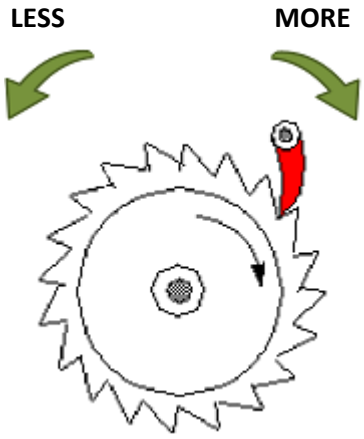
Nationalekonomiska institutionen

Stockholms universitet

Potential consequences of low or no economic growth in Canada and Sweden



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CONTENTS

INTRODUCTION

Economic growth is a fundamental policy objective in nearly all modern societies. The general belief is that most other goals in society will be more effectively achieved if the economy gets bigger. These goals also include most environmental objectives.

Yet, there is a growing concern among environmental researchers and commentators that the size of the economy itself poses a threat against the environment. Increasing production and consumption push ecosystems towards critical limits. Historical correlations between economic growth, energy consumption, fossil fuel combustion and climate change appear to be strong. The picture is not uniform for all types of environmental problems, but it is not evident that economic growth can be decoupled from growing consumption of energy and finite resources.

Finding the ideal size of the economy may be regarded as an optimization problem, and solving this equation requires much information. Economists are busy finding ways to increase efficiency and economic capacity. Environmental researchers are studying the limits to growth. The celebrated compromise is called "sustainable growth", basically promising that growth can go on. What if it can't?

Many industrialized nations have experienced more or less continuous economic growth for at least two centuries. During this period, economic growth has become deeply rooted and institutionalized in many ways. This means that compromising the growth agenda is not solely an ideological issue, but a considerable practical problem. What social, economic and political consequences might be experienced if the growth agenda is abandoned, apart from the trivial fact that the GDP will be affected? Such information is obviously crucial for discussions about the optimal size of the economy, but also helpful in shaping policies for managing without growth.

The topic addressed in this thesis is the economic aspects of the equation. A few comments are appropriate before we begin. First, the question is not really whether we can manage without growth or not. The question is rather how. Civilizations have survived throughout most of the human history without economic growth. Second, economies are dynamic systems, developing with or without growth. We cannot hope to make meaningful predictions by only focusing on the growth aspect. This is, of course, not remarkable from a scientific point of view. At best, the outcome of a thesis like this is a basis for further and broader discussions.

This study is mostly concerned with the Swedish and Canadian economies. These countries are considered representative for highly-developed industrialized countries with a long history of successful economic growth. Although the global economy is increasingly integrated, Sweden and Canada may be regarded as relatively well-defined economic systems, in the sense that they have their own central banks, national governments and labor markets. Still, the general findings should be applicable also for larger systems such as the EU, United States or even the world economy.

The performance of a market economy may be evaluated using fundamental macroeconomic aggregates. In this study we will mainly focus on the GDP, private and public debt, rate of unemployment and poverty. The basic question is how stabilization or decrease of the first aggregate (the GDP) may affect the other ones.

To do this, we will go through relevant literature and theory, statistics and a macroeconomic simulation model.

We limit ourselves to the study of the existing economic system, and we are interested in long-term effects, avoiding problems related to business cycles and short-run fluctuations in the GDP growth. The question what may cause stabilization cannot be completely avoided, but it is not the main focus of the study. However, it is likely that ceased economic growth due to exhaustion of natural resources will have different consequences than a deliberate reduction in labor input or capital investments. We will also find when we apply a simulation model that the way we accomplish low growth will be important for the outcome.

We start this study with a theoretical background including the history of economic growth and a presentation of the dilemma. In our later analysis we will also find it useful to have introduced some theoretical background concerning the monetary system. In the theoretical chapters we will look generally at modern market economies. In subsequent chapters official statistics from Sweden and Canada are analyzed, and a computer simulation model of the Canadian macro economy (LowGrow) is used to explore the development of selected macroeconomic aggregates during some no or low growth scenarios. Along the way, we will try to connect the results from the different chapters, and finally conclude with an integrated discussion of the findings.

THEORETICAL BACKGROUND

Defining economic growth

For an economist, economic growth is a well-defined concept. It is the increase in the aggregate production of a region during a specified period. Unless explicitly stated, economic growth in this study should be interpreted as an absolute increase of the gross domestic product (GDP) in a country. Of particular interest is often the GDP per capita, because this relates directly to the living standard of an average person in a country. GDP is usually measured in the national currency (*e.g.* SEK for Sweden and CAD for Canada) but may be normalized to a common currency to allow for inter-national comparison. Although the GDP is a measure of production, it may be quantified from the production side or from the consumption side.

We need to be aware that the concept of economic growth is widely used in many other ways. It is not unusual to read – even in economic media – that economic growth in fact *is* productivity growth or other advancements unrelated to economic output. It may also be confused with population growth or growth in GDP per capita.

The history of economic growth

Fascination with wealth is probably as old as civilization, but the idea of economic progress and substantial economic growth are quite recent elements of the human history. Before the 19th century the global growth in economic output was essentially zero. Starting around 1820, estimated long-term global per-capita growth rates between 0.5 and 3 % per year have been experienced (Maddison, 2001 cited in

Fregert & Jonung, 2005). During most of this period, growth has been restricted to Western Europe and North America.

The era of rapid economic growth started with the industrial revolution in Great Britain by the end of the 18th century. Preceding this period were several important historical developments including the initiation of colonialism, banking systems and political change. With the Enlightenment philosophy came the idea of progress, and Adam Smith's *Wealth of Nations* (1776) reveals an apparent interest in increasing the economic output.

Technological advances, capitalism and international trade are the factors usually employed to explain the increasing economic output accompanying the age of industrialization. Rapidly developing sectors included coal and iron production and the textile industry. The steam engine was the pinnacle of the time. Soon the industrial revolution was spread to continental Europe and America. During the 19th century the recently established United States surpassed Great Britain in economic output. German industrialization began late but caught up fast, and by the beginning of the 20th century Germany was the second largest economy of the world. The age of mass production emerged in the United States during the first decades of the 20th century, characterized by Fordism and the assembly line.

Regular measurements of economic output began in the USA and other countries during the depression in the 1930s. The economic theories developed by John Maynard Keynes attempted to explain relations between production, national income and levels of unemployment. After 1950 economic growth more generally became an official policy objective in many western countries. At that time the interest in economic growth was not only related to the health of the economies but also to the challenge of the Soviet Union and the Cold War (Victor, 2008). The golden age of economic growth was between 1950 and 1973 until the first oil crisis emerged.

The second half of the 20th century has seen the development of large multi-national corporations, expanding financial markets and the arrival of modern information technology. It has also seen the rise of many new rapidly growing economies, most notably the economies of East Asia.

During the two and a half centuries that have passed since the industrial revolution, economic growth has been continuous, only interrupted by short periods of war and economic depressions. Historians have observed the occurrence of apparently regular variations in global growth rates. Long waves in the economy, sometimes referred to as Kondratiev waves, seem to occur in 45 to 60 year intervals. In his *Long Waves of Capitalist Development* (1978), Ernest Mandel identifies five cycles since the industrial revolution and connects them to certain technological advances, including the industrial revolution (starting around 1770), steam and railways (starting around 1830), steel and electricity (starting around 1875), oil and automobiles (starting around 1910) and information technology (starting around 1970). Growth theory today is an integral part of economic sciences. While innovations such as the ones described by Mandel may be important for the economy, factors influencing growth rates turn out to be much more diverse. Common aspects referred to by economists include technological innovations, investment decisions, productivity growth, education, communication, social, political and environmental factors.

Limits to growth

If something grows at a constant rate the result is in fact exponential. This explains why the world GDP with an annual growth rate of around 2.5 % has more than doubled since 1980 and why the Chinese GDP at a current growth rate of some 8 % per annum would expand four times until 2030.

Philosophical discussions on the limits to growth have sometimes been lively, with interesting contributions from writers such as Thomas Malthus (1766-1834), John Stuart Mill (1806-1873), Joseph Schumpeter (1883-1950) and Kenneth Galbraith (1908-2006). However, it was not until the birth of the modern environmental movement in the 1960s (often attributed to the publication of *Silent Spring* by Rachel Carson in 1962) that an intense public debate emerged, largely ignited by *The Limits to Growth* delivered by the Club of Rome (Meadows et al., 1972).

The Limits to Growth presented extensive evidence for the rapid exhaustion of finite resources on Earth. The following debate, however, suggested that the economic analysis was too weak. Economists argued that efficient markets would react to resource scarcity through price mechanisms by shifting consumption towards more abundant resources. Economic incitements would also promote technological development that would improve overall resource efficiencies (see *e.g.* Solow, 1974; Nordhaus, 1992).

There is some historic evidence that in the long run economic growth is in effect beneficial for the environment. The argument is illustrated by the inverted U-shapes of the two upper curves in **Figure 1**, and might be explained by an increasing ability to invest in efficient technologies and increasing attention to environmental health as income per capita rises. As shown by the lower curves in the same figure the relationship is not evident for all environmental problems.

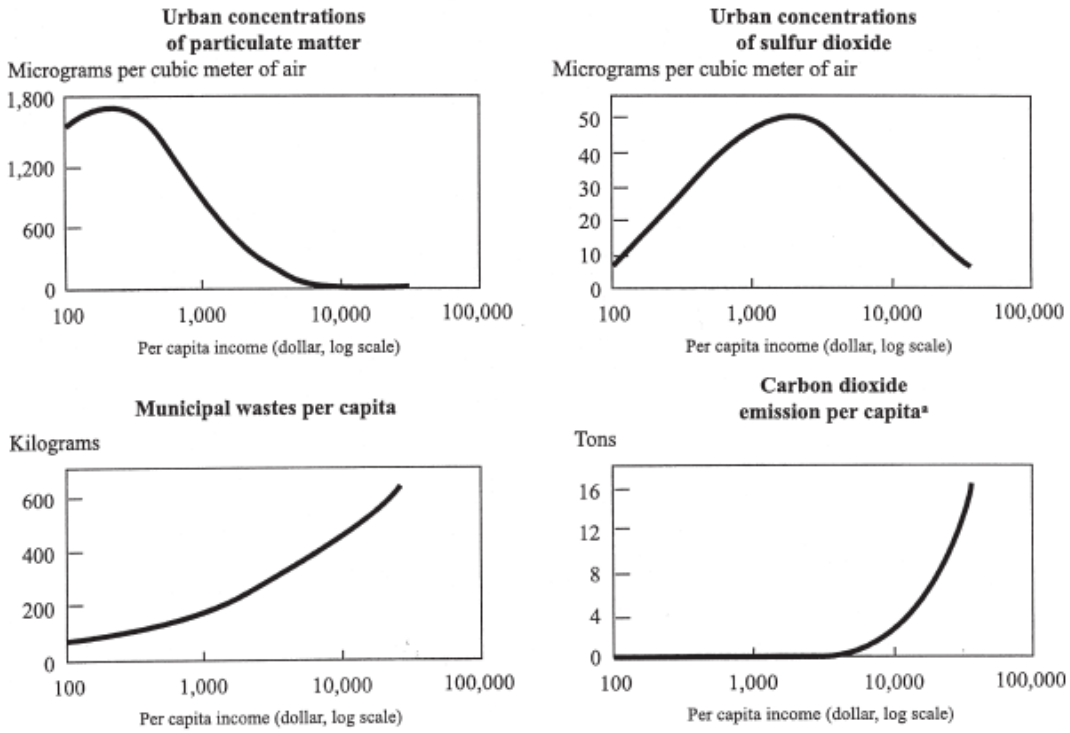

Figure 1 Relationship of per capita income (US$) to various environmental impacts. From Chertow, 2000. World Bank data.

At the large environmental summits in Rio de Janeiro 1992 and in Johannesburg 2002 there were basically no serious objections to the growth agenda. Instead, a broad consensus has emerged around the concept known as "sustainable development" promoted by the Brundtland report (World Commission on Environment and Development, 1987). According to the United Nations Environmental Program, "sustainable consumption is not about consuming less, it is about consuming differently" (UNEP, 2001).

In the last decade or so, however, there has been a growing concern about the limits to growth, enhanced by the acute threat of climate change (*e.g.* Daly, 1996; Latouche, 2006; Jackson, 2009; Simms et al., 2010).

Critical resources such as phosphorus and other minerals are in increasingly short supply. Several studies suggest that the peak in oil production may be reached within one or two decades (IEA, 2010), which is the first time in history that the world faces declining supply in the dominant fuel (Smil, 2003 cited in Victor, 2008). Two thirds of the most important ecosystems in the world are used above their capacity. Unsustainable exploitation of groundwater poses a threat to global agriculture (McKibben, 2003). The Earth's productive capacity is limited, and food production is highly dependent on water and fossil fuels. On average, 2.2 units of fossil fuel energy are needed to extract 1 energy unit of plant-based food. In the case of meat, the input/output ratio amounts to 25 (Simms et al., 2010). Assessments of the human demand on the Earth's ecosystems, the so-called ecological footprint (Wackernagel et al., 1999), suggest that the equivalent of 1.5 earths are consumed annually, obviously eroding the stock of natural capital (WWF, 2010). If this is true, there is not much space left to sustain other species and biodiversity.

The threat of dangerous climate change due to combustion of fossil fuels and emissions of carbon dioxide (CO_2) into the atmosphere has caused great public attention, especially after the release of the Fourth Assessment report by the Intergovernmental Panel on Climate Change (IPCC, 2007). Since around 1850 the global average temperature increased by 0.8 ºC and is projected to increase between 1.4 and 5.8 ºC if current greenhouse gas emission trends persist. Atmospheric carbon dioxide concentrations have increased from around 270 ppm (parts per million) in 1850 to 390 ppm at present, and should at least be kept below 450 ppm to avoid dangerous climatic change. According to recent research, it may be necessary to actually reduce atmospheric CO_2 levels to 350 ppm to be on the safe side (*e.g.* Hansen, 2008). The 350 ppm target has also been given support by Rajendra Pachauri, chair of the IPCC.

Reaching the 450 ppm target will require absolute reductions in global CO_2 emissions of 50-85 % until 2050 (IPCC, 2007). The largest emissions are generally associated with high-income countries, implying that even larger reductions will be required from these countries. The correlation between GDP and CO_2 emissions – the carbon intensity – is strong, both historically and between different countries. **Figure 2** shows world GDP, fossil fuel consumption and CO_2 emissions after 1990 and reveals a slight relative decoupling between GDP and CO_2 emissions (around 0.7 % per year). At present, one US$ on average corresponds to 768 g of CO_2 emitted to the atmosphere.

If the world GDP grows at an annual rate of 1.4 % and the human population at 0.7 %, achieving the 450 ppm target will require the average CO_2 content of economic

output to be less than 40 g CO_2/US$ in 2050 (Jackson, 2009). This would require the CO_2 intensity to decrease 7 % each year – around ten times faster than presently. Indeed, there has to be an absolute decoupling between emissions and economic output, *i.e.* resource efficiency needs to increase more rapidly than the GDP.

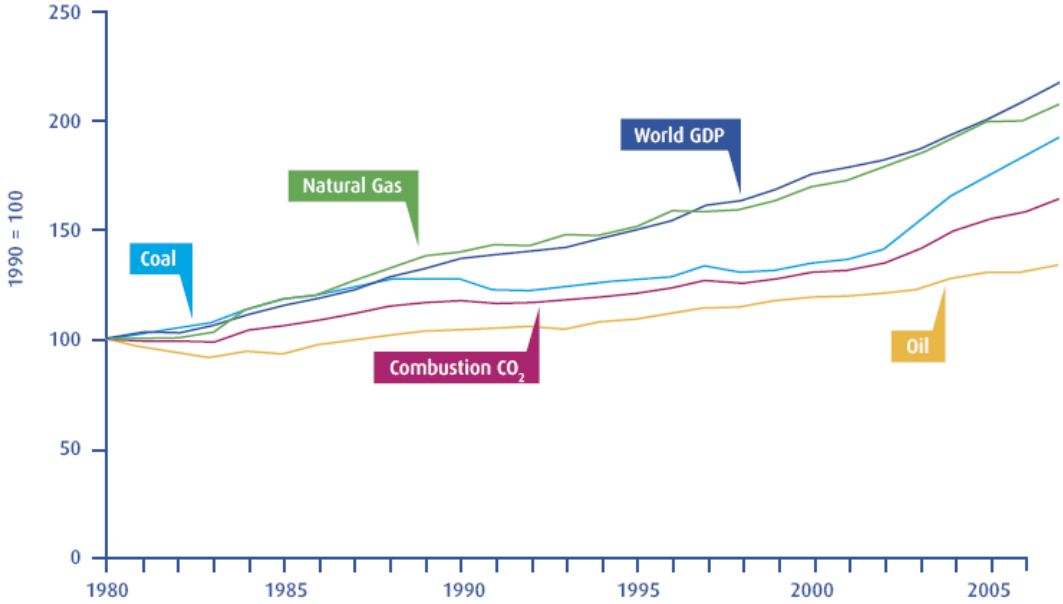

Figure 2 Trends in Fossil Fuel Consumption, CO_2 and GDP 1980–2007. From Jackson (2009).

Apart from warnings that the global economy is crowding out ecosystems and threatens world climate, there are also arguments that economic growth in rich countries after 1970 has had no net positive effect on human wellbeing measured as, *e.g.*, longevity, participation in education and overall happiness (Inglehart, 1997; Donovan & Halpern, 2002; Wilkinson & Pickett, 2009). Such statements, however, are highly controversial (Hall & Jones, 2007; Stevenson & Wolfers, 2008). Supply of services such as health care and education does not necessarily improve with increasing GDP, since productivity gains are mostly achieved in material goods production, making labor intensive services relatively more expensive. This phenomenon is known as the Baumol effect (after Baumol, 1967) and may explain why even very rich nations find it hard to finance important health and educational services.

There is an apparent need for many poor people in the world to increase their material wealth. As shown above, however, there is a rising concern that there are absolute limits to growth, and that there is little time to lose in avoiding dangerous climate change and further loss of ecosystems. It does not seem premature to consider if rich countries would be able to manage without economic growth.

Are we dependent on growth?

Few studies directly address the questions *if* and *how* modern market economies are dependent on economic growth for their prosperity. Important insights to the subject are provided by *e.g.* Daly (2005), Feasta (2005), Lawn (2005), Fotopoulos (2007), Victor (2008) and Griethuysen (2010). General assumptions that capitalism must grow to survive are relatively common (*e.g.* Latouche, 2006; Kovel, 2007; Foster

& Clark, 2009). In the following, we will briefly summarize the most common arguments found in the literature. Later on, we will make a more analytical effort to evaluate the significance of some of the arguments for macroeconomic aggregates addressed in our study.

Possible reasons for growth dependence in market economies may be grouped into seven categories: Psychology and ideology; We already counted on growth; We want more resources; Overproduction and unemployment; Financial and monetary institutions; Competition and survival on the market; Democratic arguments

These different complexes of growth-dependence are certainly interrelated. Clearly, our present societies are built upon expectations of economic growth. Hence, many things from political and market strategies to institutions and treaties are adapted to these expectations.

Psychology and ideology

It is quite understandable that growth is associated with success in many ways. Rather obviously, a growing garden is more attractive than a fading one. Even Adam Smith declared that "...the stationary is (a) dull..." (cited in Kerschner, 2010). It seems to some extent that the growth paradigm is related to the Enlightenment idea of progress and that current trends in consumption growth are assumed by habit. Hence, discussions about confronting the growth agenda often pay attention to the growth ideology of the modern world (*e.g.* Brekke et al., 2003; Jackson, 2009).

We already counted on growth

In a broader sense this paragraph could include most of what follows below in subsequent sections. However, we should first consider the very direct ways in which we already counted on growth in our planning. This includes agreements and international treaties designed to support economic growth. It also includes all calculations we did when making decisions about the future. One good example is the pension systems in many countries that more or less depend on economic growth for their funding. More generally, investment decisions are typically based on present values discounting future incomes. An interesting example is provided by the Stern Review (Stern, 2007), which used discounting principles to compare future costs of climate change with present costs of acting against climate change, assuming future generations to be more wealthy than us.

Related to this issue is the rating of different assets including real estate, bonds and stock markets. Without growth, many people will find their asset values declining. Such assets are also included in capital reserves in central banks and commercial banks.

Most of the problems that may arise in a non-growing economy mentioned in this section would probably be transitional. Once growth is no longer counted upon, more or less painful adjustments could be made.

We want more resources

There are still things that we apparently cannot afford in our modern society that would require more money to pay for, such as health care and measures against poverty and environmental deterioration. The way our economy is structured the obvious way to find the means is through taxation. Typically, governments depend on business sectors to supply the monetary resources necessary to pay for public

services (Feasta, 2005; Ruzzene, 2008). The Baumol effect (see the previous chapter) acts towards making non-productive services relatively more expensive than material production.

In a growing economy it is easier to accept the current socioeconomic structure, including large income gaps, since most people seem to be getting richer with time. Growth is also probably an important stimulation for innovation and entrepreneurial spirit.

Overproduction and unemployment

As productivity increases less labour is required to produce a given amount of output. Unless total production increases this will decrease labour demand and cause unemployment. This also puts a pressure on consumption to increase in order to sustain demand for goods and services. This familiar set of problems were referred to by Karl Marx as overproduction and by John Maynard Keynes as underconsumption.

Another aspect is the substantial amount of job opportunities provided by investment, typically accounting for 15-30 % of GDP in industrialized economies. The motivation for investment is often to increase productive capacity and to promote growth (Feasta, 2005), although investments are also required to maintain existing productive capacity.

Financial and monetary institutions

Probably the most common theme among those who believe that capitalism must expand to operate, the works in this area follow two different lines, which may well be compatible with each other. One school maintains that the debt-based money creation mechanism and the need to repay debts with interest require economic growth for functioning. The second school is more occupied with the motivation of private investors in the financial sector to maximize their profits.

There is certainly a relation between the money supply and the size of the economy (GDP). For money supply to increase there has to be corresponding collateral representing some real assets (e.g. Steiger, 2006). The argument here is that new money is constantly required to service payments on new and existing debts. If there is a need for the money supply to increase, there is also a need for the economy to expand. There is a host of literature suggesting monetary reforms to reduce our dependence on growth, including calls for an interest-free economy (see e.g. Kennedy, 1995; Lietaer, 2001; Ruzzene, 2008).

In pre-capitalist societies, according to Karl Marx, money is used as a medium of exchange. The economic process starts with commodities (C) exchanged for money (M) which in turn is exchanged for new commodities (C-M-C). Capitalism is characterized by a different sequence. The motivation for market transactions is to exchange money for more money, with commodities as a transitional medium: M-C-M' (Marx, *Capital*, vol. 1, Ch. 4). The latter seems to be true for at least some economic activities in modern market economies, especially in the financial sector. The difference between M' and M is basically the return from investment.

Opinions differ whether 'capitalism' as presented above would be able to survive without economic growth. A common view is that steady-state capitalism would be conceivable in theory but difficult in practice (see, *e.g.*, Latouche, 2006; Schweickart, 2010). Others maintain that a steady-state economy is different from a static

economy, and that profit opportunities will occur in response to any economic development even without overall growth (*e.g.* Brittan, 2002; Lawn, 2005). Daly (2005) expects the financial sector to contract in a steady-state economy. The motivation for households to provide capital for private investment relies on the return on their savings. Hence, financial mechanisms may not function in the same way in a non-growing economy. Historical periods in which capitalist economies failed to grow were usually problematic times of crisis and despair. Ultimately, the function of financial markets depends on growth expectations. It may not yet be ruled out that financial sectors could adapt smoothly to zero growth expectations.

On the shorter term the present conditions have left many firms and households (and whole countries) highly indebted as they expected the future to bring returns on investments and savings. This adds to the transitional problems that might be faced if economic growth is suspended.

Competition and survival on the market

In the present mode of production, growth is a guide to profit and success on the market. This holds for firms, regions and countries. Productive capital is attracted to growing business, discouraging or eliminating less competitive agents. Individual actors may hence be reluctant to avoid growth. This is probably one important driver of economic growth, and an obstacle to managing without growth.

If the growth agenda is abandoned in one single country, for instance, there is a severe risk that investors will transfer their capital abroad (Victor, 2008; Griethuysen, 2010). This might act towards currency depreciation and worsening terms of trade. In the globalized economy, international trade is more sensitive to absolute advantages than to comparative advantages due to the high mobility of capital (Lawn, 2005). There may be negative feedbacks turning low growth into de-growth if capital used in production migrates to faster growing places.

Competition in a steady-state economy must necessarily be a zero-sum game. This means that any market share seized by one competitor must be lost by another. This is a less attractive situation than a world where everyone can win.

Democratic arguments

Given the different reasons for our growth dependence, some of them self-sustaining processes triggering economic growth, it seems likely that a steady-state economy will have to involve a high degree of planning by government. To many, this would obviously seem rather unattractive. For various reasons given above, interest groups including both workers and investors may have short-term interests in sustaining growth. In the end, this could turn out to be a fundamental basis for resistance against a steady-state economy.

Money and interest

In order to study growth in GDP and possible links to money creation, credit expansion and financial debt we will here briefly review some theoretical background concerning the monetary system.

GDP in a country is a measure of production, balanced by a corresponding level of expenditures. This can be written as:

$$GDP = C + I + G + X - M \quad (1)$$

where C is consumption, I is investments, G is government expenditure, X is exports and M is imports, measured in monetary units. Economic growth, *i.e.* an increase in production, should be matched by an increase in at least one of the terms on the right hand side of the equation. An increasing GDP is normally associated with an increasing demand for real money to pay for the new expenditures.

The money supply can be measured in different forms of aggregates. M0 is the available amount of currency in circulation (coins and banknotes) provided by the central bank. Other aggregates include M1, M2 and M3 incorporating different kinds of deposits and funds. As a rule, the function of money as a means of exchange is most apparent in M0 while the other aggregates incorporate an increasing proportion of money functioning as a store of value. M0 is included in M1, and M1 is included in M2, implying that M1 is larger than M0 and so on.

The ratio between GDP and money supply is termed *the velocity of money* and may be measured using any of the monetary aggregates. The velocity of money is typically higher in periods of high economic activity and lower during recessions. As an example, the velocity of money in the USA (measured as GDP/M2) varied between 1.2 and 2.1 during the 20th century, with the lowest values occurring during the depression in 1932 and directly after WW2 (Mauldin, 2008). Since inflation operates equally on the value of GDP and on the monetary aggregates it does not directly influence the velocity of money.

Hence, there seems to be a relation between the GDP and the real money supply although there are different opinions about the causal relationship. Private banks are required to keep a certain amount of reserves of cash and other highly liquid assets in relation to their demand deposits, making the central bank ultimately accountable for the total money supply. Either the central bank actively injects money to the system according to some policy objective, or it passively responds to the market demand for money. According to the Keynesian school, exogenously supplying money to the system may be effective in promoting GDP growth, while monetarists and post Keynesian views consider money supply as a function of economic activity (Lavoie, 1984).

In order to increase the money supply the central bank may lend money to commercial banks, or it may buy government bonds or other assets in the open market. In both cases, a net increase of the central bank's assets is registered in the balance sheet. Private banks in turn may create money by granting credit to the market. This is possible since a large proportion of the money is only present in deposit accounts, allowing banks to lend a specified multiple of their reserves. This is how money measured as M1, M2 and M3 enters the system.

Since bank loans generally involve property serving as collateral, credit may be regarded as monetization of property (Steiger, 2006). This contrasts to the Keynesian view of money as effectively divorced from commodities (Bell, 2000). The Keynesian view is reasonable concerning state money directly issued by the central bank. In modern economies, however, the major part of the money in circulation is issued as debt secured against collateral. As a derivative of assets, property-based money demonstrates a notable stability in value (Griethuysen, 2010).

Borrowing money from a bank usually involves paying back interest on the debt. The association of money with interest was probably a reason why fiat money (*i.e.* money devoid of intrinsic value) became accepted as a means of payment. The first paper money issued in the USA in the beginning of the 19th century was convertible on request into interest bearing securities (Zarlenga, 2002). The interest rate paid on debt may be regarded as the price of money, warranting supply to be scarce enough for money to have value.

Linked to the introduction of fiat money is also the phenomenon known as inflation. Inflation generally occurs when too much money is chasing too few goods and services in the market, *i.e.* when money is not scarce enough. This is consistent with the quantity theory of money expressed, *e.g.*, by Milton Friedman in his *Studies in the Quantity Theory of Money* (1956). According to Friedman the optimal rate of nominal interest is zero (Friedman, 1969 cited in Chari et al., 1996). This would imply that the money supply is not controlled by the interest rate. However, according to macroeconomic models including the familiar IS-LM model, money demand is directly influenced by the rate of interest, indicating an option for the central bank to control inflation and money supply through the interest rate policy. In the zero-interest regime of 21st century Japan, the central bank has consequently found it difficult to control the price level (Hamada & Okada, 2009).

Distinct from the interest rates charged by banks is the real interest rate of the economy. According to theory the real interest rate is the return available from investment or the marginal productivity of capital. Equilibrium rates of real interest depend on supply and demand for investments. If the interest rate paid in deposit accounts is higher than the general rate of return on capital it tends to discourage real investment. Keynesian strategies suggest low interest rates to be effective in stimulating investment and consumption during periods of low economic activity.

An important observation relevant to our study is the apparent relationship between inflation and unemployment. This relation is known as the Phillips curve, revealing a trade-off between the two variables. The logic to the relationship is that a high demand for labor (low unemployment) tends to raise wages and prices and cause inflation in the short run. High inflation on the other hand, tends to reduce real wages and promote employment.

LowGrow

Economist Peter Victor has developed a dynamic simulation model of the Canadian macro economy (LowGrow), designed to explore the potential to achieve a stable, non-growing economy in a realistic setting. A simplified overview of LowGrow is shown in **Figure 3**.

The model contains modules and equations for several important economic variables including consumption, production, private investment, government expenditure, taxes, fiscal position and labor. It is driven by data for Canada between 1981 and 2005. There are no monetary or financial sectors included. Detailed model descriptions can be found in Victor & Rosenbluth (2007) and Victor (2008). The model itself can be accessed at www.managingwithoutgrowth.com. A brief selection of important model equations is given in the following.

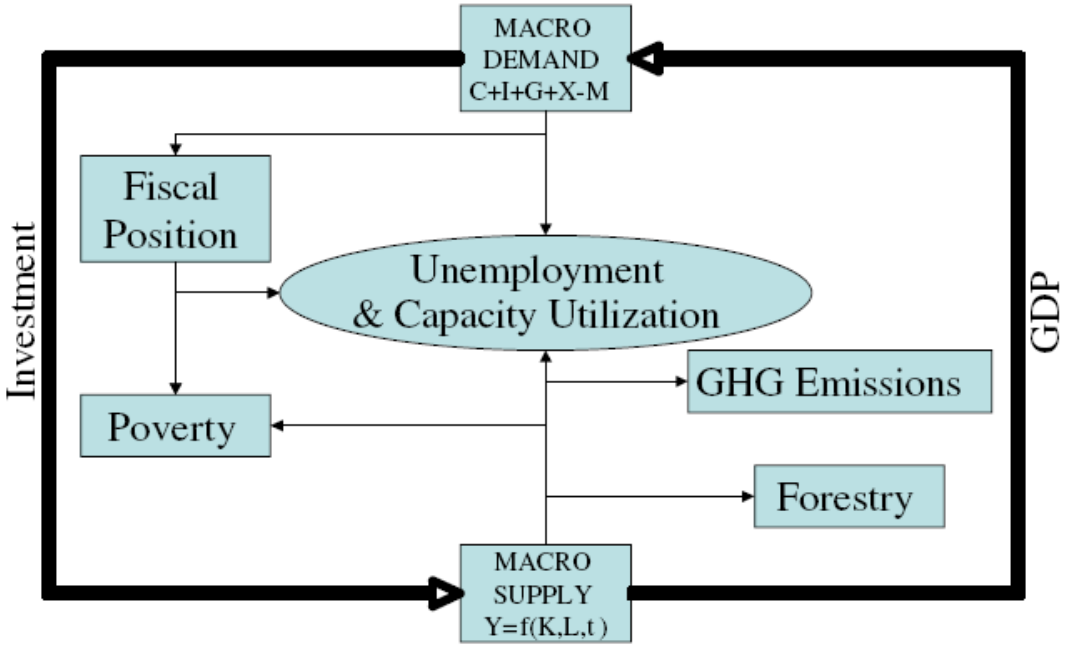

Figure 3 Simplified structure of LowGrow. From Victor & Rosenbluth (2007).

Per capita consumption (C/p) is a function of GDP, population size (p), disposable income (d), interest rate (i) and exchange rate against the US$ (xrt) so that:

$$C/p = 0.58 \cdot GDP/p + 0.0039 \cdot d/GDP - 0.00005 \cdot i - 0.0017 \cdot xrt \quad (2)$$

A Cobb-Douglas production function is employed to establish the relation between GDP, productive capital (K), capacity utilization (CU) and employed labor (L) according to the following equation:

$$GDP = 5.9 \cdot 1.01^{t} \cdot (K \cdot CU)^{0.32} \cdot L^{0.60} \quad (3)$$

where t is the time in the simulation. The role of the production function in the model is to calculate the demand for labor. Private investment (I) is given by:

$$I = 66739 + 0.18 \cdot GDP - 2141 \cdot i - 161854 \cdot CT \quad (4)$$

where CT is the average rate of corporation profit tax. Equations 2-4 are empirically determined using data from Statistics Canada. Government income includes taxes and transfers from persons, corporation profit tax and taxes on production and imports, plus government investment income. Government outlays include transfers to households, business and nonresidents and interest payments on government debt.

In the model, economic growth is driven by net investments adding to productive assets, growth in labor force, productivity, population, trade balance and growth in government expenditures. Low and no growth scenarios can be examined by reducing any of these factors. Additional government expenditures on literacy, health

and poverty reduction may be imposed. The average work week may also be reduced, and interest and exchange rates can be controlled.

The model includes some additional modules for greenhouse gas emissions and forestry that are not applied in this study. The simulation time is 30 years, starting from 2005. Projected figures for several variables can be studied, including GDP, unemployment, government debt and poverty.

Theoretical summary

More or less continuous economic growth has been experienced by many industrialized nations for at least two centuries. Primarily due to rising concerns about dangerous climate change, loss of ecosystems and important natural resources, discussions about the limits to growth have been intensified in the last decades. There are several and complex reasons why market economies may find it difficult to manage without growth. Given the long history of growth in many countries, expectations of sustained growth are built into society. It is generally assumed that growth will provide more resources useful in *e.g.* poverty reduction, health care and environmental protection. Economic activity is often motivated by growth, supporting investments and labor opportunities. New money supporting economic growth is often provided by going into financial debt. We have briefly introduced a simulation model (LowGrow) that can be used to explore the development of different macroeconomic aggregates during no or low growth scenarios, including unemployment, poverty and government debt. We will now turn to statistics regarding growth in GDP, money supply and investment in Canada and Sweden in search for informative relationships.

RESULTS

Official statistics: GDP, money supply, indebtedness and investment

In this section we will explore official economic statistics for two countries, Sweden and Canada. Most data is taken from the OECD Statistics database. The data may be useful to investigate relationships between growth in the different aggregates and implications for the prospect of managing without growth.

GDP composition

In **Table 1** the composition of the GDP in Canada and Sweden is shown in national currency and in US$.

Table 1 Average composition of GDP in Canada and Sweden 2004-2009. Data from the OECD Statistics database (http://stats.oecd.org).

	Consumption	Investments	Government expenditures	External balance	GDP
Canada					
Billions (CAD)	820	325	288	29	1 462
Billions (US$)	676	264	237	23	1 200
Sweden					
Billions (SEK)	1 415	552	782	223	2 972
Billions US$	157	61	87	25	330

As shown in Table 1, private consumption constitutes around half of GDP, with investments and central government expenditures equally constituting the remainder of the internal balance in both countries. The external balance is slightly positive, with a little more surplus in Sweden. Measured in US$ the Canadian economy is around 3.5 times larger than the Swedish economy, which corresponds quite well to the difference in population (33 million in Canada vs. 9 million in Sweden).

Growth of GDP and money supply

The growth in GDP (current prices) and in the money supply 2005-2009 is shown in **Table 2**.

Table 2 GDP, money supply and inflation (total consumer price index) in Canada and Sweden 2004-2009. Data from the OECD Statistics database, Statistics Canada, Bank of Canada and Statistics Sweden (SCB).

	Canada				Sweden			
	GDP	M1	M3	Inflation	GDP	M1	M3	Inflation
2004	1 291			1.8	2 661	981	1 291	0.4
2005	1 374	348	944	2.2	2 769	1 081	1 408	0.5
2006	1 450	377	1 013	2.0	2 944	1 209	1 631	1.4
2007	1 530	411	1 124	2.1	3 126	1 342	1 896	2.2
2008	1 600	447	1 258	2.4	3 214	1 423	2 113	3.4
2009	1 527	507	1 303	0.3	3 108	1 535	2 133	– 0.3

GDP growth in Canada during the period was 18 % and the corresponding number for Sweden was 17 %. Real GDP growth (nominal growth minus inflation) in both countries was around 9 %. The annual average velocity of money (GDP/M3) was 1.3 in Canada (standard deviation = 0.1) and 1.7 in Sweden (standard deviation = 0.2).

Monetary debt

We can generally expect the money supply to grow when the GDP grows, and this is observed in Table 2. Demand for new money can also be expected from increasing indebtedness when money is issued as credit. Interest payments on existing debt may contract the money supply if banks receiving interest do not distribute all their profits. If this is compensated by new money issued as credit, total debt rises with a corresponding increase in interest payments. This will put a pressure on the national income to grow in order to service interest costs. To compensate for money lost in interest payments plus the increasing interest cost in the next period when debt has increased, the required increase in borrowing (ΔB) is given by:

$$\Delta B = IP/(1-i) \qquad (5)$$

where IP is the cost for interest payment and i is the nominal interest rate (assuming constant interest rates). We can test the importance of this effect by observing the growth in M, indebtedness and interest payments over time. Income statements and balance sheets for all national banks (including commercial banks, savings banks and cooperative banks) are given by the OECD database, including loan statistics and interest incomes. In **Table 3** numbers for M3, bank loans, interest incomes and expenses are shown for Canada and Sweden.

Table 3 M3 and bank loan statistics for Canada and Sweden 1999-2009. Numbers in billions of national currency. Data from OECD Statistics, Statistics Canada and Statistics Sweden.

	Canada				Sweden			
	M3	Bank Loans	Interest Incomes	Interest Expenses	M3	Bank Loans	Interest Incomes	Interest Expenses
1999		946	89	59	1 066	995	113	80
2000		989	96	65	1 163	1 181	142	108
2001		1 045	97	62	1 182	1 331	143	104
2002		1 055	78	40	1 208	1 383	132	90
2003		1 060	76	38	1 259	1 347	111	67
2004		1 126	74	35	1 291	1 407	99	59
2005	944	1 249	85	46	1 408	1 684	116	78
2006	1 013	1 384	105	65	1 631	1 969	160	120
2007	1 124	1 514	125	82	1 896	2 655	210	159
2008	1 258	1 730	124	75	2 113	2 970	272	209
2009	1 303	1 718	102	46	2 133			
Δ[a]	360	469			1 046	1 975		
Σ[b]			457	268			1 387	994

[a] ΔM3 and ΔB computed 2005-2009 for Canada and 1999-2008 for Sweden

[b] Sum of interest payments computed 2006-2009 for Canada and 2000-2008 for Sweden

We can observe in Table 3 that bank loans exceed money supply and that $\Delta B > \Delta M3$ during the period in both countries. Assuming the rate of interest = 5 % (*i.e.* 20 % for 4 years in Canada and 45 % for 9 years in Sweden) a rough estimate of IP/(1-i) gives 240 billion CAD for Canada and 710 billion SEK for Sweden based on net interest income (income minus expenses). Hence $\Delta B > IP/(1-i)$ in both countries. The numbers should be carefully interpreted for several reasons. The statistics do not reveal who is borrowing money, and loans may also be granted by institutions not included in the data, including foreign banks. Data including all national monetary financial institutions are provided by Statistics Sweden and show around 50 % higher numbers than the OECD data. Central government debt also adds to the total indebtedness. In **Figure 4** the development of M3, private and public debt in Sweden between 2001 and 2009 is shown.

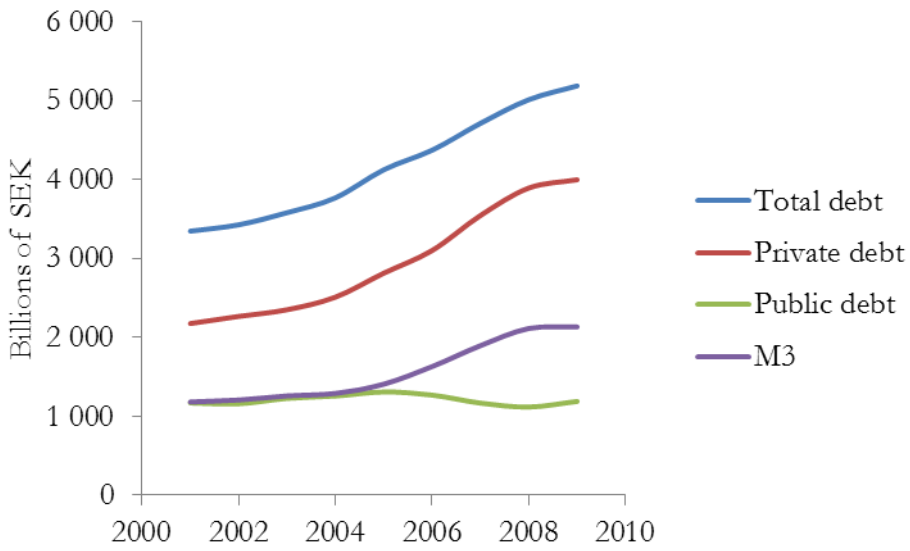

Figure 4 Development of debt and money supply in Sweden 2001-2009. Data from Statistics Sweden.

The private debt can be specified based on collateral for the Swedish data (**Figure 5**). Houses and real estate make up the greater part of the securities. Other securities include *e.g.* company mortgage, financial instruments, public and personal guarantees. The government debt in Sweden mainly consists of government and other bonds (65 %) and foreign debt (30 %).

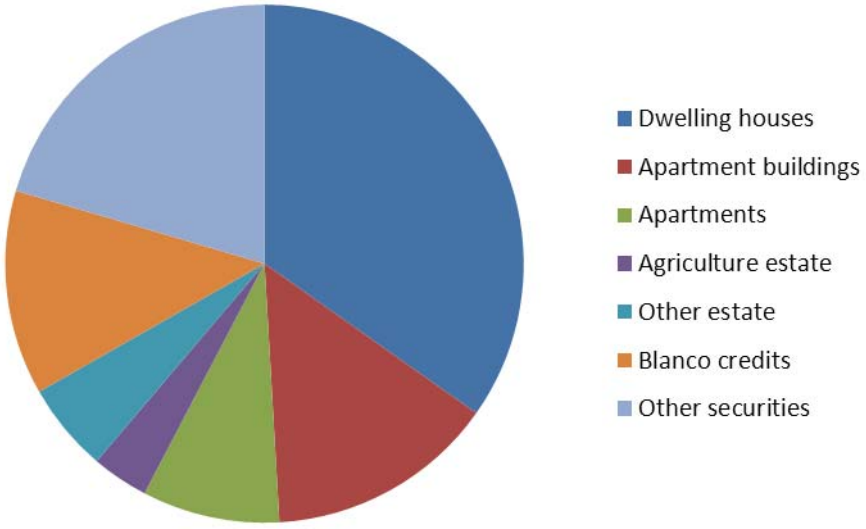

Figure 5 Household and non-financial company debt in Sweden based on security (average 2000-2009). Data from Statistics Sweden.

Investment

As indicated above the growth in money supply is largely covered by private debt, with real estate serving as collateral. It appears then that capital investments are not directly financed by loans. This is where financial institutions come in, including stocks, bonds, pension funds, options etc., serving to mobilize different kinds of savings and make them available for capital formation. **Table 4** shows average

annual investment volume in Canada and Sweden compared with net debt increase and GDP growth.

Table 4 Total investment volume and components compared with net debt increase and GDP growth. Average values between 2005 and 2009 (Canada) and between 2004 and 2008 (Sweden). Data from OECD Statistics.

	Canada	Sweden
Total investment	337	552
- Dwellings	101	101
- Other buildings and structures	118	133
- Transport equipment	26	52
- Other machinery and equipment	63	176
Net debt increase	118	325
Nominal GDP growth	47	138

The total investment volume is roughly twice the size of the net debt increase. It turns out that a large part of the investments are dwellings and other buildings possibly serving as collateral in loan contracts. Investments in transport equipment and other machinery, likely intended for the industry, make up a smaller proportion somewhere between the magnitudes of net debt increase and GDP growth.

Empirical summary

Around half of GDP is made up from private consumption and the other half is equally split between investments and central government expenditures in both Canada and Sweden. Real GDP growth was around 50 % of nominal GDP growth 2004-2009 in both countries. Money supply measured as M3 is similar in magnitude to the GDP. Bank loans exceed money supply and the indebtedness growth was larger than the growth in M3 indicating that money growth is largely explained by credit expansion. The rate of debt increase is higher than the rising cost for servicing the debt, ensuring that the money supply does not contract.

Private debt makes up the largest part of total indebtedness but central government debt is also significant. Private loans are mostly backed by real estate serving as collateral. Credit expansion apparently requires additional collateral, *i.e.* additional monetization of property. Investments are not primarily financed through bank loans contributing to money growth, but the order of magnitude of investment is similar to the net debt increase.

Although not explicitly demonstrated it seems likely that GDP growth is critical to avoid monetary contraction and deflation. If interest payments are not balanced by money creation the proportion of total GDP required for servicing the debt may increase and cause instability.

Model results

The default setup of LowGrow assumes business as usual conditions. This means for example that productivity, investment and government expenditures continue to grow along projections based on present conditions. The outcome of the default

scenario is shown in **Figure 6**. The displayed variables are given as indices of 100 starting in 2005.

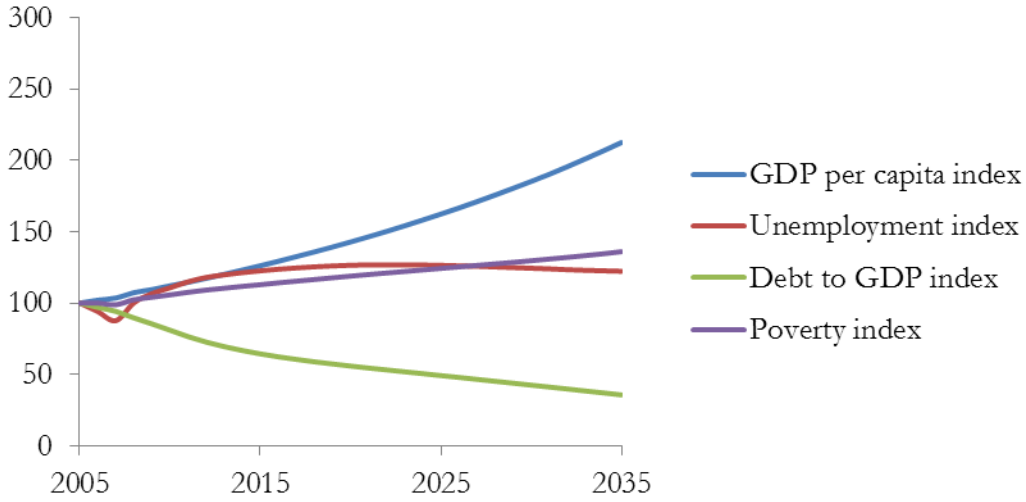

Figure 6 A business-as-usual scenario (2005=100).

Poverty is measured as HPI (Human Poverty Index) based on income, adult illiteracy, unemployment, and longevity (United Nations Development Programme, 2006). In LowGrow the HPI depends on unemployment and specific government transfers, and it remains fairly stable in the business as usual scenario. GDP per capita grows 113 % until 2035 (in real, constant dollars) and the government debt to GDP ratio is reduced to 36 % compared with 2005. HDI and unemployment remains fairly stable.

In the model, GDP grows due to growth in investments, government expenditures, productivity, trade balance, labor force and population. Lower rates of GDP growth can be obtained by reducing any of these factors. To see one possible effect of insensibly reducing all these factors, **Figure 7** demonstrates the outcome of a "no growth disaster". The reductions are phased in over several years. A similar scenario was produced by Victor (2008).

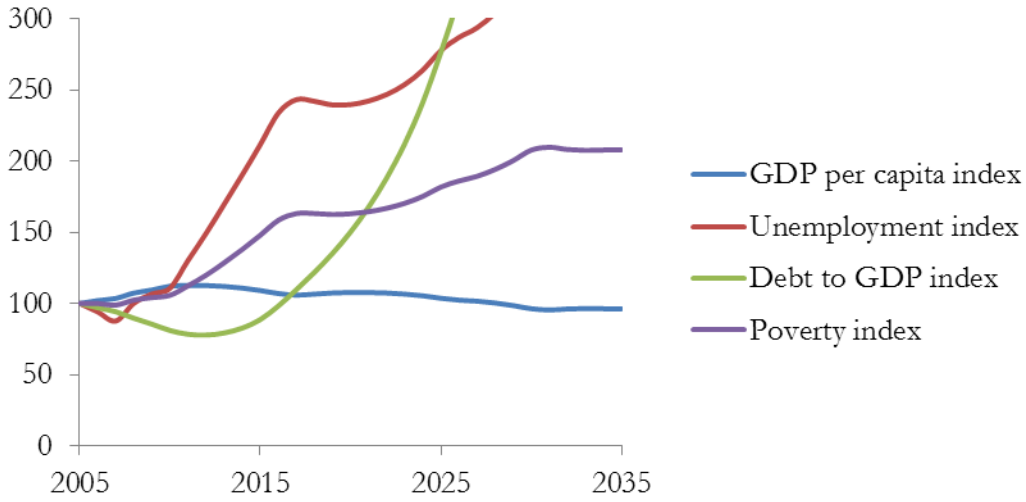

Figure 7 A no growth disaster (2005=100).

In this scenario the GDP per capita remains more or less constant while unemployment, debt and poverty rise dramatically. Labor demand is directly related to the GDP which explains why unemployment rises when GDP does not grow. Productivity growth, although lower than in the business-as-usual scenario, further decreases the demand for labor. Government expenditures exceed incomes due to increasing costs for unemployment and growing interest payments. Since fiscal prudence is required in the model the capacity for debt repayment decreases and the debt to GDP ratio increases. The rise in poverty index in this scenario is mainly explained by falling personal incomes due to unemployment.

It is possible to produce more hopeful scenarios in LowGrow by more carefully controlling relevant parameters. One example is given in **Figure 8**. In this scenario investments are initially allowed to increase although not as much as in the business-as-usual scenario. The scenario also includes a reduction in the average work week (to 85 %) and funds reserved for a government programme for poverty reduction (the cost for poverty reduction is calculated in LowGrow based on Canadian data). A similar scenario was produced by Victor (2008).

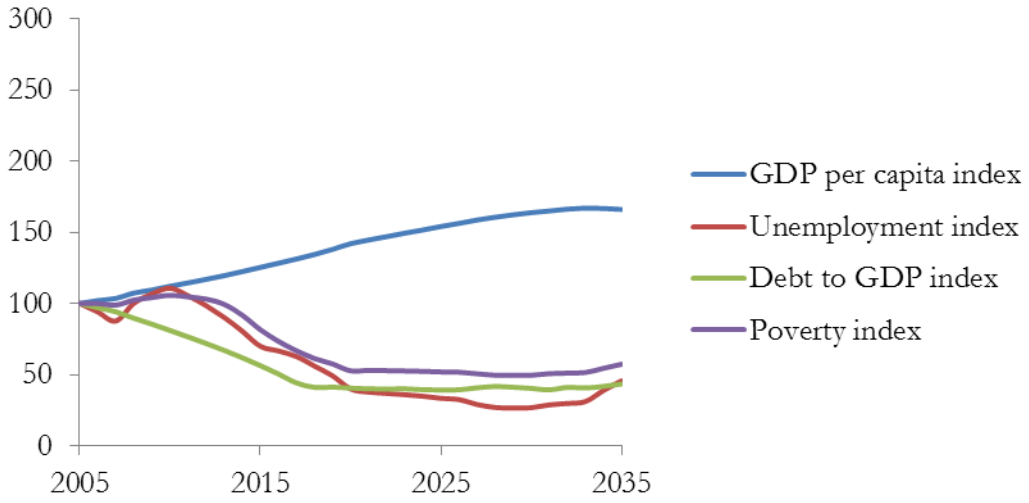

Figure 8 A high investment scenario with slow GDP growth (2005=100).

Allowing investments to grow in this way apparently allows for the government debt to decrease. The main explanation for the low unemployment is the work week reduction. Without the work week reduction unemployment would have been 18 % in the simulation, it now closes at 3 % at the end of the simulation. Paying for the poverty reduction is not very costly and turns out successfully. The GDP per capita is growing more slowly than in the business-as-usual scenario and is stabilized near the end of the simulation 66 % higher than the initial value.

The investment level has two major effects on the simulation results. One effect is the direct effect on the GDP (cf. equation 1). Labor demand, in turn is positively correlated to the GDP. A second effect from investments is a decrease in labor demand since productive assets compete with labor in the Cobb-Douglas production function. The net effect from investments is different in different scenarios depending on other variables. Reducing investments, however, is reasonable if GDP growth is supposed to decrease.

Reduced productivity growth is a likely effect from reduced investments. There might still be productivity improvements due to *e.g.* innovation and organization in a no-growing economy. It is possible to obtain a balanced outcome regarding GDP, unemployment and poverty with a low debt to GDP ratio, with a low investment level and increasing productivity. This is the case in the scenario shown in **Figure 8**. In this scenario, productivity increases slightly less than in the business-as-usual scenario. Furthermore the interest rate is decreased and the work week is reduced to 75 %. Here the net effect of reduced investments is to decrease GDP and still increase the demand for labor.

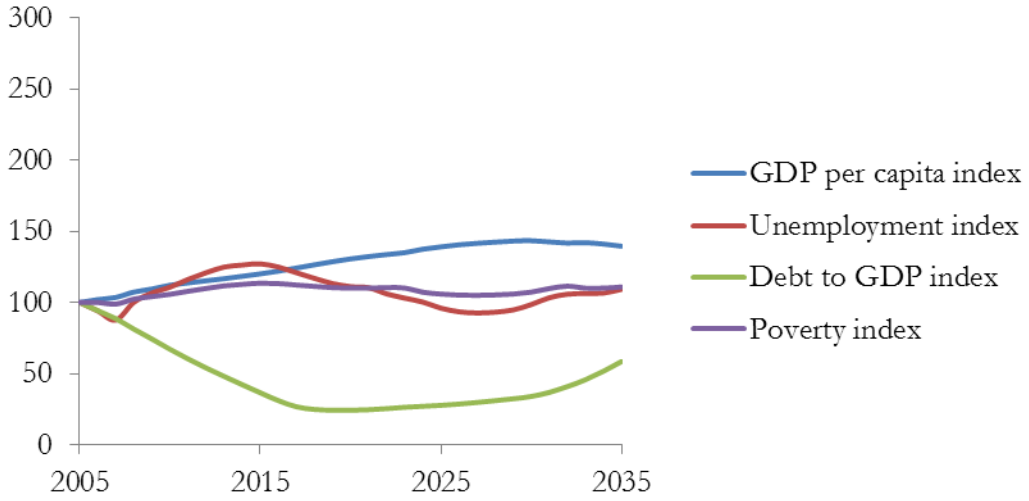

Figure 8 A low investment scenario with slow GDP growth (2005=100).

The composition of GDP develops differently in the scenarios produced above. The initial and final compositions in the different scenarios are shown in **Table 5**.

Table 5 Initial and final composition of GDP in different scenarios (% of total).

	Consumption	Investments	Government expenditures	External balance
Initial	57	20	22	1.8
Business as usual	59	19	20	1.9
No growth disaster	59	12	28	0.0
High investment	58	16	26	0.2
Low investment	58	11	25	6,0

Consumption constitutes 57-59 % in all scenarios, whereas the distribution between investments and government expenditures is different depending on the setting. In the business-as-usual scenario the GDP composition is similar to initial conditions, which is reasonable. In most scenarios the proportion of government expenditures is greater than the initial value.

Options outside the above scenarios that would intuitively reduce growth in GDP would be to reduce the work week or to decrease private consumption. However, as isolated actions they hardly affect GDP growth in the model simulations. Work week reduction is only effective in reducing unemployment (and do affect personal

income). Decreasing consumption has much more undesirable effects on government debt and unemployment than it influences the GDP growth.

Although there is no monetary sector in LowGrow, interest and exchange rates are included in a number of model equations. High interest rates discourage investments and consumption and increase the expenditures for government debt. However, the model results are not very sensitive to moderate interest rate changes. A high rate of exchange discourages domestic consumption (see equation 3) but increases export revenues. Both the exchange rate and the interest rate are set exogenously and are not affected by the rate of GDP growth. The model does also not address the development of price levels in the economy following different growth paths.

Simulations summary

In a business-as-usual scenario based on projections of current trends in major driving variables the Canadian economy grows 113 % until 2035. Three alternative scenarios are studied where the GDP growth is reduced by different combinations of investment, productivity, government expenditures, length of work week and a few other factors. It turns out that unemployment, poverty and government debt develop quiet differently in the different scenarios ranging from "disaster" to more hopeful outcomes. One message is that growth reduction may be compatible with a healthy economy given a reasonable management.

The scenarios must not be regarded as predictions of what will happen in the future under different circumstances. They do, however, provide quantitative indications about the sensitivity of the economy to different factors in a 30 years perspective. As any model, LowGrow is based on a number of assumptions and abstractions, and necessarily excludes several aspects of the macro economy that may be important for the outcome. We will come back to this in the following discussion.

DISCUSSION

We have seen that economic growth has had a long and fairly unbroken history in Europe and North America for more than two centuries, and that individuals, companies and institutions have had a long time to adapt to expectations of growing production. It is therefore not unreasonable to suspect that if economic growth is discontinued some time for structural adaptions would be required. According to our review there are several parts of the economy that might be more or less dependent on growth for their functioning, including labor markets, monetary and financial institutions. Growth expectations are underlying strategic decisions at various levels of the economy. However, only few economic studies directly address the questions if and in what ways modern market economies are dependent on growth, and even fewer studies provide quantitative information of how fundamental macroeconomic aggregates such as unemployment, poverty, private and public indebtedness would be affected if GDP growth would be halted.

In this study we have gathered qualitative information based on economic theory and reasoning found in published literature. In addition, quantitative figures for some macroeconomic aggregates in Canada and Sweden were compiled and a simulation model was employed to explore scenarios of low and no economic growth in the Canadian economy during 30 years. One essential finding is that there is really not much information available on the topic, and hence any conclusions drawn in this

work must be regarded with caution. Indeed, there seems to be little preparedness among economists for the prospect of managing without growth.

The study object in this work is the current structure of modern market economies. If a steady-state economy would materialize it would most likely be accompanied by structural modifications. The relevance of this study is partly to identify which parts of the economy that might need to be modified in a no-growing economy. In addition, quantitative results provided by the simulation model indicate *e.g.* levels of investment and labor supply that may support an economy that is stable in terms of GDP, unemployment, poverty and public debt.

Results for studied aggregates

In the studied economies, investments account for around 20 % of GDP and likely a similar proportion of the job opportunities. Since investments are often motivated by increasing production it is reasonable that lower rates of investment are realized in low growth scenarios. This is one reason why unemployment may increase without economic growth. A second reason is the rise in productivity with time resulting in a decreasing demand for labor for a given level of production. Hence if production (GDP) is non-growing unemployment may rise. In the model simulations a moderate work week reduction (down to 75 or 85 % depending on the scenario) can solve this problem within the simulation period.

Common measures suggested by economists to increase employment include wage reductions, tax reductions and increased flexibility in labor markets. Although such measures may sometimes be effective in the short term, it should be kept in mind that they are typically directed towards creating new jobs, which is another way of stimulating economic growth and hence incompatible with our scenarios. Still, unemployment is clearly a cost for society affecting the ability to pay for other costs (including poverty reduction and debt service, for instance). There are many potential links between unemployment and other macroeconomic aggregates.

One potentially critical set of problems is the ability to repay debts in a no-growing economy and in particular in relation to the money supply. Although money can theoretically be issued by other means than debt creation, we have seen that the current system is largely based on credit expansion. The present money supply is smaller than the monetary debt. Anyone going into debt generally prepares to repay it with interest, which means paying back an amount of money that exceeds the size of the loan. If this is done on a societal level, the whole society must pay back more than what was initially borrowed, which is the case with the money supply. We have examined the size and growth of money supply, debt and interest in Canada and Sweden, and concluded that the growth in total debt is larger than the interest payments, ensuring that the money supply does not contract. Although a no-growing economy may present low interest rates (see further below) there is a risk that money supply may contract and cause deflation if new money is not issued, increasing the real cost for debt service. Although we cannot make any predictions in this aspect, our investigation reveals that the size of total nominal debt is close to nominal GDP in both countries, so the magnitude of any debt related problems is potentially huge. A recent hint of the magnitude is the financial crisis in and after 2008 when a significant number of indebted households, especially in the USA, failed to repay their debts and induced a worldwide economic depression.

Government debt is allowed to decrease in some of the better LowGrow scenarios, and the Swedish public debt is currently decreasing in reality. This apparently does not mean that total indebtedness is decreasing. Private indebtedness is not included in LowGrow.

If unemployment and government debt can be controlled the model simulations indicate that poverty can be kept at low levels. If it fails, unemployed persons are likely to enter poverty and the government will be less capable of supporting poverty reduction. Poverty is apparently also affected by private debt. Not accounted for in LowGrow is the influence of productivity and working time on the consumer price level, which is also relevant for poverty and the cost of living.

Further thoughts on the effects of no growth

There are many potential indirect effects on our studied aggregates of a GDP growth reduction. Short-term instability in asset values and financial markets due to decreasing growth expectations may impact the whole economy, as in the current financial crisis. Also long-term effects on *e.g.* financial institutions are imaginable that could influence the demand for labor. In this study, however, we are far from quantifying any such effects.

Of particular relevance is the expected real and nominal interest rate, not least in relation to debt service in a no-growing economy. To some extent, real interest rates reflect the profitability of investments, but interest rates also reflect the time preferences of individuals typically favoring consumption today before potential consumption in the future. Lower investment profitability may contribute to lower interest rates in a no-growing economy whereas time preferences are likely to persist. Lower interest rates would obviously ease the burden of debt service, but only a zero-interest economy would completely eliminate the need for new money if all money is issued as debt. Almost trivial is the observation that banks would hardly create new money unless they received interest payments. The same is true for government bonds that would not be sold if they did not yield interest.

Monetary policy would work very differently in a zero-interest environment. Apparently the value of money depends on the interest rate. Neoclassic economic theory including the IS-LM model and the Phillips curve do not seem to be valid for zero-interest rates but they would indicate weird results for investments and unemployment. Low interest rates may actually stimulate investment and consumption and hence promote economic growth. But if returns on investments would be zero (for some reason) lower interest rates could be compatible with low investments and low/no GDP growth. Curiously, John Maynard Keynes envisaged a future zero-interest economy when marginal utility of net investment would be zero due to human satisfaction of material demands (Kerschner, 2010).

Remaining questions and limitations of this study

If there is a single reason for the observed money growth in the studied economies we do not know it. Economic growth is pursued by governments and if successful it is natural to expand the money supply to support a larger economy. Coincidentally, it seems that money growth is helpful in servicing existing monetary debt. For debt service nominal money growth is relevant whereas real money growth is relevant to GDP growth. Expansion of money supply is generally supported by property monetization, *i.e.* new buildings, factories, machines and infrastructure are used as collateral in money creation. Alternatively, existing assets are revalued for some

reason. Recent loan statistics indicate that houses and apartments account for a large part of the securities in loan contracts. Further money expansion is thus likely to involve creation of new buildings or increasing prices on existing ones. Industrial investments, on the other hand, do not seem to be directly involved in money creation but they are likely indirectly involved by their contribution to economic growth and the capacity to pay for new debts. Moreover, new money is required to support investment funds. The magnitude of industrial investments appears to be of the same order of magnitude as the level of money creation during the period studied in Canada and Sweden.

It is evident that structural links exist in the economy between GDP growth, investments, money growth and debt expansion. A reduction in GDP growth is likely to occur in concert with decreases in debt expansion, money growth and investments. Our concern is whether they will decrease in a balanced way or if instabilities are likely to occur. More specifically, we have argued that the existing debt may become difficult to service, and that money supply may contract and cause deflation. More research is needed to establish the quantitative significance of these problems.

The existence of a macroeconomic model such as LowGrow is particularly valuable for investigating quantitative relationships between different aggregates and specifically to study the development of unemployment, poverty and government debt under realistic assumptions. Although the outcome of the model simulations intuitively seem reasonable, we should not neglect the limitations of any such model that is by necessity a very simplified abstraction of a complex system, based on certain assumptions and parameter estimations that may not accurately apply to conditions faced in future scenarios.

Obvious shortcomings of the model in relation to this study is that there are no monetary or financial sectors included and that private debt is not accounted for, so we cannot use the model to evaluate any problems related to these issues. It would probably be possible to develop the model to include budget control for the private sector similar to the fiscal balance of government that is already present. Other remaining questions not accounted for in the model are the effects on interest rate and foreign exchange rate if GDP growth is reduced. These are set exogenously in the model although they are obviously affected by GDP growth.

LowGrow does not directly simulate effects of reduced GDP growth, but rather the outcome of scenarios in which growth is reduced by some selected mechanism, *e.g.* reduced investments. This is certainly a reasonable way to approach the problem. It would have been interesting to be able to simulate other scenarios of growth reduction, such as resource limitation or constraints on consumption. In the present setup, consumption is a function of GDP while the other components of the GDP may be adjusted and thus exert influence on the level of production. There is always a balance between production and consumption in the model, assuming that consumers (including the government and investors) are able to pay for what is produced. This requires prices to be flexible so that supply and demand always correspond, which is also assumed in the long-run in most economic models.

The model is highly aggregated and does not specify which economic activities actually make up the economy. If growth reduction is achieved by decreasing investments in productive capacity, it would probably imply that material production

decreases and is exchanged for services, or that material production becomes more labor intensive. Most likely this would affect prices of both commodities and services. Work week reductions would reduce labor supply and hence induce rising wages which would also affect consumer prices. On the aggregated level that LowGrow is operating there is no way to analyze effects of price changes although it would be highly relevant to address, for instance in relation to poverty.

Ultimately the total volume of material and service production is determined by the availability of production factors. On a theoretical level this is limited by supply of labor and capital. On a practical level it is determined, or at least measured, by the money supply and the velocity of money. Although the practice of money creation can be developed, the current monetary system is based on monetization of property. It is uncertain if the current system can support expenditures for a more service based economy unless there is a way to monetize services. Goldfinger (2000) provides an interesting discussion on the problems of prizing intangible resources including services, brands and knowledge since they are by nature less persistent than material assets. Consequently, services such as health care and education are financed with money created in the so-called productive economy. We can actually observe governments working very closely with business sectors to keep them going. There is always an apparent lack of resources to pay for essential health and educational services, even in very rich nations. This resource shortage occurs although the principal production factor in service activities – human labor – exists in excess supply. The obvious explanation is a failure to provide monetary resources to pay for labor costs. Lower wages, if accepted by workers, would make services less expensive but would necessarily reduce consumption capabilities for wage earners.

Needless to say, the shortage concerns real money rather than nominal money. Dropping new money from a helicopter over a country, as Milton Friedman once famously suggested, would obviously not create any new real resources. Scarcity of money is actually required for money to contain value. Money creation by government and recourse to seigniorage has proven extremely dangerous. History presents many examples of destroyed currencies in fiat money systems, for instance in Germany 1922-23 and ongoing in Zimbabwe. There are good reasons for constraints to deficit financing and debt stabilization programmes in modern economies. Money creation either through credit expansion with property serving as collateral or through the government going into debt by selling bonds to the central bank has become standard praxis. As we have seen both ways involve interest service and demand for economic growth.

Several writers suggest monetary reforms to better correspond to the needs of a steady state economy. A larger proportion of the money stock supplied directly by the government and spent into circulation either through investments (Zarlenga, 2002) or paying for public services (Lawn, 2010) may be sustainable if combined with high taxes to ensure scarcity of money (Bell, 2000; Lawn, 2010). Ruzzene (2008) suggests separate currencies for different economic activities, to decouple the supply of time consuming services from the production of material assets. Interest-free banking has also been advocated (Kennedy, 1995; Lietaer, 2001) and is actually practiced for example by the Swedish JAK bank and by most Islamic banks.

Outlook

The focus in this study has been to identify possible consequences for a number of important macroeconomic aggregates in a no-growing economy relative to a growing

economy as presently manifested in Canada and Sweden. Simulations with LowGrow explicitly also address the question *how* low or no growth is achieved, and it appears to be an important issue. Different scenarios resulting in low growth rates turn out very differently in terms of unemployment, poverty and government debt. Throughout this study, however, we have largely ignored the question why low growth rates may occur. This is admittedly a severe limitation of the scope.

If economic growth for some reason would be intentionally abandoned, *e.g.* due to environmental concerns, it would probably be difficult to achieve in a single country without negative effects on the terms of foreign trade. If there are structural reasons for growth dependence, such as the monetary system as discussed above, these structures would need to be confronted.

A final remark is that most of our analysis seems to indicate that managing without growth would be more or less problematic in several aspects. This should perhaps not prevent us from suggesting that some of the possible consequences are not entirely negative for society. If a general working time reduction is required to prevent unemployment, it may be associated with improvements in life quality for many individuals. Indeed, productivity growth should not be seen as a problem but an opportunity to take advantage of. Resources and efforts currently employed to promote economic growth can be released and redirected towards *e.g.* social goals. A steady-state economy should not be confused with a static economy. Although total output does not increase in monetary terms, it may still be dynamic.

CONCLUSIONS

Much of modern economic research is concerned with how to promote economic growth. In contrast, very few economic studies deal with questions regarding how macroeconomic performance would be affected if GDP growth would be halted. In addressing unemployment, poverty, private and public indebtedness in steady-state economies in this study, only limited information from other studies have been available for comparison. For this reason all conclusions must be regarded with caution. Consequences of low or no economic growth discussed in this work truly have the character of *potential* consequences rather than *predicted* effects.

Based on economic theory and reasoning found in published literature, there are several reasons to believe that a transition to a low or no growing economy might be problematic. We have attempted to gather arguments found in the literature into seven groups of reasons for potential growth dependence. In summary, these categories include psychological dependence, growth already counted on in asset valuation and future decisions, the demand for more resources to meet the needs of society, the need to supply job opportunities for the entire population, demand for returns in financial and monetary institutions, individual gains from growth in market competition and, finally, administrative reasons indicating that a steady-state economy will have to involve a high degree of planning by government which may be politically controversial.

Unemployment may result from decreasing investments providing job opportunities and from productivity gains reducing the demand for labor. According to the model simulations, different scenarios indicate that working time reductions down to 75-85

% of the present working time may be sufficient to keep unemployment at low levels during the 30 year simulation period in Canada with low or no economic growth.

Poverty as defined in the simulation model is highly related to unemployment and hence depending on labor market strategies. As long as unemployment is kept at low levels in the simulations the poverty index is also kept low. Potential reasons for poverty not accounted for in the simulations are private indebtedness and consumer price levels in relation to labor wages, which may be related to economic growth.

Public debt may be kept at acceptable levels in the model simulations during low growth scenarios, whereas private debt is not accounted for. Official statistics from Canada and Sweden reveal that private debt levels are currently in the same order of magnitude as the GDP and growing. The loan statistics only concern loans provided by banks involving monetary credits, and hence do not include any borrowing between agents outside the banking system. The monetary system is largely based on credit expansion, raising concerns that money growth may be critical to afford interest payments. It is uncertain how this system would perform in a low or no growth environment. Low interest rates in a low growth environment may lessen the problem.

There are many remaining questions concerning effects of decreasing growth rates. The significance of most potential consequences discussed in this work remains to be confirmed. Quantitative results from model simulations and statistics remain uncertain and should be supported by further studies to become reliable. There is presently little preparedness among economists for the prospect of managing without growth. Nevertheless, if we don't change direction, we will probably end up where we are heading – as the proverbial saying predicts.

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