University of Malta
Faculty of Economics, Management and Accountancy

Assessing the Relationship between
Health and Economic Growth:

Malta’s Case

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at the Department of Economics

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“In an ageing Europe, 
a healthy society and active workforce 
will be key determinants of sustainable 
productivity and economic growth.”

EurActiv (2008)
DECLARATION OF AUTHENTICITY

I, the undersigned, hereby declare this work to be of original content, whereby clear reference to others’ work has been made. All errors that remain are my own.

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ABSTRACT

Sustaining heath care costs is a crucial issue for each government though such increasing costs from the public sector tend to be justified due to social implications. This study was intended to analyse the relationship between health and economic growth and to assess whether the two actually effectuate each other justifying further the rising expenditure. The relationship was examined for Malta where the granger causality test was used to determine the presence and direction of causality.

Four variables were incorporated into the model so as to exploit all possibilities of causality, for the period 2000 to 2012. Economic growth was captured by using seasonally adjusted and not seasonally adjusted GDP. On the other hand, health was represented by total health expenditure and by another variable HENM (where capital construction costs incurred between 2000 and 2009 to build the new hospital were deducted from total health expenditure). The model was also run for different period sets: 2000 – 2012, 2000 – 2006 and 2007 – 2012. The findings suggest that causality does not run either way and that economic growth and health expenditure are independent. This means that increased investment in health through health expenditure will not trigger increased economic development and as the economy develops it does not bring about higher expenditure on health.
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LIST OF ACRONYMS

GDP – Gross Domestic Product

NPISH - Non-profit institutions serving households

NSO – National Statistics Office

OECD - Organization for Economic Cooperation and Development

OIC - Organisation of Islamic Cooperation

TFP – Total Factor Productivity

WHO – World Health Organisation
CHAPTER 1:
INTRODUCTION
CHAPTER 1: INTRODUCTION

Health expenditure has been increasingly under the spotlight in recent years and will continue to be for the coming decades. This is mainly a result of rising pressures being exerted on governments across the globe regarding the sustainability of such increasing health expenditures. A study by the OECD in 2010 shows how health expenditures in relation to GDP have been surging in recent years, where the European Union average stood at 8.3% in 2008, a 1% increase over the previous decade; thus governments are allocating more economic resources towards the health sector. Yet one must keep in mind that changes in the mentioned ratio can result from changes either in health spending or economic growth. However, it is crucial to ask whether such increased investments in this sector are reaping long-term social and economic benefits.

Health is measured by a number of indicators with the most common being life expectancy, infant mortality rate and the fertility rate. Most of the developing and developed countries have experienced progress in health; as increases in life expectancy have been accompanied by declines in mortality rates and fertility rates, across the years. Demographic changes are likewise major issues that have led to such increased importance on health. It is a challenge that each and every country must deal with due to its repercussions on productivity and economic growth. It is believed that health and economic growth are interrelated and that a relationship between the two does exist. The World Health Organization (WHO) states that: “the linkages of health to poverty reduction and to long-term economic growth are powerful, much stronger than is generally understood”. In fact, the United Nations has also exemplified the significance of health through the

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1 The figures are quoted from the OECD/European Union (2010), Health at a Glance: Europe 2010, OECD Publishing.
introduction of the Millennium Development Goals, most of which deal with health improvements across countries, particularly in the African Continent.

But how can health impact economic growth? As discussed in this study health can impact output via different channels: directly as well as indirectly. Firstly, improvements in health contribute to better well-being across a society. A healthier work force is expected to contribute to increased productivity as well as less absenteeism compared to an unhealthy workforce. The increased life expectancy brings about changes in expenditure and savings decisions, thus resulting in increased savings rates which in turn boost investment and economic growth rates. Health can impact economic growth indirectly via education, where healthier children tend to have higher school attendance rates, hence improving the overall quality of the labour force, once again resulting in enhanced output. In this manner, health and economic growth are interrelated.

Is this relationship between health and economic growth significant in small economies such as Malta? Do changes in health follow output growth or is it output growth that follows health improvements? What is health’s role in economic growth? This study tries to answer the above questions for Malta and attempts to identify the policy implications depending on the significance of the results attained. The main aim of the study goes beyond just examining the presence of causality between health and economic growth but also determines its direction. Since Health care spending is a dominant component of public sector expenditure in all developed countries, the results obtained will influence crucial decisions regarding optimal resource allocations and interventions from the public sector.
The study is segmented into six sections; where section 2 reviews the existing literature and empirical evidence regarding the relationship in question. Here, a detailed analysis of the channels by which health and economic growth influence each other is incorporated. Additionally, the empirical evidence regarding the causality between the two variables is also identified. Section 3 discusses Malta’s health care system, developments of the health sector across the years and identifies some projections for the coming decades. This section analyses trends in health and economic growth in Comoros, Botswana, Malta, Switzerland and Luxembourg, so as to establish the significance of the relationship across different countries in different stages of development. Section 4 explains the methodological approach undertaken to analyse the causality between health and growth. Once the tests and model are run, Section 5 discusses the results obtained, whilst section 6 summarizes the overall results, their implications and the conclusions attained from this study.
CHAPTER 2:
LITERATURE REVIEW
CHAPTER 2: LITERATURE REVIEW

Early growth theories have tended to emphasise the need of capital accumulation and technological progress for economic growth. Since Human Capital has generally been perceived as a determinant of economic growth, people can supply and accumulate capital only if they are both mentally and physically healthy. In theory, health may spur economic growth since it is a key factor of human capital, thus, more recent studies have shifted the focus towards human capital by incorporating health into their models. The literature observes the effect of health on growth at myriad levels: both macro and micro as well as at the state, national and international level, across different time periods.

The World Health Organisation (WHO) defines health as a “state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. Health itself is often classified as a ‘fundamental commodity’ i.e. one which enables the creation of other tangible goods in an effort to meet people’s wants. Some of the main characteristics of health are that it impacts society’s welfare, it cannot be manufactured by households or people, it is scarce, it cannot be traded and it is non-transferable.

In theory, Health care tends to be classified as an economic good since the resources for it, such as human capital, are limited. However, society’s needs and wants are infinite. The consumption and production of health care can only be increased by diverting resources from other sectors in the economy towards the health care system. Such decisions are based on the ‘opportunity cost’ concept; which would represent the benefits foregone if the resources were utilized for the next best alternative. Grossman (1972) suggested that people both demand and produce health. Health care has a ‘derived demand’ from health since people purchase goods such as health care to meet their needs, thus indirectly
purchasing health improvements. In Grossman’s model, health is considered as a capital good since it can affect a person’s ability to work, hence the linkage between health and economic growth.

“Health is multifaceted. It defies simple definition, and no single variable summarizes it, especially at the aggregate level” (Arora, 2001). In fact the studies discussed below include a number of different health indicators to try to capture the overall effect of health. The most commonly used indicators are:

- **Life Expectancy**: this indicates the number of years an individual is expected to live, given that health patterns remain the same over his lifetime.
- **Infant Mortality Rate**: this indicates the number of mortalities amongst infants and is usually expressed as a number per 1000 live births.
- **Crude Health Rate**: this can either indicate crude birth rate which demonstrates the number of live births over a year or else indicates the crude mortality rate which reflects the number of deaths over a period of one year.
- **Adult Survival Rates**: this indicator captures the probability of surviving the sixtieth birthday after reaching the age of 15 years thus giving a measure of survival during an individual’s working years.

The relationship between health and economic growth is crucial. This relationship is important since economic performance in developing countries could be hindered by ill-health of its citizens. Improving the overall health of society at large could enhance economic development (Bhargava et al, 2001). In developed countries, health care is a major component of investment, spending and employment; hence the effective
administration of a health care system is directly linked to the economic well-being of both
the country and its citizens (Morris et al, 2010).

2.1 Empirical Evidence on the Relationship Between Health and Economic Growth

Although historical empirical evidence may depict different opposing views, there tends to
be a general consensus suggesting that a strong positive, significant relationship between
health and economic growth exists. Different authors use varying methods to observe such
a relationship: from simple methods such as two stage least squares approach to complex
methods such as cointegration and error correction models. However, most of the studies
tend to integrate health as human capital in a production function via the Total Factor
Productivity approach (TFP). TFP involves evaluating the efficiency with which inputs are
utilized within the economy; and in this case health is incorporated as part of human capital.

Mainly, the literature advocates that Health can impinge on economic growth either directly
via labour productivity or indirectly via its effects on education. The direct impact of health
(as measured by life expectancy) on growth, has been reported by a number of studies.
Barro and Lee (1996) conclude that improvements in health via increased life expectancy
are reflected in higher growth rates. Similarly, Bloom, Canning and Sevilla (2001)
assimilate life expectancy in a well specified aggregate production function for a panel of
countries and find that output can increase by 4 percent as a result of a one year
improvement in a population’s life expectancy.

Acemoglu and Johnson (2006) analyze the relationship from a different perspective. They
regress income growth (i.e. per capita GDP) on the increase in life expectancy for the
period 1940 to 1980 and use the wave of health innovations during the 1950s to capture the growth of life expectancy. Their overall findings suggest that improvements in life expectancy over the period under investigation have no significant positive effect. Similarly, Malik (2006) suggests that health does not have a high significant impact on gross national income in India. He makes use of three main health indicators, life expectancy, infant mortality rate and crude health rate, to establish the relationship. Since the author believes that the indicators, i.e. the independent variables, may be correlated with the error term he opts for a two-stage least square method, where the population growth rate is used as an instrumental variable, to ensure that this problem of endogeneity is dealt with.

The relationship has also been reconsidered in view of prevailing endogenous growth theory. In fact, Aghion, Howitt and Murtin (2010) introduce an integrated framework that combines the growth effects of the rate of improvement in health and the level of health. Based on cross-country regressions over the period 1960-2000, for OECD countries, they assert that a higher initial level and a higher rate of improvement in life expectancy both have a significantly positive impact on per capita GDP growth.

Evidence also suggests that enhanced health is not just a sheer by-product of growth but rather growth enhancing in itself. Over the last 100 to 125 years, health improvements have diminished constraints on human ability and increased the speed of long-term growth by 30 to 40 percent (Arora, 2001). Arora (2001) examined the impact of health in industrialized countries including Australia, Denmark, Finland, France, and the United Kingdom using the Cointegration and Error-Correction Model. OIC member states, such as Iran, have also experienced enhanced economic growth rates as a result of improved health in the form of higher life expectancy (Peykarjou et al, 2011). Here, the relationship is analyzed using panel data covering the periods 2001-2009 in the framework of a Semi log
regression model, since this model makes it easier to interpret the coefficients under investigation. Peykarjou et al also established a negative relationship between fertility rate and economic growth for the same nations.

Trends in India (as illustrated in Malik, 2006) convey a relationship between a country’s incidence of disease and its income. Gallup and Sachs (2001) examine this relationship and find that per capita growth rate in the sub-Saharan African region could increase by as much as 2.6 percent if malaria and other communicable diseases are controlled. Hence, a high disease burden in any economy may have detrimental impacts on the country’s growth, productivity and, ultimately, economic development. Even though affected individuals may still remain active within the labour force; their productivity would be significantly impaired.

The associations between disease and economic growth could easily form into vicious cycles: a disease in itself slows growth, reduced growth decreases the capacity to control diseases from spreading, which in itself slows down growth even further (Huang et al, 2010). Using a three-period overlapping generations’ model, Huang et al (2010) analyze the consequences of health on education and economic growth. The model establishes a mechanism where HIV/AIDS influence growth rates through the decline in investments in human capital due to lower returns from investment associated with falling fertility rates. As expected, their findings clearly indicate that declining life expectancies have significant adverse effects both on human capital investment as well as the economic growth rate.

Likewise, recent authors have also examined the adverse effects of undernourishment on economic growth through its impact on health outcomes. Arcand (2001) approximates ‘the efficiency cost of hunger’, that is, he analyses how undernourishment can hinder growth rates. His study concludes that reducing undernourishment in Sub-Saharan African
countries could effectively vary economic growth rates between 0.34 percentage points and 4.63 percentage points. Better nutrition affects growth directly, through labor productivity, as well as indirectly, through improvements in life expectancy (Wang and Taniguchi, 2003). Using a sample of 114 countries (27 developed and 87 developing) over a 39-year period, Wang & Taniguchi (2003) establish a causal relationship amongst the two, that is, nutrition can affect growth and growth can affect nutrition. Furthermore, the incidence of hunger can be costly in terms of economic growth, both in the short and longer term, although enhanced nutrition tends to be related with faster economic growth in the long run. Health, specifically early child development, plays an essential role in human capital investment and thus in long-term economic growth (Mayer, 2004).

Healthier children tend to perform better in school, thus malnutrition can indirectly impact economic growth due to its effect on the quality of the labour force. Glewwe & Jacoby (1995) analyze the relationship from this point of view and conclude that delayed primary school enrollment is caused by nutritional deficiencies in early childhood. Strauss and Thomas (1998) evaluate the interconnectedness of nutrition, productivity and wages. As a result of such associations, a causal relationship between health and productivity does appear to exist (Strauss and Thomas, 1998). Healthier workers are anticipated to make greater use of the time and resources available to them, and are less likely to be absent from work; hence directly increasing productivity.

Additionally, poor health affects economic development fundamentally via total factor productivity (Cole and Neumayer, 2006). Development traps may also arise due to the vicious circle of high mortality rates accompanied by low investment and can explain about 42 percent of cross-country variations of economic growth rates (Chakraborty, 2004). Cole and Neumayer (2006) observe the determinants of TFP in less developed countries,
concluding that poor health is a cause of insistent underdevelopment in many regions of the world since poor health significantly diminishes aggregate productivity.

Other macro-level economic studies report that the adult survival rates of a nation are also indicative predictors of the link between health and economic growth (Bargava et al, 2001; Weil, 2005). Bhargava, Jamison, Lau & Murray (2001) investigated the effects of this indicator in developed and developing countries using 5-year intervals for the period 1965-1990. The resultant figures specify the influence of adult survival rates on growth rates mainly highlighting that the advantages of health may be exploited primarily in poor countries. Eliminating health gaps among countries would reduce the variance of log GDP per worker by 9.9 percent (Weil, 2005). Weil (2005) provides a thorough review on how countries that started developing earliest, such as Sweden, have experienced a long, steady improvement in most health indicators. On the other hand, more recent episodes of rapid growth have been complemented by rapid changes in the health indicators.

Some authors opt to investigate the relationship by including other aggregate variables to convey a unified picture of the economy at large. Narayan et al (2010) explore the relationship between health and economic growth for 5 Asian countries for the period 1974 to 2007 by including investment, exports, imports, and research and development. The relationship is modeled within a production function framework and the findings suggest that all the variables, except imports, contribute positively to economic growth. However, it is crucial to note that although health’s impact is a positive one, the magnitude of the impact is fairly low. Overall, it is estimated that income per capita can rise by about 0.3% for every 1% increase in health expenditure as a percentage of GDP.
2.2 Health & Economic Growth: Causality

Some theoretical and empirical work regarding the association between health and economic growth accent that better health is conducive to higher economic growth while other studies assert that economic growth actually improves health. Thus establishing a relationship between health and economic growth is vital; however, determining the direction of causality between the two is also crucial. Granger (1969) suggested a time-series based approach so as to analyse causality. In this sense, ‘x’ is said to cause (i.e. granger cause) ‘y’ if lagged terms of this variable are useful in forecasting ‘y’.

There are three possible cases of causality:

i. **Unidirectional causality** – where either health granger causes economic growth or economic growth causes health, meaning that there would be only one way causality.

ii. **Bilateral Causality** – where both variables cause each other thus resulting in a two-way causal relationship.

iii. **Independence** – meaning that the two variables are independent from one another and thus their coefficients would be statistically insignificant.

Improved health, in the form of higher life expectancy, lower mortality rates, and other health indicators is partially brought about by increased investment in the health sector, that is, by expanding health expenditures. However, there are opposing views regarding government intervention to sustain economic growth. While keynesian economists state that increased government intervention, possibly in the form of government spending, promotes economic growth, classicists assert that higher government expenditure may
actually slowdown overall performance of the economy and believe that a free market ensures economic sustainability.

Certain European countries, such as Ireland, have experienced a period of relative strong economic growth accompanied by increases in health spending between 1998 and 2008 (OECD/European Union, 2010) suggesting that a relationship may indeed exist between the two. Elmi & Sadeghi (2012) investigated the causality and co-integration relationships between economic growth and health care expenditures in developing countries during 1990-2009, using a Vector Error Correction Model. They conclude that in the short-run there is uni-directional causality from GDP to health care spending, but not vice versa. However, they find bilateral causality in the long-run between economic growth and health spending; therefore, in the longer-term, economic growth is significant in expanding health care spending and increases in health spending also act as an engine of economic growth for developing countries.

A similar relationship has also been observed for Nigeria between 1970 and 2008 using Ordinary Least Squares by Bakare & Olubokun (2011). Yet, Nurudeen & Usman (2010) observe that rising government expenditure in Nigeria has not translated into considerable development since Nigeria is still classified as one of the world’s poorest countries. To investigate the total effect, the authors engage in a disaggregate analysis of government expenditure. Their findings propose that rising government expenditure on health, amongst other expenditures, results to an increase in economic growth. Thus, this implies that the Nigerian Government should devote its expenditure in the development of the health sector in an effort to boost productivity and economic growth.
Likewise, Amiri and Ventelou (2010) also make use of the direct granger causality test to observe the causality between health care expenditure and GDP in the United States for the period 1960 to 2004. They divide the period into three different period sets and distinguish different causal relationships for each period. They find a bilateral relationship existed from 1965 to 1984, whilst uni-directional causality from health care expenditure to GDP was present between 1975 and 1994. For the period 1985 – 2004, uni-directional causality from GDP to health care expenditure was established. Amiri and Ventelou (2010) believe that the effective effect of health care expenditure is diminished when large parts of such spending are particularly aimed at elderly people.

Causality has also been found to run from life expectancy to total GDP and GDP per capita and vice versa. Swift (2011) examined this causality and established whether there has been a long-term endogenous relationship between health and GDP in 13 OECD countries between 1820 – 2001 and 1921-2001, and whether this relationship has remained stable over such a long period of time. The relationship was analyzed using the Johansen multivariate cointegration method since this method takes into account long-run and short-run relationships within a system of equations, where all variables are considered as potentially endogenous. The results show that a long run relationship is present between life expectancy and total GDP and GDP per capita. A 1 percent increase in life expectancy in the long run is related with an increase in total GDP ranging from just under 3 percent, for Wales and England, to around 9 percent for Australia, Canada and Norway.

Very often health tends to be considered as a cost rather than as a long-term investment, in the form of human capital, for the nation at large. Thus, in this regard if causality between the two does exist investing in health care would result in increased economic performance
and vice versa. “Health and healthcare play a key role in generating social cohesion, a productive workforce, employment and hence economic growth” (Kyprianou, 2005).

2.3 CONCLUSION

All in all, understanding the relationship and causality between the two is central due to the possible policy implications of such a relationship. The following chapter gives a brief overview of the health care system in Malta and analyses the relationship discussed for underdeveloped, developing and developed countries. As suggested in the literature, two main health indicators, life expectancy and infant mortality, are used to capture the effect of health improvements across the years.
CHAPTER 3:
MALTA’S HEALTH CARE SYSTEM AND TRENDS
CHAPTER 3: MALTA’S HEALTH CARE SYSTEM AND TRENDS

3.1 MALTA’S HEALTH CARE SYSTEM

In general, health care financing is crucial since resource allocation must be apportioned into a system which ensures equity as well as effectiveness. Although, different countries adopt different financing methods, many countries opt for a public-private mix. The following is a financing flow chart which depicts a basic overview of the main financing alternatives.

Source: Healthcare Delivery in Malta (PWC, 2012)
Malta relies on a universal health care system organized at national level, generally financed out of taxation. Through the Ministry of Health, the Elderly and Community Care, the government bestows its overall responsibility for the healthcare system in Malta. All residents of the Maltese Islands are offered primary, secondary as well as tertiary health care services free at point of use with no user charges or co-payments involved. Only certain provisions are administered on a means tested basis such as dental treatment, optical services, or formulary medicines; although these are provided for free to some population groups. In special circumstances, such as rare diseases, certain patients are flown overseas for the required specialised health care. The private health sector complements the general health care coverage, through the use of out of pocket payments or health insurance.

Primary health care services are provided through two independent services, either at government health centres located in different localities around the island or through private general practitioners. In general, the private sector accounts for about two-thirds of the primary health care segment\(^2\). Provisions of secondary and tertiary care are subject to a number of public hospitals varying in size and function. Up to mid-2007 the general acute hospital in Malta was St. Luke’s Hospital. Since then a new acute general teaching hospital, Mater Dei, has been inaugurated; which took over all of the basic hospital care functions, including ambulatory, inpatient care, specialized care as well as intensive care services. Thus, St. Luke’s Hospital together with Zammit Clapp Hospital nowadays offer geriatric rehabilitation services. Gozo too has its own small general hospital providing basic hospital care and limited specialised care. Sir Paul Boffa Hospital administers oncology as well as

\(^2\) Price Waterhouse Coopers (2012) *Healthcare Delivery in Malta: A publication outlining trends within the healthcare sector*
dermatology services whilst the provision of most of the mental care services takes place at Mount Carmel Hospital.

From the 2008 Household Budgetary Survey, it is estimated that households’ annual consumption on health is approximately 6.4%. This includes expenditure on pharmaceutical products, other medical products, medical and paramedical services, dental services and hospital services. Moreover, expenditure on insurance connected with health is around 0.4% of total household consumption expenditure. Therefore, there is a need to exploit further the role of the private sector in the health care financing in Malta.

Malta has two Bilateral Health Care Agreements with Australia and the United Kingdom where free medical treatment is given to Maltese citizens who require medical treatment whilst on holiday in such countries and vice versa. Likewise, arrangements have also been established across the European Economic Area (EEA) and Switzerland to offer coordination between their respective health care systems. Citizens of such countries can apply for the European Health Insurance Card (EHIC) so as to benefit from such agreements via free or reduced medical treatments when temporarily visiting such countries.

![Health Expenditure as a % of GDP](image)

*Figure 3.1 - Health Expenditure as a % of GDP*
As can be viewed in graph 3.1 above, health expenditure as a percentage of GDP has been increasing during the past years. One must note that the sharp increases in health expenditure between 2002 and 2006 were a result of the capital development costs incurred for the construction of the new hospital. On the other hand, the decline in this ratio after 2006 to 2009 is a direct result of declines in health expenditure during 2007 and 2008 and declines in GDP in 2009, as depicted by graphs 3.2 and 3.3 respectively below.

Here, health expenditure incorporates private and public expenditure on health, including capital formation by both sectors, and NPISH expenditure. NPISH stands for Non-Profit Institutions Serving Households which are private, non-market producers not controlled or financed by the government. Such institutions offer goods and services to households for free or at reasonably low prices, which in reality are not economically significant. In this case, NPISH expenditure includes all expenditure incurred by such institutions in the provision of health care services including capital formation.
Similar to most European countries, Malta is expected to experience an ageing population which tends to strain health expenditure even more. According, to the Ageing Report 2012 (European Commission, 2012), Malta’s health care expenditure is expected to continue rising as life expectancy is expected to increase to around 87 years in 2060 thus exerting pressure on long term care expenses. Moreover, with the new hospital in place, fewer people are seeking coverage from the private sector, hence a shift from private to public health care has been experienced throughout the years; once again straining more the sustainability of health care financing.

Long term care for the elderly, in Malta, is provided at the national level funded through taxation. Residents in state funded homes pay a proportion of their income in an effort to relieve some of the pressures on the financing of long term care. The long term care system in Malta ensures universal access and solidarity across all population groups. In this regard, the private and public sector have collaborated thoroughly to meet the rising demands. Private-public partnerships have been established through new homes and facilities for the elderly. For example, CareMalta Group (one of Malta’s leading private care providers) controls government-owned facilities in Cospicua as well as hotel services in Mellieha.

Currently, the Maltese population exhibits a relatively high health status. The government faces the challenge of providing continuous high quality services, accompanied by rising demands and higher health care costs, in the light of limitations to the share of public sector health expenditure. Malta’s health care spending is expected to increase by 2.9 percentage
points of GDP between 2010 and 2060\(^3\), keeping in mind that such changes in spending are brought about by a combination of changes in the population structure.

As reported by the European Commission in the Ageing Report 2012 Malta’s population structure is expected to change quite significantly in the coming decades. Between 2010 and 2060 the prime age population (25-54) and the working age population (15-64) are expected to decrease by 6.8 and 13.6 percentage points respectively (as a percentage of the total population). On the other hand, both the elderly population (65 and over) and the very elderly population (80 and over) are projected to increase by 16.1 and 7.9 percentage points respectively (as a percentage of total population), over the same period. Such increases are expected to be reflected in increased long-term care costs. In fact, total public spending on long-term care as a percentage of GDP is estimated to increase by 1.0 percentage point from 0.7% in 2010 to 1.7% in 2060. However, all in all the government should view health care expenditure as an investment rather than a cost, if this indeed results in increased economic growth in the longer term.

### 3.2 Trends: Cross-Country Analysis

An analysis of the relationship between health and economic growth is to be established below. Health will be denoted by two main health indicators, life expectancy and infant mortality rate, and GDP per capita is used as an indicator of economic growth. Health expenditure per capita will also be included in the analysis to indicate whether expenditure on health over time reflects improvements in health as determined by the indicators used. The evaluation is to be considered across five countries, including Malta, to examine

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whether the relationship is present in underdeveloped, developing and developed countries respectively. The analysis will depict data for the period 1960 to 2011 for GDP, life expectancy and infant mortality rate collected from the World Bank's Data Section whilst health expenditure data will only be depicted for the period 1995-2011 due to the unavailability of the data.

As can be viewed above, GDP per capita in Comoros has been fluctuating over the years although gradually increasing; though the overall gain has been very minimal, rising from 376 dollars in 1980 to around 810 dollars in 2011. Both health indicators show significant improvements across the period as life expectancy has increased from 43 years in 1960 to 61 years in 2011, whilst infant mortality rates have decreased from 172 to 59 deaths per 1000 live births. Moreover, the decline in health expenditure between 1995 and 2001 seems to follow the decline in GDP over the same period too. Though both variables are in per capita terms and could reflect changes in the population size, it is not the case here, since the population had increased during the same years from 494,486 in 1995 to 577,569

Figure 3.4 – Comoros’s Health Status vs. GDP
Figure 3.5 – Comoros’s Expenditure on Health
in 2001. Therefore, even though there is major room for improvements both in health and overall economic well-being, a positive relationship between economic growth and health seems to be present.

Figures 3.6 and 3.7 above depict Botswana’s economic development and health improvements across the years. Botswana’s GDP per capita has been increasing significantly over the years from 58 dollars in 1960 to around 8,532 dollars in 2011. Similarly, health indicators show strong improvements up to 1990 where infant mortality decreased considerably and life expectancy increased from 51 in 1960 to 64 in 1990. However, between 1990 and 2000 health diminished resulting in lower life expectancies and higher infant mortality rates; with health improving in the 2000s once again. It is believed that the prevailing low rates of life expectancy are a result of very high HIV prevalence rates; in fact Botswana fell 51 places in the Human Development Index.
rankings of 174 nations between 1996 and 1999. Such epidemics and diseases tend to adversely affect any country’s economic and social performance. In fact, “pre-AIDS pandemic projections based on 1990 census data were that life expectancy would rise from 50 to 68 years for males, and from 60 to 74 years for females between 1980 and 2020” (OPEV, 2002).

In general, the data seems to portray a positive relationship although it is somewhat ambiguous between 1995 and 2005 because as GDP per capita is still increasing moderately, the health improvements are negative. It is useful to note that health expenditure per capita was also increasing between 1995 and 2005, thus such expenditure might have been allocated towards infrastructure since the health outcomes were worsening rather than improving during the same period.

---

Unlike, the two countries considered above, Malta is regarded as a developing, middle income country with its GDP per capita at 21,380 dollars in 2011. As Malta’s economic development evolved across the years, so did the health status of its citizens. Life expectancy increased to 82 years in 2011 and its infant mortality rate slashed down from 37 to 5 deaths per 1000 live births. The overall picture depicts a positive relationship between health and economic development. The minor fluctuations in GDP during some periods (such as between 1980 and 1986) are not equally reflected in the health indicators per se, probably due to the fact that such fluctuations are a result of the increased emigration flows. However, expenditure on health and GDP do follow the same patterns across time.

![Switzerland's Health Status vs. GDP](image)

![Switzerland's Health Expenditure per Capita](image)
Switzerland is one of the developed countries considered in this analysis; it is a high income country with GDP per capita increasing considerably over the period analysed standing at 83,326 dollars in 2011. Once again, health indicators have ameliorated across the same time frame with life expectancy peaking to 83 years whilst infant mortality declining notably during the first 20 to 25 years then settling moderately around 4 deaths per 1000 live births. Health expenditure per capita also increased across the years following the patterns depicted by GDP per capita. Thus, as GDP per capita is increasing, health is improving too; hence a positive relationship between the two is clearly extant.

Luxembourg's overall health and economic performances displays drastic changes over the years. Currently, Luxembourg is considered as the country with the highest GDP per capita amongst members of the Organization for Economic Cooperation and Development. GDP
per capita has increased from 2,242 dollars in 1960 to about 114,231 dollars in 2011. Similarly, health has improved significantly during the same period with life expectancy standing at 81 years in 2011 and infant mortality rates being as low as 2 deaths per 1000 live births; thus the increases in health expenditure have been reflected in improved health outcomes. This proves that a high income country attains a positive relationship between health and economic growth comparable to the relationship attained above for the low income countries.

Conclusively, from the above analysis a positive relationship between health and economic growth tends to persist in all of the countries examined; whether underdeveloped, developing or developed. Although all countries displayed a positive trend in health improvements, underdeveloped countries still have a lot to strive for in terms of health status. The key question is whether investment in health care services is also crucial in sustaining economic growth or is it increased economic growth that induces investment in the health care sector. Hence, in an effort to bridge this gap (between correlation and causation) the next part of this study attempts to examine the causality between the expenditure on health and GDP for Malta.
CHAPTER 4:
METHODOLOGY
CHAPTER 4: METHODOLOGY

This section seeks to analyse the model that will be undertaken to establish the relationship under investigation. The model is run on data that is disaggregated and thus the results will be based on such data. The data used in this section was collected from two different sources, and the data covers the period 2000 to 2012 using quarterly intervals, hence using a sample size of 52 observations. Four variables will be considered to establish the causality between health and economic growth. Economic growth is represented by the GDP and SGDP variables whilst health is denoted by the HE and HENM variables. Data for not seasonally adjusted GDP (denoted by GDP) and total health expenditure (HE) was collected from Malta’s National Statistics Office whilst the data for the seasonally adjusted GDP (SGDP) was gathered from the Eurostat. Another variable, HENM, was constructed where the capital expenditure (provided by NSO) incurred to build Mater Dei between 2000 and 2009 was excluded from total health expenditure. This was considered since this expenditure was a one-off large expenditure for the construction of the new hospital Mater Dei and thus is most unlikely that such huge expenditures will occur again in the near future.

The graphs of all the variables have been plotted separately and can be viewed in Appendix A. As can be viewed, the GDP variable is very volatile due to the seasonality in the series. On the other hand the SGDP variable is rather smooth and portrays an upward trend. Both HE and HENM depict upward trends with some small peaks and troughs. The variables have also been plotted against each other and graphs A.5 to A.8 seem to instigate that overall GDP and expenditure on health are moving together across time. However, correlation does not necessarily imply causality.
In general, the testing procedure can be classified into 2 main steps: establishing the order of integration of the series and running the granger causality test. The first step involves performing the appropriate unit root tests to ensure that the variables are stationary. For the interpretations of the results to be valid, one must ensure that all tests are carried out on I(0) variables. Non-stationarity can lead to spurious regressions; where two variables could result in statistically significant results due to time trends even though they are not related in reality. However it is important to note that non-stationarity is not the only reason that can lead to spurious regressions. To test for stationarity, the Augmented Dickey-Fuller (ADF) test is used where the following general regression is run:

\[ \Delta y_t = \alpha + \gamma y_{t-1} + \beta t + \sum_{i=1}^{P} \phi_i \Delta y_{t-i} + u_t \]  

Where \( \Delta \) is the first difference operator, \( \alpha \) is the intercept (called a drift), \( \beta \) is the coefficient on a time trend and \( u_t \) is a stationary random error term. Such ADF test is a one-sided test which evaluates the significance of the coefficient \( \gamma \) by testing the null hypothesis of \( \gamma = 0 \) (i.e. the data is not stationary and needs to be differenced) against the alternative hypothesis \( \gamma < 0 \) (i.e. the data is stationary and thus does not need to be differenced).

The Augmented Dickey-Fuller test is sometimes criticised for its low power resulting in incorrect judgements. This means that in some cases the null hypothesis should be rejected but one fails to do so. Alternatively, a KPSS test introduced by Kwiatkowski, Phillips, Schmidt and Shin (1992) can be used to try to overcome such a problem. This KPSS test for stationarity is also run where the null hypothesis is essentially reversed and the series is assumed to be stationary under the null.
Once the variables are adjusted to I(0), step 2 is attempted, which involves the application of the standard Granger Causality Test. The basis on which this test is founded is the fact that a cause precedes the effect. This study uses the Granger bivariate causal structure (Granger, 1969) where X is said to cause Y, if given an information set, Y can be anticipated better by incorporating past values of X apart from the past values of Y, rather than without them. The test assumes that the information set pertinent to the prediction of X and Y is comprised exclusively in the time series data on such variables. The test entails estimating the following regressions:

\[
Y_t = \sum_{i=1}^{n} \alpha_i X_{t-i} + \sum_{j=1}^{n} \beta_j Y_{t-j} + u_{1t} \tag{2}
\]

\[
X_t = \sum_{i=1}^{n} \pi_i Y_{t-i} + \sum_{j=1}^{n} \delta_j X_{t-j} + u_{2t} \tag{3}
\]

Where X represents economic growth (represented by GDP and SGDP) and Y represents health (denoted in HENM and HE). It is also assumed that the error terms \(u_{1t}\) and \(u_{2t}\) are uncorrelated and X and Y must be stationary. The null hypothesis is that X does not granger cause Y and is only rejected if \(\alpha_1 = \alpha_2 = \ldots = \alpha_n\) are jointly significantly different from zero in equation 2. Such restriction is based on the standard Wald coefficient statistics. If the null hypothesis is rejected then unidirectional causality flows from X to Y. On the other hand, if the restriction holds then past values of X do not cause Y thus there is no causality:

\[
Y_t = \sum_{j=1}^{n} \beta_j Y_{t-j} + u_{1t} \tag{4}
\]
Similarly, if the π’s in equation 3 are jointly significantly different from zero then the null hypothesis that Y granger causes X is also rejected. A feedback relationship between GDP and health expenditure requires that the null hypothesis in both equation 2 and equation 3 are rejected.

Conversely, it is important to identify the limitations of the granger causality test. The most crucial is the number of lagged terms that must be introduced in the model especially since it is based on past values of both the dependant and the independent variables. Incorporating few lags may result in biased estimators or correlated error terms whilst including too many lags may adversely affect the power of the test. All in all it is believed that it is better to use more rather than fewer lags. Furthermore, one has to be aware of any ‘spurious’ causality and thus the model should be well-specified since spurious relationships may be sought even though the variables may actually not be related at all.

It is crucial to note that all variables in an economy could respond to some factor that is not incorporated in the model, such as war, and if the reactions of both X and Y are diffused across time then it will display causality even though the real causation varies. It has been found that the functional form of the time series affects the sensitivity of the Granger Causality Test as well. Roberts and Nord (1985) found that untransformed data yields significant results. However when the data is transformed using logs, it demonstrates independence between the variables. In addition, it is believed that the direct granger causality test tends to depend on over fitting, and although this is not problematic in terms of biasedness it can cause estimator inefficiency.
Conclusively, the results must be interpreted in the light of such limitations that the model possesses. Moreover, data availability may also play a crucial role here. In practice, health improvements must be considered over a long-term period and in this case the model only covers 13 years even though there are 52 observations in total, thus, one has to be careful in the interpretation of the results.
CHAPTER 5:
RESULTS
CHAPTER 5: RESULTS

Following the methodological approach identified in the previous chapter, the suggested tests and model were run. This section gives a detailed analysis of the results attained and their significance. The tests were carried out on all four variables and the model was run a number of times to include all the possible combinations of causality between the variables.

5.1 UNIT ROOT TESTS

5.1.1 AUGMENTED DICKEY-FULLER TEST RESULTS

The Augmented Dickey-Fuller test was carried out for each variable and all the results attained are shown in tables B.1 and B.2 in Appendix B. For each variable, the test was incorporated into three different tests/cases as indicated below:

i. one including an intercept and a trend

\[ \Delta y_t = \alpha + \gamma y_{t-1} + \beta t + \sum_{i=1}^{p} \varphi_i \Delta y_{t-i} + u_t \]  

(1)

ii. one with just a trend

\[ \Delta y_t = \alpha + \gamma y_{t-1} + \sum_{i=1}^{p} \varphi_i \Delta y_{t-i} + u_t \]  

(2)

iii. and one without a constant and a trend

\[ \Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{p} \varphi_i \Delta y_{t-i} + u_t \]  

(3)

The lags were generated automatically using the Akaike Information Criteria which are indicated in the brackets in both tables. In table B.1, the series were tested at levels and in each case the null hypothesis of a unit root test was accepted at the 5% level. For all the variables the t-statistics are greater than the critical values, so the four series are non-stationary and therefore they require differencing.
Table B.2 then shows the results attained after applying first differencing to all the series. As can be viewed, the null hypothesis of a unit root test can be rejected for all the variables at the 5% critical value, since this time around the t-statistic generated by the ADF test is smaller than the critical value for all variables. Therefore, the four series have become stationary at first difference hence, they have an order of integration of one, I(1).

5.1.2 KPSS RESULTS

When the KPSS test is run, it generates an LM statistic defined as:

$$LM = \sum_{t} \frac{S(t)^2}{(T^2f_0)}$$

If this statistic is greater than the critical value, then the series is not stationary and vice versa. Once again this test was run for the four variables first at levels and then at first differencing with the results obtained being shown in tables B.3 and B.4 respectively, in Appendix B.

In table B.3 the LM statistics are greater than the critical values (the same critical values apply for all variables) for all the series. Thus, the null hypothesis of a stationary series was rejected at the 5% level. Similar to the ADF test, we can conclude that the series are not integrated of order zero. On the other hand, table B.4 illustrates the results achieved after applying first differences to the series. This time, the null hypothesis of a stationary series was accepted for all the variables since the LM statistic was lower than all the critical values. Thus, we can confirm that such macroeconomic series are stationary at first differences.
5.2 Granger Causality Results

Accordingly, when performing the granger causality test the series were generated at first differencing. When the model is run the variables are denoted as DGDP, DSGDP, DHE and DHENM where ‘D’ represents the fact that the variables have been differenced. The test was carried out for different period sets; first on the sample as a whole i.e. from 2000Q1 to 2012Q4, then the sample was split in two from 2000Q1 to 2006Q4 and from 2007Q1 to 2012Q4.

5.2.1 Granger Causality Results: Whole Sample

The granger causality test was conducted between four different combinations of the variables thus resulting in eight granger causality outcomes. The four combinations were DGDP and DHE, DGDP and DHENM, DSGDP and DHE, and DSGDP and HENM. Each combination must be run both ways to check for the presence and direction of causality attaining the 8 outcomes. Each combination was also tested using 4, 8, 12 and 16 lags. The results attained are summarized in table 5.1 below.

Although there are some slight variations across the combinations, there seems to be a consensus that causality does not run either way since the null hypothesis that ‘x’ does not granger cause ‘y’ (indicated by an arrow -> in the table) seems to be accepted in most of the results. The null hypothesis (that economic growth does not cause health expenditure) is rejected when 8 and 12 lags were incorporated. However, this does not seem to hold across other lags and other variables. Overall the variables seem to be independent from one another and causality does not seem to run in either direction.
<table>
<thead>
<tr>
<th>Granger Causality</th>
<th>DGDP -&gt; DHE</th>
<th>DHE -&gt; DGDP</th>
<th>DGDP -&gt; DHENM</th>
<th>DHENM -&gt; DGDP</th>
<th>DSGDP -&gt; DHE</th>
<th>DHE -&gt; DSGDP</th>
<th>DSGDP -&gt; DHENM</th>
<th>DHENM -&gt; DSGDP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of Lags</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.0760*</td>
<td>0.5611*</td>
<td>0.0100</td>
<td>0.0283</td>
<td>0.1106*</td>
<td>0.3463*</td>
<td>0.4939*</td>
<td>0.5990*</td>
</tr>
<tr>
<td>8</td>
<td>0.0334</td>
<td>0.7811*</td>
<td>0.0665*</td>
<td>0.0884*</td>
<td>0.0627*</td>
<td>0.6302*</td>
<td>0.5437*</td>
<td>0.6738*</td>
</tr>
<tr>
<td>12</td>
<td>0.0123</td>
<td>0.6806*</td>
<td>0.0421</td>
<td>0.2998*</td>
<td>0.2054*</td>
<td>0.6943*</td>
<td>0.2963*</td>
<td>0.5807*</td>
</tr>
<tr>
<td>16</td>
<td>0.3052*</td>
<td>0.3311*</td>
<td>0.2111*</td>
<td>0.8053*</td>
<td>0.1249*</td>
<td>0.8551*</td>
<td>0.5592*</td>
<td>0.6874*</td>
</tr>
</tbody>
</table>

*H₀ is accepted (i.e. ‘x’ does not granger cause ‘y’)

GDP, HE, HENM (Source: NSO)

SGDP (Source: Eurostat)
5.2.2 **Granger Causality Results: Splitting the Sample**

When the data was split into the two periods the model was run using just 4 and 8 lags for the first half of the period and using 4 and 6 lags for the second half of the period. Since the second period has 4 observations less than the first period, the number of maximum lags allowed was 6. Table 5.2 below represents the results attained for the first half of the period (2000Q1 – 2006Q4) whilst table 5.3 shows the results attained for the second half of the period. Once again, both tables indicate that the null hypothesis is accepted nearly in all the cases applied. The only time that there seems to be bi-directional causality is between HENM and GDP. Similar to the above conclusion, this does not hold significantly across the rest of the variables.

Conclusively, the general trend is that there is no causality between any of the variables even though all possible combinations have been considered. Using different variables to incorporate different macroeconomic impacts and splitting the data into different sample periods seems to have illustrated the same results.
### Table 5.2: Granger Causality Test Results (2000Q1 - 2006Q4)

<table>
<thead>
<tr>
<th>No. of Lags</th>
<th>DGDP -&gt;DHE</th>
<th>DHE -&gt; DGDP</th>
<th>DGDP -&gt; DHENM</th>
<th>DHENM -&gt; DGDP</th>
<th>DSGDP -&gt;DHE</th>
<th>DHE -&gt; DSGDP</th>
<th>DSGDP -&gt; DHENM</th>
<th>DHENM-&gt; DGDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.3636*</td>
<td>0.4961*</td>
<td>0.4643*</td>
<td>0.8253*</td>
<td>0.2311*</td>
<td>0.4119*</td>
<td>0.8204*</td>
<td>0.5241*</td>
</tr>
<tr>
<td>8</td>
<td>0.3447*</td>
<td>0.8799*</td>
<td>0.3683*</td>
<td>0.1645*</td>
<td>0.2264*</td>
<td>0.9990*</td>
<td>0.9008*</td>
<td>0.4160*</td>
</tr>
</tbody>
</table>

*accept H_0 (for both tables)

### Table 5.3: Granger Causality Test Results (2007Q1 - 2012Q4)

<table>
<thead>
<tr>
<th>No. of Lags</th>
<th>DGDP -&gt;DHE</th>
<th>DHE -&gt; DGDP</th>
<th>DGDP -&gt; DHENM</th>
<th>DHENM -&gt; DGDP</th>
<th>DSGDP -&gt;DHE</th>
<th>DHE -&gt; DSGDP</th>
<th>DSGDP -&gt; DHENM</th>
<th>DHENM-&gt; DGDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.3310*</td>
<td>0.6685*</td>
<td>0.0277</td>
<td>0.0018</td>
<td>0.6837*</td>
<td>0.4158*</td>
<td>0.6055*</td>
<td>0.8177*</td>
</tr>
<tr>
<td>6</td>
<td>0.8008*</td>
<td>0.2657*</td>
<td>0.3089*</td>
<td>0.0296</td>
<td>0.4524*</td>
<td>0.6985*</td>
<td>0.2209*</td>
<td>0.3288*</td>
</tr>
</tbody>
</table>
CHAPTER 6:
CONCLUSION
CHAPTER 6: CONCLUSION

The aim of this study was to investigate the relationship between health and economic growth since most of the empirical evidence tends to suggest that a healthy population may be considered as an engine for economic growth. The analyses and estimation of this relationship was tackled in two different stages. Firstly, this study analysed whether improvements in health and economic development tend to move together across time. The analysis included in chapter 3 examined this by plotting health improvements, in the form of life expectancy and infant mortality, against GDP. The aforementioned was conducted for five countries in different stages of economic development to establish whether the relationship still holds. As discussed, there seemed to be an inclination of a positive relationship since health improvements appeared to move in line with GDP increases and declines. However, as specified in the dissertation it is crucial to keep in mind that correlation between health and increased economic growth does not necessarily imply that they are conducive to each other.

For this reason, the second part of this study was intended to establish whether causality runs between expenditure on health and economic development, and if so in which direction. Hence, the direct granger causality test was used to answer the research question of whether changes in health follow output growth or if output growth follows health investment. The model was run on different periods and four variables were considered to ensure that all possibilities of health expenditure and GDP were exploited. The periods considered were 2000 – 2012, 2000–2006 and 2007–2012 at all quarterly intervals. Recall that GDP was considered seasonally adjusted as well as not seasonally adjusted and expenditure on health was considered as total (including public, private and
NPISH expenditure as well as capital formation from all 3 sectors) as well as total expenditure on health less the capital costs incurred to build the new hospital since it was considered as a one-off large expenditure. The study found that there is no causality between economic growth and expenditure on health. Such results imply that for a small economy, Malta, increased investment in health through health expenditure will not effectuate increased economic development. Likewise, as the economy develops it does not bring about higher expenditure on health. Thus, the two seem to be independent in terms of causation.

One must keep in mind that such results should be interpreted with care due to some limitations incurred in this study. Mainly, the investigation was limited by the data used i.e. the size of the sample under observation. In general, Health should be observed over a long-term period and although the model was run using 52 observations they were only spread out over thirteen years. Ideally the data should be obtained at yearly intervals and the sample size should be at least thirty years considering that the granger causality test is run using lags.

These findings provide some overall insights for future research in this field. As stated, this study used expenditure on health as a health indicator. Future work can analyse the relationship between health and economic by using an indicator of health outcome to denote health rather than an indicator of expenditure. This means that instead of analysing the total expenditure that an economy invests in its health sector, it might be prominent to analyse an outcome of health, such as life expectancy or adult survival rates, so as to capture the effectiveness of the expenditure.
Taken in context, such findings suggest that increased health expenditures in Malta are not brought about by increased economic development but rather by other considerations such as demographic changes. Therefore, it is crucial to identify where and how such expenditure is being invested. For example, due to increasing life expectancies, the country has been experiencing increased expenditures in terms of long-term care. Furthermore, the costs associated with ageing tend to be very high especially in terms of medications required for the elderly which are also provided for free in Malta. Additionally, the elderly tend to make use of medical services much more than the younger age groups in society. In this regard, policies should be directed at improving and altering behaviour towards a healthier lifestyle. In the light of an ageing population, governments must take the time and resources in promoting healthy ageing, in an effort to contain such costs associated with ageing.

Moreover, the expenditure may be increasing due to investments in new technologies to improve the overall quality of health care provided. Although, the health care system must ensure fairness and equity across all cohorts within the country, the government must not crowd-out investment from the private sector. The government should try to establish policies that provide incentives to citizens who make use of private health insurance rather than use the free-universal public hospital. In conclusion, optimal resource allocation must be considered by quantifying the opportunity cost foregone in investing in health rather than other sectors in the economy such as education.
REFERENCES
REFERENCES


APPENDICES
APPENDIX A

Figure A.1 - GDP Variable

Figure A.2 - SGDP Variable
Figure A.3 - HE Variable

Figure A.4 - HENM Variable
Figure A.5 - Correlation between GDP and HE

Figure A.6 - Correlation between GDP and HENM
Figure A.7 - Correlation between SGDP and HE

Figure A.8 - Correlation between SGDP and HENM
APPENDIX B

<table>
<thead>
<tr>
<th>ADF Test</th>
<th>Statistics</th>
<th>GDP</th>
<th>SGDP</th>
<th>HE</th>
<th>HENM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ADF (Constant &amp; Trend)</strong></td>
<td><strong>t-statistic</strong></td>
<td>-2.386 (4)*</td>
<td>-1.893 (0)*</td>
<td>-2.991(4)*</td>
<td>-2.303 (4)*</td>
</tr>
<tr>
<td></td>
<td><strong>5% Critical Value</strong></td>
<td>-3.519</td>
<td>-3.500</td>
<td>-3.509</td>
<td>-3.059</td>
</tr>
<tr>
<td><strong>ADF (Constant only)</strong></td>
<td><strong>t-statistic</strong></td>
<td>-0.294 (6)*</td>
<td>0.210 (0)*</td>
<td>-1.212 (6)*</td>
<td>1.237 (7)*</td>
</tr>
<tr>
<td></td>
<td><strong>5% Critical Value</strong></td>
<td>-2.925</td>
<td>-2.919</td>
<td>-2.928</td>
<td>-2.292</td>
</tr>
<tr>
<td><strong>ADF (none)</strong></td>
<td><strong>t-statistic</strong></td>
<td>3.011(6)*</td>
<td>3.919 (0)*</td>
<td>2.537 (6)*</td>
<td>3.680 (7)*</td>
</tr>
<tr>
<td></td>
<td><strong>5% Critical Value</strong></td>
<td>-1.948</td>
<td>-1.947</td>
<td>-1.948</td>
<td>-1.948</td>
</tr>
</tbody>
</table>

Table B.1: ADF Test Results (At Levels)

*H₀ accepted

<table>
<thead>
<tr>
<th>ADF Test</th>
<th>Statistics</th>
<th>GDP</th>
<th>SGDP</th>
<th>HE</th>
<th>HENM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ADF (Constant &amp; Trend)</strong></td>
<td><strong>t-statistic</strong></td>
<td>-4.374 (5)*</td>
<td>-8.525 (0)*</td>
<td>-3.643 (6)*</td>
<td>-4.318 (6)*</td>
</tr>
<tr>
<td></td>
<td><strong>5% Critical Value</strong></td>
<td>-3.513</td>
<td>-3.502</td>
<td>-3.515</td>
<td>-3.515</td>
</tr>
<tr>
<td><strong>ADF (Constant only)</strong></td>
<td><strong>t-statistic</strong></td>
<td>-4.445 (5)*</td>
<td>-8.427 (0)*</td>
<td>-3.579 (6)*</td>
<td>-6.062 (3)*</td>
</tr>
<tr>
<td></td>
<td><strong>5% Critical Value</strong></td>
<td>-2.928</td>
<td>-2.921</td>
<td>-2.929</td>
<td>-2.924</td>
</tr>
<tr>
<td><strong>ADF (none)</strong></td>
<td><strong>t-statistic</strong></td>
<td>-2.957 (3)*</td>
<td>-1.380 (4)*</td>
<td>-1.846 (3)*</td>
<td>-2.183 (3)*</td>
</tr>
<tr>
<td></td>
<td><strong>5% Critical Value</strong></td>
<td>-1.948</td>
<td>-1.948</td>
<td>-1.947</td>
<td>-1.948</td>
</tr>
</tbody>
</table>

Table B.2: ADF Test Results (1st Difference)

*H₀ rejected
Table B.3: KPSS Test Results (At Levels)

<table>
<thead>
<tr>
<th>KPSS Test</th>
<th>Statistics</th>
<th>GDP</th>
<th>SGDP</th>
<th>HE</th>
<th>HENM</th>
</tr>
</thead>
<tbody>
<tr>
<td>KPSS (Constant only)</td>
<td>LM Statistic</td>
<td>0.949*</td>
<td>0.952*</td>
<td>0.951*</td>
<td>0.951*</td>
</tr>
<tr>
<td>5% Critical Value</td>
<td>0.463</td>
<td>0.463</td>
<td>0.463</td>
<td>0.463</td>
<td></td>
</tr>
</tbody>
</table>

*H₀ rejected

Table B.4: KPSS Test Results (1st Difference)

<table>
<thead>
<tr>
<th>KPSS Test</th>
<th>Statistics</th>
<th>GDP</th>
<th>SGDP</th>
<th>HE</th>
<th>HENM</th>
</tr>
</thead>
<tbody>
<tr>
<td>KPSS (Constant only)</td>
<td>LM Statistic</td>
<td>0.262*</td>
<td>0.152*</td>
<td>0.183*</td>
<td>0.213*</td>
</tr>
<tr>
<td>5% Critical Value</td>
<td>0.463</td>
<td>0.463</td>
<td>0.463</td>
<td>0.463</td>
<td></td>
</tr>
</tbody>
</table>

*H₀ accepted