Department of Economic History
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The Impacts of Economic Conditions on Total Fertility Rate in Denmark from 1956 to 2008

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Abstract: This paper tries to connect economic development and total fertility rate together and used two VAR model with the optimal lag respectively to analyze the impacts of economic conditions on total fertility rate in Denmark within half a century from 1956 to 2008. From the regression result of the first model VAR (4), there are slight difference in the impacts caused by GDP per capita, consumer price index and unemployment rate respectively. However, the general trends are similar. When divided the research period into two separate ones according to the change of the total fertility rate, regression results told us there are slight differences in impacts. It is hard to get all questions clear in one article, and this paper leaves more detailed issues to discuss in further studies.

Key words: GDP per capita, unemployment rate, consumer price index, total fertility rate, VAR model, optimal lag-length

Context

1. Introduction

1.1 Background

DINK, a word was created in recent decades, which refers to a type of family that has double income and no kid. The born of this word reflects people's deep concerns about the worse situation that more and more young couples tend to pursue a lifestyle with no child or fewer children than they did before. The article published on Global Times on July 14th, 2010, investigated how much will cost on earth for fostering a child in target countries such as Japan, the United States and so on, and the article also expressed the spreading worries about the tendency that young couples do not want children.[1] According to the report, no matter in Asia group, which have extremely high expectations for their children, or in the Western-style family that having a belief of keeping children independent, the cost for having a child is no less than 150,000 dollars on average. In Japan, the rate of women above thirty years old having no children grows at 4% every year, fertility of Japan has already dropped below the replacement level in the middle of the 1970s. At the same time, the American media warns young couples that it is principal to get the money prepared before they make mind to have offspring. Low fertility is a serious problem spread to almost every corner of the world.

From the view of economics, fertility is a crucial element which would affect the behavior of human beings. On the other side, people's economic activities may change the patterns of fertility. In the study of demography, fertility is a vital index to investigate the population structure of a country in addition to mortality and nuptiality, and which is also can influence government's intervention and measurement. Reproductive is an activity which has complicated nature both biologically and socially. On the one hand, human have incentives to choose having children or not having children and this behavior is not easy to predict, on the other hand, their reproductive behavior might be affected or motivated by stimulations caused by social transition or economic performance therefore there is possibility to forecast future fertility according to the economic performance in this year.

As the world economy has experienced dramatically giant revolutions and evolution from pre-industrial era to today's information age, demographic transition from high to low fertility rate occurred simultaneously. The world population rapidly grew before the industrial revolution and fertility rate was once very high. But then, it dropped sharply at an unexpected rate, which is named as the fertility transition. In most of the developed countries, fertility transition has been completed or get close to the end in 1990s and some of the developing countries are entering to this phase

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[1] The article is written in Chinese and title can be translated as "Increased cost for children affected young couple's decision for having children", which is published on Global Times, July 14th, 2010.

(Bongaarts, 2002), fertility level stepped from a high-rate period to a controlled period.

In recent decades, countries experienced or are still experiencing downtrends in fertility and very low fertility level becomes a worldwide challenge. Figure 1 shows total fertility rate in some countries in 2009. According to Central Intelligence Agency (2009), Niger is the country with highest total fertility rate, which reaches 7.75 while the World's average total fertility rate is 2.56 in 2009. France ranks 133 all over the world and it has the highest total fertility rate among all European countries. The ranks of TFRs in Scandinavia countries are very close to each other: Iceland has the highest one — 1.90, then followed by Norway (1.78), Denmark (1.74), Finland (1.73) and total fertility rate of Sweden is relatively low, only 1.67.

Figure 1 TFR (2009)
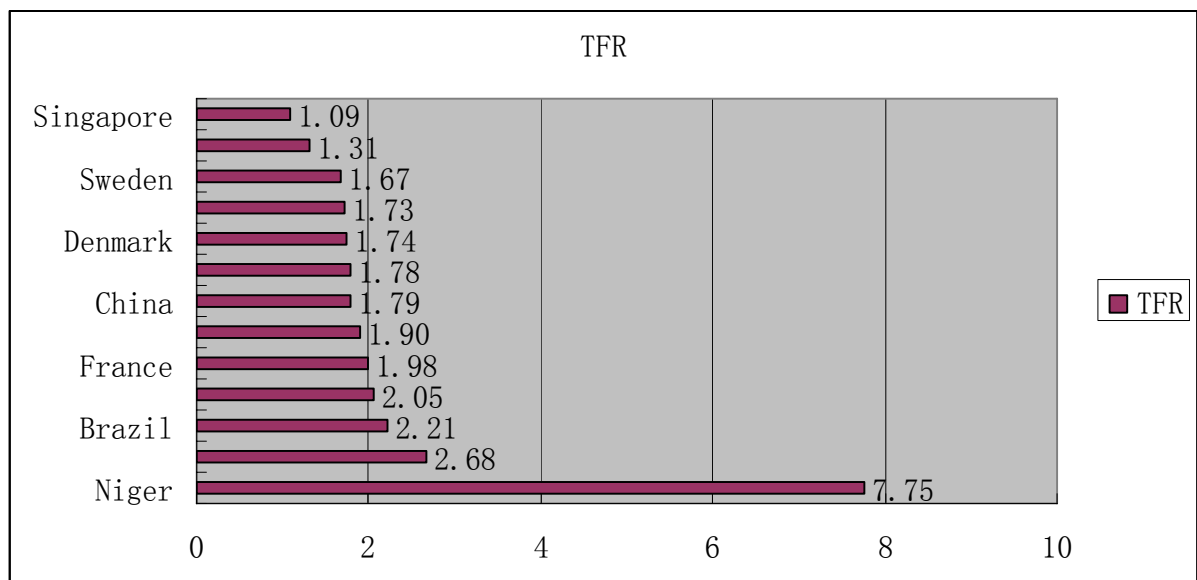
Source: Central Intelligence Agency, Country comparison of Total Fertility Rate, 2009.
https://www.cia.gov/library/publications/the-world-factbook/rankorder/2127rank.html

According to the United Nations population division, 2.9 billion people were living in countries below the replacement fertility level during the period from 2000 to 2005, and the number is projected to over a half of total world population in the middle of next decade (The Economists, Oct. 29th 2009). Low fertility, accompany with aging population becomes serious issues that call for more attention, particularly in European nations. According to the Council of Europe (2001), almost in all European countries, fertility rates are now below 2.1, the replacement level. And according to the World Factbook of Central Intelligence Agency (2009), total fertility rate of France is 1.98, the highest among European countries in 2009. In the meantime, low rate of childbearing in addition to expanded life expectancy would result in population aging, which should be one of the most challenged issues in this century. Since increasing proportion of elderly population would augment the elderly dependent ratio, which means given the number of work-force people, with the increase in elderly

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dependants, working people have to produce more necessities and they face more pressure. Not only the society, but also individual family has heavier burden for supporting elderly family members in every aspects. As a response, governments may take different actions to improve the situation and which could lead to other social issues and make consequences for economics. Actually, the consequences brought by low fertility and what factors have tight ties to fertility change are very interesting and meaningful to research. It makes sense to study fertility trends and fertility behavior.

However, investigating fertility pattern is not that simple as expected since reproductive is personal choice to a large extend and it is hard to predict, and factors may affect fertility are complicated, for example, Lee (1981) once investigated the relationship between the change of weather and fertility in England during a long-run term, Murphy and Knudsen (2002) researched the effects of number of sisters or brothers and birth order as well as children's gender on changes of fertility rate in contemporary Denmark. Even under the framework of European integration, the paces and influential elements of fertility decline in different countries are not the same, not alone the rest of the world due to the different rates of economic growth and diverse cultures as well as policy heritages. For instance, Spain and Italy are members of lowest-low fertility group (Council of Europe, 2001) while the situations of their European neighbors - the Nordic countries are much better in recent years.

It is a matter of course to ask what will happen to the world when fertility rate keeps downward or what the relation between decreasing fertility rate and economic index is. The Economists has published an article on Oct. 29th 2009, which reassessed the link between population and economic growth. The article tried to answer why fertility has fallen at such a high rate and in such a wide range from perspective of wealth accumulation. It proved that fertility began to drop when annual income reached 1,000 to 2,000 US dollars per person. Gap of fertility not only exist cross-countries but also among people from different social class within a country. The article gave some examples in developing countries such as India and China to illustrate the negative link between living standards and fertility. Is this relationship applied to the developed countries? Olney (1983) compared fertility with real wage trends in early modern England. His procedure proved a link between fertility and real wage change, which cannot be interpreted as a general theory however. In this article, it makes Denmark as a target to discuss the propensity of fertility rate and also to investigate is there any link between the change of fertility trends and economic development.

1.2 Purpose and Scope

This thesis has two aims. It is no doubt that in a long period, total fertility rate of Denmark has experienced downwards to different degree, the first aim of this thesis is to investigate fertility decline in Denmark since 1956, and how some of the vital economic index change accordingly in the same period. In fact, it has been a long time in Denmark since its fertility rate started to fallen below the replacement level.

However, this paper is only focus on the period after 1956 for two reasons: first of all, the infinite influence of the Second World War is unprecedented, on the one side, the Second World War made mankind experienced an unparalleled catastrophe, thousands of years of human civilization was destroyed, which had profound effect on the process of human society; but on the other side, the war promoted rapid progress of science and technology, narrowed the distance from country to country. After Second World War, the world entered a temporary peace phase and created a healthy environment making a possibility for economic development. Under that case, it is meaningful to see how fertility changed while giant changes occurred widely in economic index in post war period; secondly, a very important reason of choosing this scope is because of the limits of data. Because of the limitation of available data, there is no choice but erased a decade from 1945 to 1955 in order to unify all data, and this will be further discussed in chapter 3. And the paper will also focus on studying the relationship between fertility rate and some important economic index related to living standards and economic development. The association between fertility decline and changes in economics will be taken into consideration.

There are thousands of previous studies in fertility decline and investigations in enhancement of economic development. Demographers tried to analyze the decrease in birth rate from different point of views while economists concentrate on economic growth and social progress. However, researches that connected the two topics are not many. And like Örsal and Goldstein (2010) mentioned that economic theory is unclear when it is used for analyzing fertility pattern, even the economists and demographers are debating the association is whether "counter-cyclical" or "pro-cyclical". This thesis just tries to relate the two issues and to explore what is the relation and how they affect each other exactly.

The purpose of this thesis is to take a general picture of trends and pattern in childbearing in Denmark since 1956. Besides, studying the association between fertility trends and economic development could be helpful in understanding the relevance of human fertility behavior to economic situation and outside influence. Additionally, there leaves discussion for further study in Denmark's family policy that work for encouraging childbearing from 1956 to 2008.

1.3 Research Questions

The basic research question of the thesis is: How economic development affects the changing trends of total fertility rate? The main research question is a big topic and it can be subdivided into several small subjects:

First of all, before answering the research question, we need to see the picture of changing trends of total fertility rate in the chosen period from 1956 to 2008. And then, it is necessary to define economic development. Economic development contains a lot from every side of social life, but in this thesis, we should specify some

vital index which can represent the development of economics. The last step to do is using econometric techniques – the vector auto-regression model to answer is the change of birth rate associated to economic growth.

1.4 Outline of the paper

The structure of this thesis is arranged into six sections as follows: this section is the introduction part, in which raised the research question and limited the research scope. And it is followed by literature reviews. In the part of literature reviews, related theories and studies would be included, and the hypotheses will be also discussed briefly. Content in Section 3 describes the variables used in this paper, different sources of data as well as data transformation. And after that, the next part is focused on methodology, which includes further discussion of the VAR model and its advantages as well as disadvantages. This section is the main part of the thesis, the regression and the lag-length chosen are both included in this section. Section 5 analyses the regression results and open further discussion of fertility in contemporary Denmark. Conclusion will be drawn in the last section.

2. Theory and Literature Review

There are three parts included in this section: first of all, I will generally sum up theories related to fertility and demography transition; and then move to the literatures those discuss fertility and its influential factors. Since I will adopt VAR model when analyzing the impact that some economic index imposed on total fertility rate, I will choose variables based on hypothesis which is in the third part of this section.

2.1 Theories

Devoted demographers spent a large amount of time to analyze theories and possible factors that affect fertility. Among those well-known theories and hypotheses, the Malthusian perspective was discussed and studied for decades. Malthus believed that population grow indefinitely until it hits the equilibrium. He raised theories of "positive check", which refers to events that would cause mortality and "preventive check", which refers to behavior that would cause fertility decline (Robert Allen). According to Malthus, the size of population was determined by the size of economy, which was affected by technology and capital. And he noted that in a society managed by the "preventive check", incomes decline would lead to drop in fertility and in return, decrease in fertility would reduce pressure caused by population. However, Malthusian perspective is no longer useful for explaining fertility decline after the fertility transition.

Some researchers, such as Davis and Blake (1956) and Bongaarts (1982), they believed that behavioral and biological factors dominated in affecting fertility behavior and they summed that socioeconomic aspects, cultural causes and environmental influential could be indirect determinants affecting fertility and they divided those proximate determinants into three different groups: 1) exposure factors, which refers to the proportion of married women or women in a stable relationship; 2) deliberate marital fertility control, which includes contraception and induced abortion; 3) natural marital fertility factors, which includes lactational infectunddability, frequency of intercourse, sterility, etc.

Menken et al. (1981) focused on the link between nutrition and fertility, rather than a behavior-oriented perspective. They reviewed available literatures and found evidence that food affects fertility to certain degree. Via investigating different consequences caused by temporary malnutrition and chronic malnutrition, Menken et al. summarized different degree of impact.

Becker (1976) raised a theory of "quality" and he assumed that next generation's happiness is a component of their parents' happiness, which indicates that parents have preferences to have fewer children if they have higher standards with providing

their children a better life. The essence of "quality" is the preference of quality of children may lead to a decline in fertility. Becker also noted that the time and economic cost caused by fostering children can be taken as opportunity cost and he mentioned that opportunity cost would affect childbearing decision. If it is expensive to have children, mothers would tend to not have children. Becker's theory contributed to behavior indicators in affecting fertility. However, with respect to "quality" and "cost", Easterlin (1966) attributed fertility decision to people's "desire" and aspiration. If family income and expenditure of childcare are both fixed, the possibility to have children might be directly proportional to their desire for children. In that case, people's desire for having children changed will have fertility rate changed. Easterlin and Crimmins (1985) analyzed childbearing from perspective of supply and demand. Supply refers to the number of children born by natural fertility and rate of survival, not up to other outside influents. And demand is defined differently in different phase of society. They put forward another concept: regulation cost, which is defined as the cost paid to control fertility, including economic costs and psychological costs.

Actually, subject to the issue of fertility decline, there are other main points of views. Thompson (1929) and Notestein (1943) emphasized that fertility fallen was the result of changes in industrialization and urbanization, which followed decline of mortality. The viewpoint of Caldwell (1982) was partly in line with "cost" theory that he stressed that children were burden to their parents due to compulsory education and other kinds of protection acts for children. Consequently, not having children or having fewer children become solution for parents to cut expense. According to Caldwell, there is a link between family structure and fertility change, and family structure here generally means the direction of wealth flows within a family. Caldwell emphasized that fertility decision in a family with downward wealth flows would be different from fertility choice in a family with upward wealth flows. According to his theory, in a society that respect norms of upward wealth flows within family, as a rational human, the best decision should be have as many children as possible, because children will put in their parents' wealth and become their parents' security in old age. To the other side, if the norm of a society is wealth should flow downward within a family, having one extra child might add additional cost to parents. Therefore, as rational human, parents would make decision to have no child or fewer children to cut cost (Caldwell, 1976).

In additional, some scholars attributed lower fertility to spread knowledge and upgrade tools of contraception, such as Cleland and Wilson (1987). And in several case studies of fertility decline such as Mexico, India and Norway, the authors partly proved that the spread and increase in alternatives of contraception methods is one of the explanations for fertility decline (Chen, et al. 1990; Pathak, et al. 1998; Sogner, 2006).

2.2 Literature Review

It is an uncontroversial result that low fertility is approximately a universal phenomenon. However, when it comes to the causes of low fertility, there are a lot of different opinions and estimations.

China, had been considered as a populated country, it experienced a sharp fallen in birth rates. When Li (2009) analyzed fertility revolution in China, he built a theoretical model on the dynamic structure of fertility revolution. According to different patterns of dynamic mechanisms, the fertility decline can be divided into three phases: the first one is the most initial phase of fertility decline, which is driven by mortality change; and then it is followed by the second phase, which is driven by the changes of people's preference, aspiration and attitudes to reproductive; the third phase of fertility decline is motivated by fertility cost control. He mentioned that the fertility level did not remain stable as expected after it dropped noticeably at the first time; instead, it would further get into the ultra-low fertility level. Li explained that below-replacement fertility level did not mean the end of reproductive revolution, but claimed that it entered a new phase of fertility decline, a phase of fertility decline caused by other reason which is different from the reasons for the former phase. Li's model of first phase is partly in line with the viewpoints of Thompson (1929) and Notestein (1943), who emphasized that fertility fallen was the result of changes in industrialization and urbanization, which followed decline of mortality. Fertility was seen as natural weapon to withstand death in less-developed world. With development of modern public health and medical technology as well as economic growth, mortality decline significantly increased survival of infants and children. Therefore, it was no longer necessary for people to have more children in order to counter the high mortality. The second phase in Li's model can be explained properly with Leibenstein's (1954) and Easterlin and Crimmins's (1985) point of views. Compared to the first phase, human desire and preference for fertility required higher level of social and economic development, including education, income and social security system, etc. In the third phase, the costs of reproductive, including direct costs and opportunity costs, played more significant role in affecting fertility change. When increase in reproductive costs becomes the main factor that couples worried about for fertility decision, fertility decline was no longer because of reduction in fertility preference and aspiration, but because of costs increase, which made people can not fully realized their desire for having children.

Lee (1981) analyzed vital data of prices and whether, and estimated the change of demographic data in Britain. Via investigating the relationship between vital rates of living standards and nuptiality, and the relationship between vital rates and mortality, Lee tried to find out how high food prices affect fertility. According to the result of Lee's econometric evaluation, low food prices and high real wage would encourage nuptiality, and there is "link between new marriages and first births", therefore, it can be deduced that fertility might changed accordingly with changes of food prices. And

it is obvious that mortality change will affect fertility, thus changes of vital rates related to living standards and economic development would change mortality rate (including infant mortality), fertility varied accordingly. Lee concluded that fertility rate is sensitive to the fluctuations of economic development.

Andersson et al. (2009) investigated how female income affects reproductive behavior in Denmark and Germany in two decades from 1981 to 2001. The work has a lot of aspiration that the authors take special views from the connection of female wages and the risk of different birth orders. According to Andersson et al. educational participation among younger generation is a trigger to decrease the risk of first birth risks while unemployment rate has a contrast impact at these ages, however, there is no significant impact caused by unemployment on the time of first birth at higher age groups. Their findings imply that both of women's education and female earnings would affect first birth rates, but the degree of impacts differs according to the ages of objectives. Situation is not totally the same when it comes to the second birth and third birth, but which is not the related topic for this thesis.

From the view of public policy, Apps and Rees (2004) analyzed to which extent that public policy can explain the positive relationship between female labor participation rates and fertility. Historical evidence shows that there should be a negative relationship between women's labor supply and fertility, but actually, actual data from Germany, Spain and Italy display that with the lowest birth rates, the three European countries also have the lowest women employment rates, which denoted a positive relationship. With the help of two instrumental variables, child bonus and subsidies for buying childcare facilities, Apps and Rees built up a model to explain this untypical occurrence. They assumed that women's time is the only input for childcare and considered children as market goods. The result shows that in countries with individual tax system, the relationship between female labor supply and fertility tends to be positive, similarly, if a country does not provide direct payments for children, but offer families more flexible choices for childcare is likely to have positive relationship as well. In this case, the pattern of public policy indeed plays an important role when discussing the relationship between women's working participation and fertility level. Gauthier and Hatzius (1997) also focused on family benefits when analyzing fertility trend. Their research is based on the investigation of governmental support for families in 22 developed countries and the period is as long as two decades since 1970. According to the result of their empirical study, the decision to have a child is not only affected by direct cost caused by fostering child, but also affected by family policy. For example, if there is cash assistance provided by governments, people may have tendency to bear a child even the direct cost of raising a child remains the same. Gauthier and Hatius adopted econometric techniques and they built up their econometric model based on collected data from 22 industrilized countries. And their regression results are in line with the hypothesis that economic benefits such as family allowances and other cash assistance are directly positively affect fertility decision.

Since there is tighter and tighter association between fertility behavior and economic development, researchers chose to discuss fertility from different aspects of economic conditions. Örsal and Goldstein (2010) have based their analysis on a period from 1976 to 2008 in twenty-two OECD countries. Different variables that can explain economic condition the authors have chosen include the total unemployment rate, the female unemployment rate and the male unemployment rate, besides, they adopted a dummy variable in family policy which refers to paid parental leave. By analyzing the regression results, Örsal and Goldstein draw their conclusion that the economic variables do have impacts on the total fertility rate. When economics in good conditions, the total fertility rate increases, but when the economic conditions turns badly, which would leads to a decrease in the total fertility rate.

2.3 Hypothesis

According to many demographers, it seems that there exists a pro-cyclical relationship between economic growth and total fertility rate. In addition to the postponement effects, economic recession or depression would lead to a decline in the total fertility rate in the following years. And once economy recovers from recession, the total fertility rate would rebound accordingly. Since there is rare literature of discussion the relation between economic conditions and fertility rate, we can only assume if there is any connection between them from the results and discussion of other works. It has already been mentioned above that there are papers investigated the consequence of the total fertility rate with an increase in wage or GDP per capita and the results tend to be a negative relationship. But when it comes to family policy or women's working participation, the relationship seems to be positive somehow (Andersson, 2007). Different from the situation in Denmark, Sweden has relatively complete records of demographic data and researches related the total fertility rate to economic conditions are comparatively more than Denmark, and moreover, being close to each other geographically, Sweden and Denmark share a lot of features both economically and demographically. Therefore, we can deduce our hypotheses in the situation of Denmark by concluding the conclusions drawn from Sweden.

Hypothesis 1: the tendency of the total fertility rate in the whole period from 1956 to 2008 might not follow a unified trend. On the contrary, the general trend would decrease at the beginning and then increase a little bit in 1980s.

Hypothesis 2: economic conditions might have effects on the total fertility rate in the scope from 1956 to 2008.

Hypothesis 3: the impact of economic conditions might vary in a sub-period of fertility decrease from a sub-period of fertility increase.

3. Variables and Data

In this part, I will detailed discuss all the variables adopted and data used for building model in this paper. The demographic data used in this thesis are annual series of births and annual data of population, which come from the Danish Fertility Database. This database is based on data from registers, which consist of data on a different number of birth cohorts. The Danish Fertility Database provides a convenient and accurate instrument for demographic research on the developments in fertility of Denmark. And for the economic index, they are collected from Historicalstatistics.org, Central Intelligence Agency and OECD database respectively.

3.1 Variables

There are more than one indicator could be used for investigating fertility trends and patterns, such as the Crude Birth Rate (CBR), the Age-specific Fertility Rate (ASFR), the Total Fertility Rate (TFR), etc. The total fertility rate is considered as a more direct measure using for evaluating the fertility level. It is not only an indicator that refers to the number of children that a woman has, but also shows the potential modification of population structure in a society. Therefore, in this thesis, total fertility rate is the main indicator used to investigate the fertility decline in Denmark.

There are a lot of factors that would affect fertility. From the perspectives of demography, there are three categories of factors affected fertility: 1) gender structure of population; 2) age structure of population; and 3) infant mortality. And from economic perspectives, status of employment, income, prices of consuming commodities, cost of education and so on, are all considered as influential elements. When it comes to the social aspects, cultures, family norms, religions and public policies related to family planning and birth, etc. are all concerned. Since this thesis only discusses the effects of economic conditions on change of birth rate, the other variables used are all economics-related variables, which include unemployment rate, consumer price index, and GDP per capita.

Örsal and Goldstein (2010) had proved that there is a negative association between fertility and unemployment rate in Netherlands in recent years. As it is mentioned in the second section that to some extent family income has something to do when couples need to make fertility decision. But according to Becker (1960) and Mincer (1963), the rise in the female income and increase in male wages affect fertility to different degree. They noted that change of female income has two contrast effects; on the one hand, women's increase wages may lead to higher fertility rate since they have got more sufficient money to support their family, but on the other hand, higher income of women means higher opportunity cost of having children which may lead to decrease in fertility rate. However, it is not that complicated when it comes to

men's income. There is only single effect of male wage on fertility rate. According to Becker (1960) and Mincer (1963), increase in male wage may make increase in fertility rate if women's income in their family is ignored for a while. It is a widely accepted consideration that widespread education level and improved social status of women can partly explain the universal situation of low fertility. Stanfors (2003) related the total fertility rate to socioeconomic change among female, and look into fertility variation in twentieth century Sweden. She focused on investigating the relevance between women's education level and fertility change, in addition to the issue that how female labor force participation affect fertility change. According to Stanfors, not only the advance in education opportunities opened for women, but also increase in female labor force participation lead to significant change in mitigating and eliminating gender inequality, which plays important role in economic development and make fertility rate fluctuated during a long period over twentieth century. Although the dissertation discusses Sweden situation, it also applies to Denmark since the two Nordic countries share a number of similar characters both politically and geographically. In particularly, Denmark and Sweden go forward hand in hand in many aspects of female rights protection. As it works in Sweden, advance in women education and increase in female labor force participation are considered as effective incentive for women when they make decision for childbearing behavior.

However, because of the absence of detailed data in wage level in Denmark since 1955, I can not adopt wage as a variable to build a model. Instead, unemployment rate and GDP per capita are used. GDP per capita can illustrates economic development, but which is not easily equal to level of income for citizens. It is usually that GDP per capita increase while wage boost, but growth rate would not be the same. And it is also a possibility that during a period, GDP per capita increase while average wage decrease. However, some scholars tried to make compromise when using GDP as a measure of government's wage level, such as Heller and Tait (1983).

3.2 Data

It has been emphasized constantly that fertility decline is a universal trend in the process of development. However, countries have taken different pace of fertility transition. Many developing countries started to move towards large fertility declines in recent decades while a number of countries are almost in the end period of fertility transition (Bongaarts, 2002). According to the report of United Nations (2001), fertility of industrialized countries was already in a low level in the early 1950s. And their demographic transition can be traced back to 18th – 19th century (Knodel, 1977).

3.2.1 Total fertility rate

Figure 2 shows the trend of Denmark fertility in five decades since 1956. It can be seen that in the first decade from 1956, the general trend was moderately stable with a

slight increase from 2.59 in 1956 to 2.61 in 1966. From then on, the general trend of total fertility rate goes down constantly in the following years until 1983, accompanying with some insignificant ups and downs during that period. In 1983, total fertility rate of Denmark hit the bottom at 1.3. And after that, there appeared a recovery, in which period Denmark made progress in encouraging fertility. During this period, Denmark experienced a steady increase in fertility, but then came up against a slight decline since 1996, rebounded during 2000s.
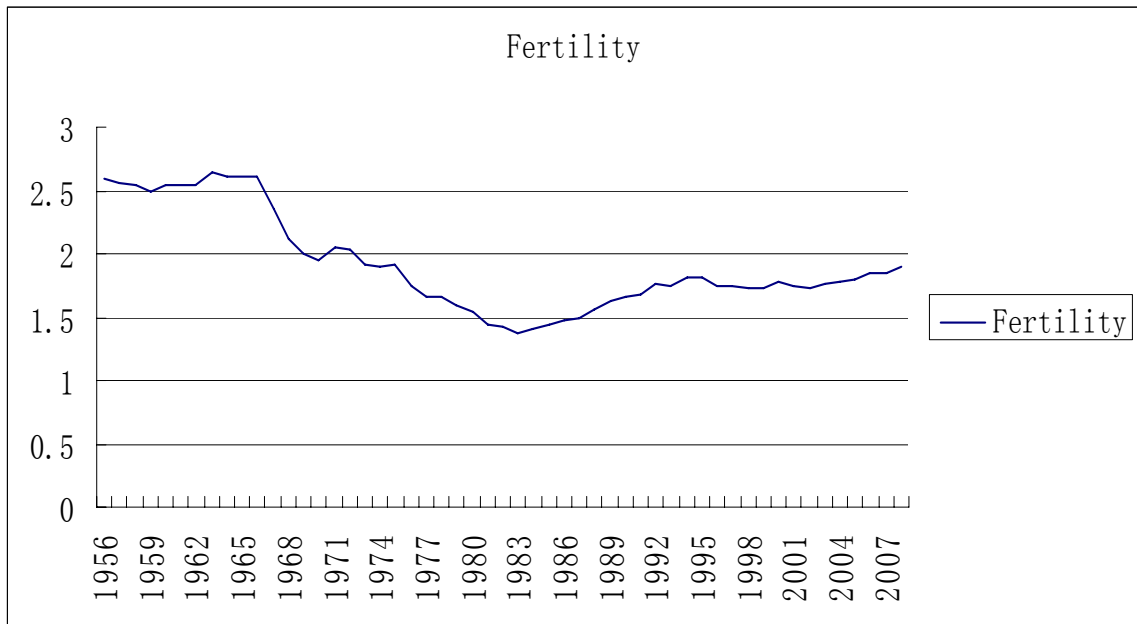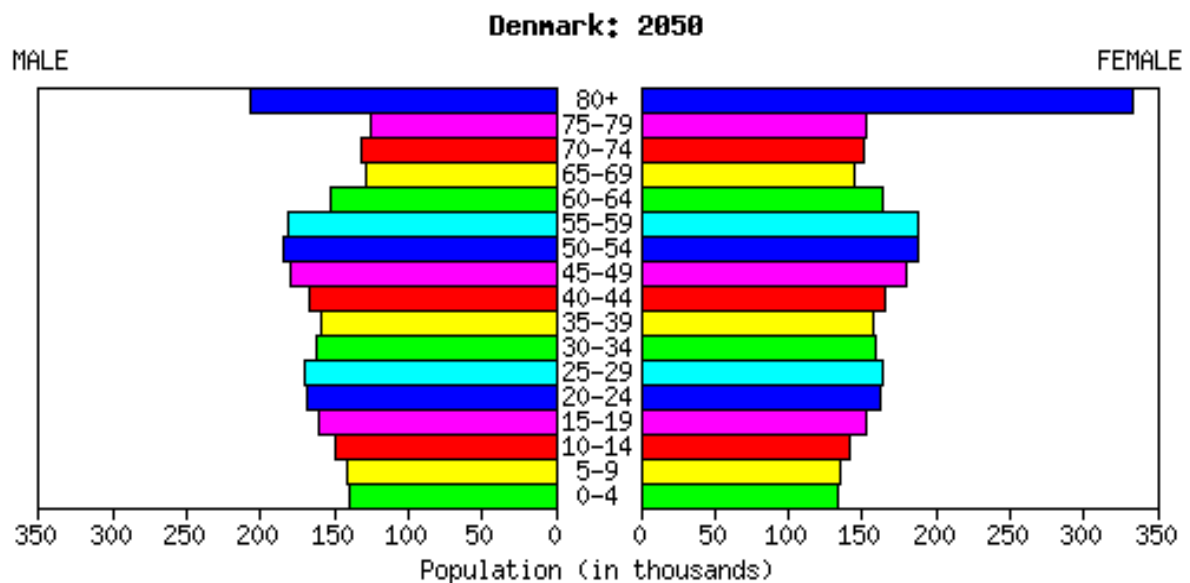
Figure 2 Fertility rate from 1956 to 2008

Figure 3 Population Pyramid (2050)

Source: http://www.nationmaster.com/country/da-denmark/Age-_distribution

The change of fertility level will modify elements in a variety of social aspects as well as family arrangements. The age structure of a population, resource allocation within a family, social responsibility and so on, which would be influenced by the change of fertility level. The most direct consequence caused by fallen of the total fertility rate is aging population crisis, which is serious and would bring tough challenges to economic development and even national security. Figure 3 is a population pyramid capped from the webpage of "NationMaster", which predicted the distribution of age and sex for the year 2050. It is obvious that a society of elderly population is around the corner according to the projected result.

Population aging would have serious impact on many aspects, and one of them is affecting government policies and financial budget. Increase in number of elderly people means that the government has a larger sum of money to expend on establishing and improving social welfare targeted on senior citizens, which is a heavy financial burden. When the proportion of expenditure on senior citizens occupies a larger percentage of tax, government would overwhelm financially.

Tremendous changes in age distribution of population will make substantial transfer of wealth. In most countries, people can get pension in their old age. But people create fortune are in the working force from 15 to 65 (legal retire age is different according to different country's law and rules). People in working force work for raising the whole population, and they will be financially supported when they get old. Once a country's elderly population is larger than population in other age groups and fertility continually drop, this country will run into serious crisis of labor shortage. In the case of constant productivity, the decline in labor supplement will lead to significant increase in dependency ratio, which refers to the proportion of non-working force population to working-age population. This revolution will intensify social burdens and change people's behavior pattern such as consumption custom and saving habits. Therefore, low fertility might changes all aspects of society and personal lives.

Accompanied with change in fertility level, family resource including financial resource and non-financial one is also reallocated among family members. A reduction in fertility indicates that women save time from pregnant and delivery. And low fertility generally indicate a smaller family size and fewer children in a family, which means that both of the parents can save time from taking care of children or doing chores produced by having children. With the extra time, they can choose to attend other activities and other way to utilize their time other than spending with additional children, which is a symbol of time transfer within a family.

The other aspect of family resource is financial resource, which is also sensitive to the change of fertility. On the one hand, once the total fertility rate increased, women tends to invest more time that is supposed to spend in working and earning money, therefore, family income is lower. On the other hand, raising children is a money-cost activity that parents need to invest in children's education and health protection, therefore, family expenditure will increase while family income decrease. When

fertility level reduced, women tend to allocate their time to other doings and they open the opportunity of earning money and improving family income. With the money that is supposed to spend on child rare, people have obtained many more options. This is a brief discuss of family resource reallocation.

From figure 2, we can see the general trend of total fertility rate in such a long term. However, it is not comprehensible enough to observe the patterns of alternative in total fertility rate. Therefore, the formula below is adopted to calculate the growth rate of total fertility rate.

$$Ln(Y_t - Y_{t-1})$$

where Y_t means total fertility rate in year t and Y_{t-1} refers to total fertility rate in year (t-1).

Figure 4 displays the growth rate of total fertility rate. The curve in figure 4 shows the growth rate of total fertility rate. It is much more straightforward to see the amount of increase (or decrease) of total fertility rate. From figure 3, it can be told that in most years of such a long period since 1956 to 2008, total fertility rate decreased and the amount of decrease is significantly huge during a term from 1966 to 1977, except a shortly rebound.

Figure 4 Growth rate of TFR
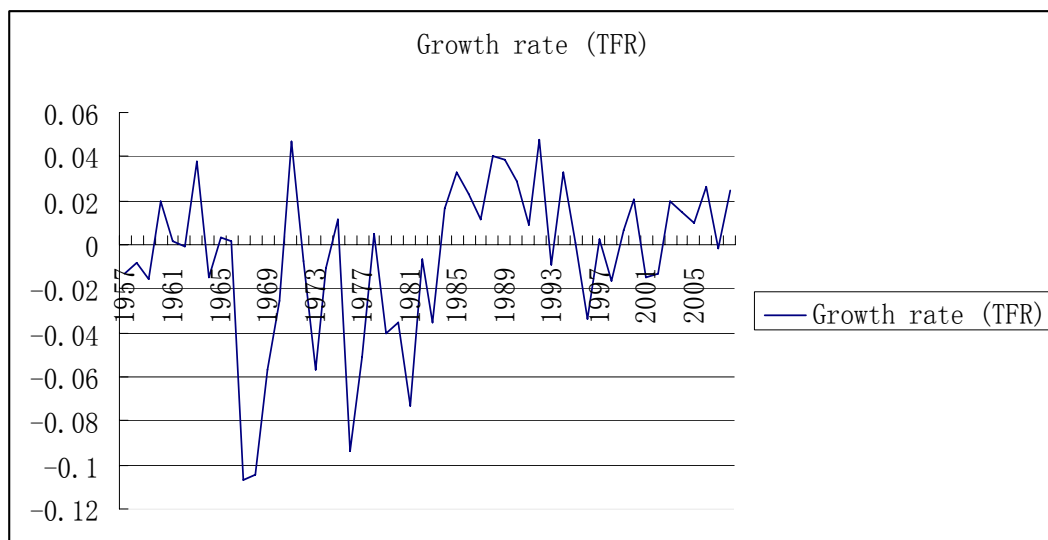
3.2.2 Unemployment rate

Figure 5 illustrates how unemployment rate changed in last five decades since 1956. Actually, after the Second World War, most countries experienced sharply decline in employment. However, Nordic countries had not been influenced considerably like their counterparts. For Denmark, unemployment rate was kept within range of 2%-6%

during the initial term after the Second World War. In 1960s, the unemployment rate of Denmark had been under control, which declined continually to below 2% until 1973 and reached the lowest level at almost 0.7% in 1970.

Agriculture has a deep history in Denmark, but after the Second World War, Denmark gradually developed from an agricultural country to an industrial country. After the first oil crisis took place at 1973, Denmark came up to a huge challenge of deficit in balance of payments due to excessive dependence on imported oil. Consequently, inflation and unemployment became serious social problem. In 1979, the second oil crisis out broke, Denmark's international balance of payments deteriorated furthermore and unemployment rate kept increasing. In 1982, Prime Minister Poul Holmskov Schlüter[2] made them both as primary objectives to reduce the deficit in international balance of payments and lessen fiscal deficit. As a result, economics grew constantly after 1983 and both of inflation rate and unemployment rate dropped.

Figure 5 The trends of unemployment rate

The curve in Figure 5 shows clearly that unemployment rate of Denmark reached the highest point at more than 11.4% in 1983, from then on, it dropped dramatically until 1988. At the end of 80s and beginning of 90s, Denmark, even the whole Europe got a recovery after recession. However, growth of employment rate is scarce. It is a common phenomenon in Europe that unemployment rate, not only structural unemployment but also cyclical unemployment, started to rise again. While unemployment rate in most of the European countries continued to rise, Scandinavian countries including Denmark made some progress in lower unemployment rate. Although in 15 years from 1993 to 2008, there are ups and downs in unemployment rate, general trend is downwards. In reducing unemployment, Denmark did not through the way of encouraging the development of welfare in private sector, but consolidating state welfare and providing job opportunities. In Denmark, as well as

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[2] Poul Holmskov Schlüter, the Prime Minister of Denmark from 1982 to 1993.

other Nordic nations, employment rate in public sector is high and female employment is high as well. In the 21st century, Denmark still has strong momentum of economic development; moreover, it maintains a lower unemployment rate.

Just like Figure 4 displays the growth rate of total fertility rate, Figure 6 shows the growth rate of unemployment rate from 1956 to 2008. The formula used is all the same. However, the letters refer to different variables.

$$Ln \, (Y_t - Y_{t-1})$$

where Yt means the unemployment rate in year t and Yt-1 refers to the unemployment rate in year (t-1).

Figure 6 Growth rate of unemployment rate
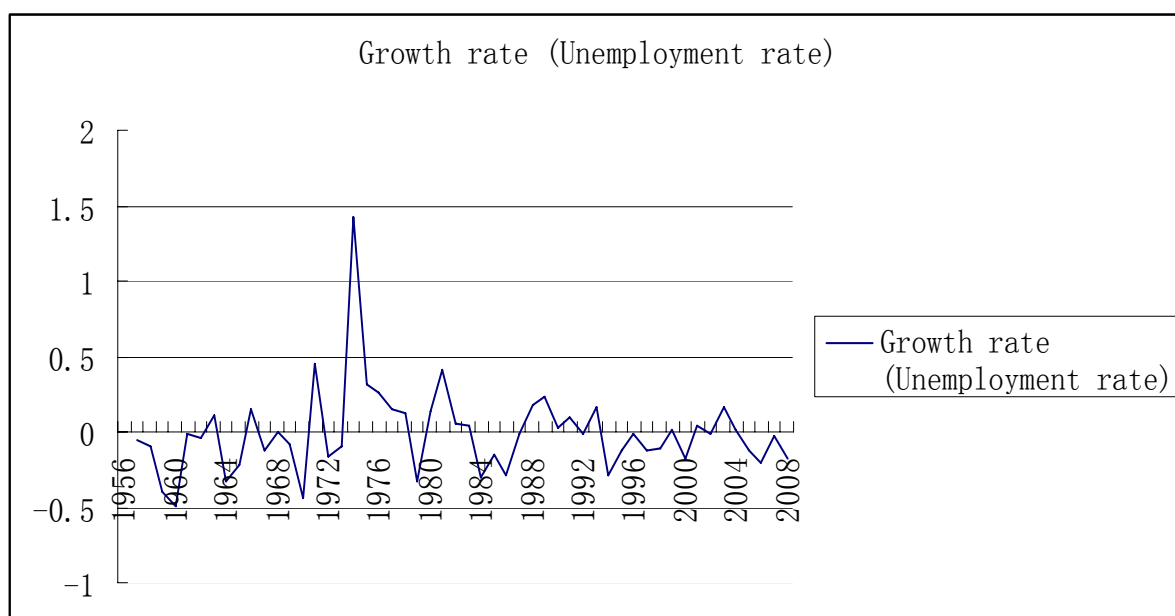
3.2.3 Consumer price index

In Figure 7, we can see the increasing figures of consumer price index. The consumer price in 1900 is taken as the base, i.e. 1900 = 100. It is no doubt that consumer price index is increasing all these years. There are many reasons may make increase in CPI, for instance, increase in price of international crude oil or food, loosing monetary conditions or the gradual formation and strengthening of inflation. However, it is hard to assert is there a connection between growing consumer price index and lowering total fertility rate. Hypothetically, as a consequence of climbing consumer price index, price of necessities increased, cost of raising children increased accordingly, which might drive people not having children in order to take a break from heavy pressure. And climbing price in housing would also cause negative effects on fertility theoretically since in many cultures people believe that house is a necessary priority

for marriage.

Figure 8 shows the growth rate of consumer price index, using the same approach as mentioned above. But the capital letter Y refers to consumer price index. From Figure 7, it shows nothing special but a continued increasing curve in consumer price index, which is indeed happened in our real life. However, Figure 8 illustrates that in the early 70s, consumer price index grew more rapidly than other time during the period from 1956 to 2008. And in the 80s, the growth rate of consumer price index decreased dramatically in Denmark, from then on, Danish consumer price index went up at a relatively steady speed.

Figure 7 Consumer price index
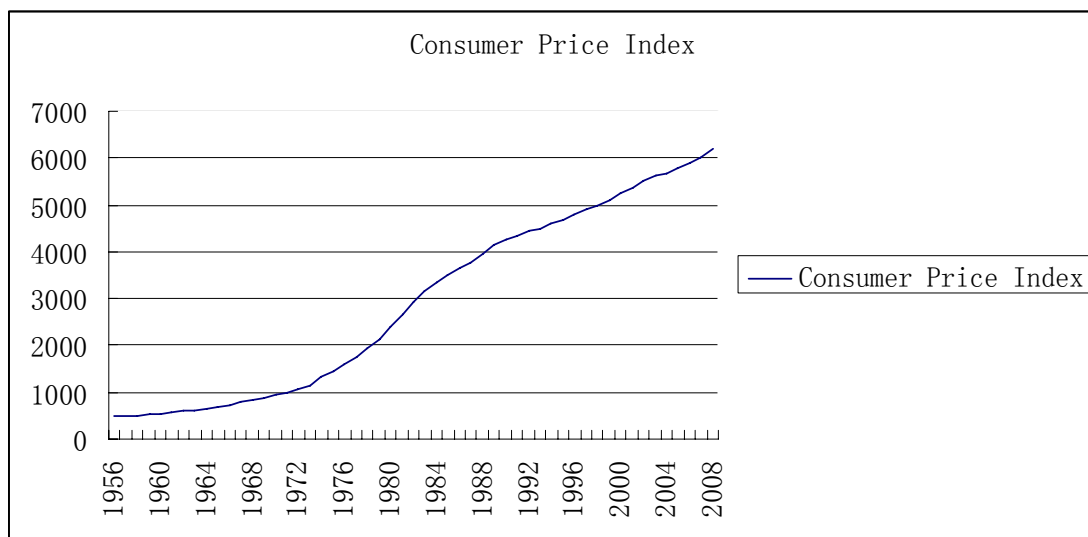
Figure 8 Growth rate of CPI
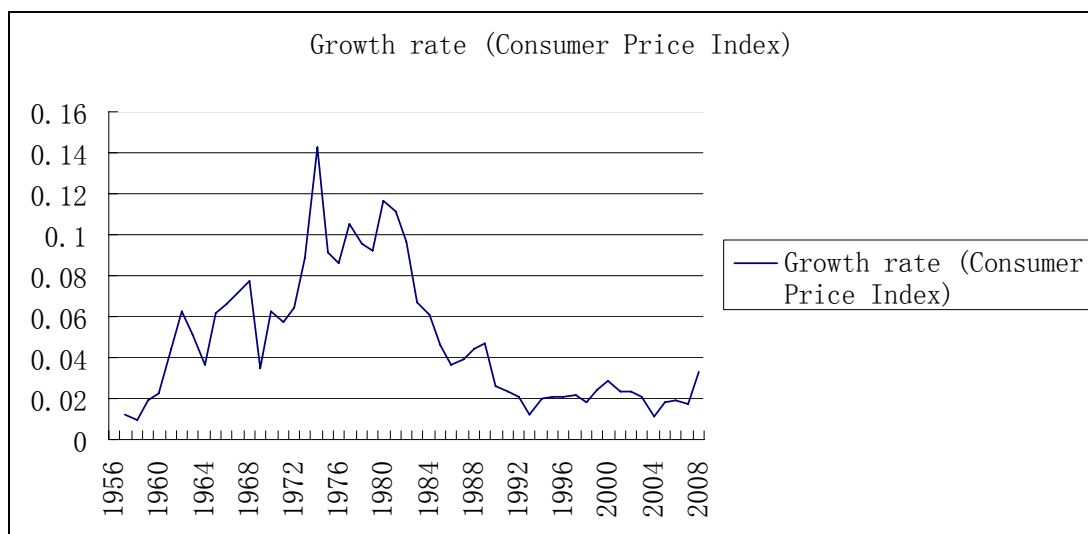
3.2.4 GDP per Capita

From Figure 9, we see that GDP per capita rose from 7,439 DKK in 1956 to 23,983 DKK in 2008. Chen et al (2009) investigated the relationship between GDP per capita and total fertility rate when they analyze Chinese below replacement level fertility in province-level. But since it is required to assure an approximate linear relation in path analysis, they adopted log GDP per capita instead of GDP per capita. And Mapa et al (2010) also analyzed the relationship between total fertility rate and GDP per capita. They used regional income per capita from 1993 to 2006 and regional fertility data in the same period.

Figure 9 GDP per capita (DKK)
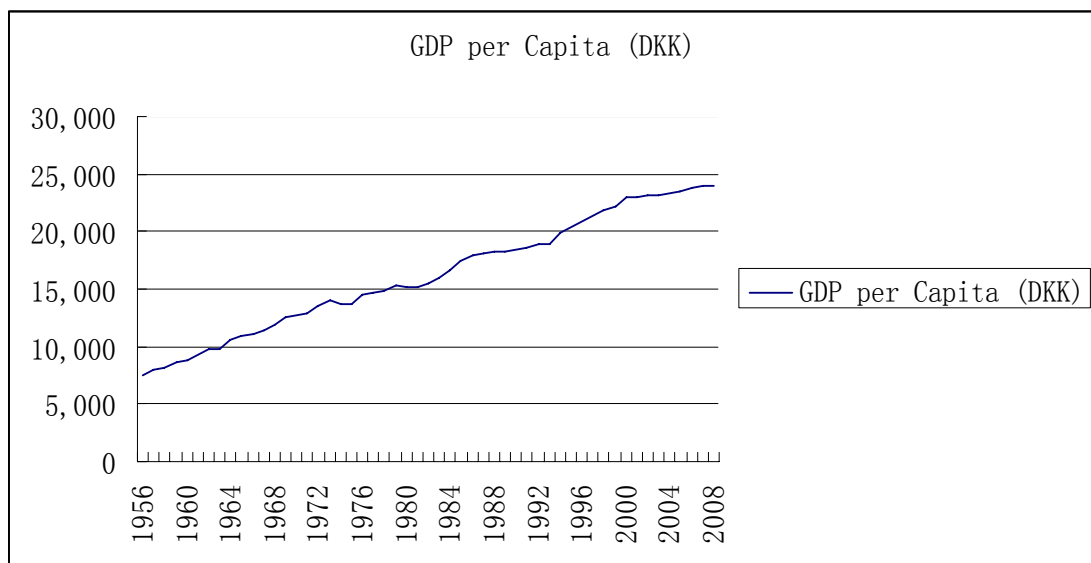
Figure 10 Growth rate of GDP per capita
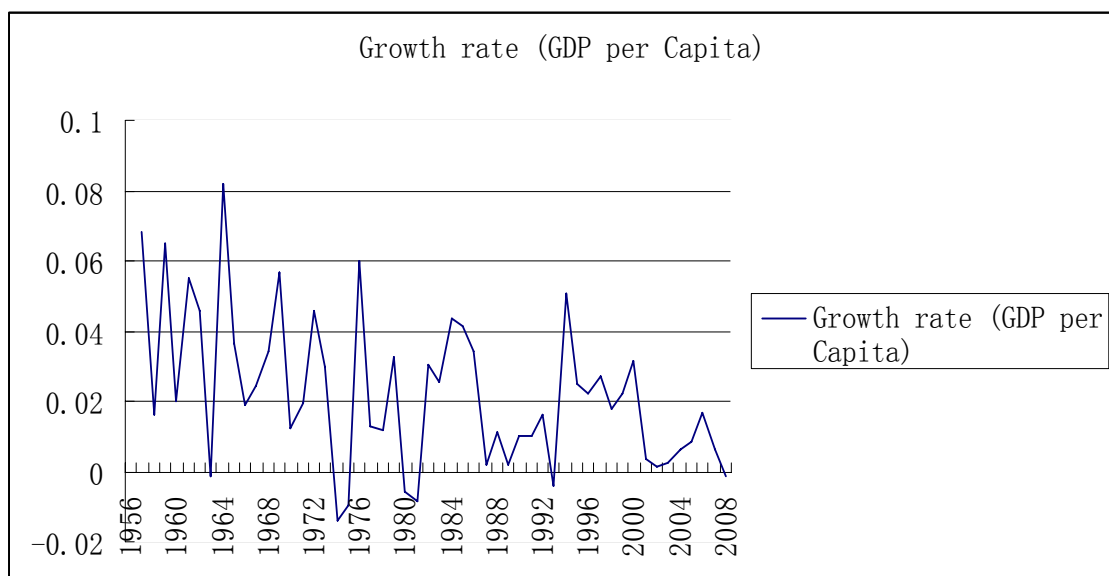
The formula Ln (Yt –Yt-1) was used again to get the growth rate of GDP per capita in Denmark. Yt here means Danish GDP per capita in year t while Yt-1 represents GDP per capita in year t-1. The figure below displays the growth rate of GDP per capita from 1956 to 2008 in Denmark. In most of the years, GDP per capita increased, except in 1963, 1974, 1975, 1980, 1981, 1993 and 1994. In those years Danish GDP per capita had experienced slight reduce, which is in the negative area displayed in Figure 10.

3.3 Data sorting and transforming

As it has been mentioned in the hypothesis part, the trends of the total fertility rate are different in the first sub-period (1956 – 1983) from the second sub-period (1984 – 2008). In order to see whether or not the impact of the factors changed during the two different sub-periods, I will conduct three separate estimations: the first one is for the whole period, the second one is taking a term from 1956 to 1983, when fertility rate declined, as a period and the last estimation is taking the rest of years as a period when the total fertility rate increased.

3.3.1 Data sorting

First Model

In order to estimate the impacts of social economic factors on total fertility rate of Denmark in the whole period from 1956 to 2008, I would like to include the social economic factors in the equation, which are unemployment rate, GDP per capita and consumer price index. In addition to the total fertility rate, there are four variables inclusive.

Second model

The second model includes the same four variables: unemployment rate, GDP per capita, consumer price index and the total fertility rate. However, the scope changed into a relatively short term from 1956 to 1983. In this target period, the general trend of the total fertility rate decreased.

Third Model

The last estimation using the same four variables as the former two models did: unemployment rate, GDP per capita, consumer price index and the total fertility rate. But the scope is from 1984 to 2008, where the total fertility rate grew up.

3.3.2 Data transforming

As it is known that in the general form of vector auto-regression model, all variables would be stationary. However, in most case the economic time series are not stationary, which may easily lead to spurious regression problem if we directly discuss the relationship between variables. In order to avoid spurious regression problem, it is usually needed to test the stability of time series. And the data description part above in this section clearly shows that all the variables are not stationary but with an obvious trend. In order to make the data suit for the principle of VAR model, it is necessary to move the trends away. Therefore, the approach of first log difference is adopted for data transforming. After that, we get new serials of data accordingly. And then, it moves to another step that we need to make sure the new serials of data are already stationary. Thus, the Unite Root Test is used here as usual. The table below shows the results of crucial information of variables after data transforming in two general form of VAR model.

Table 1

fertility		t-Statistic	t-Statistic obtained
	1% level	-3.56543	-4.48841
	5% level	-2.91995	
	10% level	-2.59791	
GDP per Capita			
	1% level	-3.56543	-6.83163
	5% level	-2.91995	
	10% level	-2.59791	
Consumer Price Index			
	1% level	-3.56831	-7.95053
	5% level	-2.92118	
	10% level	-2.59855	
unemployment rate			
	1% level	-3.56543	-6.02746
	5% level	-2.91995	
	10% level	-2.59791	

Table 1 displays the data information of total fertility rate, GDP per capita, consumer price index and unemployment rate, which are all variables used in the first model. From this table, it shows that the result of t-statistic test for total fertility rate is -4.48841, the obtained t-statistic result of GDP per capita is -6.83163, the result of

t-statistic test for consumer price index is -7.95053 and the t-statistic test result of unemployment rate is -6.02746. According to the introduction of Dickey-Fuller test, the values for t-statistic test should be different when different level was conducted at. For example, if the t-statistic level is at 1%, the value should be less than -3.56543, but if the level is at 5%, the value of t-statistic should be smaller than -2.91995 and while we adopt level of 10%, the value for the t-statistic should be no more than -2.59791. Since the obtained t-statistic value for total fertility rate is -4.48841, and it is less than the theoretical value -3.56543. Therefore, we can get a conclusion that the total fertility rate is significant at level of 1%, and then it can deduce that the data of total fertility rate is stationary and can be used in the general form of VAR model. Then it moves to the other three variables: GDP per capita, consumer price index and unemployment rate. We found out that all the obtained results of t-statistic for GDP per capita, consumer price index and unemployment rate are less than the theoretical value at level 1%, which means that GDP per capita, consumer price index and unemployment rate are all significant at the level of 1%. Thus, the conclusion that the data of all the three variables are stationary is drawn.

Table 2 1956-1983

	fertility	t-Statistic	t-Statistic obtained
	1% level	-3.7115	-3.723201
	5% level	-2.981	
	10% level	-2.6299	
GDP per Capita			
	1% level	-3.7115	-5.78904
	5% level	-2.981	
	10% level	-2.6299	
Consumer Price Index			
	1% level	-3.7241	-5.719928
	5% level	-2.9862	
	10% level	-2.6326	
unemployment rate			
	1% level	-3.7115	-4.338822
	5% level	-2.981	
	10% level	-2.6299	

Likely, the Unit Root Test is conducted again for testing variables in the second and the third model. The results displays in Table 2 and Table 3 told us that after data transforming, the values of t-statistic for total fertility rate, GDP per capita, and consumer price index as well as unemployment rate in two sub-periods. From Table 2,

we see that the values of t-statistic for the four variables in a fertility declining period from 1956 to 1983 are -3.723201, -5.78904, -5.719928 and -4.338822. All of the values are smaller than the theoretical t-statistic value at 1% level. Therefore, in the period from 1956 to 1983, all of the four variables are significant at the level of 1%, which indicates that the data of those variables are still stationary in the first sub-period and they can be put into the standard form of VAR model.

The results display in Table 3 are the values of t-statistic for the total fertility rate, GDP per capita, consumer price index and unemployment rate in a fertility increasing period from 1984 to 2008 are -4.14348, -7.57751, -4.47772 and -3.88447 respectively. All of those figures are less than the theoretical t-statistic value at level of 1%, which means all the four variables are significant at level 1% in the fertility increasing period from 1984 to 2008. Thus, the four variables are still stationary in the second sub-period and they can be put into the standard form of VAR model as well.

<center>Table 3 1984-2008</center>

fertility		t-Statistic	t-Statistic obtained
	1% level	-3.73785	-4.14348
	5% level	-2.99188	
	10% level	-2.63554	
GDP per Capita			
	1% level	-3.75295	-7.57751
	5% level	-2.99806	
	10% level	-2.63875	
Consumer Price Index			
	1% level	-3.83151	-4.47772
	5% level	-3.02997	
	10% level	-2.65519	
unemployment rate			
	1% level	-3.73785	-3.88447
	5% level	-2.99188	
	10% level	-2.63554	

4. Methodology

In order to answer the research questions, I am going to use vector auto-regression models to estimate the relationship between economic variables and total fertility rate and to look into how economic development affected birth rate in Denmark since 1956 from the aspects of unemployment rate, GDP per capita and consumer price index. In order to make it more clarified, I employed three estimations with different periods. All three estimations include four variables: total fertility rate, GDP per capita, consumer price index and unemployment rate. The first estimation is for the whole period from 1956 to 2008, while the second one is from 1956 to 1983 and the third one is from 1984 to 2008 respectively.

There are three parts in this section. It will firstly describe the model and explain the advantages as well as disadvantages of adopting VAR model. And then, the lag-length of effects will be further discussed. Finally, based on the results of regression, conclusion will be drawn.

4.1 Brief Introduction of VAR model

The traditional econometric method is to use a model to illustrate the relationship among variables, which based on the traditional economic theory. However, economic theory is not sufficient for providing a rigorous description that can explain the dynamic relationship clearly in most of the cases. In addition, the endogenous variables can appear in the left side of the equation or appear in the right side of the equation, which makes it more complex to estimate. In order to address those issues, there came out a method that using non-structural model to describe the relationship between variables, which is called vector auto-regression (Sims, 1980). In 1980, Sims raised two different regression models: vector auto-regression model and vector error correction model. Both of VAR and VEC are non-structural multi-equation models.

According to Sims, the vector auto-regression model is based on the statistical properties of data. The VAR model takes all variables in the system as the lagged values of all endogenous variables to construct the model; therefore, a single variable from the regression model will be extended to variables from the multivariate time series. The VAR model is one of the most easy-to-do models that can deal with the multiple correlation analysis and forecast of economic indicators. And under certain conditions, multiple MA and ARMA models can also be transformed into a VAR model. Thus, in recent years, the VAR model wins more and more attention and economists are tend to conduct VAR model frequently.

VAR model can provide us useful information from three aspects: first of all, it estimates the regression parameters of explanatory variables and relevant test statics;

secondly, the decomposing to the variance of explanatory variables. It provides an explanation to the variance of each variable and the share of other explanatory variables; finally, VAR model also implies the impulse response function, which explains how the variables are reflected to various shocks. In history, many demographers and researchers have adopted the VAR model in their fields. Kim and Lee (2005) conducted VAR model in investigating the effects of demographic changes on both saving accounts and current accounts. Huynh et al. (2006) analyzed the case of study, using VAR model to estimate the impact of demographic structure and macroeconomic variables on share price. Lee et al. (2010) adopted VAR approach to investigate aggregate composition of US population after the financial crisis exploded in 2008.

4.1.1 Description of VAR model

VAR model is widely used in testing multivariate time series data, which is a quite valuable approach for analyzing dynamics among economic phenomena (Lu, 2001). The VAR model was firstly introduced by Sims in the 1980s for macroeconomic forecasting. According to Lu, the general form of VAR model was represented by:

$$Y_t = C + A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_n Y_{t-n} + \varepsilon_t$$

where Y_t is a m*1 vector of time serial variables, C is a m*1 vector of coefficients, A_n is a m*m matrix, while ε_t is the error terms and n refers to the lag-length for the endogenous variables. The error terms have to meet the following properties: the error terms have zero mean when $E(\varepsilon_t) = 0$, and if $E(\varepsilon_t \varepsilon_t^{'}) = \Omega$, it can be assert that the error term is a m*m matri, and if $E(\varepsilon_t \varepsilon_{t-m}^{'}) = 0$, ε_t and ε_j are not correlated when $t \neq j$.

4.1.2 The advantages and disadvantages of VAR model

Just like a coin has two sides, everything has its benefits as well as drawbacks. Using the tool of vector auto-regression model also has advantages and disadvantages.

Advantages

Usually speaking, unlike a traditional regression model, it is not necessary for a VAR model to differentiate dependent variable and independent variable, and besides, VAR model do not require making assumptions about the endogenous or exogenous of variables. To the contrast, all the variables can be taken as endogenous variables. Put it in another way, it is much simpler and more efficient to adopt VAR model to test whether or not there existing stable relationship among each variable. Therefore, it is very convenient to conduct VAR model when dealing with a large amount of

variables.

Disadvantages

As a matter of fact, there is also some disadvantages for using VAR model. Unlike traditional regression model, VAR model do not need to distinguish dependent variables from independent variables, which is one of its most significant advantages. However, it is also its disadvantages somehow. Because there are a large amount of variables, it is hard to identify which variables we need to include into the model and which variables are not relevant.

4.2 The lag-length for the VAR model

Another important issue for analyzing VAR model is to choose the optimal lag-length before estimating the effects of chosen variables (in this paper they refer to social economic factors: GDP per capita, consumer price index as well as unemployment rate) on the total fertility rate of Denmark. However, it is a confused question for many people that how to determine the optimal lag-length. Generally, there are two approaches in commonly use for deciding the optimal lag-length. The first method is called information criteria, which can be shortly noted as AIC since it is created by Akaike, while the other way is cross-equation restriction (Brooks, 2002).

According to Brooks (2002), the principle of using information criteria method for determination of optimal lag-length is to choose the largest value of lag-length which has to meet the requirement that in the process of enlarging lag value, the value of AIC has to be minimum. And the advantage for using AIC method is that there is no strict restriction on requiring normal distribution of the error term. But of course, there is other rule when deciding the optimal lag-length with the approach of AIC, it is better to make all variables in the same model have the same lag-length. In other words, it is a limitation or can be considered as the disadvantage of conducting the method of Akaike information criteria. In order to decrease the negative impact of the unfavorable limitation, we could transfer the information criteria into another version, which is called multivariate Akaike information criteria, shortly, MAIC. As Brooks (2002) noted, the formula of multivariate version of information criteria can be quoted as:

$$MAIC = \log |\hat{\Sigma}| + 2k'/T$$

where $\hat{\Sigma}$ is the sum of residuals and which is a variance-covariance matrix, and k' refers to the number of regressors while T refers to the number of observations.

By the way of multivariate information criteria, I firstly calculate the value at lag 1,

lag 2, lag 3, lag 4 and lag 5 respectively. The figures in the second column in the table below shows all the results at different level in the first model respectively. According to the definition of information criteria approach, the lag-length at which MAIC get the smallest value is the optimal lag-length. The smallest value of MAIC for the first model is -14.79018 when calculating at lag 4. Therefore, lag 4 is the optimal lag-length for the first model. And then, the process was run again and we get the results of MAIC for the second VAR model. The figures in the third column in Table 3 are values of MAIC at different lag-length from 0 (lag 0 refers to no lag) to 5, and the smallest value is -14.54590, which is at lag 1. Thus, for the second general form of vector auto-regression model, the optimal lag-length should be lag 1. In conclusive, the first model should be VAR (4), which means that the total fertility rate would be affected by GDP per capita, consumer price index and unemployment rate, moreover, the lags of those factors would also have effects on the total fertility rate in Denmark. And for the second and the third estimation, the optimal lag-length might be different since the number of time series has been shorted. Since there are only 25 observations for the two estimations, it is not easy to conduct many lags, thus I prefer to check the first four lags. From the second column and the third column of Table 4, we can see that the optimal lag-length for the second estimation is lag 2 and the optimal lag-length for the third one is lag 3. The result implies that when we divided the period into two sub-periods according to the change of fertility trends, GDP per capita, consumer price index and unemployment rate still affect the total fertility rate, however, their impacts changed over time.

Another thing the table told us is that it can be deduced that in the same year, one unit increase in variables in the first model, the total fertility rate would decline 13.17%. And one year later, the relationship between social economic conditions and the total fertility rate is still negative. And in the following years, the relationship keep negative but elastic is not at the same level. If we keep doing the regression by using more lags, we will find that there are fluctuations. This link between the total fertility rate and important social economic conditions is only demonstrated by using data, there is no theory that totally supports the conclusion however. Situation for the second and the third estimations are similar, different figures refer to different degree of impacts.

Table 4

Lag	First model	Second model	Third model
0	-13.17439	-12.42562	-18.39905
1	-14.31535	-12.85526	-19.76958
2	-14.36786	**-13.2207**	-19.47974
3	-14.67541	-12.50651	**-21.63999**
4	**-14.79018**	-14.09151	-29.48889
5	-14.64988	N/A	N/A

As it is mentioned above, there is another method of deciding the optimal lag-length, which is called the cross-equation restrictions method. By this approach, we can use the likelihood ratio test for testing the optimal lag-length, which can be considered as a complicated test. This test is following the formula below:

$$LR = T[\log|\hat{\Sigma}_r| - \log|\hat{\Sigma}_u|]$$

where T refers to the size of the sample, and $\hat{\Sigma}_r$ is the variance-covariance matrix of residuals for restricted model while $\hat{\Sigma}_u$ is the variance-covariance matrix for the residual for the unrestricted model (Brooks, 2002).

However, since there are some limitations and drawbacks with likelihood ratio test when it is used for deciding the optimal lag-length for the general form of VAR model, it is not as commonly used as AIC method. According to the econometrists, the most significant disadvantage for the likelihood ratio test is that if we conduct likelihood ratio test for choosing the optimal lag-length, the priority is that we have to make sure there are a pair of VAR models and they should be compared to each other. That is why likelihood ratio test is a "joint" test. What is more, the two models have to had the same lag, otherwise, it can not get any useful information from the test and there would be no results. Besides, unlike information criteria approach, if we adopt the likelihood ratio test, it has to be certain that the error term must be normal distribution. To put it in another way, if the error term of a model is not normal distribution, the likelihood ratio test could not be valid. On the contrast, the results get from the likelihood ratio test make sense when the error term has normal distribution.

5. Results and discussion

In this section, it focuses on explaining the results of two regressions and further discussing Danish total fertility rate. Figure 11, Figure 12 and Figure 13 are pictures show the results of regression VAR (4) for the first model, VAR (2) for the second model and VAR (3) for the third one respectively. In those pictures, red dotted lines represent confidence interval and the blue line can be taken as the response of the total fertility rate to variables.

5.1 Results of the first VAR model

Figure 11 shows the regression results of VAR (4) for the first VAR model. In Figure 14, there includes three pictures, they respectively represent response of the total fertility rate to GDP per capita, response of the total fertility rate to consumer price index and response of the total fertility rate to unemployment rate. For the first picture, it can be told that at the first lag, the impact of GDP per capita on the total fertility rate is too weak to zero. With time goes by, the impact is more significant but almost negative except there is a positive effect at the third lag. It shows that the response get weaker and weaker with time and at lag 10, GDP per capita has very small impact on the total fertility rate. Because of inertia and the special nature of fertility behavior, there should be lagged response to shocks. For instance, increasing house price will affect marriage rate as in many cultures that house is necessary for marriage. House price increased, marriage rate may decreased, further lead to drop in marital fertility. But this effect is not instant because it cost time to make decision for having children and also cost time to pregnant. Similarly, the impact of GDP per capita on the total fertility rate can not appear immediately, on the contrast, there requires some time to reflect. Therefore, we can see that the impact at the initial period is not the most obvious. And with time goes by, the impact on the total fertility rate caused by GDP per capital becomes faint.

From the second picture in Figure 11, we can see that the response of the total fertility rate to consumer price index is always negative from lag 1 to lag 10. At the very beginning, the response is not significant, but from the second lag to the third lag, there appear a sharp decrease and three years lag is very significant. Unlike GDP per capita, consumer price index still affects the total fertility rate at lag 10. It is not difficult to understand that once consumer price index changed, people can hardly feel immediately. After a while, when people find out and they change their mind of reproductive decision, time cost and lag appeared.

Then it comes to the third picture in this figure, which is quite different from the former two pictures. From the very beginning, unemployment rate has positive impact on the total fertility rate until the fifth lag. And in the first five lag, impact at the

second lag is the most significant. After the fifth lag, impact of unemployment rate on the total fertility rate starts to decrease, since then it gets to be negative. After the tenth lag, impact gets weaker and weaker. Ahn and Mira (2002) pointed out that at the old times, there was a negative relationship between the total fertility rate and female employment rate, but after the 1980s, the correlation changed into positive. It is also believed that countries with higher female employment participation would be lower in fertility rate during the late 1970s. However, situation was not as worse as expected in Scandinavian countries. Although, in this thesis it analyzed unemployment rate as a whole, not detailed distinguishing female unemployment rate from male unemployment rate, results are essentially the same. In addition, the change of female or male unemployment rate, the patterns of marriage and norms of nuclear family would change as well. The rate of marriage has been reduced in recent years, the age at first marriage was postponed, the interval between marriage and reproduction widened, and moreover, divorce rate increased substantially. All of those changes and transition contributed to the decline of the total fertility rate. To a large extent, decline in marriage rate is a reflection of improvements in women's social status and their sense to control their life. Under this circumstance, women have stronger sense of independence and self-awareness. Consequently, the role that marriage and family plays is less significant than it did before. The process of individualism recognizing has played a far-reaching impact on changing people's values and attitudes, especially the relationship between people from different groups in aspects of sex, age and marital status (Van de Kaa, 1987). The traditional norms of female subordination have been completely abandoned. It is emphasized that both men and women should be responsible for maintaining and extending personal independence and to preserve the dual role of family and career. Once this ideal condition is difficult to achieve, people will tend to delay the establishment of long-term relationships, further affect making decision of childbearing.

Figure 11

Response to Cholesky One S.D. Innovations ± 2 S.E.
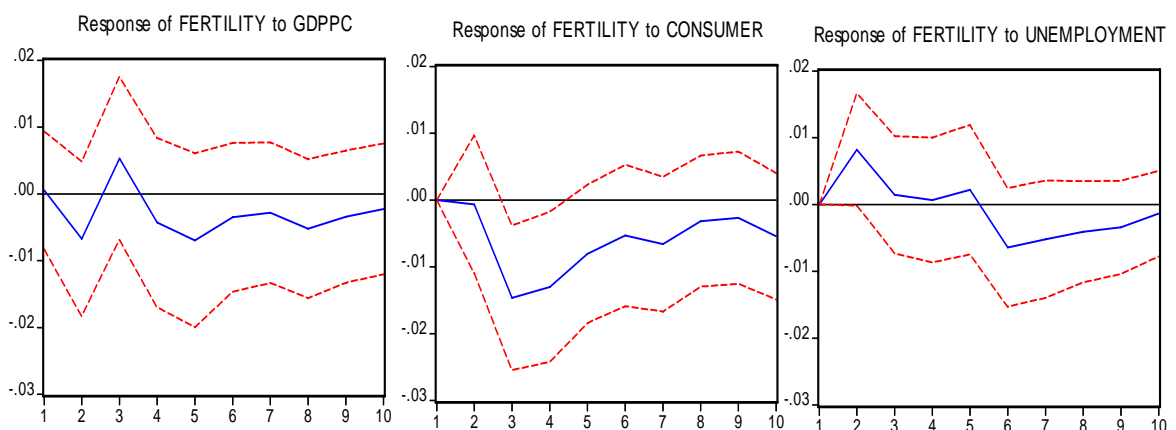
5.2 Results of VAR (2) and VAR (3)

In this part, it is going to discuss the regression results of the second and the third estimations. As it is known that the optimal lag-length for the two models are lag 2 and lag 3, so we conduct the VAR models as VAR (2) and VAR (3). Figure 15 shows the response of the total fertility rate to GDP per capita, consumer price index and unemployment rate in a sub-period when the fertility trends kept down. The curve in the first picture of Figure 12 indicates response of the total fertility rate to GDP per capita from 1956 to 1983. The impact of GDP per capita on the total fertility rate reached the most significant level at the third lag. And the picture also tell us when we limited time series in a short term where fertility trends went down, the GDP per capita affected the total fertility rate in a different way from it affected the TFR in the whole period from 1956 to 2008. In the first four lags, GDP per capita affected the total fertility rate positively and then follows a negative impact in two years. And then, there is a positive impact again, which is followed by a negative impact one lag later. All in all, compared to the first picture in Figure 11, the response of the total fertility rate to GDP per capita is much more fluctuated in Figure 12. The first picture in Figure 13 shows response of the total fertility rate to GDP per capita during a period from 1984 to 2008 where the fertility level grew up. The response is not stable either.

Figure 12

Response to Cholesky One S.D. Innovations ± 2 S.E.
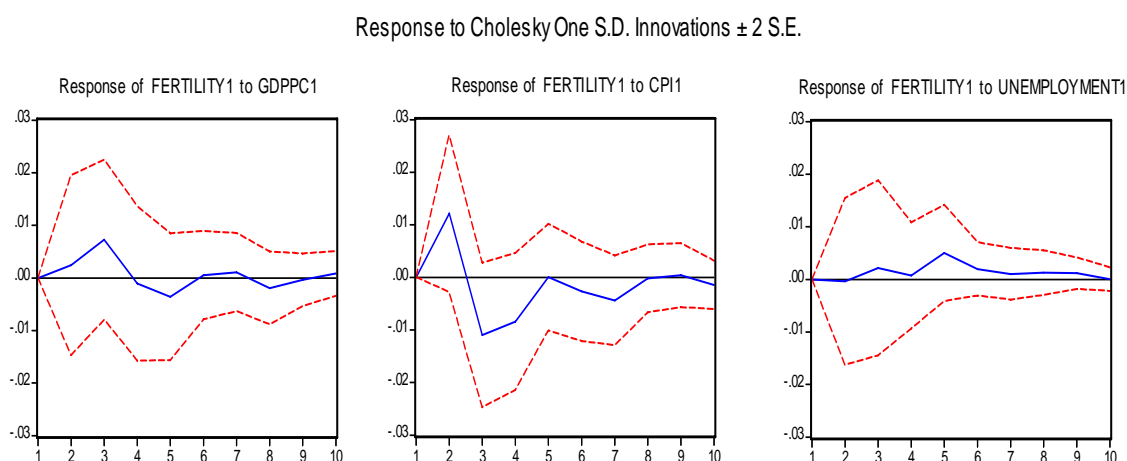
The second pictures in Figure 12 and Figure 13 respectively imply responses of the total fertility rate to consumer price index from 1956 to 1983 and from 1984 to 2008. In both pictures, there is no significant impact in period one because pregnant women had no time to adjust their plan when CPI increased. However, women had family planning but not already pregnant would change their original plans because of higher CPI. This can be illustrated in the pictures. In both pictures, the impact of CPI on the total fertility rate became significantly negative in the third period. As it has been

mentioned above that according to Ahn and Mira (2002), the relationship between the total fertility rate and unemployment rate of female is positive before 1980s, but which turns to be negative from then on. The third picture in Figure 12 and the last picture in Figure 13 perfectly demonstrated their conclusion. In the third picture of Figure 12, the response of the total fertility rate to unemployment situation in the first sub-period from 1956 to 1983 becomes weaker and weaker after the fifth lag and gets close to zero with time. But for the second sub-period from 1984 to 2008, situation is not totally the same. Instead, the response becomes stronger and more significant with time.

Figure 13

Response to Cholesky One S.D. Innovations ± 2 S.E.
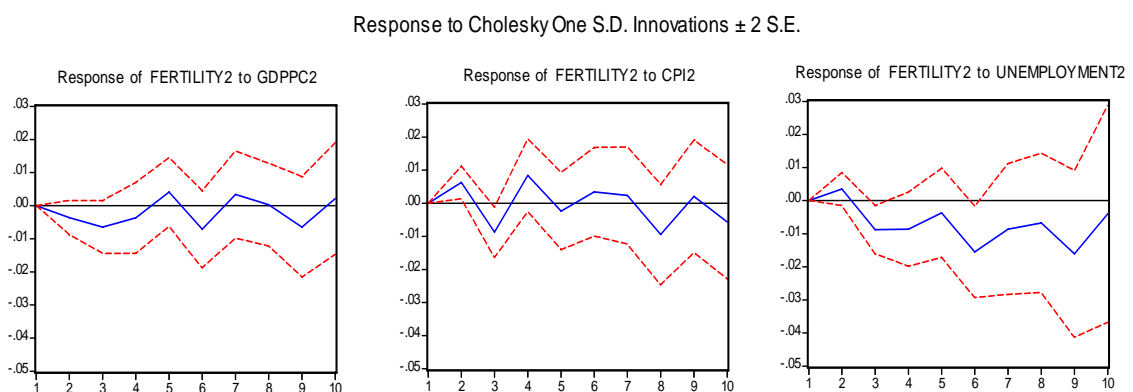
5.3 Further discussion

The most direct consequence caused by fallen of the total fertility rate is aging population crisis, which is serious and would bring tough challenges to economic development and even national security. The population pyramid displayed above shows obviously that a society of elderly population is around the corner according to the projected result. Population aging may cause serious social problems even affects the decisions of government policy-making and. A growing number of elderly people would make a heavier financial burden for the government because the government has responsibility to make the life of senior citizens better and securer. Tax collection is the main source of state revenue, a change in age distribution of population would also make a change in transfer of wealth. Not only in a social range, but also within families, resource both financially and non-financially would be reallocated among people. Within a family, lower fertility level indicates fewer children that requiring attention and money from parents. Therefore, parents have more extra time to choose varied activities rather than stayed home to take care of their children. In addition, with less burden regarding to taking care of children and doing chores, women saved time and they can choose to return to work force and create economic achievements, which may further changed the relationship and status of male and female.

6. Conclusion

Fertility in European countries dropped below replacement level and is still decreasing in most countries. There are many factors that influence fertility behavior. For the case of Denmark, fertility declines dramatically in early twentieth century but the fertility trend actually reversed in recent years. In this paper, I focused on post war period from 1956 to 2008 for the sake of data and historical reasons as well. Vector auto-regression model is adopted for analyzing the relationship between social economic factors and the total fertility rate. In order to take a clear picture, I conducted three estimations and there are four variables inclusive in this model: the total fertility rate, GDP per capita, consumer price index and unemployment rate. For the first estimation, I took the long-term from 1956 to 2008 as a whole period. Conducting MAIC method, the optimal lag-length for this VAR model was found out: VAR (4). And then, the period was divided into two sub-periods according to the trends of fertility level: a general decreasing fertility period from 1956 to 1983 and an increasing fertility period from 1984 to 2008. For the second estimation, the optimal lag-length is VAR (2) while for the third estimation the optimal lag-length is VAR (3).

From the regression results, it pointed out that three factors mentioned in the article have various degrees of impacts on the total fertility rate. For the fertility decreased period, one similar point of three variables is that with time passes by, the impacts get weaker and weaker until close to disappear. It is concluded that on the one hand improvement in economic conditions opens more choices for people and fertility decline is obviously a consequence. But in the fertility increased period, situation is no longer the same. It can be observed that the responses of the total fertility rate to both GDP per capita and consumer price index are more fluctuated than they are in the first sub-period. When it comes to unemployment rate, impacts of two separate sub-periods are in line with the combined effects in the whole period. On the other hand, fertility decline would benefit people from many aspects, for example: better distribute resource within family. At the same time, aging population caused by fertility decline and longer life expectancy alarms shortage of labor force and a large proportion of dependent population. Low productivity would become another serious problem that put off further growth of economy and improvements in living standard.

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Appendix

1. Result of the first estimation

Vector Autoregression Estimates			
Date: 10/26/10　Time: 22:23			
Sample (adjusted): 1961 2008			
Included observations: 48 after adjustments			
Standard errors in ( ) & t-statistics in [ ]			
	FERTILITY	GDPPC	CONSUMER	UNEMPLOYMENT
FERTILITY(-1)	0.259552	0.026878	-0.152446	-1.348353
	(0.17240)	(0.11835)	(0.08168)	(1.24695)
	[1.50553]	[0.22710]	[-1.86628]	[-1.08132]
FERTILITY(-2)	-0.049902	-0.084670	0.233701	0.864266
	(0.16747)	(0.11497)	(0.07935)	(1.21132)
	[-0.29797]	[-0.73646]	[2.94517]	[0.71349]
FERTILITY(-3)	0.007953	-0.009198	-0.039313	1.486848
	(0.17666)	(0.12127)	(0.08370)	(1.27773)
	[0.04502]	[-0.07585]	[-0.46969]	[1.16367]
FERTILITY(-4)	-0.046049	-0.036709	-0.118692	-0.962972
	(0.17180)	(0.11794)	(0.08140)	(1.24263)
	[-0.26803]	[-0.31125]	[-1.45810]	[-0.77495]
GDPPC(-1)	-0.072816	0.010406	0.158014	-2.022525
	(0.29174)	(0.20028)	(0.13823)	(2.11012)
	[-0.24959]	[0.05196]	[1.14313]	[-0.95849]
GDPPC(-2)	0.201501	0.227288	0.004119	0.266117
	(0.30412)	(0.20878)	(0.14410)	(2.19967)
	[0.66257]	[1.08867]	[0.02858]	[0.12098]
GDPPC(-3)	-0.287292	0.371039	0.140308	0.451623
	(0.30210)	(0.20739)	(0.14314)	(2.18502)
	[-0.95100]	[1.78913]	[0.98024]	[0.20669]
GDPPC(-4)	-0.108170	0.064573	0.041947	-1.167591

	(0.29193)	(0.20041)	(0.13832)	(2.11151)
	[-0.37053]	[0.32221]	[0.30326]	[-0.55297]
CONSUMER(-1)	-0.356129	-0.505756	0.950829	11.79914
	(0.41780)	(0.28682)	(0.19796)	(3.02191)
	[-0.85239]	[-1.76335]	[4.80318]	[3.90454]
CONSUMER(-2)	-1.395075	0.580797	0.325971	-7.313674
	(0.53188)	(0.36513)	(0.25201)	(3.84702)
	[-2.62292]	[1.59066]	[1.29349]	[-1.90113]
CONSUMER(-3)	0.906750	-0.032185	-0.447325	-7.755480
	(0.55052)	(0.37793)	(0.26084)	(3.98184)
	[1.64709]	[-0.08516]	[-1.71493]	[-1.94771]
CONSUMER(-4)	0.488424	-0.143931	0.008503	5.845236
	(0.46859)	(0.32168)	(0.22202)	(3.38926)
	[1.04233]	[-0.44743]	[0.03830]	[1.72464]
UNEMPLOYMENT(-1)	0.054148	-0.001616	-0.021009	-0.220764
	(0.02709)	(0.01860)	(0.01284)	(0.19596)
	[1.99859]	[-0.08690]	[-1.63664]	[-1.12658]
UNEMPLOYMENT(-2)	-0.000126	0.007751	-0.002955	0.385253
	(0.02802)	(0.01924)	(0.01328)	(0.20267)
	[-0.00450]	[0.40296]	[-0.22261]	[1.90086]
UNEMPLOYMENT(-3)	-0.038826	0.014877	0.021132	0.255947
	(0.02434)	(0.01671)	(0.01153)	(0.17606)
	[-1.59505]	[0.89028]	[1.83227]	[1.45374]
UNEMPLOYMENT(-4)	-0.015363	-0.001959	0.009721	-0.448573
	(0.02414)	(0.01657)	(0.01144)	(0.17460)
	[-0.63642]	[-0.11824]	[0.84989]	[-2.56921]
C	0.019083	0.010015	0.000263	-0.060747
	(0.01468)	(0.01007)	(0.00695)	(0.10615)
	[1.30030]	[0.99411]	[0.03787]	[-0.57230]
R-squared	0.564808	0.324552	0.869320	0.597221
Adj. R-squared	0.340193	-0.024066	0.801873	0.389335
Sum sq. resids	0.028912	0.013625	0.006491	1.512527

S.E. equation	0.030539	0.020965	0.014470	0.220887
F-statistic	2.514563	0.930967	12.88884	2.872832
Log likelihood	109.8437	127.8995	145.6972	14.86902
Akaike AIC	-3.868487	-4.620813	-5.362384	0.088791
Schwarz SC	-3.205770	-3.958096	-4.699667	0.751508
Mean dependent	-0.006165	0.020859	0.051216	0.011698
S.D. dependent	0.037597	0.020717	0.032508	0.282663
Determinant resid covariance (dof adj.)	1.69E-12			
Determinant resid covariance	2.93E-13			
Log likelihood	420.1502			
Akaike information criterion	-14.79018			
Schwarz criterion	-12.02206			

2. Result of the second estimation

Vector Autoregression Estimates				
Date: 10/25/10 Time: 23:57				
Sample (adjusted): 1959 1983				
Included observations: 25 after adjustments				
Standard errors in ( ) & t-statistics in [ ]				
	FERTILITY1	GDPPC1	CPI1	UNEMPLOYMENT1
FERTILITY1(-1)	0.406942	-0.004354	-0.094880	-1.111262
	(0.23045)	(0.11457)	(0.10723)	(2.06784)
	[1.76582]	[-0.03800]	[-0.88483]	[-0.53740]
FERTILITY1(-2)	-0.421810	-0.030428	0.360704	2.448257
	(0.24119)	(0.11991)	(0.11223)	(2.16416)
	[-1.74888]	[-0.25377]	[3.21412]	[1.13127]
GDPPC1(-1)	0.507201	-0.660378	0.276618	-0.286973
	(0.46789)	(0.23261)	(0.21771)	(4.19833)
	[1.08402]	[-2.83896]	[1.27058]	[-0.06835]
GDPPC1(-2)	-0.044852	-0.343299	0.384485	4.314780
	(0.50737)	(0.25224)	(0.23608)	(4.55258)
	[-0.08840]	[-1.36100]	[1.62863]	[0.94777]

CPI1(-1)	0.826142	-0.883587	0.596952	11.58684
	(0.52814)	(0.26257)	(0.24574)	(4.73895)
	[1.56424]	[-3.36520]	[2.42916]	[2.44502]
CPI1(-2)	-1.193578	0.040884	0.717492	-2.073143
	(0.66440)	(0.33031)	(0.30915)	(5.96159)
	[-1.79647]	[0.12378]	[2.32089]	[-0.34775]
UNEMPLOYMENT1(-1)	-0.001402	0.006821	-0.014431	-0.300631
	(0.02988)	(0.01485)	(0.01390)	(0.26807)
	[-0.04694]	[0.45926]	[-1.03813]	[-1.12145]
UNEMPLOYMENT1(-2)	0.016849	0.007982	-0.022202	0.027175
	(0.03034)	(0.01508)	(0.01412)	(0.27224)
	[0.55533]	[0.52918]	[-1.57270]	[0.09982]
C	-0.015640	0.113029	-0.028514	-0.717731
	(0.04860)	(0.02416)	(0.02262)	(0.43612)
	[-0.32179]	[4.67763]	[-1.26081]	[-1.64571]
R-squared	0.456563	0.641623	0.780529	0.501758
Adj. R-squared	0.184845	0.462434	0.670794	0.252638
Sum sq. resids	0.021911	0.005415	0.004744	1.764092
S.E. equation	0.037006	0.018397	0.017219	0.332048
F-statistic	1.680282	3.580710	7.112828	2.014118
Log likelihood	52.52220	69.99372	71.64902	-2.332969
Akaike AIC	-3.481776	-4.879498	-5.011922	0.906637
Schwarz SC	-3.042980	-4.440703	-4.573127	1.345433
Mean dependent	-0.024404	0.027168	0.072934	0.035764
S.D. dependent	0.040987	0.025092	0.030010	0.384092
Determinant resid covariance (dof adj.)	7.13E-12			
Determinant resid covariance	1.20E-12			
Log likelihood	201.2587			
Akaike information criterion	-13.22070			
Schwarz criterion	-11.46552			

3. Result of the third estimation

Vector Autoregression Estimates
Date: 10/25/10   Time: 23:54
Sample (adjusted): 1987 2008
Included observations: 22 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	FERTILITY2	GDPPC2	CPI2	UNEMPLOYMENT2
FERTILITY2(-1)	-0.188083	-0.107039	-0.017130	2.734238
	(0.18023)	(0.26258)	(0.12657)	(2.84981)
	[-1.04359]	[-0.40765]	[-0.13533]	[0.95945]
FERTILITY2(-2)	0.520091	0.360242	0.237454	-2.910016
	(0.15607)	(0.22739)	(0.10961)	(2.46784)
	[3.33242]	[1.58428]	[2.16638]	[-1.17917]
FERTILITY2(-3)	-0.284246	-0.189147	-0.093457	0.411692
	(0.14459)	(0.21066)	(0.10155)	(2.28632)
	[-1.96587]	[-0.89788]	[-0.92034]	[0.18007]
GDPPC2(-1)	-0.062486	0.652022	0.157991	-5.018104
	(0.28627)	(0.41708)	(0.20105)	(4.52659)
	[-0.21828]	[1.56331]	[0.78584]	[-1.10858]
GDPPC2(-2)	-1.448941	0.001421	-0.416047	0.367856
	(0.34169)	(0.49782)	(0.23997)	(5.40287)
	[-4.24057]	[0.00285]	[-1.73377]	[0.06809]
GDPPC2(-3)	0.366886	0.930706	0.189809	3.059650
	(0.38189)	(0.55640)	(0.26821)	(6.03867)
	[0.96070]	[1.67273]	[0.70770]	[0.50668]
CPI2(-1)	1.217065	0.214297	0.499346	3.367587
	(0.41818)	(0.60926)	(0.29369)	(6.61238)
	[2.91041]	[0.35173]	[1.70027]	[0.50929]
CPI2(-2)	-2.163178	-1.172363	-0.145524	9.056953
	(0.49891)	(0.72689)	(0.35039)	(7.88899)
	[-4.33579]	[-1.61286]	[-0.41532]	[1.14805]
CPI2(-3)	1.692205	0.054940	0.194720	-3.413953
	(0.29473)	(0.42940)	(0.20699)	(4.66033)

	[5.74161]	[0.12795]	[0.94073]	[-0.73256]
UNEMPLOYMENT2(-1)	0.033681	0.064420	-0.000324	-0.274529
	(0.02344)	(0.03415)	(0.01646)	(0.37060)
	[1.43705]	[1.88655]	[-0.01969]	[-0.74076]
UNEMPLOYMENT2(-2)	-0.064460	0.021849	-0.041746	-0.101104
	(0.02713)	(0.03953)	(0.01906)	(0.42904)
	[-2.37567]	[0.55269]	[-2.19071]	[-0.23565]
UNEMPLOYMENT2(-3)	0.009081	0.069237	-0.009745	0.318599
	(0.02852)	(0.04155)	(0.02003)	(0.45093)
	[0.31844]	[1.66641]	[-0.48657]	[0.70653]
C	0.006504	0.014601	0.008141	-0.226346
	(0.00722)	(0.01052)	(0.00507)	(0.11419)
	[0.90060]	[1.38774]	[1.60523]	[-1.98221]
R-squared	0.932517	0.632555	0.830367	0.608631
Adj. R-squared	0.842540	0.142629	0.604189	0.086806
Sum sq. resids	0.000612	0.001298	0.000302	0.152936
S.E. equation	0.008244	0.012011	0.005790	0.130357
F-statistic	10.36395	1.291123	3.671298	1.166351
Log likelihood	84.17735	75.89787	91.95196	23.43988
Akaike AIC	-6.470668	-5.717988	-7.177451	-0.949080
Schwarz SC	-5.825961	-5.073281	-6.532744	-0.304373
Mean dependent	0.011163	0.013061	0.024294	-0.022287
S.D. dependent	0.020776	0.012972	0.009203	0.136412

Determinant resid covariance (dof adj.)	1.48E-15
Determinant resid covariance	4.16E-17
Log likelihood	290.0399
Akaike information criterion	-21.63999
Schwarz criterion	-19.06116