increase because the dragon is symbolized as a king in the ancient dynasty, which means people who are born in a dragon year are more likely to be intelligent or successful in the zodiac superstition (Lee, Holroyd & Ng, 2001; Yip, Lee, & Cheung, 2002). But no increases occurred in the dragon year of 2000, which is strange. Therefore, there must be some other reasons that can explain this result.

Second, economic indicators is applied as independent variables and since the data of *life ladder* starts with the year 2006, it is easily observed that there was a drop in 2009, which flowed from the Financial Crisis of the previous year. In 2010, there was also a decrease in the *fertility rate* because it was a year of the tiger as well and it is also suspected that the economy had not yet recovered from the financial crisis. Therefore, the *fertility rate* was low. However, there is a small correlation between *life ladder* and *fertility rate*. *Life ladder* does not affect *life expectancy* so much compared to *HDI* and *life expectancy* since there is a small correlation between these two and it is not significant. Finally, adding *social support* as the dependent variable, it is observed that *social support, life expectancy* and *fertility rate* have experienced different fluctuations and there are no significant correlations between them.

For Taiwan, SPSS forecasting of *life ladder* and *life expectancy* has an upwards slope in the future. There is also an insignificant weak and negative correlation, but it differs from China, where China has a positive value. However, this correlation seems to be strange since *life ladder* includes *life expectancy*, which means there should be a positive value. It is suspected that the source of *life expectancy* is different, which causes this result to happen. For instance, *life ladder* obtains the data of *life expectancy* from WHO which is based on 100 different health factors. However, the *life expectancy* that is applied here is from the National Statistics of Taiwan, which is concerned only with age numbers.

In the first method which excludes *democratic quality*, there is a weak correlation of *life ladder* and *total births in a year* in the one-tailed test, which is the same in the second method that includes *democratic quality*. The results from these two methods differ from China. However, according to the data of total births of Taiwan, there is also a drop in 2010 and an increase in 2012. This result is similar to China, which is reasonable since there is a similarity of cultural background in both countries. Next, in these two methods, there is weak correlation between *life ladder* and *school enrolment rate* and the same with *social support*, which shares the same result as China. In the second method, when *perception of corruption* is chosen to be the independent variable, there is a significant one-tailed p-value and almost moderate correlation between *life ladder* and *democratic quality*. There is a drop in 2009 of *life ladder*, which can be the result of the Financial Crisis in 2008. *Freedom to make life choices* does not visibly affect life ladder since there is no significant correlation.

On the other hand, *HDI* and *life expectancy* have a small correlation which is like China. But the forecasting demonstrates increases in both variables. The correlation of *HDI* and *total births in a year* is same as China. As *HDI*

increases, *total births in a year* decrease, which means there are other reasons that can explain this result. There is a weak correlation in *HDI* and *school enrolment rate* which differs from *life ladder*. The forecasting of *school enrolment rate* and *total births in a year* is opposite and the correlation suggests no influence between them. The forecasting of *total births in a year* and *life expectancy* is the same, and there is a strong and significant correlation, which is different from China where there is no significant correlation at all.

Overall, the results of QOL have increased with economic indicators in recent years in both countries from the data collected which is similar to the previous studies. Moreover, as economic indicators increase, *CO2 emissions from fossil fuels* also increase in China and Taiwan.

5.4 Limitations and Unexpected findings

During the process of data collection, economic indicators are easily found and collected from the national statistics or the websites of international organizations such as World Bank. However, there are not enough international social indicators nor the data of social indicators from the 1970s for China. Social indicators like *life ladder* and *HDI*, however there is no data older than the 1990s and the data is not complete. There are also some difficulties like not being able to access data from Gallup polls, PQLI, Well-being of nationals from OECD and World Happiness Data. In particular, the data of social indicators of Taiwan is more difficult to obtain compared to China, since either there is not enough data, or the data is included with China due to the political situation. On the other hand, even though there are some useful and interesting data like World Database of Happiness and Survey Research Data Archive from Taiwan, they are not able to combine or apply in the data analysis due to the different methods or calculations of data collection compared to the rest of the data. Therefore, this research is not able to precisely answer the changes of QOL in both countries for the past 40 years, but only for 30 years. Moreover, according to Hypothesis 3, the QOL in one of the countries is higher in recent years, but the data does not allow for this conclusion in this research because there is not enough data within the same scales, which makes it impossible to compare the differences between these two countries.

The unexpected finding of China is that there are no significant correlations between economic indicators and social indicators or between social indicators themselves such as *life expectancy*, *fertility rate* or *social support* …etc. This result has differed from the previous studies because in the previous studies when economic indicators improve, there is also an increase in social

indicators. Therefore, the result here means there might be some relations or effects between these indicators. According to this result, it is suspected that there might be some other factors or reasons that influence QOL in China even though *HDI* and *life ladder* have increased with economic indicators over time.

On the other hand, it was unexpected to find that there is a significant correlation between *life ladder* and *total births in a year* for Taiwan in the first method. Surprisingly, there is weak correlation between *social support* and *life ladder* where most people would think that if life ladder increases, it would mean there are some benefits provided by the government from an increase of social support. The next unexpected finding of Taiwan was that there is a significant moderate correlation between *democratic quality* and *life ladder* in the second method, which means democracy has a certain degree of influence over the QOL in Taiwan. It is also interesting to find out that there is a small correlation between *school enrolment rate* and *HDI*. However, it is strange that as the *school enrolment rate* increases, the *total births in a year* decrease.

6 Conclusion

The purpose of this research is to discover and compare how economic development influences the QOL in China and Taiwan during the past 40 years. In this research, some social indicators such as *HDI, life ladder, life expectancy, fertility rate, democratic quality, social support*…etc. are identified and applied to conduct the empirical tests with economic indicators such as *GDP, GNI, private consumption and household consumption*…etc. The reason is to observe the changes in QOL and connections between these indicators and QOL. When policy makers in a country make decisions for economic development, this can affect uncertainty and the country's future and result in changes in QOL for the citizens.
According to the results of SPSS forecasting, the QOL in China and Taiwan has increased as economic indicators grew especially in the past 20 to 30 years but not for 40 years since the data does not allow for this conclusion. Therefore, to enhance the accuracy of the changes in QOL under the influence of economic development, the data set of social and economic indicators are eliminated to the point where they share the same length of years and where the data set are the most complete. The result is similar when there is no elimination of data set which shows the QOL has improved in the past 20 to 30 years in China and Taiwan. Moreover, there are some lag in economic indicators when comparing them with social indicators, which might decrease the accuracy when evaluating the changes in QOL.

Secondly, the correlations between economic indicators and social indicators are mainly weak and have insignificant p-values. Therefore, it is difficult to confirm that there is a significant effect of each economic indicator on the QOL in China and Taiwan for the past 40 years. Most correlations between these indicators have positive values which means when one increases, the other one would increase as well. Moreover, QOL does not seem to influence or to be affected much by other social indicators such as *life expectancy, fertility rate, total births rate in a year, social support*…etc. for China and Taiwan.

In addition, due to the limitations of collecting older data from the 1970s and obtaining data within same scales and calculation methods, this research is not able to provide an effective answer of the change of QOL in China and Taiwan for the past 40 years since the QOL in one of the countries is higher in recent years. Even though these questions are not being answered, there are some unexpected findings. Since most correlations between economic and social indicators are weak or insignificant in China and Taiwan, this result is different from the previous studies. The explanation of this result could be that

there are some other reasons or factors such as psychological, spiritual, political, environmental influences, health factors or criminal rate in the society…etc. that are waiting to be uncovered, considered and explored. Among most of the insignificant correlations, the correlation of *life ladder* and *total births in a year* in Taiwan is strong in the recent years; there is also a moderate correlation between *democratic quality* and *life ladder* for Taiwan. Also, during the process of conducting SPSS forecasting, there are some indicators that are unable to be forecasted or give any significant p-values. This is because of the incomplete and lacking data set, which causes the occurrence of a naïve model, therefore some results are ignored.

In the future, instead of only collecting secondary data from organizations and government authorities, conducting surveys in both countries might help to improve the accuracy of the changes in QOL that are brought by the effects of economic development of both countries. In the survey, questions focusing on the perception of happiness and life satisfaction, the amount of social support received from the national authorities, the accessibility of health treatment, the coverage of health expenditure by governments, the quality of medical treatment, the criminal rate…etc. could be considered and help to evaluate the QOL. However, this could be costly and time consuming under the circumstance of limited budgets and resources. On the other hand, reducing the time length of economic and social indicators and focusing on the more recent years where there are sufficient and completed data sets could be helpful. Then, after collecting this secondary data, conducting SPSS forecasting and correlation are completed, one could compare the results between different indicators to evaluate and conclude the changes of QOL under the influence of economic development in a certain period. It is also recommended to look for more theories that are related to psychological changes in human or perception of quality of life…etc.

The QOL in China and Taiwan is predicted to continue to improve by different amounts in the future according to SPSS forecasting with the growth of economic development. However, many scholars have been discussing there will be a global recession happening soon internationally, so there is a possibility of a slump in QOL for many countries in the future.

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