

Secular Stagnation: Evidence from the Irish Economy
Mark Bentley
MSc. Finance
National College of Ireland, ISFC

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Abstract

A over decade after the financial crisis, the global economy has been slow in returning to the growth that was seen in previous recoveries. That in turn has led to the revival of secular stagnation theory. This study investigates the symptoms of secular stagnation and indeed for the existence of secular stagnation within the Irish economy. The research in this paper is conducted through the quantitative methodological paradigm using 33 years of historical data to investigate for the presence of the symptoms of secular stagnation, as well as to generate a model to test if the symptoms of secular stagnation have a significant effect on Irish growth prospects. The findings of this research paper would imply that there is evidence of the symptoms of secular stagnation within the Irish economy and that these symptoms do have a significant effect on domestic growth prospects. However, the Irish economy continues to grow at a significant rate implying that secular stagnation is not present in the Irish economy at this time.

Keywords: Secular Stagnation; Ireland; Economic Growth; Real Interest Rates;

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List of Abbreviations

CBI	-	Central Bank of Ireland
CSO	-	Central Statistics Office
ECB	-	European Central Bank
EU	-	European Union
GNI	-	Gross National Income
OECD	-	Organisation for Economic Co-operation and Development
SQRT	-	Square Root
US	-	United States of America
WBDB	-	World Bank Data Bank

Secular Stagnation: Evidence from the Irish Economy

I. Introduction

“Deflation and secular stagnation are the risks of our time”

Lawrence Summers (2013)

“When depression economics prevails, the usual rules of economic policy no longer apply: virtue becomes vice, caution is risky and prudence is folly”

Paul Krugman (2008)

The boom and bust cycle of the global economy has offered investors, governments and indeed, ordinary people hope of a better tomorrow in hard times. In the past, even the bleakest of recessions have been followed by extended periods of growth. Specially thinking of the depression – defined as a severe recession - known as the Great Depression which rocked the US in the late 1920’s and early 1930’s, while recovery took time, growth returned to the US economy due to a number of factors such as an increase in productivity post the Second World War and an increase in the number of non-farm households to name a few (Barber, 1978). Given the fact that the economy recovered from such a depression was what stuck with people, not that the recovery took such a long time to be realised in full. A number of economists such as Alvin Hansen called out this fact as being a fundamental shift in the global economy and that the kind of growth seen during past recoveries would not reoccur. Hansen’s warnings were largely ignored.

The next recession to hit the global economy on such a scale was the financial crisis of 2008. The crisis was so bad that it required a write down of \$2 trillion from financial institutions alone, while lost growth from the crisis and resultant recession has been estimated to be in the region of \$10 billion which amounted to one-sixth of 2008 global GDP (Oxenford, 2018). The resultant depression saw 2009 become the only recorded year since records began where global GDP declined in real terms (Bloomberg, 2013). As with the Great Depression, the recovery has been slow with scarring effects seen across the global economy even in 2019.

Within the global economy, the Irish economy was a significant casualty of the 2008 financial crisis from a number of standpoints. Following a period of significant growth starting in

the 1980's, commonly referred to as the "Celtic Tiger" which was fuelled by a housing bubble and significant foreign investment in the economy. Ireland found itself in the midst of a banking crisis and deep recession. The end result was a bank guarantee from the government which ensured that banks would remain solvent as well as an EU and IMF led "bail out" in 2011. Ireland was no exception to a deep fall in GNI – the measurement for domestic output in an economy – experiencing a decline in real terms of 16% in 2009 alone according to World Bank data. Additionally, statistics sourced from the CSO show that unemployment nearly doubled to 12.6% in 2009 and increased to a high of 15.5% in 2012. Unemployment levels have only recently fallen back to similar levels seen before the financial crisis recently (c. 5.0%) and GNI in real terms took over five years to get back to 2009 levels. While many could say that the Irish economy has recovered from the financial crisis, the recovery has been slow and has mimicked that of the US economy post the Great Depression and the most recent financial crisis.

There have been a number of theories as to why the global economic recovery has lagged ranging from a global debt overhang (Lo & Rogoff, 2015) to inefficient stimulus from both monetary and fiscal policy (Krugman, 2010). Another theory which resurfaced was Hansen's initial theory proposed after the Great Depression. Lawrence Summers resurrected Hansen's original secular stagnation theory and built upon it further. secular stagnation theory encompasses a broad range of existing economic theories which try to account for the slowing trend in recoveries post recessions and the general downward trend in economic growth in the global economy. Hansen's theory of secular stagnation laid out three fundamental elements of the economy which had previously been driving growth but were now starting to wane. Those three elements were changing population dynamics, slowing economic innovation and diminishing resource exploitation (i.e. business investment). At the time, Hansen did not foresee a number of one-off events which would boost growth levels in the global economy and his theory fell into obscurity. Lawrence Summers reintroduced Hansen's initial theory with the added element of the decline in real interest rates to near or below zero, thrusting the modern secular stagnation theory back to the fore. Modern secular stagnation theory gained considerable momentum in the US where it was heavily debated by economists and government alike. The theory was also used to investigate the potential existence of secular stagnation in the EU, which was seeing, and some would argue

continues to see, slow return to growth post the financial crisis. However, the existing research would appear to focus solely on the large mature economies of the EU as a whole and the US.

The primary aim of this research paper is to test for the possible existence of both, the symptoms of secular stagnation and secular stagnation itself in the Irish economy. Should the research be successful in its primary purpose, it is intended that this will assist key policy stakeholders such as the department of finance, industry officials and Irish economists in making more informed decisions in respect to future policy direction. Specifically, the researcher aims to achieve this by conducting an empirical study on the current state of the four elements of modern secular stagnation theory in the Irish economy as well as a controlled study on the current growth rate of the economy and the four symptoms.

From an initial examination of the relevant literature and a review of the available statistical data, this researcher has identified a number of gaps within the present body of work. Although there are a number of in depth studies of the evidence of secular stagnation and its associated symptoms in the large mature economies of the US (Bleker, 2016), and the EU (Podkaminer, 2015). While these studies, among others, provide a significant grounding in the literature and add value to the field of study, the researcher notes that there is a lack of literature around smaller economies and particularly the researcher's domestic economy of Ireland. Another gap identified in the literature is that while there is a plethora of research in respect to the symptoms of secular stagnation such as Papa (2019), Chand & Markova (2019) and Henderson (2019) to name a few. However, in the Irish context, there does not appear to be a study available which combines all the symptoms together with a view to studying secular stagnation. The researcher has also identified that there is a real lack of quantitative grounding in secular stagnation, with only one study of note, that being Eggertsson, Mehrotra and Robbins (2019).

This study aims to investigate and provide some background to the existing gaps in the literature using the quantitative methodology, more specifically, the correlational and experimental approach to examine for the presence of the symptoms of secular stagnation within the Irish economy and how those symptoms are related to the growth rate of the domestic economy, if at all. Then this researcher proposes to use thirty-six annual data points for each symptom to

investigate on a high level, if there is a relationship that exists between the combined symptoms of secular stagnation and growth of the domestic economy. Should a relationship be evident from the model, the researcher will examine if the Irish economy is indeed suffering from secular stagnation. The adoption of this research method and subsequent approaches ensures the depth and breadth of the data being studied is robust and appropriate.

The main focus of this research and the specific research objectives are to investigate the relationships between Growth in GNI and:

- I. Economic Progress;
- II. Capital Formation;
- III. Real Interest Rates; and
- IV. Population dynamics.

The above will be studied in the wider context of the Irish economy.

The remainder of this study shall then be presented in the following structure:

Section II will present a current literature review. This will provide the reader with an in-depth review of the literature which defines secular stagnation and its original origins. Then, a full review of the supporting literature on the four elements or symptoms of secular stagnation providing the reader with an in depth understanding of the current state of play. Section III will explain the methodology and approach taken for this research. This section will also detail the data sample and explain the statistical model employed. Section IV will combine an in-depth analysis and discussion of the current trends in the symptoms of secular stagnation as well as. This section will also present and evaluate the results of the research objectives as laid out. Section V will provide a conclusion, discuss potential limitations and propose recommendations for further study.

II. Literature Review

“This is the essence of secular stagnation - sick recoveries which die in their infancy and depressions which feed on themselves and leave a hard and seemingly immovable core of unemployment.”

Alvin Hansen (1939)

II.i Introduction to Literature review

The business cycle can be defined as a period of economic fluctuation which an economy experiences over time (Fenton, 2019). These fluctuations are typically determined by a number of economic factors such as business investment, employment dynamics, interest rates and innovation among other things. Periods of contraction – known as busts - are often followed by periods of robust growth – known as booms. The most recent business cycle hit its lowest point in 2009; however, the recovery of the global economy since then has been weaker than most models would have predicted (Fernald, et al., 2017). Economists have been attempting to explain the factors behind the lagging recovery and have suggested slowing human capital accumulation, protracted uncertainty, misallocation of capital, tight credit conditions and China’s integration into world trade – to name a few – could be the cause of the slow recovery (Adler, et al., 2017). The focus of this paper is on a theory which is not new to the Economic and Finance fields.

Alvin Hansen, a Harvard economist, coined the term ‘secular stagnation’ during his 1939 presidential address in an attempt to explain the slow recovery. Hansen’s theory of secular stagnation was based on established works of Adam Smith (1776 cited by Capaldi & Lloyd 2011). Smith argued that there was a link between economic progress, capital formation, population demographics and the economic growth. According to Hansen, the availability of new exploitable resources had been in decline for some time and population growth had stagnated in the sense that the working age population – or those available for work – was not growing quick enough to meet demand. The result of these two factors meant that the US economy would be more reliant economic progress - i.e. innovation – for growth. Hansen was sceptical that innovation drive the levels of growth required and said that “this is the essence of secular stagnation - sick recoveries which die in their infancy and depressions which feed on themselves and leave a hard and

seemingly immovable core of unemployment" (Hansen, 1939). Post Hansen's prediction, a number of one-off economic events such as the Second World War, women entering the labour force en masse and the popularisation of the internet meant that the global economy saw period of unprecedented growth. As a result, secular stagnation theory was largely disregarded.

It was only after the most recent financial crisis that secular stagnation came back to the fore. Lawrence Summers (2013) speech at the IMF suggested that Hansen's initial three-pronged secular stagnation theory had in fact played out as Hansen had predicted and resulted in the need for a lower natural rate of interest (the equilibrium in an economy between savings and investment) to stimulate both private and business investment which in turn contribute to growth in the economy. Summers formalised this updated Secular Stagnation theory in writings in 2014 and 2015 stating that US economic growth rates have been on a downward trend going as far back as the early 1990s. According to Summers, the natural rate of interest is now below zero meaning that investors, both private and business are storing up funds rather than investing in the economy and contributing towards growth and recovery – this is the fourth element of secular stagnation according to Summers. The negative natural rate of interest being negative is complicated by the general consensus that Central Banks cannot reduce nominal interest rates below zero as should the economy enter into recession while interest rates are negative it could then become stuck in a liquidity trap – a situation where inflation and employment are permanently low (Krugman, et al., 1998). A number of high profile economists came out in support of Summers' updated theory, on the demand side, Paul Krugman states that the global economy is more reliant on asset bubbles to achieve growth and this has been increasing in severity since the early 1980s (Krugman, 2013). In the same paper, Krugman also studies the relationship between growth, population dynamics and investment. Booming population in the 1980s drove demand for assets leading to an asset bubble. Once population growth slowed, the bubble burst. The data based on US data would appear to support the slowing population growth with an average growth rate of just 0.5% forecast per annum in the ten years to 2024 down from just 0.6% in the ten years previous (Mitra, 2015). Alternatively, on the supply side Robert Gordon states that it is in fact supply side shortfalls that are the cause of secular stagnation in the form of lower productivity (a proxy for innovation) as a result of education saturation and a lull in technological advancement (Gordon, 2016). For example, in the US, it is estimated that educational attainment increased 0.8 years per decade from 1890 to 1970 which in

turn led to a 0.35% increase in productivity and output per year (Goldin & Katz, 2008). This literature review will study secular stagnation from the perspective of both demand and supply side effects and how both contribute to the four pillars of Secular Stagnation using mostly US based data as it is the most easily available and widely researched.

II.ii Economic Progress

Joseph Schumpeter pioneered the relationship between growth and economic progress (i.e. innovation) in 1934, he argued that where innovation prompts new business to replace the old via “Creative Destruction” booms and recessions are an intrinsic part of the economic cycle (Schumpeter, 1934). Effectively, innovation drives efficiency as older less efficient businesses are driven out of the marketplace and are replaced by more efficient and advanced businesses. Over time, the new innovative firm lowers the cost of one or more inputs to production (in a simple model this can be assumed to be labour and capital) which therefore improves overall productivity and allows the firm expand production and increase supply provided demand remains stable. This in turn stimulates savings and investment within an economy as workers are more productive and can therefore earn more and can choose consume more – as can firms – which directly leads to growth in output per person or real GDP growth (Caliskan, 2015). Alternatively, consumers can choose to save which has a limited impact on economic growth in rich countries (Aghion, et al., 2016).

According to Robert Gordon there have been three major periods of innovation which resulted in extended periods of growth. Firstly, from 1750 to 1830, the invention of railroads and steam engines resulted in growth from increased levels of trade and lower costs of transport as goods could be moved quickly from the exterior to the interior and vice versa. From 1870 to 1900 the invention of the combustion engine and electricity again improved output through increased trade and gains from automation. Lastly from 1960 to present the invention of computers and the internet has helped improve efficiency and automation even further (Gordon, 2012). However, it would appear that the rate of innovation has been slowing as the returns for each new innovation are diminishing. Effectively, the value of each new innovation to growth becomes less and less as time goes on (Fernald & Jones, 2014). This is due to the fact that any simple or easy innovations that would drastically improve productivity and efficiency have been realised and it is now harder and

less frequent to innovate to the same scale (Cowen, 2011). Another factor playing a part in declining economic progress is educational attainment. Beginning in 1880, total years of schooling increased dramatically from seven to thirteen by 1950 in the US, before drastically levelling off and stagnating at fourteen years (Goldin & Katz, 2008). Given the stagnation of educational attainment, it stands to reason that it has played some part in the overall decline in innovation and economic growth (Lutz, et al., 2008).

The arguments above feed into the first pillar of Secular Stagnation, while the above studies are focused on the U.S. economy, they provide a good overview of innovation and the effects of innovation on growth on a global level. In summary, innovation is a key driver of growth in the global economy as it increases efficiency of labour through human capital growth and capital through capital formation or both. Improving supply side factors shifts the aggregate supply curve out – all else being equal – which results in increased output and lowers input prices which should in theory drive consumption and therefore result in increased output. However, there are diminishing returns to investment over time which has resulted in declining rates of innovation over the last number of years (Strumsky, et al., 2010). Diminishing returns to innovation on its own may not have been enough to curtail growth significantly, however, when combined with the other three pillars of Secular Stagnation, it is possible that the harder it is to innovate, the harder it is to induce growth through improved productivity. Particularly in terms of capital formation, innovation requires investment in the capital that is being invested. As innovation lowers the costs of production, businesses have surplus cash to invest, conversely falling innovation leads to the potential falling of capital investments.

II.iii Capital Formation

The global financial crisis of 2007 had a material effect on the global economy. In a normal economy real interest rates are in equilibrium when aggregate investment equal aggregate savings within the economy. However, the real interest rate is free to float, while nominal interest rates are constrained by the zero-lower bound (Belke & Klose, 2017). In the aftermath of the financial crisis a gap between investment and savings opened meaning that there is too little investment or too much saving – consistent with scarring in the economy. This scarring effect has resulted in a decline in overall capital formation as investors shy away from risk and prefers to hold off

investments until they are certain of a low risk return on investments. Effectively, there has been a hangover period post the financial crisis. While not ideal, this doesn't explain the lack of capital formation. Low nominal interest rates should have encouraged both business and private investment which in turn should have stimulated growth and prevented the global economy from stagnating. Studies have shown that private investment across advanced economies was barely 2.1% annually between 2010 and 2014 vs. an average of 3.3% annually between 1996 and 2006; additionally, business investment actually declined between 2008 and 2014 and is 20% below pre-crisis levels (Busière, et al., 2017). Low business investment is particularly concerning as it is a strong indicator of both short- and long-term growth. Interestingly, there has been an increase in “investment-less” credit booms since 2010 where – driven by benign financial conditions there has been considerable credit growth (Kose, et al., 2017) – growth has been driven by consumption rather than actual business investment.

A number of reasons have been proposed for continued sluggish investment. Firstly, uncertainty continues to play a crucial role as uncertainty contributes to stock price volatility and reduces overall investment, output and employment (Baker, et al., 2016). Investors are no longer confident of returns in the future and are unwilling to invest capital given the uncertain nature of returns regardless of the nominal interest rate. This causes growth to stagnate and a perpetual cycle of low investment ensues. Secondly aggregate demand – total demand for goods and services within the economy – has been weaker than it was pre-crisis. Therefore, the basic AS/AD economic model would tell us that to reach equilibrium the AS curve would shift down resulting in an equilibrium with a lower level of output in the economy. If the demand for goods and services isn't there, then firms do not need to invest as heavily to provide a given level of output nor do they need to employ more workers to meet demand.

Both innovation and capital formation are reliant on the performance of the other in order to drive growth in the economy. Innovation requires investment with no guarantee of a satisfactory return for the investment or improvement in efficiency at the end. In a simple model of production there are two inputs – capital and labour – both capital formation and economic progress relate to the capital element of the function. So far, this literature review has reviewed the literature surrounding the capital element of the production function. Labour plays an important role in production and

is intrinsically linked to innovation – labour tends to be the innovators – and capital formation – labour is required to manage the investments that have been made. Of all the literature available on secular stagnation, there is wide ranging consensus that populations are maturing and entering a period of decline in developed economies, academics agree that this is bad for growth (Eggertsson, et al., 2018).

II.iv Population Dynamics

When Hansen first coined secular stagnation, the population growth of the U.S. had begun to slow, and this was having a negative impact on the labour force in terms of total numbers of people available to work as output is constrained by population – not enough people to work limits the maximum amount of output that can be achieved. What Hansen couldn't foresee was World War Two which had the effect – perhaps counterintuitively – of increasing total employment and labour force participation rates. This was largely driven by an increase in patriotism which encouraged previously disenchanted potential workers into the labour force as it was their 'duty'. Secondly, women entered the workforce en masse for the first time and perhaps broke a stigma of women in the workplace – in 1890 only 18.2% of the working age female population were active in the workforce, by 1990 this had increased to 57.5% (Acemoglu & Autor, 2004). This acted as a boom for productivity and subsequently led to an increase in output and a recovery from the stagnant recovery. Additionally, there was both a marriage and baby boom post World War Two as couples who had put off getting married or starting a family during the War made up for lost time. Again, this benefited the labour force in the 1970s to 1990s. However, these effects are now receding as the number of women in the workforce has been stable for some time and the baby boom generation begins to reach retirement age.

The effect of aging populations on growth in terms of secular stagnation is twofold. Firstly, if the proportion of individuals in the working age population declines and are not replaced, then it can be said that there are less people in the workforce who are productive and therefore overall potential productivity level is reduced. Productivity is negatively impacted by an aging population (Choudry, et al., 2016). Secondly and perhaps more importantly, as a higher percentage of the population reaches retirement, they are dependent on support from the working age population through supports such as state pensions, increased healthcare costs and further supports – each eats

up more tax revenues which could have been used for other infrastructure projects that would have driven growth (Valkonen & Barslund, 2018). This is known as the dependency ratio.

Looking at the dependency ratio in the US, spending on public programmes for the ageing such as Social Security, Medicare and Medicaid will account for 73.8% of the growth in government spending in the coming years (Hoagland, 2017). The figure will also continue to rise as it is predicted that the total population over ninety years of age will quadruple from 2010 to 2050 and the population of those 65-85 will double (He & Muenchrath, 2011). The growth in the dependency ratio means that expansionary government fiscal policy will need to focus more on care for the elderly rather than growth generating capital projects that aid the wider economy. Japan already has the highest dependency ratio of any developed nation and it is predicted to rise to 85% by 2050 (Kitao, 2015). As a result of increasing fiscal spend on elder care, substantial tax increases in Japan will be required to adequately balance the fiscal budget – he suggests an increase of 13.5%. Increases in taxes leave those who are employed with less disposable income and therefore consumer spending which forms part of growth in the economy is impacted leading to lower growth. Another point to note is that as dependency rates increase, the implication is that people are living for longer – therefore they require more savings to fund retirement and require state support for longer. Studies show a positive relationship between increasing life expectancy and savings (Zhang & Zhang, 2005). If people are saving more today, this will impact growth today and lead to a lower growth society. Interestingly the authors also point out that there is a positive relationship between life expectancy and education – people stay in education longer and put off joining the labour force which in turn exacerbates the falling labour force participation, but, as outlined above increased educational attainment can be good for growth which mitigates the effect of longer education slightly.

Stagnant or falling labour force participation rates combined with a lack of business investment and falling innovation levels were somewhat hidden by the financial crisis in 2007. The housing and an equity bubble fuelled investor and consumer sentiment which in turn fuelled growth via consumption and increasing debt fuelled investment. However, in the aftermath of the crisis elements of Hansen's secular stagnation theory were evident in the US, UK, and EU economies.

However, as alluded to earlier, Lawrence Summers added a fourth tier to the secular stagnation theory, that of the natural rate of interest.

II.v Natural Rate of Interest

Going back to Lawrence Summers' Speech in 2013, he proposed that secular stagnation was a threat to growth for the U.S. economy. He however added a fourth element, that being a negative natural rate of interest. As discussed earlier, the natural rate of interest is the equilibrium interest rate where savings equals investment. A number of issues arise when the natural rate of interest falls below zero. Firstly, Monetary Policy – the setting on nominal interest rates by Central Banks - becomes ineffective as it cannot set rates below zero as that would incentivise individuals to hoard cash rather than saving it in Banks, who can then use the funds to provide loans for investment. When Monetary Policy becomes ineffective, there is a risk of the economy falling into a liquidity trap – where output is permanently depressed and interest rates remain low for the long term. A lower natural rate of interest means that there is too much saving and too little investment in the economy – something that the literature outlined above would support.

There are two main concerns with a lower natural rate of interest, and one cannot discuss secular stagnation without looking at deflation and hysteresis in the context of the zero-lower bound. Firstly, deflation occurs when the prices of goods and services decline not due to increased efficiency driven by innovation but rather because consumers are putting off planned spending. After some time, if consumers expect prices to keep falling in the future, it becomes a self-fulfilling prophecy and therefore prices do fall, and the economy slips into a deflationary cycle where prices fall in each period causing growth to stagnate and then fall (Krugman, 2010). The second issue with deflation was that as prices fall the real value of debt increases (Fisher, 1933) – think of the Irish housing bubble as an example of this – and as debt rises, people cut spending and the deflationary cycle is exacerbated. Lastly as prices fall, firms have to cut costs. They can do this by letting people go or by dropping wages. There is a certain wage rigidity meaning that employees are not willing to accept pay cuts and therefore a firm has no other choice but to let people go which creates unemployment which further harms growth prospects of an economy.

Hysteresis is scarring within the economy from past events. This was particularly pertinent post the financial crisis of 2007 as hysteresis accounted for over half of the withdrawal from the labour force. The impacts of this were more keenly felt by low income, older workers who were less likely to return to the labour force in the long run (Yagan, 2017, Revised in 2018).

II.vi Arguments against Secular Stagnation

There have been a number of arguments in recent times against the secular stagnation theory as the global economy has attempted recovery, with perhaps Kenneth Rogoff being the loudest voice. Rogoff proposes that rather than secular stagnation, the current slow return to growth is being driven by debt overhang as a result of the global housing and equity bubbles. During this time, investors were highly leveraged, and it has taken time for investors to deleverage and then in turn begin to leverage up again. Rogoff believes that the US was on the way out of this debt super cycle while Europe was still in the process of deleveraging and China would soon enter a period of deleveraging and slower growth (Rogoff, 2016). Other economists have pointed to Gordon's 'technology lull' as being a temporary blip as seen at the end of previous ages of advancement. It takes time for populations to get up to speed with new technology before the next wave begins (Mokyr, 2014). In essence, these researchers state that constantly increasing levels of innovation which Hansen referred to, would be enough to sustain growth.

While these arguments provide plausible alternatives to secular stagnation, they tend to look at the issue from a macroeconomic level only i.e. slow output growth. Most propose alternative theories for sluggish growth rather than looking at the underlying microeconomic shifts which have taken place in the global economy over the last number of years - including in Ireland. That being slowing innovation, lower capital formation, sagging population growth and more recently lower real natural rate of interest as this paper will show below.

III. Methodology

“To do successful research, you don’t need to know everything; you just need to know one thing which isn’t known”

Arthur Schawlow (1921-2002)

This research paper adopts a dual quantitative research methodology. The quantitative approach aims to add to the existing research by generating primary research data to test for evidence of secular stagnation within the Irish economy. The selection of this particular research topic was influenced by this writer’s educational and work experience as well as the perceived need for the economy to be prepared for the next financial downturn.

There are two main research paradigms, quantitative and qualitative research. These can in turn, be broken down into sub-paradigms such as traditional, positivist, experimental, or empirical under the quantitative approach and constructivist, naturalistic, interpretive, postpositivist and postmodern in the qualitative context (Creswell, 2003). As a researcher, one selects a preferred methodological paradigm based on a number of factors, known as assumptions which can be defined by Ponterotto (2005) in **table 1** below:

Assumption	Concern	Quantitative	Qualitative
Ontology	The form and nature of reality	The reality is singular and objective	Reality can be multiple and subjective
Epistemology	The relationship between the subject and the researcher	The researcher is independent from the data being researched	The researcher may interact with subjects
Axiology	The role of values in the research process	Unbiased approach	Value laden and biased
Rhetorical Structure	Language used to present results	Formal language used based on a set of definitions	Informal language based on evolving definitions
Methodology	Process and procedures of the research	Deductive process studying cause and effect	Inductive process open to mutual simultaneous shaping of factors.

Table 1: Assumptions for research (Ponterotto, 2005)

Once a “world view” of assumptions has been formed based on the above approach, a researcher can then make a decision on the most appropriate paradigm to ensure the robustness of the research. Given the nature of the research topic under study and the assumptions adopted by the researcher, a quantitative research has considered the most appropriate approach based on Creswell’s paradigm criteria seen in **table 2** below:

Criteria	Quantitative Paradigm	Qualitative Paradigm
Researcher’s World View (assumptions)	Researchers comfort with the Ontological, Epistemological, Axiological, Rhetorical and Methodological assumptions of the quantitative paradigm	Researchers comfort with the Ontological, Epistemological, Axiological, Rhetorical and Methodological assumptions of the qualitative paradigm
Training and Experience	Technical writing skills; computer statistical skills; library skills	Literary writing skills; computer text – analysis skills; library skills
Psychological Attributes	Comfort with rules and guidelines for conducting research; low tolerance for ambiguity; time for a study of short duration	Comfort with lack of specific rules or procedures for conducting research; high tolerance for ambiguity; time for lengthy study
Nature of the Problem	Previously studied by other researchers so that a body of literature exists, is known along with the variables and existing theories	Exploratory research, variables unknown; context important; may lack theory or base for study
Audience for Study	Individuals accustomed to/supportive of quantitative studies	Individuals accustomed to/supportive of qualitative studies

Table 2: Creswell’s paradigm selection criteria (Creswell, 2003)

To further break down the quantitative paradigm, there are two main methodologies available to researchers – correlation and experimental (Walliman, 2011). Correlation methodology is used to determine if a relationship exists between two variables and if there is a relationship, to what extent does the relationship exist (Clark, 2005). Experimental methodology can be used to research causality between a number of variables while controlling for exogenous factors (Kothari, 2004). The dual correlation and experimental approach have been adopted for this study to allow for a fully objective study whereby the researcher is removed from the data. This in turn will ensure the robustness of results which can then be used to test the hypothesis being put forward.

III.i Data Sample

Given the wide-ranging data variables used in this study, data has been collected from a number of different sources. Where possible, the researcher has attempted to use data collected from the WBDB which applies the same data collection methodologies across countries. Sourcing data in this way ensures that there is an element of homogeneity in the way the data has been compiled across countries which ensures that the experiment can be mirrored across countries by other researchers without a compromise of the data. However, where the data was not available from the WBDB, the Irish CSO and the CBI datasets have been used. This does not hinder the robustness or validity of the data given the credibility of both institutions.

WBDB:

Of the four independent variables studied as part of this research, two have been sourced directly from the WBDB – Non-Financial Business Investment and Domestic Patent Registrations. The WBDB data set for both variables source the data directly from the relevant governing bodies in Ireland, homogenises the data to allow for consistency across the globe and is published on an annual basis. The annual data available ranges in availability depending on when national agencies began publishing data. In terms of the two variables being researched, Non-Financial Business Investment was available from 1972 to 2016 (44 years of data) and Domestic Patent Registrations was available from 1980 to 2017 (37 years). Data from the WBDB has been widely cited in quantitative research publications across the academic spectrum and is considered a robust source of data.

CSO:

The CSO is Ireland's national data collection agency and is responsible for the collection, analysis and publication of primary Irish data. For the purposes of this research, the dependant variable (Real GNI) and population statistics have been sourced from the CSO. The GNI dataset is published on a quarterly and an annual basis with annual data points available from 1970 to 2018 (49 years) on the CSO website. Population statistics are published on an annual basis with data from 1950 to 2018 (68 years). As with the World Bank, the CSO adopt a robust collection methodology to ensure the integrity of data collected.

CBI:

The CBI oversees the regulation of the Irish Banking sector and as a result publishes monthly, quarterly and annual data and reports. For the purposes of this research, the final independent variable (Real Interest Rates) has been sourced from the CBI monthly report on retail interest rates. The most appropriate interest rate chosen was the marginal lending rate which is effectively the base borrowing rate for banks and therefore any individual bank margins are excluded from the sample. As noted above, the source data is published on a monthly basis with historical data dating from 1979 to 2018 (39 years).

III.ii Sample Size

In order to present a meaningful statistical analysis the sample size needs to be big enough to allow for appropriate analysis but not too large as to overly complicate the data set (Lenth, 2001). In respect to sample size, this researcher has collated maximum amount of data available across all variables which results in a number of varying sample sizes for the correlation study ranging from 48 comparable data points to 36 comparable data points. However, in the experimental study, the limitation of the business investment data to 36 data points results in a sample size of 36 annual comparisons for the analysis which was further reduced to 33 as a result of data transformation for the regression analysis. While this data set is not overly large, the current secular stagnation theory as proposed by Summers (2013) relates to the most recent financial crisis which is included completely in the data set. Therefore, this researcher would consider the sample size as appropriate for this study while noting it would be ideal to have a larger data set. For completeness the entire data set is broken down in **table 3** below:

Variable	Variable Type	Data Set Range	Years in the Data Set	Source of the Data Set
Growth in Real GNI	Dependant	1971-2018	48	CSO
Domestic Patent Registrations	Independent	1970-2016	38	WBDB
Domestic, Non-Financial Business Investment	Independent	1972-2016	36	WBDB
Real Interest Rates	Independent	1970-2018	48	CBI
Population 65+	Independent	1950-2018	68	CSO

Table 3: Data set being investigated

III.iii Data Analysis, Validity and Reliability

All of the variables used in this study have been extensively used across the economic and finance spectrum in the study of particular correlation/causality effects on corresponding variables.

Hypothesis of this Study:

H_0 = The Irish economy is not showing signs of secular stagnation as defined by Hansen and Summers.

H_1 = The Irish economy is showing signs of secular stagnation as defined by Hansen and Summers.

Dependent Variable Used in this Study:

(SQRT Domestic Growth)

- Y_1 – SQRT (Nominal GNI*Inflation Rate (2010 = 1.00))

This figure generates a measurement for real growth in the domestic economy. Given Ireland's reliance on foreign investment for growth, GNI is used to more accurately reflect the domestic economy. GNI is then multiplied by the inflation rate to ensure any inflationary effects are removed from the sample.

- During the investigation of the regression, the author notes that the domestic growth variable was showing signs of significance in the Kolmogorov-Smirnov and Shapiro-Wilk tests for normality meaning that the population was not normally distributed. To account for this, the researcher transformed the data using SPSS to create a new variable SQRT Domestic Growth which did not show signs of significance in either test.

Independent Variables Used in this Study:

(Economic Progress)

- X_1 – Annual change in domestic patent registrations

This figure generates an annual percentage increase or decrease each year in the number of patent applications by domestic firms in Ireland. This acts as a proxy for economic progress (Idris, 1977).

(Capital Formation)

- X_2 – Nominal annual non-financial business investment*Inflation Rate (2010 = 1.00)

This figure generates the growth in real monetary terms in the real business investment within the Irish economy exclusive of business investment in financial assets. This acts as a good proxy for capital formation.

(Real Interest Rates)

- X_3 – Annual Marginal Lending Rate – Annual Inflation Rate

This figure represents the real interest rate in the economy taking annual inflation into account as determined by the Fisher equation (Fisher, 1933).

(Population Dynamics)

- X_4 – SQRT (Annual percentage growth of the population over 65)

This figure represents the growth rate of the Irish population over the age of 65. As discussed in the literature review, those over the age of 65 are more likely to be retired and therefore more dependent on the state and consume less. This acts as a good proxy for population dynamics - the faster the growth rate, the larger the impact on economic growth.

- During the investigation of the regression, the author notes that the population dynamics variable was showing signs of significance in the Kolmogorov-Smirnov and Shapiro-Wilk tests for normality meaning that the population was not normally distributed. To account for this, the researcher transformed the data using SPSS to create a new variable SQRT Domestic Growth which resulted in a non-significant result on the Kolmogorov-Smirnov test.

III.iv Approach Adopted

Given the nature of the data and the presentation of the theory, the researcher adopted a three-tiered approach to the data;

- Firstly, an assessment on the symptoms of secular stagnation as set out by Hansen (1939) and Summers (2013) was conducted with a view to critically analysing the general trend in the four independent variables. The results of this were then examined and discussed in detail with reference to supporting literature and theories.
- Secondly, a correlation methodological approach was undertaken with a view to determining if there was indeed a correlation between the individual independent variable

data sets and the dependent variable. To ensure the robustness of analysis, the analysis and discussion comprised of a number of descriptive statistics contextualised around the existing literature.

- Lastly, an experimental methodological approach was adopted whereby a regression analysis using SPSS was carried out where GNI growth was controlled for using proxies for the four symptoms of secular stagnation within the Irish economy to test for the existence of secular stagnation within the economy and if the four symptoms act as a robust predictor of future GNI growth.

Using the three tiered approach allowed the researcher to investigate the full effects of secular stagnation on an economy from an embryotic stage right through to Hansen's (1939) definition of secular stagnation where "sick recoveries which die in their infancy and depressions which feed on themselves and leave a hard and seemingly immovable core of unemployment." Based on what the analysis showed, while one tier of the approach may not be significant currently, there is potential for a future crisis. The adoption of this approach allowed for some statistically significant findings which can be utilised in further research into the topic of secular stagnation to both improve the robustness of the secular stagnation model used in the experimental approach and the correlational findings of this research.

IV. Analysis and Discussion

“The only people who see the whole picture are the ones who step outside the frame.”

Salman Rushdie (1999)

IV.i Economic Progress in Ireland

As laid out in the review of the literature above, there are two main measures of economic progress - domestic patent registrations and educational attainment. It would stand to reason that increasing patent registrations and increasing educational attainment would have a positive effect on GNI growth. Domestic patent registrations are measured simply by the annual number of new patent applications in Ireland made by residents. Measuring this way ensures that only registrations that would directly contribute to Irish economic progress are captured. Additionally, educational attainment has been measured as a total percentage of the working age population (those aged 15+ per the World Bank methodology) who have at least some tertiary level education.

Patent Registrations:

An initial review in the global context of domestic patent registrations provides a rather mixed pool of results as per **appendix 1**. While patent registrations have seen an increase in nominal terms in patent registrations across OECD Countries, the EU and the USA from 1981 to 2017 with increases of 415%, 18% and 371% respectively, nominal growth has decreased in the UK and Ireland by 36% and 60% respectively. Interestingly, the trend in growth rates across all five of the selected regions has been on a downward trajectory across the sample data, although it is noted that the declines vary in velocity across the five regions. Given that the OECD, the USA and the EU are considered advanced, high income regions, Schumpeter’s (1934) creative destruction theory would apply whereby as these economies advance towards greater levels of efficiency the nominal number of patent applications would be expected. It would also stand to reason that the annual growth rate would begin to decline over time as new innovations and inventions would be harder to come by (Heubner, 2005). What is perhaps more surprising in the data is that domestic patent registrations have declined in nominal terms in the United Kingdom and Ireland. Additionally, the United Kingdom and Ireland have also seen the steepest downward

trend in annual growth rates. Given the positive relationship established between innovation and economic growth (Acs, 2006) and that these two economies, particularly Ireland, saw a sustained period of economic growth from the 1980's to the middle of the 2000's (see **figure 1** for Ireland) - this finding is somewhat surprising.

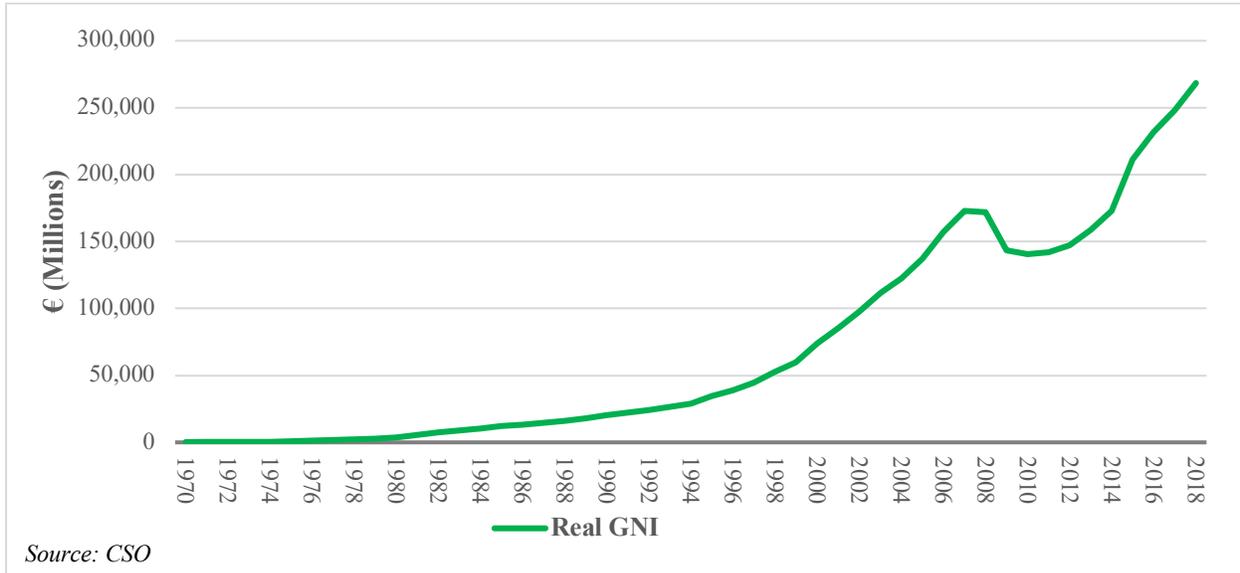


Figure 1: Real GNI in Ireland from 1970 to 2018

Ireland is a particularly interesting case study in this context given that Ireland came from what was classed as a developing economy in the 1980's to a developed economy after a prolonged period of economic growth from the 1980's to the time of the financial crisis in 2008. As **figure 2** below shows, the Irish economy saw domestic patent applications of 394 in 1980 (the first year of published records), this grew in sync with the economy to a peak in 2001 at 1,090 applications before starting a steep decline to its current level of 183 in 2017. Only four years of registration growth in the intervening sixteen years and the 2017 figure was over 60% below the 1980 level in nominal terms.

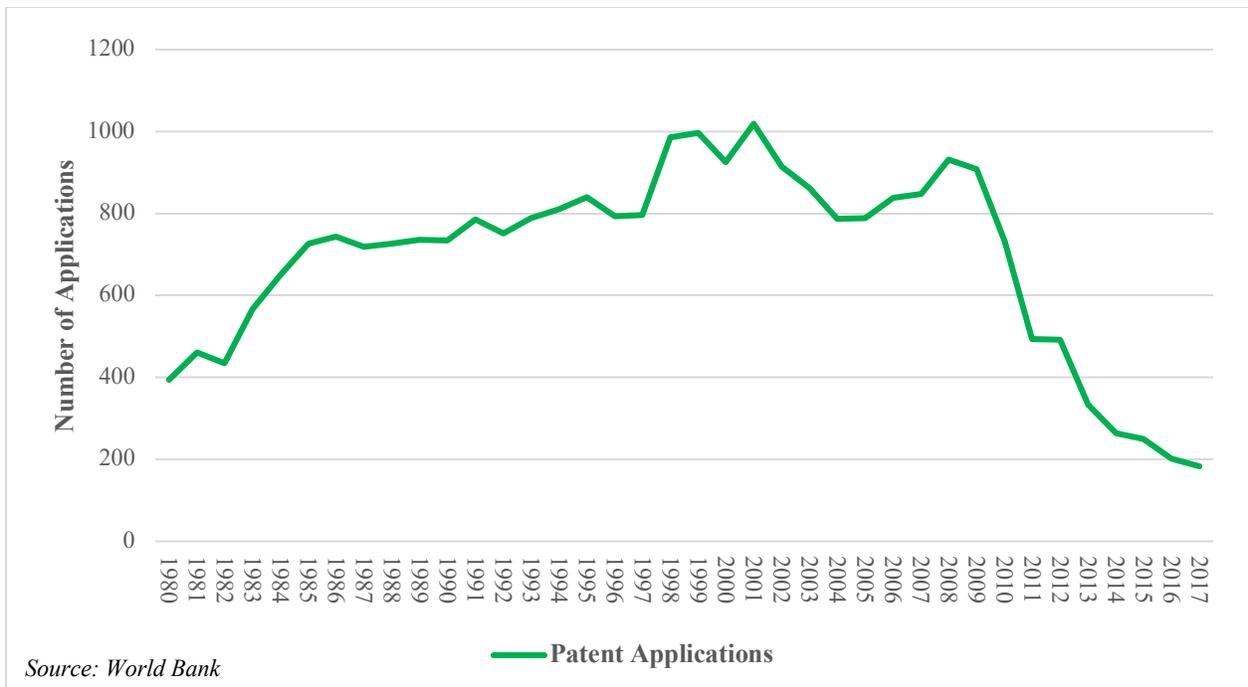


Figure 2: Domestic patent applications in Ireland between 1980 and 2017

Perhaps the fall off in patent registrations could have been seen as an indicator of an overstimulated economy and a precursor to a recession. Post the financial crisis, it can be seen that the number of patent registrations has declined each year indicating that there remains a reluctance or an inability to register new patents in Ireland despite the improving economic climate in the last number of years.

In comparison to the other regions in the sample taken, Ireland has also had the starkest downward trend in patent registration growth rates over the sample period. Interestingly, Ireland managed to generate an annual growth rate greater than 10% on five occasions over the last 37 years as per **figure 3** - the second best across the data sample.

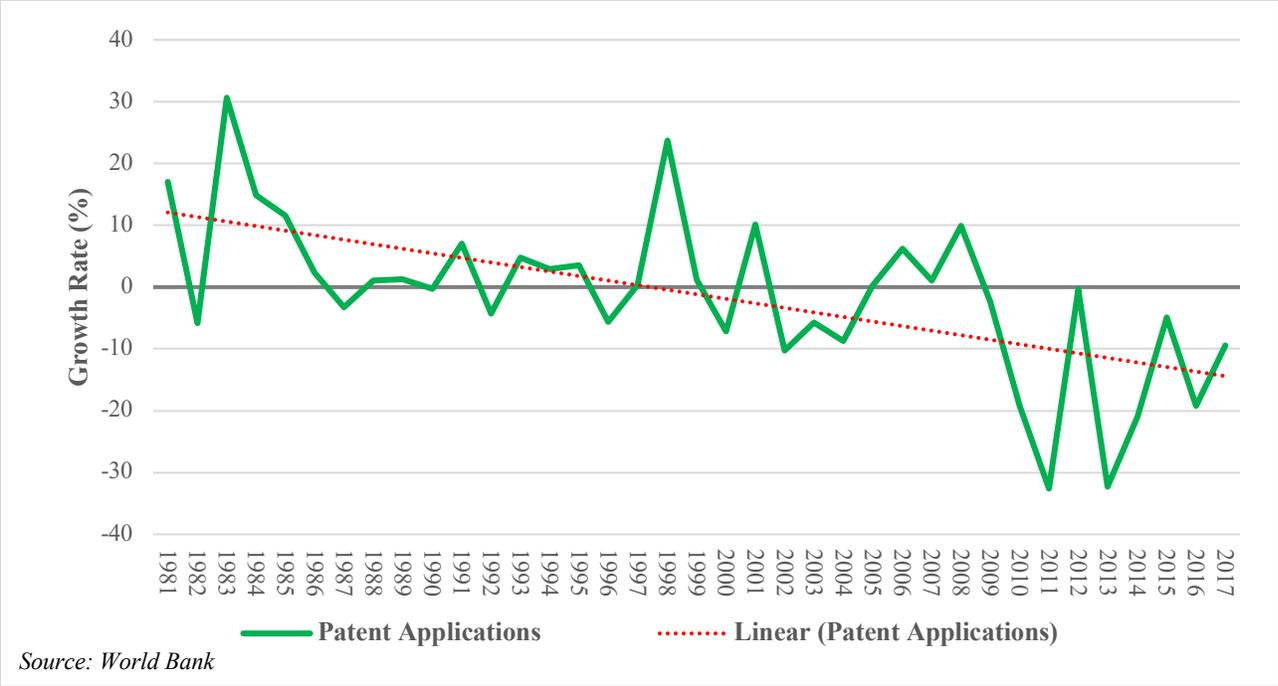


Figure 3: Growth rate in domestic patent applications in Ireland between 1980 and 2017

This is in comparison to just twice across the OECD, twice in the EU, seven times in the US and none in the UK. Ireland has also had six (five of those post 2010) periods where annual growth has registered a decline of greater than 10% - the worst performing region in the sample. The OECD, The EU and UK had no declines greater than 10%, whilst the US only had one.

The most surprising finding that the data shows in the Irish context is that GNI made a robust recovery post the financial crisis, while patents registrations, a proxy for economic progression has stagnated and declined significantly over the same time period. While it would be expected to see a decline in both GNI and patent registrations post the financial crisis, it would have been expected that as the economy improved, both business and individuals would have the confidence to reinvest in innovations and register successful innovations via patents. That does not appear to be the case. It could be the case that a number of exogeneous factors have played a role in the continued decline in domestic patent registrations such as a decline in the risk appetite of Banks and investors to invest and support new “start-ups”, or it could be the case that individuals are no longer willing to take the risk on a venture that is not guaranteed success, particularly when employment conditions are favourable. The alternative is that there are simply no new fresh innovations

coming to the market which enhance efficiency in the marketplace and therefore no new patent applications.

Educational Attainment:

The second element of economic progress investigated as part of this research paper relates to economic attainment. Education is seen as a significant contributor to economic growth via economic progress. As more complex innovations have come to the market, educational attainment plays a critical role in assisting economic growth as more complex processes and equipment require more complex and highly trained employees to operate or exploit the innovations in order for the potential efficiencies to be realised. Additionally, as innovations become harder and harder to create or invent, it requires more complex or trained individuals to spot and implement new innovative opportunities. However, there is a limited stock of individuals who can obtain a certain level of education because once 100 percent of the population has a level of education, no further gains can be achieved as the economy has hit a saturation point. As the literature points out, the last fifty years have seen a massive increase in the contribution of educational attainment to economic growth, however, that is now starting to plateau, particularly in the US (Jorgenson, et al., 2016). This will undoubtedly have an impact on economic progress and subsequently growth.

In the Irish context, as **figure 4** shows, the number of Irish people of working age who have some level of tertiary education has followed a similar path as described above since the 1971 when only 11% of the population had some level of tertiary education. That figure has continued to rise over the last forty years culminating in 78% of the population having some level of tertiary education in 2016 - an increase of 67 percentage points. There are a number of interesting observations one can take from the data, the first being the increase has been driven by both increased male and female enrolments, however, since 1995, the largest contribution has been from female entrants rather than male entrants as **figure 5** shows which perhaps is an indication of the more significant role women play in the workplace and the requirement for higher levels of education.

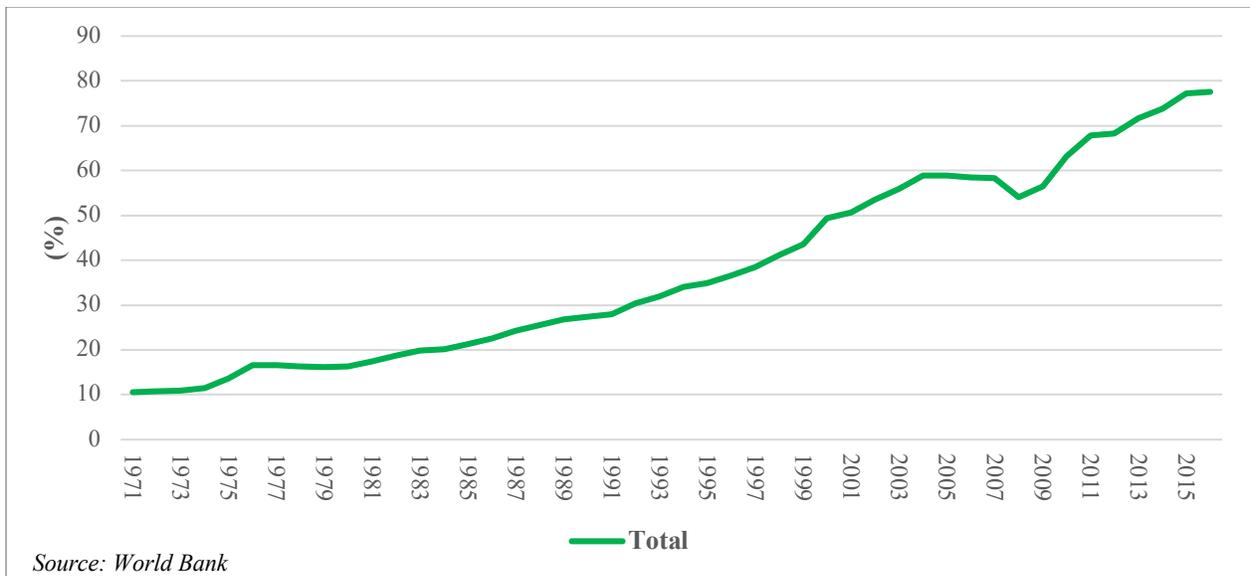


Figure 4: Percentage of the Irish working age population with some level of tertiary education between 1971 and 2016

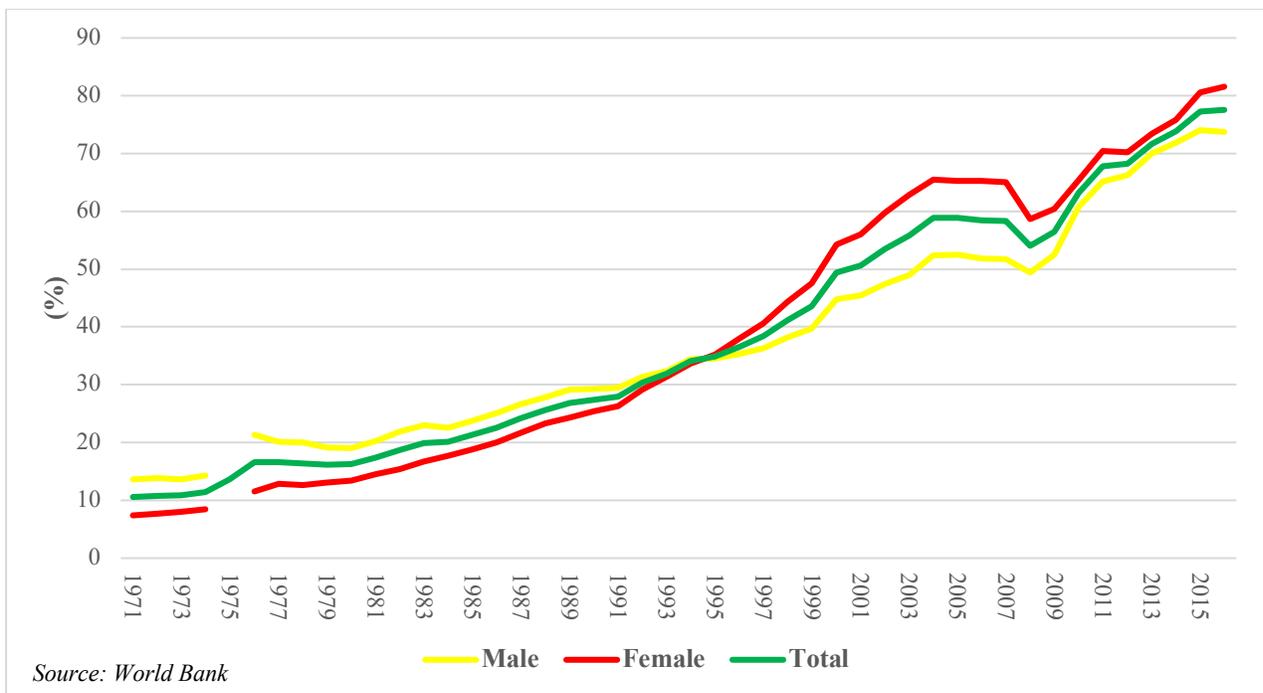


Figure 5: Percentage of working age population with some level of tertiary education from 1971 to 2016 broken down by gender

Interestingly, the percentage of the male population with some level of tertiary education fell slightly in 2016, while females with some level of tertiary education continued on an upward trend and now sits above 81%.

While it can be said that educational attainment continues to play a significant role economic progress in Ireland, it is not unreasonable to consider that, in terms of educational attainment, the Irish economy may be reaching a point of saturation and the plateau that can be seen in the US may soon become more evident in the Irish economy. Additionally, it would appear the increased levels of education among the general population is not feeding through to increased levels of innovation by the domestic population which is somewhat surprising to the researcher.

IV.ii Capital Formation

It is said that business investment (also known as capital formation) follows a recovery but does not lead it. Post the financial crisis, business investment declined by €109bn between 2008 and 2009 and at the same time, European firms have accumulated in region of €700 billion in additional cash. American businesses have been no different with net capital investment averaging about 12% of GDP in 1950, this fell to eight percent in 2007 and declined further to four percent in 2014 (McKinsey & Company, 2016). Secular stagnation theory as discussed in the literature review posits that due to a fall in aggregate demand firms are no longer willing to invest in capital formation at the rates that were previously seen and thus business investment has fallen, and stockpiles of cash have continued to increase.

While business investment may have stagnated in the EU and the US, on the face of it, **figure 6** would indicate that business investment in non-financial assets has somewhat recovered from the financial crisis and was more or less back at 2008 levels in 2016 at over €4 billion on a net investment basis. When considered in the global context, the Irish economy can be considered a success. In 1972, in real terms, net business investment amounted to €2.8 million or 0.9% of GNI, with the continued expansion of GNI, business investment increased to a peak of €4.4 billion in 2008 or 2.6% of GNI. Then the financial crisis hit and resulted in a more than halving of net business investment to €2.2 billion by 2011. The recovery however is what has differentiated Ireland from its larger global neighbours as business investment rocketed back to €4.4 billion by 2016 - albeit at a lower overall contribution to GNI at 1.9%.

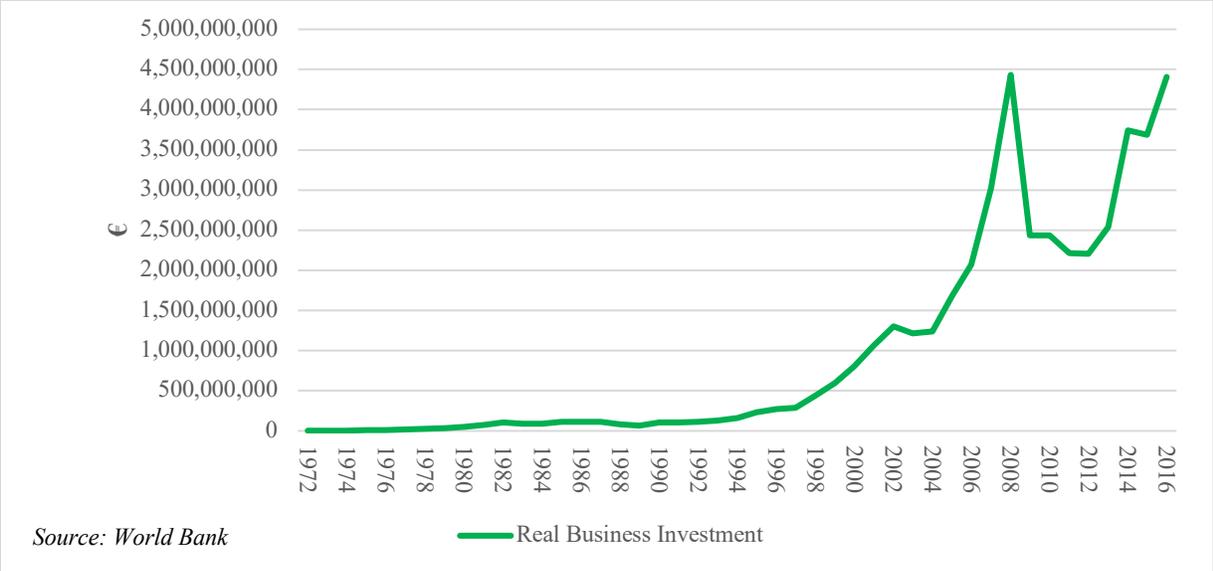


Figure 6: Real business investment in non-financial assets from 1972 to 2017

Given that the contribution of business investment has decreased from 2.6% of GNI in 2008 to just 1.9% in 2018, it indicates that perhaps business investment has not recovered at the same rate as the rest of the Irish economy. Looking at **figure 7** it would appear that the rate of business investment has been on a downward trajectory over the course of the last 44 years.

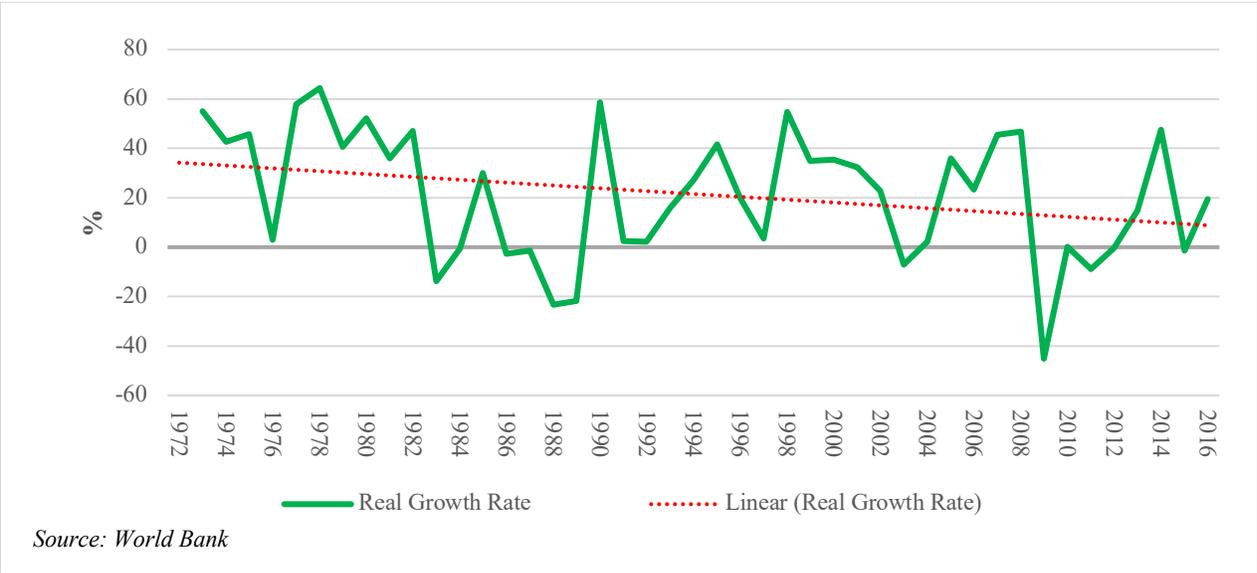


Figure 7: Growth in real business investment in non-financial assets from 1972 to 2017

Although, it can be said that the downward trend is due to the fact that the growth rate in business investment is volatile. The downward trend is unmistakable, nonetheless. Since the peak in 2008 of 48.8% growth, the growth rate has been dampened somewhat by historical standards with the

exception of 2014. One only has to look at the growth peaks in the early 1980's and early 1990's with annual growth rates of over 60% to see that the level of growth has waned slightly.

It is not surprising to see high levels of growth in business investment throughout the 1980's and 1990's as Ireland was going through a period of significant growth and was transitioning from a developing economy to an established economy by global standards. That would have implied that there was significant demand and a capacity shortfall which would have stimulated investment in the economy. As the economy has matured, Ireland has followed the path of other developed economies and seen a fall in the growth rate of business investment as a percentage of GNI. Interestingly, as the reader will see below, the Irish economy has benefitted from favourable interest rates over the last twenty years as real interest rates have declined towards zero making business investment cheap and therefore inflating investment.

IV.iii Irish Population Dynamics

The global population dynamic has been changing for some time with a shift towards a mature population and the associated requirements that come with that. Secular stagnation theory states that changing population dynamics will hinder growth as there isn't enough human capital to drive growth and spending requirements and priorities for individuals and governments change as a population gets older. The focus shifts to eldercare, healthcare and retirement savings. For example, Japan is the most widely discussed demographic shift that has taken place over the last number of decades. This has been discussed at length in the literature review section. Currently it is estimated that those over the age of 65 make up approximately 25.9% of the Japanese population, and this is expected to rise to over 33% by 2050 (Statistics Bureau of Japan, 2019). This increased population will put strain on the Japanese economy and require a fundamental shift in spending habits - there is early evidence to suggest that this is already happening (Marlow, 2018). The US and Canadian populations are also heading in the same direction.

The Irish population has always had a tendency towards volatility with the Irish known to an emigrant population, particularly in the 1950's this results in an interesting study of Irish demographics as it is the often highly educated young people within a population who are more likely to migrate (Zaiceva, 2014). Additionally, the decision of parent to foster smaller family units

than their families before them and the advancement of medical technology in recent times, is likely to fundamentally alter the existing population dynamics within economies such as Ireland. These effects are likely to result in a number of results in the context of secular stagnation.

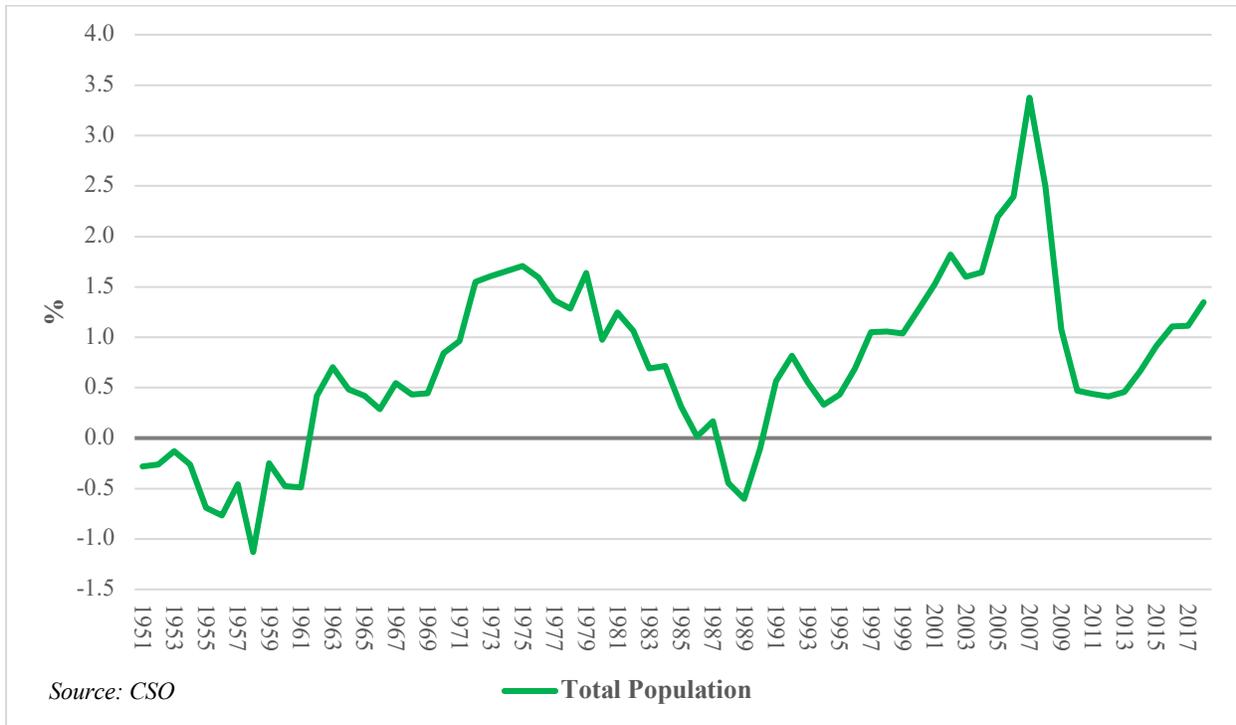


Figure 8: Growth rate in the Irish population 1951-2018

Figure 8 supports the initial assertion that Irish population numbers have been rather volatile since the 1950's. Initially Ireland saw a number of years of population decline, however, the population only decreased from 2.97 million in 1950 to 2.82 million in 1960 before increasing sharply to 2018 with only three years of negative population growth between 1988 and 1990. The population in Ireland is currently 4.9 million (**figure 9**) with the trend continuing on its upward trajectory. One would think that an increasing population would result in an increased number of people at work and therefore a greater working age population to support those who are retired. However, there are a number of things to note, firstly, not all population growth is coming from births outstripping deaths, in fact, the majority of it is coming from those emigrating to Ireland. Not all those people entering Ireland are participating in the labour force. Additionally, given the free movement of people in Europe, those migrating to Ireland, may be sending money back to their home countries in order to support families over there.

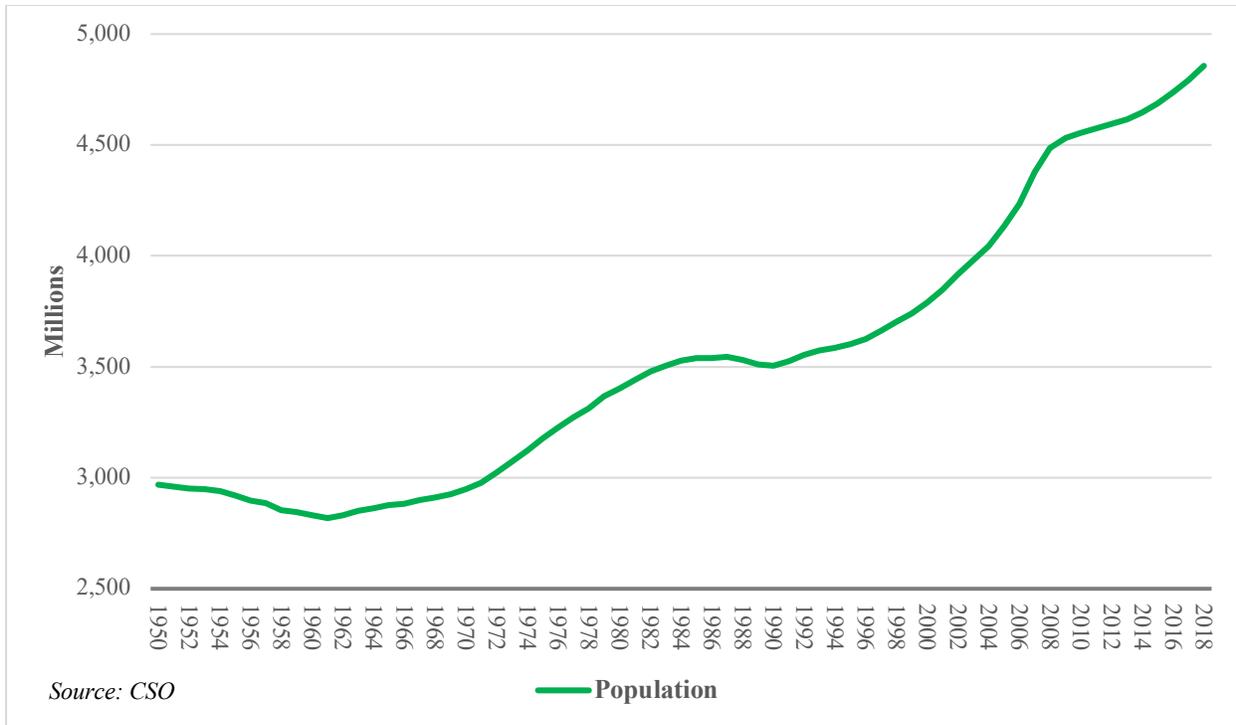


Figure 9: Irish population 1951-2018

From a secular stagnation standpoint, increasing population is not a concern, so long as that population can support itself. Currently, in the Irish context, it would appear that Ireland is able to do that with current government expenditure on “old age” at 13% compared to an EU average of 22% (Walsh, 2019). It would appear the Irish economy is not suffering from this symptom of secular stagnation. When taking a closer look at the data though, **figure 10** shows that while the percentage of the Irish population has remained relatively stable from 1951 to 2009 - moving between a range of less than one percentage point in that time - in the last nine years the population over the age of 65 has dramatically increased from 10.8% to 13.6%. While on the face of it, a 2.8 percentage point increase is not significant, but in the context of the financial crisis in 2009 and the fact that the 65+ population had remained stable for the 58 years previously is a concern.



Figure 10: Percentage of the population over 65 from 1951-2018

Additionally, if one segment of the population is increasing, it must mean that another segment is decreasing. The working age population which is those aged above 15 but below 65 has been steadily decreasing since 2005. While it once accounted for over 69% of the population at its peak, it has since sunk to just above 65% as **figure 11** shows.

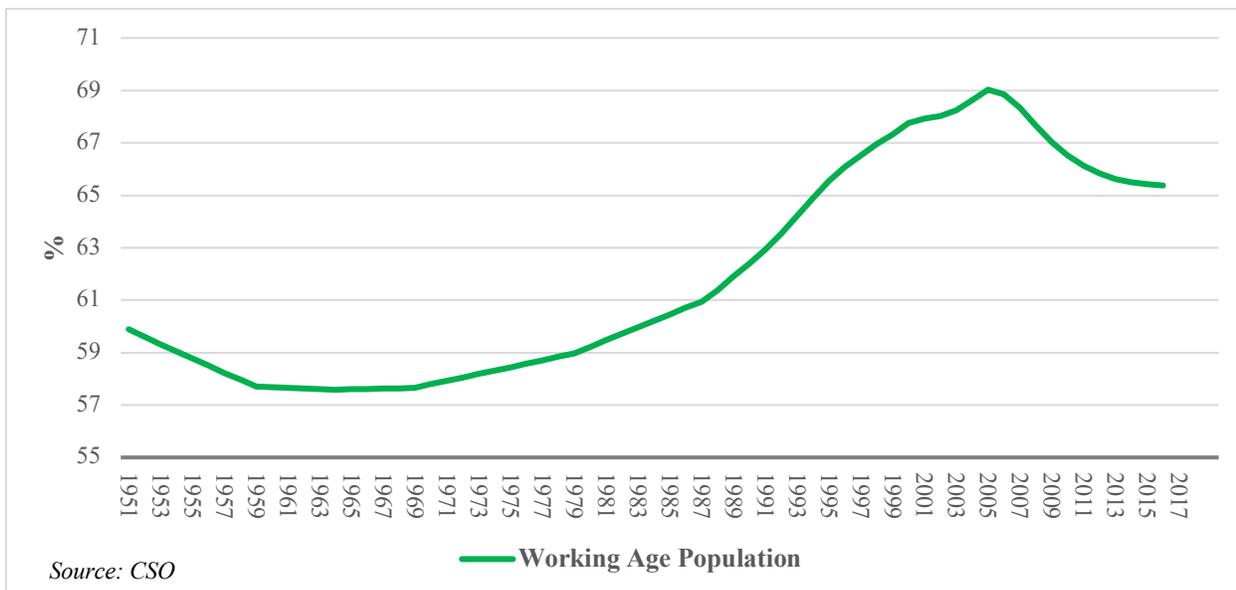


Figure 11: Percentage of the working age population from 1951-2018

While there was a reduction in the working age population in the late 1950's and early 1960's this was likely as a result of emigration rather than any significant shift in the workforce. However, the most recent decline in the working age population has been more noticeable and would be of more concern given that post the financial crisis the Irish economy has been booming and therefore, it would be expected that the working age population would be increasing as a result of immigration. That does not yet seem to be the case. In fact, the booming economy does not seem to have had an impact on slowing the loss of individuals from the working age population at all.

Perhaps the most alarming trend in the population data that can be seen is the increase in the percentage of the population who are in the pre-retirement bracket (**figure 12**).



Figure 12: Percentage of the pre-retirement population from 1951-2018

The pre-retirement cohort now accounts for over 24% of the population and is continuing the upward trend. What that means is that over the next number of years, it is likely that the percentage of those in the 65+ age bracket is likely to continue to increase as well. So while Ireland's 13.5% of retired workers may seem minimal when compared to the likes of Japan at over 25%, Ireland's population is heading in the same direction and if the economic impact is not currently being felt, it will soon play a larger role in economic growth as further resources are required to meet demand and therefore cannot be spent elsewhere.

Another important implication of the aging Irish population is that the cohorts of retired individuals and pre-retirement individuals is that they reduce spending in order to save for retirement and then once retired, they spend down those savings on day to day items but are unlikely to invest as heavily as those in other cohorts. This is a vital element of the secular stagnation argument and how an aging population hampers growth. In respect to Ireland, we in **figure 13** that this appears to be the case.

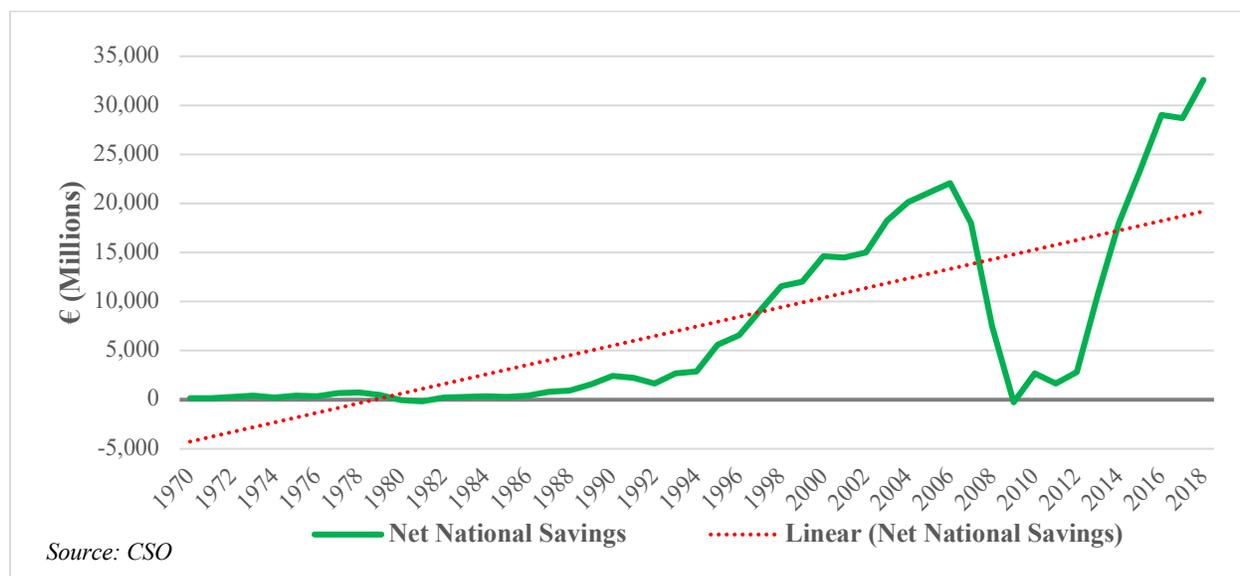


Figure 13: Net national savings from 1970 to 2018

With the increase in older cohorts, Ireland’s net national savings has increased dramatically in the last number of years - with the exception of the financial crisis period. The net national savings were negligible for a number of years but began to climb at a faster pace from 1994 onwards, shortly after the increase in the pre-retirement cohort began. Despite the capitulation of savings post the financial crisis, the national savings recovered robustly and are currently the highest they have ever been by some margin. Despite the decline post the financial crisis, the trend over time is still significantly towards a greater level of savings within the economy. If people are more inclined to save, it would imply that they are less likely to invest in the economy which in turn hampers growth somewhat. Interestingly, as the reader will see below, real interest rates are at historic lows meaning that it is cheap to borrow but also, savers do not get significant return on their savings, however, individuals are still choosing to save. This indicates a fundamental change to individuals risk appetite. This could have been caused by an element of hysteresis post the financial crisis as individuals have been burnt once, and do not want to take a chance again. Or, as

people are getting older their risk appetites have changed and they are less willing to invest in risky investments and would rather be sure that funds are available for retirement. Either way, this increase in the national savings should have a negative impact on economic growth which can in part be attributed to changing population dynamics within the Irish economy.

IV.iv Real Interest Rates

The long-term decline in real interest rates is the fourth and newest element of secular stagnation theory. As outlined in the literature review, Lawrence Summers reintroduced secular stagnation as an explanation for the current slow economic recovery post the financial crisis. Summer's added a fourth element to secular stagnation theory, that being the decline in the real rate of interest to such an extent that the natural rate of interest (the savings to investment equilibrium) is now negative. This has in turn resulted in the potential for economies to become stuck in a liquidity trap whereby monetary policy becomes an ineffective tool in the fight against recession because no matter how low central banks adjust the nominal interest rate to - noting that they cannot lower the nominal rate below zero - they cannot stimulate investment in the economy which in turn means they cannot boost an economy out of recession. Summers suggested that this decline was a real threat to the future growth of the global economy and the research would appear to back that theory up (Del Negro, et al., 2018).

Looking at the above in line with the previous symptoms of secular stagnation above, from the Irish standpoint, **figure 14** shows that nominal interest rates - measured by the marginal lending rate - have been decreasing significantly in Ireland over time.

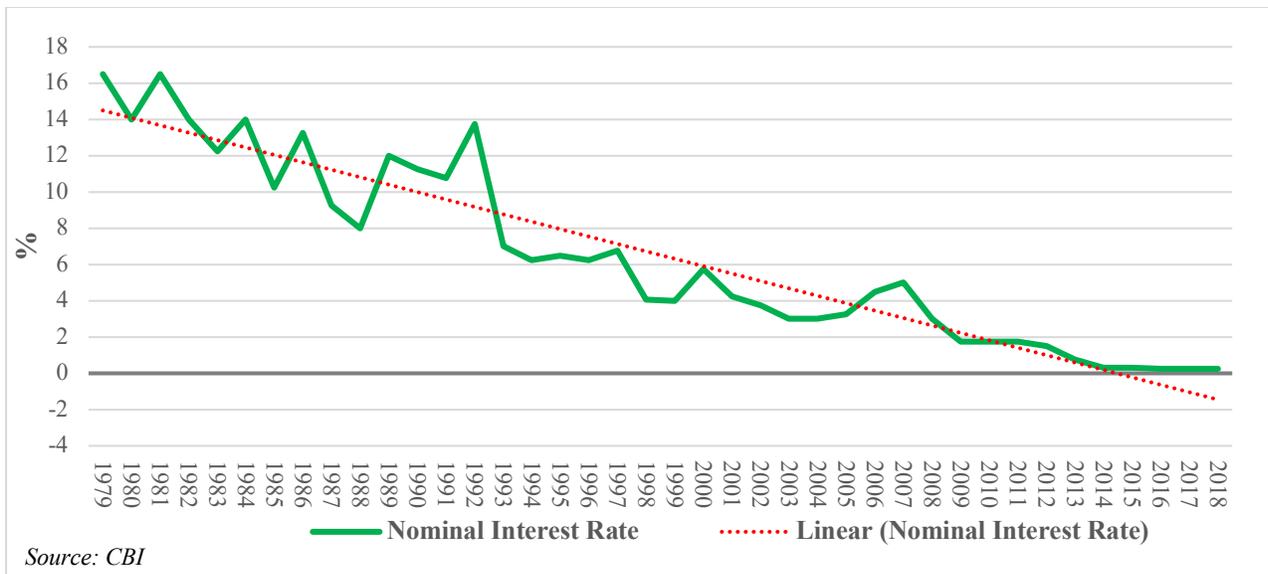


Figure 14: Nominal interest rates in Ireland from 1979 to 2018

During the recession of the early 1980's nominal interest rates were surprisingly high for an economy that was struggling to generate any significant levels of growth. However, there is undoubtedly a downward trend in the nominal interest rate post 1992 and most notably the nominal interest rate has been less than one percent since 2013, however, it has never breached the zero lower bound indicating the ECB's reluctance to bow to the pressure of some economic circles who have suggested that central banks should consider reducing nominal interest rates to below zero.

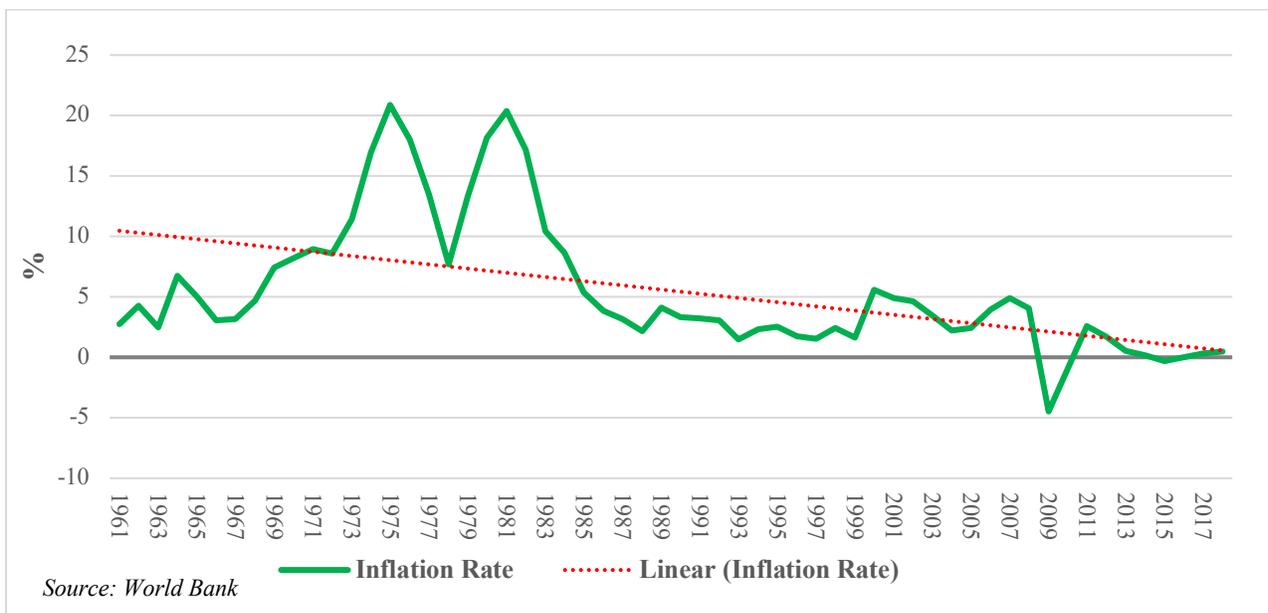


Figure 15: Irish inflation rates from 1961 to 2018

Similar to nominal interest rates, inflation rates in Ireland were initial rather volatile by global standards with inflation rates reaching more than 20% in 1975 and 1981 (**figure 15**). The trend in inflation has tended to follow that of nominal interest rates, declining substantially over time and interestingly they have been less than one percent since 2013, the same year that nominal interest rates fell and stayed below one percent. The ECB’s target rate of inflation is just below two percent for the EU as a whole. Therefore, it can be assumed that the target inflation rate for Ireland is also just below two percent. Ireland’s interest rate has been below two percent on 12 occasions since 1961. However, inflation can be too low which is also harmful to the economy. The Irish economy has in fact had three years of deflation - 2009, 2010 and 2015. Therefore, one can assume the optimum inflation rate for the Irish economy would be in the range of 1.8% to 2.0%. The Irish economy has not had a single year of inflation within that range since 1961 and that is important because the Central Bank aims to strike a balance between inflation and unemployment within the economy by adjusting interest rates. Historically there is a negative relationship between inflation and unemployment. As inflation goes up, unemployment goes down. This is known as the Philips curve and central banks aim to hit the sweet spot between unemployment and inflation. Ireland’s Philips Curve between 1983 and 2017 appears to hold true in a number of years as **figure 16** shows despite number of outliers from earlier years.

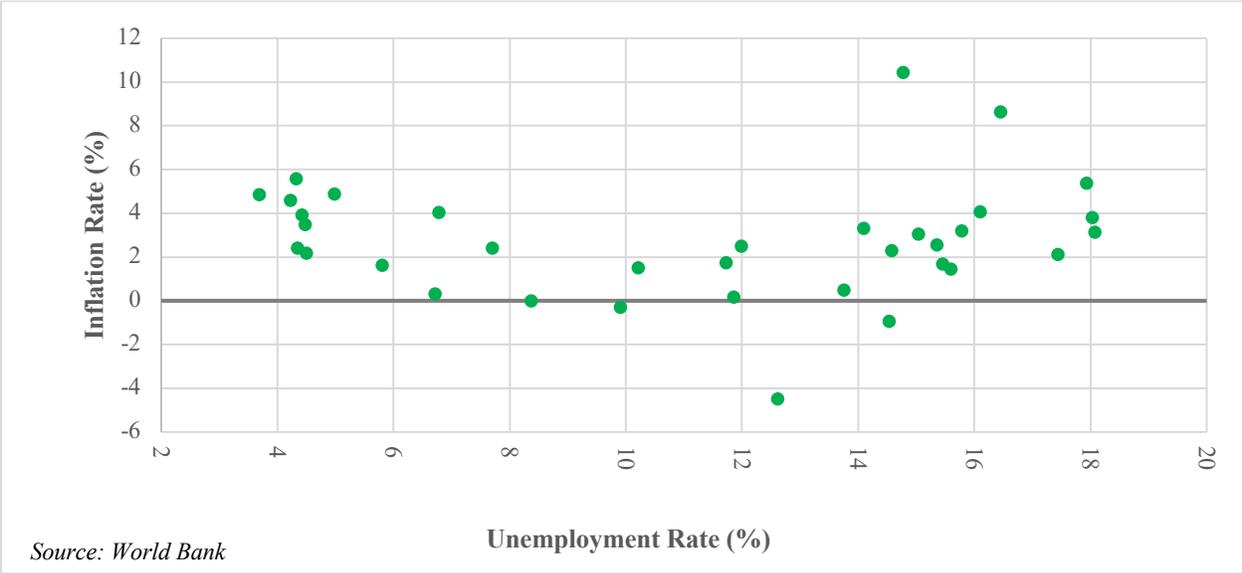


Figure 16: Irish Philips Curve 1983-2017

However, the Philips curve also shows in Ireland’s case that inflation is now proving harder and harder to generate. Additionally, in order to generate increased inflation, the economy may no longer see the benefit of decreased unemployment.

Pulling both nominal interest rates and inflation together, **figure 17** shows the unsurprising downward trend in real interest rates from a peak of over twenty percent in 1981 to -0.24% at the end of 2018. The downward trend is not as stark as nominal interest rates, however real interest rates have breached the zero-lower bound a number of times over the time period due to higher levels of inflation. In a sense that is what Central Banks want, low enough real interest rates that investors choose to invest in assets rather than holding funds on deposit.

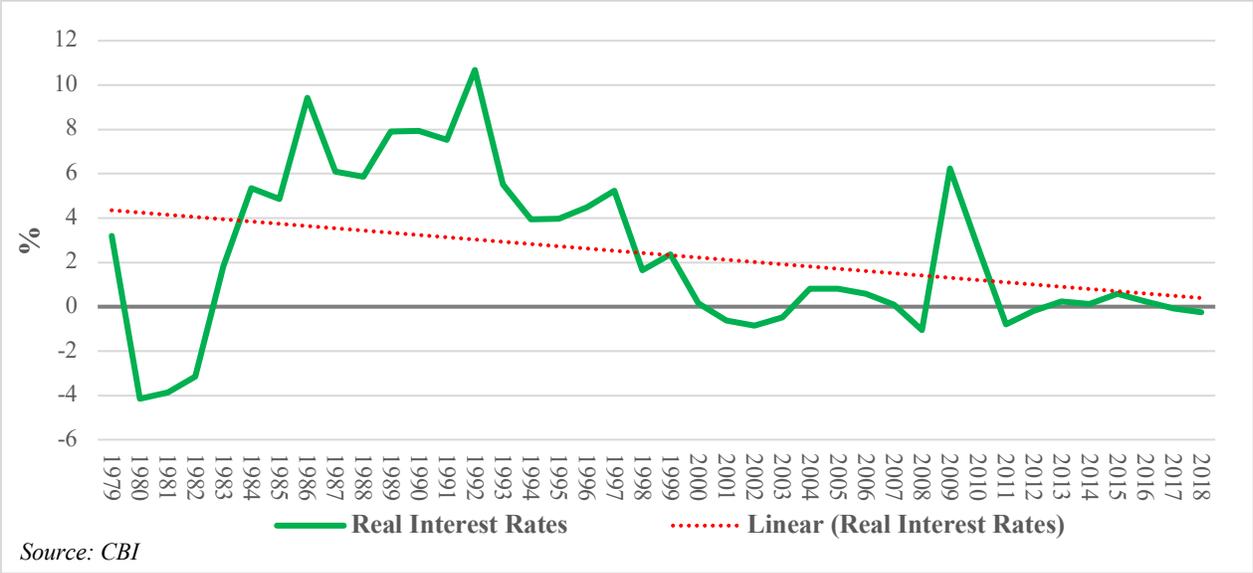


Figure 17: Real interest rates in Ireland from 1979 to 2018

However, besides a spike in real interest rates in Ireland due to deflation of 4.8% in 2009, real interest rates in Ireland have been below one percent or negative since the year 2000. No doubt these low real interest rates spurred on the Celtic Tiger and subsequent recovery in business investment (as shown above) post the financial crisis. In fact, it would actually stand to reason that nominal interest rates could have been higher in Ireland for the last number of years in order to stem the flow of cheap money in Ireland which could be fuelling another bubble in the economy. That is one of the disadvantages of monetary policy being set at an EU level rather than at individual country level. While the EU has struggled as a whole, Ireland has boomed as a result of low interest rates. The issue that could arise for Ireland is one of the previously mentioned liquidity

trap, once a recession inevitably happens, the CBI cannot use monetary policy to try and boost the economy, firstly, because they don't set the rates and secondly, because rates are already as low as the ECB are willing to reduce them.

Interestingly, while real interest rates have been at historic lows, we do not see a reduction or even a levelling off of net national savings. It would stand to reason that low interest rates mean low deposit rates for saving money with a Bank and therefore, retail customers would go out and invest in other assets, say the stock market or some other financial asset per say because it gives them a better return. Therefore, there is an element of truth in Summer's statement that the natural rate of interest has fallen below zero for retail customers in Ireland anyway. The downward trend in real interest rates and even nominal interest rates over time would indicate that central banks are having to work particularly hard in order to continue to stimulate growth through business investment. Should the current trend continue in Ireland, it could be a case in the future where the central bank has to consider an alternative monetary policy manoeuvre such as quantitative easing, further forward guidance or even taking nominal interest rates past the zero-lower bound.

IV.v Secular Stagnation Model

The four symptoms of secular stagnation theory have now been examined in detail in the wider Irish economic context. The next section provides the outcome of a regression analysis on secular stagnation within the Irish economy. There are a number of important observations to note in advance of the data presentation. The approach adopted by the researcher was to conduct a linear regression using the annual Real GNI growth as the dependant variable and the four symptoms of secular stagnation as the independent variables. What **figure 18** below shows is that the trend growth rates of real GNI in Ireland have been trending downwards for nearly fifty years. That would on the face of it appear to satisfy Hansen and Summer's assertions that economies are failing to recover from the recessions or indeed boom at that are seen historically - i.e. secular stagnation.

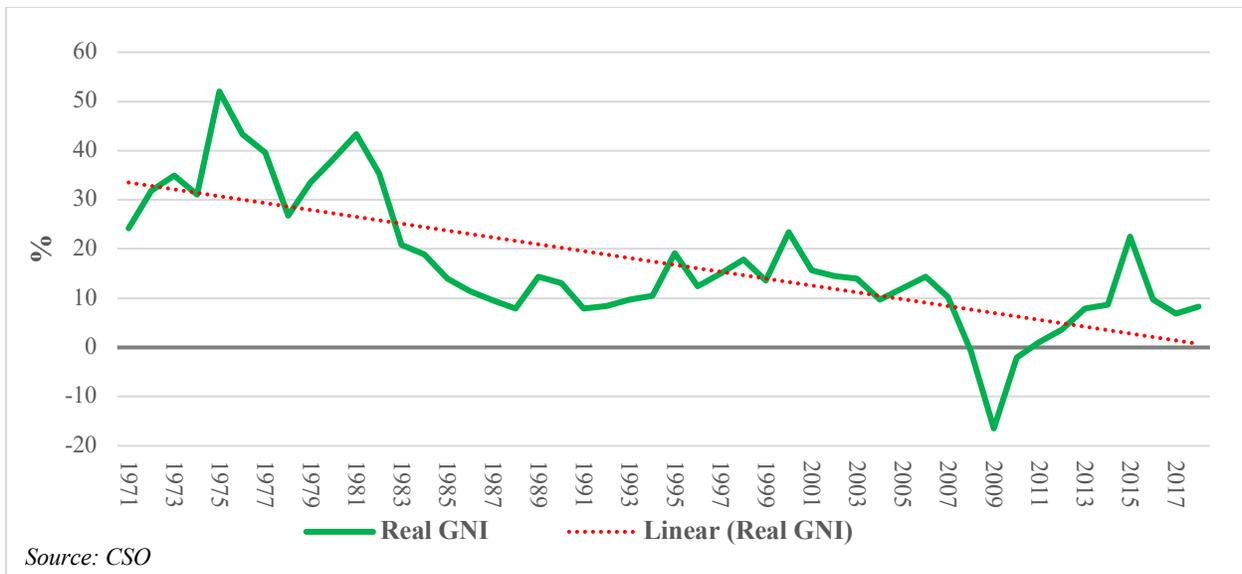


Figure 18: Trend in real GNI growth rates in Ireland 1971 to 2018

Therefore, the linear regression attempts to investigate whether the symptoms of secular stagnation as described are significant contributors to this downward trend in growth. Should there be a significant relationship between our dependant and independent variables and the model provides a strong explanation for the variances in our dependant variable, we could reject our null hypothesis that the Irish economy is not suffering from secular stagnation.

The first step before conducting the regression, the researcher had to ensure the population under investigation was conformed to the rules allowing for the completion of a linear regression - i.e. the population data was linear. To do this, Kolmogorov-Smirnov and Shapiro-Wilk tests for normality were completed. During these tests, the researcher notes that the Domestic growth dependant variable and the population dynamic independent variable showed as being significant - meaning the affected populations were not normal and therefore a transformation of the populations would be required. This was completed in SPSS via trial and error which resulted in the researcher finding the square root of both populations. **Appendix 5** shows a complete list of the Kolmogorov-Smirnov and Shapiro-Wilk tests for normality for all variables and confirms normality across variables and therefore compliance with the rules of linear regression. Based on this, the researcher generated two new variables - SQRT Domestic Growth and SQRT Population Dynamics.

Descriptive Statistics

	N Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Deviation Statistic	Skewness	
						Statistic	Std. Error
SQRT_Population_Dynamics	36	.39	1.89	1.1622	.43430	.482	.393
SQRT_Domestic_Growth	33	1.03	6.58	3.6402	1.02489	.513	.409
Real_Interest_Rates	36	-3.87	10.68	2.6694	3.58339	.400	.393
Capital_Formation	36	-45.13	58.50	15.9447	24.61538	-.255	.393
Economic_Progress	36	-32.61	30.65	-.9289	13.24410	-.300	.393
Valid N (listwise)	33						

Table 4: Secular stagnation model descriptive statistics

SPSS generates a list of descriptive statistics for the variables associated with the regression which can be seen above in **table 4**. There are a number of useful insights which can be gained from a review of the descriptive statistics, the first being the sample size (“N Statistic”) and secondly the test for skewness.

In terms of the sample size used, the data available for each of the variables being used in the regression gave a total population of 36 years to test (1981-2016 inclusive). What is seen though is that there were only 33 valid readings in the transformed dependant variable – SQRT_Domestic_Growth. This was due to the negative growth from 2008 to 2010 which the transformation of the data could not complete. The result was that the total population was reduced from 36 to 33. All of the independent variables had valid readings across the population.

The second useful piece of information which can be taken from the descriptive statistics is the skewness reading. Skewness tests for asymmetry in both a positive and a negative direction. To interpret the values presented above, any level of skewness above + or – 1 is considered to be skewed. As can be seen, none of the variables used in the regression suffered from skewness. The domestic growth was the most skewed with a skewness statistic of 0.513. The most interesting thing to take away from the skewness statistic is the direction of the skewness. While it would be expected that the population dynamics variable would be positively skewed given the increasing growth rate in those aged 65+ and that the capital formation and economic progress would be skewed negatively given that the data presented in the sections above points to evidence that the growth rates in these variables have been in decline for some time. However, domestic growth and

real interest rates are positively skewed which is somewhat surprising. In the context of real interest rates, this is likely explained by the inelasticity of interest rates over the last number of years – meaning real interest rates have remained unchanged for some time due to both low nominal interest rates and low inflation. Previous to this, as shown in **figure 17** earlier real interest rates were significantly higher which has led to the positive skew. In terms of the domestic growth variable, the answer is likely as a result of a marked slow down in the growth rate of GNI since the mid-1980's which in turn results in this positive skew.

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.692 ^a	.479	.405	.79051	1.407

a. Predictors: (Constant), SQRT_Population_Dynamics, Capital_Formation, Econmic_Progress, Real_Interest_Rates

b. Dependent Variable: SQRT_Domestic_Growth

Table 5: Secular stagnation model fit

Moving onto the regression analysis, the first element of the output relates to the overall model fit – i.e. to what extent are the variations in domestic growth explained by the symptoms of secular stagnation. The first thing to look at is the Durbin-Watson statistic which gives a read on autocorrelation within the model. Autocorrelation is a characteristic in which the correlation between variables is based on a related object i.e. that our data points across variables are truly random. The Durbin-Watson statistic varies between zero and four with two meaning no autocorrelation. For the model to be a good fit there needs to be no or as little as possible autocorrelation. Therefore, any reading above 1.2 and below 3.8 is considered appropriate from a linear regression standpoint. As seen above in **table 5**, the Durbin-Watson statistic is 1.407 in the regression model, comfortably within the permitted range.

Moving onto how much of the variance in domestic growth can be explained by the independent variables. The R Square statistic gives sense of this, with a reading of 0.479 it can be said that the independent variables explain 47.9% of the variance in domestic growth. This is not

an unexpected result given what is known about domestic growth and its inputs – think of the calculation for GDP, government spending + consumption + business investment – net exports. However, with nearly half of the variance in domestic growth explained by the model, the model is by no means a weak model.

Given that the variables satisfy the requirements for a linear regression and the model accounts for nearly fifty percent of the variance in domestic growth, **table 6** shows the overall significance of the chosen model via an ANOVA table.

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	16.115	4	4.029	6.447	.001 ^b
	Residual	17.498	28	.625		
	Total	33.613	32			

a. Dependent Variable: SQRT_Domestic_Growth

b. Predictors: (Constant), SQRT_Population_Dynamics, Capital_Formation, Econmic_Progress, Real_Interest_Rates

Table 6: Secular stagnation model regression ANOVA

The first element of the above table to look at is the degrees of freedom. The model, there were 33 observations within the population and therefore the total variance can be measured to N-1 degrees of freedom which means that the model can be significant to 32 degrees of freedom. Secondly, one has to look at the F statistic which is the mean square of the model divided by the mean square of the residual. This F statistic is used as the test statistic to test if the model is indeed significant in the context that the dependant variable is accurately predicted by the independent variables. In our model the F statistic was 6.447 which resulted in a significance level or p-value of 0.001 or 0.1% meaning that the model is a statistically significant predictor of the movements in domestic growth at both the five percent and the one percent confidence intervals.

Having confirmed that the model being used conforms to linear regression rules, and that it is a reliable predictor of economic growth within the Irish economy, **table 7** is the output from the regression model.

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.782	.734		6.511	.000
	Economic_Progress	.031	.013	.403	2.360	.025
	Capital_Formation	.006	.007	.132	.851	.402
	Real_Interest_Rates	-.138	.052	-.490	-2.650	.013
	SQRT_Population_Dynamics	-.771	.519	-.312	-1.486	.148

a. Dependent Variable: SQRT_Domestic_Growth

Table 7: Secular stagnation model output

Firstly, the model provides us with an equation for the relationship between the dependant variable of domestic growth and the independent variables of economic progress, capital formation, real interest rates and population dynamics. This can be expressed as:

Domestic Growth

$$= 4.872 + 0.31(\text{Economic Progress}) + 0.006(\text{Capital Formation}) - 0.138(\text{Real Interest Rates}) - 0.771(\text{Population Dynamics})$$

There are a number of takeaways from this equation. Firstly, we see that there is a positive relationship between domestic growth and growth in economic progress and capital formation meaning that a 1% increase in economic progress and capital formation leads to a corresponding increase in domestic growth of 0.031% and 0.006% respectively. While these are hardly dramatic shifts in domestic growth, the model outputs reinforce the theory that economic progress and capital formation have a positive impact on domestic growth. Additionally, we see that there is a not unexpected negative relationship between real interest rates and population dynamics. A one percentage point increase in real interest rates or one percent increase in the growth rate of the population over 65 leads to a decline in domestic growth of 0.138% and 0.771% respectively. Interestingly, there is a much stronger downward trend in domestic growth when associated with real interest rates and population dynamics.

While the above conforms to our initial expectations, it is important to check that the results generated are statistically significant. A review of the significance levels (p-values) shows that

only the economic progress and real interest rate variables are statistically significant at the 95 percent confidence levels. In fact, it can be seen that they are the only significant variables at the ten percent confidence interval.

IV.vi Discussion of Results

Having completed a thorough analysis of the symptoms of secular stagnation and the subsequent relationship between the symptoms of secular stagnation and domestic growth in Ireland, the null hypothesis proposed as part of this body of research that there is no evidence of secular stagnation in the Irish economy cannot be rejected. The analysis shows that the symptoms of secular stagnation are currently present in the Irish economy. In terms of economic progress, patent registrations have declined at a significant rate since 1980 and show no signs of abating. While the percentage of the working age population with some form of tertiary education has been rising steadily, it is not clear how long this may be maintained and if in fact, the economy is approaching a saturation point. In terms of capital formation growth, this too has been on a downward trend for a number of years, despite the nominal value of investment in non-financial assets recovering post the financial crisis. Real interest rates have also been declining significantly since the 1980's and in fact have failed to go above one percent since 2000 (with the exception of 2009 which was fuelled by deflation) after hitting highs of over ten percent in 1992. Lastly, the proportion of those over the age of 65 in Irish society has been increasing steadily since 2008. Perhaps more interestingly, the number of people approaching retirement has also been increasing significantly in Ireland which in turn has led to an increase in savings which as pointed out, dampens consumption and investment spending. The symptoms of secular stagnation are evident in the Irish economy. The research paper then investigated if the symptoms of secular stagnation provided a valid and significant model for domestic growth. While the model has proved to be a significant and provide an explanation of nearly 50% of the variance in domestic growth, only two of the independent variables – real interest rates and economic progress – provided significant p-values.

Therefore, there is evidence of the symptoms of secular stagnation in the Irish economy; the model says that these symptoms explain nearly 50% of the variance in domestic growth. However, actual domestic growth as measured by Real GNI has in fact recovered robustly since the financial crisis. The Irish economy has not had that stagnant growth that has been seen in other

economies. Therefore, some other external factor is driving the recovery in GNI which is outweighing the symptoms of secular stagnation and the null hypothesis – that the Irish economy is not suffering from secular stagnation – cannot be rejected. However, while secular stagnation is not evident in the Irish economy at present, it is not unreasonable to posit that at some stage in the near future it may be given that the symptoms are evident in the economy currently.

V. Conclusion

“No great discovery was ever made without a bold guess.”

Isaac Newton (1642-1726)

V.i Conclusion

This study set out to investigate for the presence of secular stagnation within the Irish economy. Using the secular stagnation theory first put forward by Alvin Hansen during his presidential address in 1939 and further added to by Lawrence Summers in 2013. The theory states that recoveries in global growth have been getting weaker and weaker over time as growth rates have been steadily declining due to four main symptoms – declining economic progress, business capital formation and real interest rates as changing population dynamics whereby the population is getting older.

In order to investigate the above, the study focussed on a quantitative methodological paradigm, specifically, the correlational and experimental methodologies. Given the available data, it was only possible to extrapolate 36 full data points which corresponded across all variables. This was further reduced to 33 after the completion of data transformation to ensure that the data was suitable for regression analysis. Based on the above information and a substantial literature review, the researcher posed the null hypothesis that there was no evidence of secular stagnation within the Irish economy. Domestic growth was used as the dependent variable with economic progress, capital formation, real interest rates and population dynamics used as the independent variables. Domestic growth was determined by real GNI within the Irish economy on the basis that the study was trying to establish a link in the domestic economy only and GNI was the most appropriate proxy to achieve that. Annual growth in patent registrations was used as a proxy for the economic progress on the basis that patent registrations are a quantitative measure of economic progress within an economy representing new inventions. Annual growth in business investment in non-financial assets was used as a proxy for capital formation as this is a measure of actual business investment in capital expenditure. Annual growth in the population aged over 65 was used for population dynamics as those aged over 65 are likely to spend and invest less while using up a higher proportion of state support diverting investment from elsewhere.

This study did find evidence of the symptoms of secular stagnation within the economy. An in-depth analysis of each individual symptom found that the current trend in each symptom would support secular stagnation existing within the economy. Economic progress has been in decline for a number of years with Ireland performing worse than the EU, OECD, UK and UK in terms of nominal patent registrations per year. Additionally, the growth rate in patent registrations has been negative in Ireland since 2009. Educational attainment has been trending upwards which on the face of it is good for the economy and a driver of growth. However, there is a finite number of people and therefore an economy will become saturated at some point in terms of education. With educational attainment levels of 77.5% in terms of some level of tertiary education, Ireland may be approaching that point. While business investment has recovered somewhat since the financial crisis in 2009, it has yet to surpass the same levels of investment that were seen before the crisis. Additionally, the level of growth in investment has been on a downward trend for a number of years with business investment only contributing 1.9% to GDP in 2016 compared to 2.6% in 2008. Population dynamics have also been changing in Ireland with the percentage of the population over the age of 65 increasing by nearly three percentage point since 2009, all the while the working age population has been decreasing and the pre-retirement population has been growing steadily. Lastly, real interest rates have declined steadily since their 1992 peak at over 10%, currently at the end of 2018, they were -0.24%. The decline in interest rates has been led by low nominal rates and low inflation rates.

Given that the symptoms of secular stagnation are evident in the Irish economy, this study attempted to model the effects of the symptoms on economic growth in the Irish economy under the assumption that if the symptoms are present in the economy and the symptoms determine the growth of the economy, then the economy would be suffering from secular stagnation itself. Upon analysis of the model, it was noted that the regression model was significant to the five percent confidence level and that the model explained 47.9% of the variance in domestic growth. The output from the model was as expected; both economic progress and capital formation had a positive relationship with domestic growth, while real interest rates and population dynamics had a negative relationship. However, only the economic progress and real interest rate variables were

significant. In light of this and in light of the fact that real GNI has recovered since the financial crisis it was determined that the null hypothesis could not be rejected.

However, the researcher notes that while the null hypothesis cannot be rejected at this juncture, there is potential that the Irish economy could fall into a secular stagnation economy in the future given that it is currently showing all the symptoms of secular stagnation. Additionally, population dynamics will increasingly play a role in domestic growth as the percentage of the population at retirement age increases. Interest rates are already at historic lows and therefore should a recession befall the economy, there may well be a slump in both business investment and real interest rates which could lead to weak growth should confidence not recover.

V.ii Limitations

Small Sample Size:

The data sourced for this study was from three main databases the WBDB, the CSO and the CBI. The result was data sets which had varying commencement dates. This resulted in a complete data set of just 36 data points across all variables. To improve the quality of the regression analysis, a larger sample size would have had the potential to produce more significant findings. However, it should be noted that the model studied was significant and two of the four variables returned statistically significant p-values.

Wider Data Set:

The symptoms of secular stagnation are wide ranging. The theory isolates four main symptoms which have been analysed and discussed at length as part of this research. However, for each symptom there are multiple inputs that could have been used in the place of the variables chosen. For example, educational attainment could have been used instead of patents for economic progress. An additional study may use different data to define each of the symptoms of secular stagnation which will in turn produce a separate set of results.

V.iii Recommendation for Further Research

A number of interesting possibilities for future research emerged while testing the hypothesis of this study. In particular, while the symptoms of secular stagnation are present in the economy, the economy itself appears to be growing robustly. Building upon this research, the following areas are recommended for future research:

- i) What is driving the recovery of the Irish economy: There are a number of negative headwinds affecting the Irish economy presently, however, the economy continues to boom. What is the driving force behind growth?
- ii) The most appropriate variables to use: While the researcher has chosen four variables considered to be the best fit for the symptoms of secular stagnation, further research could investigate if this is actually the case.
- iii) Widening the scope of the research: The study conducted was focussed solely on Ireland, it may be of benefit to expand the data to other countries to investigate if there is evidence of secular stagnation in other countries and if so, what differentiates them from Ireland.

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Appendices

Appendix 1:

Nominal and annual growth rate of patent registrations across selected countries (source: World Bank)

Year	OECD	OECD Annual Growth (%)	EU	EU Annual Growth (%)	USA	USA Annual Growth (%)	UK	UK Annual Growth (%)	IRL	Ireland Annual Growth (%)
1981	162,644		89,362		62,404		20,808		461	
1982	164,571	1.18	90,430	1.20	63,316	1.46	20,530	-1.34	434	-5.86
1983	390,696	137.40	92,679	2.49	59,391	-6.20	19,893	-3.10	567	30.65
1984	422,232	8.07	93,269	0.64	61,841	4.13	19,093	-4.02	651	14.81
1985	439,107	4.00	93,718	0.48	63,673	2.96	19,672	3.03	726	11.52
1986	455,696	3.78	92,162	-1.66	65,195	2.39	20,040	1.87	743	2.34
1987	481,964	5.76	93,239	1.17	68,315	4.79	19,945	-0.47	719	-3.23
1988	490,335	1.74	96,654	3.66	75,192	10.07	20,536	2.96	727	1.11
1989	502,792	2.54	91,768	-5.06	82,370	9.55	19,732	-3.92	736	1.24
1990	525,481	4.51	86,482	-5.76	90,643	10.04	19,310	-2.14	734	-0.27
1991	529,454	0.76	86,103	-0.44	87,955	-2.97	19,230	-0.41	786	7.08
1992	547,949	3.49	94,136	9.33	92,425	5.08	18,848	-1.99	752	-4.33
1993	558,876	1.99	96,917	2.95	99,955	8.15	18,727	-0.64	788	4.79
1994	561,346	0.44	98,556	1.69	107,233	7.28	18,384	-1.83	811	2.92
1995	618,004	10.09	91,924	-6.73	123,962	15.60	18,630	1.34	840	3.58
1996	626,919	1.44	103,554	12.65	106,892	-13.77	18,184	-2.39	793	-5.60
1997	644,848	2.86	98,874	-4.52	119,214	11.53	17,938	-1.35	796	0.38
1998	656,287	1.77	102,479	3.65	134,733	13.02	19,530	8.88	985	23.74
1999	689,177	5.01	114,412	11.64	149,251	10.78	21,333	9.23	996	1.12
2000	753,063	9.27	119,259	4.24	164,795	10.41	22,050	3.36	925	-7.13
2001	753,431	0.05	107,808	-9.60	177,513	7.72	21,423	-2.84	1,019	10.16
2002	742,250	-1.48	104,566	-3.01	184,245	3.79	20,624	-3.73	914	-10.30
2003	753,214	1.48	103,560	-0.96	188,941	2.55	20,426	-0.96	862	-5.69
2004	780,904	3.68	103,752	0.19	189,536	0.31	19,178	-6.11	787	-8.70
2005	814,056	4.25	101,595	-2.08	207,867	9.67	17,833	-7.01	789	0.25
2006	810,636	-0.42	100,995	-0.59	221,784	6.70	17,484	-1.96	838	6.21
2007	830,269	2.42	111,075	9.98	241,347	8.82	17,375	-0.62	847	1.07
2008	816,320	-1.68	112,210	1.02	231,588	-4.04	16,523	-4.90	931	9.92
2009	773,769	-5.21	110,569	-1.46	224,912	-2.88	15,985	-3.26	908	-2.47

2010	789,769	2.07	110,555	-0.01	241,977	7.59	15,490	-3.10	733	-19.27
2011	799,448	1.23	109,953	-0.54	247,750	2.39	15,343	-0.95	494	-32.61
2012	829,925	3.81	108,823	-1.03	268,782	8.49	15,370	0.18	492	-0.40
2013	845,598	1.89	108,534	-0.27	287,831	7.09	14,972	-2.59	333	-32.32
2014	840,277	-0.63	108,450	-0.08	285,096	-0.95	15,196	1.50	263	-21.02
2015	831,294	-1.07	99,418	-8.33	288,335	1.14	14,867	-2.17	250	-4.94
2016	844,922	1.64	107,620	8.25	295,327	2.42	13,876	-6.67	202	-19.20
2017	838,327	-0.78	105,040	-2.40	293,904	-0.48	13,301	-4.14	183	-9.41

Appendix 2:

GNI in Ireland (Source: CSO)

Year	Nominal GNI (€'m)	Nominal Growth Rate (%)	Deflator (2010 = 1)	Real GNI (€'m)	Real Growth Rate (%)
1970	2,276		0.08	184	
1971	2,594	13.97	0.09	228	24.19
1972	3,148	21.36	0.10	301	31.80
1973	3,811	21.06	0.11	406	34.88
1974	4,270	12.04	0.12	532	31.06
1975	5,370	25.76	0.15	808	52.01
1976	6,523	21.47	0.18	1,158	43.32
1977	8,027	23.06	0.20	1,617	39.64
1978	9,444	17.65	0.22	2,050	26.73
1979	11,129	17.84	0.25	2,736	33.51
1980	13,026	17.05	0.29	3,784	38.29
1981	15,511	19.08	0.35	5,424	43.34
1982	17,925	15.56	0.41	7,343	35.38
1983	19,604	9.37	0.45	8,870	20.79
1984	21,462	9.48	0.49	10,551	18.95
1985	23,217	8.18	0.52	12,029	14.01
1986	24,921	7.34	0.54	13,406	11.45
1987	26,465	6.20	0.55	14,687	9.55
1988	27,968	5.68	0.57	15,852	7.93
1989	30,728	9.87	0.59	18,129	14.36
1990	33,650	9.51	0.61	20,511	13.14
1991	35,161	4.49	0.63	22,120	7.85
1992	36,983	5.18	0.65	23,981	8.41
1993	39,993	8.14	0.66	26,314	9.73
1994	43,175	7.96	0.67	29,063	10.45
1995	50,197	16.26	0.69	34,644	19.20
1996	55,446	10.46	0.70	38,937	12.39
1997	62,842	13.34	0.71	44,804	15.07
1998	72,286	15.03	0.73	52,783	17.81
1999	80,774	11.74	0.74	59,943	13.57
2000	94,466	16.95	0.78	74,023	23.49
2001	104,162	10.26	0.82	85,598	15.64
2002	113,983	9.43	0.86	97,991	14.48
2003	125,484	10.09	0.89	111,644	13.93

2004	134,761	7.39	0.91	122,536	9.76
2005	147,373	9.36	0.93	137,259	12.02
2006	162,239	10.09	0.97	157,046	14.42
2007	170,509	5.10	1.02	173,134	10.24
2008	162,603	-4.64	1.06	171,810	-0.76
2009	142,197	-12.55	1.01	143,520	-16.47
2010	140,540	-1.17	1.00	140,540	-2.08
2011	138,498	-1.45	1.03	142,040	1.07
2012	141,161	1.92	1.04	147,226	3.65
2013	151,579	7.38	1.05	158,896	7.93
2014	164,454	8.49	1.05	172,707	8.69
2015	202,034	22.85	1.05	211,558	22.50
2016	221,595	9.68	1.05	232,061	9.69
2017	235,951	6.48	1.05	247,936	6.84
2018	254,183	7.73	1.06	268,399	8.25

Appendix 3:

Educational Attainment in Ireland (Source: World Bank)

Year	Male (%)	Female (%)	Total (%)
1971	13.63	7.40	10.58
1972	13.82	7.64	10.79
1973	13.65	8.01	10.88
1974	14.34	8.46	11.46
1975			13.66
1976	21.35	11.59	16.56
1977	20.16	12.91	16.61
1978	19.96	12.63	16.37
1979	19.15	13.06	16.17
1980	19.00	13.45	16.28
1981	20.24	14.46	17.41
1982	21.85	15.36	18.67
1983	22.94	16.76	19.91
1984	22.56	17.65	20.16
1985	23.76	18.82	21.34
1986	25.12	19.97	22.60
1987	26.63	21.69	24.21
1988	27.80	23.30	25.60
1989	29.17	24.32	26.80
1990	29.28	25.40	27.38
1991	29.48	26.24	27.90
1992	31.39	29.21	30.32
1993	32.32	31.39	31.87
1994	34.49	33.71	34.11
1995	34.57	35.21	34.88
1996	35.29	37.91	36.57
1997	36.32	40.57	38.40
1998	38.13	44.37	41.19
1999	39.68	47.59	43.55
2000	44.77	54.25	49.45
2001	45.40	56.07	50.67
2002	47.43	59.80	53.53
2003	49.00	62.83	55.85
2004	52.41	65.53	58.92

2005	52.55	65.31	58.87
2006	51.82	65.22	58.44
2007	51.67	65.08	58.30
2008	49.37	58.68	54.02
2009	52.55	60.39	56.50
2010	60.79	65.41	63.13
2011	65.17	70.46	67.80
2012	66.26	70.18	68.20
2013	70.00	73.45	71.70
2014	71.83	75.86	73.81
2015	74.04	80.58	77.23
2016	73.72	81.56	77.56

Appendix 4:

Business Investment in non-financial assets in Ireland (Source: World Bank)

Year	Nominal Business Investment	Nominal Growth (%)	CPI (2010 = 1)	Real Business Investment	Real Growth (%)
1972	29,203,975.80		0.10	2,789,860.49	
1973	40,631,618.51	39.13	0.11	4,324,617.58	55.01
1974	49,519,785.06	21.88	0.12	6,165,376.14	42.56
1975	59,677,689.69	20.51	0.15	8,981,158.71	45.67
1976	52,059,261.22	-12.77	0.18	9,243,740.14	2.92
1977	72,375,070.47	39.02	0.20	14,582,376.22	57.75
1978	110,467,212.82	52.63	0.22	23,973,603.75	64.40
1979	137,131,712.47	24.14	0.25	33,717,107.43	40.64
1980	176,493,592.90	28.70	0.29	51,273,316.86	52.07
1981	199,348,878.31	12.95	0.35	69,711,950.76	35.96
1982	250,138,401.45	25.48	0.41	102,472,045.21	46.99
1983	195,539,664.08	-21.83	0.45	88,474,129.49	-13.66
1984	179,033,069.06	-8.44	0.49	88,013,415.11	-0.52
1985	220,934,425.65	23.40	0.52	114,472,473.20	30.06
1986	206,967,306.78	-6.32	0.54	111,339,660.35	-2.74
1987	198,079,140.23	-4.29	0.55	109,924,810.54	-1.27
1988	148,559,355.18	-25.00	0.57	84,203,425.72	-23.40
1989	111,736,950.90	-24.79	0.59	65,922,183.76	-21.71
1990	171,414,640.59	53.41	0.61	104,485,450.51	58.50
1991	170,144,902.51	-0.74	0.63	107,041,470.20	2.45
1992	168,875,164.43	-0.75	0.65	109,504,299.99	2.30
1993	193,000,187.92	14.29	0.66	126,986,718.90	15.97
1994	239,980,496.82	24.34	0.67	161,544,137.40	27.21
1995	331,360,000.00	38.08	0.69	228,688,618.46	41.56
1996	390,630,000.00	17.89	0.70	274,321,855.87	19.95
1997	398,190,000.00	1.94	0.71	283,896,967.03	3.49
1998	601,850,000.00	51.15	0.73	439,465,143.08	54.80
1999	799,280,000.00	32.80	0.74	593,150,992.43	34.97
2000	1,024,820,000.00	28.22	0.78	803,044,566.41	35.39
2001	1,292,190,000.00	26.09	0.82	1,061,895,374.45	32.23
2002	1,516,120,000.00	17.33	0.86	1,303,412,201.44	22.74
2003	1,361,040,000.00	-10.23	0.89	1,210,931,387.32	-7.10
2004	1,361,530,000.00	0.04	0.91	1,238,012,926.85	2.24

2005	1,806,100,000.00	32.65	0.93	1,682,153,500.91	35.88
2006	2,142,370,000.00	18.62	0.97	2,073,796,271.20	23.28
2007	2,971,780,000.00	38.71	1.02	3,017,531,505.61	45.51
2008	4,194,810,000.00	41.15	1.06	4,432,334,685.57	46.89
2009	2,409,460,000.00	-42.56	1.01	2,431,884,303.73	-45.13
2010	2,433,310,000.00	0.99	1.00	2,433,310,000.00	0.06
2011	2,161,000,000.00	-11.19	1.03	2,216,260,850.66	-8.92
2012	2,115,500,000.00	-2.11	1.04	2,206,398,234.32	-0.45
2013	2,417,940,000.00	14.30	1.05	2,534,662,336.26	14.88
2014	3,561,890,000.00	47.31	1.05	3,740,650,592.33	47.58
2015	3,519,110,000.00	-1.20	1.05	3,685,010,462.73	-1.49
2016	4,205,240,000.00	19.50	1.05	4,403,852,274.51	19.51

Appendix 5:

Interest Rates in Ireland (Source: CBI)

Year	Nominal Interest Rate	Inflation	Real Interest Rate
1979	16.5	13.30	3.20
1980	14	18.15	-4.15
1981	16.5	20.37	-3.87
1982	14	17.15	-3.15
1983	12.25	10.45	1.80
1984	14	8.65	5.35
1985	10.25	5.40	4.85
1986	13.25	3.83	9.42
1987	9.25	3.16	6.09
1988	8	2.13	5.87
1989	12	4.09	7.91
1990	11.25	3.32	7.93
1991	10.75	3.21	7.54
1992	13.75	3.07	10.68
1993	7	1.47	5.53
1994	6.25	2.31	3.94
1995	6.5	2.52	3.98
1996	6.25	1.75	4.50
1997	6.75	1.53	5.22
1998	4.06	2.42	1.64
1999	4	1.63	2.37
2000	5.75	5.59	0.16
2001	4.25	4.87	-0.62
2002	3.75	4.61	-0.86
2003	3	3.49	-0.49
2004	3	2.20	0.80
2005	3.25	2.43	0.82
2006	4.5	3.93	0.57
2007	5	4.90	0.10
2008	3	4.06	-1.06
2009	1.75	-4.48	6.23
2010	1.75	-0.92	2.67
2011	1.75	2.56	-0.81
2012	1.5	1.70	-0.20

2013	0.75	0.51	0.24
2014	0.3	0.18	0.12
2015	0.3	-0.29	0.59
2016	0.25	0.01	0.24
2017	0.25	0.34	-0.09
2018	0.25	0.49	-0.24

Appendix 6:

Population statistics for 65+ (Source: CSO)

Year	65 years and over	Growth Rate	Percentage of Total Population
1950	317.1		10.68
1951	316.4	-0.22	10.69
1952	316.9	0.16	10.73
1953	317.8	0.28	10.78
1954	318.3	0.16	10.82
1955	317.7	-0.19	10.88
1956	316.6	-0.35	10.92
1957	316.6	0.00	10.97
1958	314.5	-0.66	11.02
1959	315.2	0.22	11.08
1960	315.1	-0.03	11.13
1961	315.1	0.00	11.18
1962	316.5	0.44	11.18
1963	319	0.79	11.19
1964	320.5	0.47	11.19
1965	321.9	0.44	11.19
1966	323	0.34	11.20
1967	324.1	0.34	11.18
1968	324.9	0.25	11.16
1969	326	0.34	11.14
1970	328.5	0.77	11.14
1971	329.8	0.40	11.07
1972	333.6	1.15	11.03
1973	337.6	1.20	10.99
1974	341.7	1.21	10.94
1975	346	1.26	10.89
1976	350.2	1.21	10.85
1977	353.7	1.00	10.81
1978	356.9	0.90	10.77
1979	361.4	1.26	10.73
1980	364.8	0.94	10.73
1981	369	1.15	10.72
1982	373.8	1.30	10.74
1983	377.3	0.94	10.77

1984	380.7	0.90	10.79
1985	382.8	0.55	10.81
1986	384.4	0.42	10.86
1987	388.2	0.99	10.95
1988	393.2	1.29	11.14
1989	397.4	1.07	11.32
1990	400	0.65	11.41
1991	402.9	0.72	11.43
1992	405.8	0.72	11.42
1993	408	0.54	11.42
1994	408.6	0.15	11.39
1995	411.3	0.66	11.42
1996	413.9	0.63	11.41
1997	416.3	0.58	11.36
1998	420.2	0.94	11.35
1999	421.9	0.40	11.28
2000	424.7	0.66	11.21
2001	429.8	1.20	11.17
2002	436	1.44	11.13
2003	441.9	1.35	11.10
2004	449.7	1.77	11.12
2005	458.9	2.05	11.10
2006	462.4	0.76	10.92
2007	471	1.86	10.76
2008	483.7	2.70	10.78
2009	498.9	3.14	11.00
2010	515.1	3.25	11.31
2011	531.6	3.20	11.62
2012	550.1	3.48	11.98
2013	569.2	3.47	12.33
2014	589.5	3.57	12.69
2015	610.3	3.53	13.02
2016	629.8	3.20	13.29
2017	649.9	3.19	13.56
2018	673.4	3.62	13.86

Appendix 7:

Tests for normality for individual variables.

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
SQRT_Domestic_Growth	.146	33	.072	.935	33	.050

a. Lilliefors Significance Correction

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Economic_Progress	.133	36	.111	.956	36	.166

a. Lilliefors Significance Correction

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Capital_Formation	.138	36	.081	.968	36	.374

a. Lilliefors Significance Correction

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Real_Interest_Rates	.169	36	.011	.954	36	.139

a. Lilliefors Significance Correction

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
SQRT_Population_Dynamics	.142	36	.064	.905	36	.005

a. Lilliefors Significance Correction

