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The Swedish Economy is Doing Well Thanks to Innovation: an Analysis from ARDL Approach

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ABSTRACT

This article examines the success of the Swedish economy by focusing on innovation, human capital, and public spending. The ARDL approach is used to investigate the long-run relationships between these factors and economic growth in the country. The literature review highlights the importance of the new theory of endogenous growth, while recent empirical studies strengthen the links between innovation, human capital and growth. The main results show that innovation, education, and health have a positive impact on economic growth in Sweden. Finally, the article emphasizes the effectiveness of the Swedish economic model and recommends continued investment in human capital, support for innovation, and responsible fiscal policies to sustain economic growth and strike a balance between social welfare and competitiveness.

INTRODUCTION

Sweden has earned a well-deserved reputation for its exceptional macroeconomic performance, with a high growth rate and commendable human development indicators. The country's commitment to corporate social responsibility is evident, as it secured the top spot in the 2018 global ranking and maintained a strong second place behind Finland in 2020. Praised by the Organization for Economic Cooperation and

Development (OECD)[1] in a 2017 study, Sweden's wise management and prudent fiscal policy have contributed to its solid economic performance, outperforming not only major advanced economies but also its Nordic neighbors.

In addition to its macroeconomic prowess, Sweden has emerged as a leading innovator and developer of human capital, a feat recognized in the World Intellectual Property Organization's (WIPO) 2018[2] comprehensive analysis. In 2021, Sweden experienced remarkable economic growth, as evidenced by its real GDP growth (5.4%)[3]. This positive trajectory played a pivotal role in strengthening the country's overall macroeconomic strength. The government's prudent fiscal policy has been instrumental in sustaining this growth momentum, effectively managing public spending amid global economic fluctuations.

Sweden's impressive rankings, 7th in both the Human Development Index (HDI) and the World Happiness Index in 2022, reflect the nation's commitment to promoting the well-being and prosperity of its citizens. A key factor in Sweden's continued success is its unwavering commitment to investing in human capital. By prioritizing education and skills development, Sweden has fostered a highly competent and knowledgeable workforce. This strategic approach not only strengthens the country's economic resilience, but also positions it advantageously to embrace evolving economic trends and capitalize on emerging opportunities. With strong human development indicators and a focus on building a skilled and educated workforce, Sweden is poised to lead in an ever-changing global landscape.

This study uses the Autoregressive Distributed Lag (ARDL) approach to empirically investigate the impact of innovation, human capital, and government spending on the growth of the Swedish economy. The ARDL approach is well suited for this analysis as it allows the study of long-run relationships between variables, taking into account the possible presence of cointegration among them. By applying this approach, the study aims to provide robust and comprehensive insights into the key drivers of Sweden's exceptional macroeconomic performance, which has positioned the country as a regional and global leader in growth and economic development.

The advantages of using the ARDL approach in this study are many. First, it can handle mixed-order integration and cointegration among variables, making it suitable for data sets that may exhibit different orders of integration. Second, the ARDL approach does not make strict assumptions about the underlying data distribution, ensuring robustness even when the data do not exactly follow a normal distribution. In addition, it allows for the inclusion of lagged variables, which is critical for capturing potential dynamic effects and ensuring the accuracy of the model. Moreover, the ARDL approach provides reliable estimates of long-run relationships, allowing for a comprehensive understanding of the impact of innovation, human capital and government spending on economic growth in Sweden. Overall, by employing the ARDL approach, this study aims to contribute valuable insights to the field of economic analysis and to provide evidence-based policy recommendations for sustaining Sweden's remarkable economic growth trajectory. The paper is well organized with a structured approach throughout. Section 2 provides a comprehensive literature review that examines the links between economic growth, innovation, human capital, and public spending. Section 3 describes the methodology and data used in this study. Section 4 applies the ARDL model to estimate the interaction between economic growth, innovation, human capital, and government spending. The results are interpreted and discussed in detail in Section 5. Rigorous model testing for robustness is the focus of Section 6. Finally, Section 7 presents the overall conclusions of the study and the recommendations derived from the analysis.

[1] Remarks by Angel Gurría, Secretary-General. OECD, 8 February 2017, Stockholm, Sweden

[2] Global Innovation Index 2018: https://www.wipo.int/pressroom/fr/articles/2018/article_0005.html

[3] European Commission, 2023. “Recommendation for a council recommendation on the 2023 National Reform Programme of Sweden and delivering a Council opinion on the 2023 Convergence Programme of Sweden”.

1. LITERATURE REVIEW

The new growth theory refers to a school of thought that has developed in the United States since the mid-1980s. The two founding articles of this current were written by economists trained at the University of Chicago: Paul H. Romer (1986), Robert E. Lucas (1988) and Robert J. Barro (1990). The new theory of endogenous growth has brought to light ideas that played only a minor role in the growth theory inherited from the past (Solow (1956)). Increasing returns, human capital, productive public capital, research and development, experiential learning, and externalities are central to the analysis of economic growth.

At the heart of endogenous growth is the assumption that the marginal productivity of capital does not cancel out as the stock of capital becomes larger. This is the main feature of endogenous growth models, without which it is impossible to generate positive and self-sustaining growth. This new research perspective is based on a critique of the Solow model (1956).

In the Solow model, the government cannot play a specific role in the growth process because it is exogenous. Proponents of endogenous growth, on the other hand, show that government intervention can stimulate growth by inducing agents to invest more in technological progress. For example, the government may need to encourage innovators to increase their efforts by strengthening patent laws or encouraging cooperation between firms. In the case of generic research, the state can finance it with public funds. The point is not to encourage less government, but to encourage better government.

For the neoclassical theory of growth, returns to scale are constant, while Romer explains economic growth by the existence of increasing returns to scale. While the Solow model assumes that there is convergence between countries, the theory of endogenous growth emphasizes the heterogeneity of growth rates between countries, which seems to be in line with the observation, since there is more divergence of income between rich and poor countries than the opposite. This new theory also considers that the accumulation of physical capital is not sufficient to explain growth. It emphasizes the role of human capital, which is defined as the stock of economically important knowledge embedded in individuals. Moreover, the private productivity of human capital has a positive external effect. This is because each individual, by improving his or her level of education and training, increases the nation's stock of human capital and thereby contributes to improving the productivity of the national economy. Thus, the factors of endogenous growth generate positive externalities. These externalities can be seen as the basis for justifying government intervention.

The accumulation of knowledge and technological capital, the accumulation of human capital and the government expenditure are the main thrusts of this theory.

1.1 Knowledge accumulation and economic growth

The first model of endogenous growth, proposed by Romer (1986), focuses on the accumulation of knowledge. It treats knowledge and physical capital as comparable, leading to growth based on the accumulation of productive equipment equipped with the latest technical discoveries.

Aghion and Howitt (1992) extend their model by incorporating an idea from J. Schumpeter, according to which industrial innovation not only improves the quality of the goods produced, but also serves as a driver of growth.

The work of Grossman and Helpman (1991) and Aghion and Howitt (1992) has given rise to a category of models known as "creative destruction" models that incorporate a qualitative account of innovation. These models have their origins in research on the patent race. Caballero and Jaffe (1993) make an important theoretical and empirical contribution to establishing the link between patenting, innovation, and growth.

Having explored these basic theoretical references to endogenous growth models and the importance of innovation in the economic development process, it is essential to examine several recent empirical studies that have sought to verify and support these theories. Empirical research plays a crucial role in understanding the real impact of innovation on economic growth and a country's welfare. These studies

allow a concrete analysis of the relationships between knowledge accumulation, industrial innovation and economic growth.

Chi et al. (2023) conducted a study to better understand how countries allocate resources differently between knowledge production and knowledge commercialization. They did this by studying the effectiveness of innovation through data envelopment analysis and examining patterns of knowledge specialization. The study focused on two countries with different contexts, Sweden and South Korea, to explore the phenomenon of the innovation paradox. The results show that there are significant differences in the efficiency of the knowledge innovation process at the national level between these two countries. Specifically, the efficiency of Swedish knowledge production showed an increasing trend, but with a decreasing performance in knowledge commercialization. In Korea, on the other hand, an improvement in the efficiency of knowledge commercialization was observed, accompanied by only a marginal increase in the results of knowledge production. Furthermore, research has shown that the phenomenon of the innovation paradox is not uniform across sectors, indicating differences in the efficiency of knowledge production and commercialization in different industries or fields.

Rohracher et al. (2022) conducted a study that explored how the paradigm shift in intellectual property (IP) was approached and dealt with in both discourse and practice in Sweden. The research explored how this shift, while not fully realized, has led to discrepancies and tensions with current structures for program evaluation and monitoring. Although a new paradigm has emerged, the study found that the implementation of evaluation strategies has primarily adhered to the traditional "summative" framework. Ongoing discussions within the Swedish IP context indicated that for the transformative innovation potential of the paradigm shift to be fully realized, a corresponding change in program implementation and evaluation practices is needed.

Chowdhury et al. (2023) conducted a study to explore the impact of innovation hubs (IHs) on regional innovation-driven development in Sweden. They used a qualitative approach, employing a multiple case study method to collect data through 10 semi-structured interviews. The results of the research show that innovation hubs can have a significant impact on both economic and social development. These hubs have the capacity to attract knowledge, expertise and investors to the region due to their activities and strategic geographic positioning. Moreover, innovation hubs support start-ups, entrepreneurs and smart specialization, while contributing to sustainable development by creating social value. In addition, regions can benefit from resource sharing through cross-collaboration facilitated by these innovation hubs.

1.2 Human capital accumulation and economic growth

Since the introduction of the Mankiw, Romer, and Weil model, new growth theories have played a crucial role in refining the measurement of human capital stocks and their importance, especially in developing countries. This model distinguishes between the accumulation of human capital and physical capital, and recognizes human capital as a collection of skills, abilities, and knowledge possessed by individual workers.

According to this model, even small variations in the resources allocated to the accumulation of physical and human capital can lead to substantial differences in output per worker, thereby explaining the remarkable disparities in real per capita income across countries.

In line with this perspective, Pierre-Yves Hénin and Pierre Ralle (1994) argue that human capital generates robust positive externalities when individuals with similar levels of knowledge can communicate and interact effectively, a phenomenon known as network externalities.

In addition, Romer (1990) and Lucas (1988) have emphasized the endogenous nature of agents' decisions to invest in human capital and research, which has a significant impact on long-run sustainable growth rates.

We will now examine some recent empirical studies on this topic. These studies provide concrete and up-to-date evidence on the impact of human capital on economic growth.

Almutairi's (2023) research aims to examine the impact of human capital on economic growth in Saudi Arabia from 1990 to 2019, focusing on education as a measure of human capital. In addition, the study evaluates both the direct and indirect effects of oil wealth on growth, specifically through the human capital channel, to determine whether oil resources can hinder the positive influence of human capital investment on economic growth. Using an autoregressive distributed lag (ARDL) model and three different indicators of educational human capital, the empirical results show that gross enrollment in higher education and scholarships are significantly and inversely associated with economic growth. However, the average number of years of schooling is negatively related to growth, although not statistically significant. On the other hand, the interactive effect of oil wealth on economic growth through investment in human capital is positive and significant, suggesting that the presence of oil acts as a favorable factor in this context.

Doré et al. (2023) examine the extent to which human capital, structural change, and institutional quality contribute to Brazil's economic growth between 1822 and 2019. Using the ARDL cointegration technique, the results suggest that years of schooling (human capital) have a positive and long-lasting impact on Brazil's economic growth.

Mabrouki's (2022) research investigates the positive effects of human capital, education, and patents on economic growth in Scandinavian countries during the period from 1990 to 2019. To achieve this goal, the study employs Westerlund's (2007) cointegration tests and Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) with clustered mean group (PMG) estimators. In addition, non-causality tests based on the Granger approach of Dumitrescu and Hurlin (2012) are applied. The empirical results highlight a long-run and stable cointegration relationship between education, life expectancy at birth, population, gross fixed capital formation and economic growth in the Scandinavian countries. Moreover, the study shows that the number of patents in these countries has a statistically significant positive impact on economic growth. However, it also shows a negative relationship between education expenditure and economic growth.

Akinwale (2022) examined the triangular relationship between human capital, technological innovation and economic growth in South Africa over the period 1985-2015. The study used Johansen's cointegration analysis and Vector Error Correction Model (VECM) to test the relationships among these variables. The results showed that there is a long run and two-way relationship between them. Moreover, the short-term causality results revealed two things: unidirectional causality from economic growth to technological innovation and human capital; and the causality of technological innovation to human capital.

Villela et al. (2022) evaluate the relationship between public expenditure on education and human capital on economic growth in Honduras from 1990 to 2020, using the instrumental variables (IV) method, which includes the components of public expenditure on education and human capital, in addition to a set of control variables. The results show that there is no correlation between public spending on education and economic growth; they also suggest that human capital does not contribute to economic growth, confirming that human capital accumulation is not fully developed.

1.3 Government spending and economic growth

Government spending and its relationship to economic growth have been studied in various economic models. Barro's model (1990) introduces public goods as an essential component alongside private inputs in determining output. Productive public spending, such as investment in public infrastructure (e.g., roads, airports, ports, security), is recognized to play an important role in promoting long-term, self-sustaining growth.

To further analyze the impact of government policies on long-run growth, Barro (1990), King and Rebelo (1990), and Rebelo (1991) have included taxation as an explanatory variable in their models. In addition, Romer (1986), Lucas (1988), and Aghion and Howitt (1992) have found that taxation does affect the long-run growth rate. Understanding the relationship between public expenditure, taxation and economic growth is essential for formulating effective policies to promote sustainable economic development.

In recent years, numerous empirical studies have focused on investigating the complex relationship between government spending and economic growth. These studies have sought to shed light on how

public spending, particularly productive public spending and taxation, can affect the long-term growth trajectory of economies. By analyzing the effects of different types of government spending on economic performance, these empirical studies provide valuable insights for policymakers and economists alike. In this section, we examine a selection of these recent empirical studies to gain a comprehensive understanding of the dynamics between public spending and economic growth.

Longlong (2023) conducted a study to examine the relationship between the allocation of public spending on education and economic growth in Sweden, Denmark, and France. The main focus was on the analysis of Granger causality test and Pearson correlation coefficient to explore the causal relationship between different levels of education expenditure (primary, secondary and higher education) and the annual rate of economic development. The results of the study revealed several key findings. First, in Sweden, changes in the share of expenditure on both secondary and tertiary education were found to Granger-cause the GDP growth rate, and there was a significant positive correlation between changes in the share of expenditure on tertiary education and changes in the share of expenditure on education at other levels. Second, in Denmark, changes in the share of expenditure on higher education were found to Granger-cause the GDP growth rate. Third, in France, changes in the share of expenditure on secondary education were found to Granger-cause the GDP growth rate, and changes in the shares of expenditure on higher education and secondary education were found to be mutually Granger-causing, with a significant positive correlation between the two. The study also highlighted the importance of coordinated development and structural optimization. The hierarchical structure of Swedish education spending showed clear comparative advantages, suggesting the potential for further research in this area. Overall, Longlong's study sheds light on the complex interplay between education spending and economic growth in the countries studied, providing valuable insights for policymakers and researchers alike.

Yamin et al. (2023) conducted a comprehensive literature review to examine the relationship between public debt and economic growth in developed and developing economies. Despite the extensive analysis, the research revealed contradictory findings, with some studies supporting a negative impact of public debt on economic growth, while others suggested a positive long-run influence through the fiscal multiplier effect. Furthermore, a few studies aligned with the Ricardian Equivalence Hypothesis, proposing no relationship between public debt and economic growth. The research highlighted the complexity of this issue, attributing the divergent outcomes to factors such as the development level of sampled nations, methodological variations, data coverage, and control variables chosen by researchers. Overall, the study emphasized the lack of mutual agreement on the effects of public debt on economic growth in global economies.

Tkacova et al. (2023) conducted a study to investigate the influence of the size of the public sector on economic growth in the 27 EU countries from 1996 to 2021. The size of the public sector was measured by four variables: total public expenditure, total public revenue, tax revenue, and government final consumption. Using panel regression analysis, the results show a consistent negative impact of the size of the public sector on the economic growth of EU countries in all four models. In particular, the strongest negative impact was associated with government final consumption. In addition, the study showed a significant negative impact of economic crises on the economic growth of the EU countries during the study period.

Dudzeviciūtė (2023) conducted a study examining the correlation between economic growth and government expenditure by function in the Baltic countries - Lithuania, Latvia and Estonia. The study used both total expenditure and composition approaches to analyze the relationship between the variables over the period from 1996 to 2020. The study used descriptive statistics and econometric techniques, including automatic linear modeling (ALM). The results show that in Latvia and Estonia, the growth of their respective economies is significantly influenced by government spending, accounting for about 62.8% and 66.5% of economic fluctuations, respectively. In Lithuania, on the other hand, social protection expenditure accounts for 57.7% of the variation in economic growth. In addition, in Latvia, the influence of social protection and economic expenditure together accounted for 63.4% of economic growth, while in Estonia social protection and health expenditure explained 78.1% of fluctuations in economic growth.

Martin et al. (2023) conducted a study to examine the influence of public social spending, government investment, and government consumption spending on economic growth in 25 OECD countries using panel data from 2000 to 2019. Various methods, including fixed effects, random effects, and the generalized method of moments, were used for the analysis. Surprisingly, the results showed that public social

spending, government investment, and government consumption spending did not have a significant impact on economic growth. The researchers suggested that this lack of impact may be due to high tax rates and unemployment benefit programs in these countries, which may offset any potential productivity gains from government spending.

The results of these studies underscore the importance of innovation, human capital and well-targeted public spending in promoting sustainable economic growth. Investments in productive public goods and human capital emerge as critical factors for stimulating long-term, self-sustaining growth. In addition, the research underscores the importance of well-designed and strategic government policies to foster innovation and technological progress, which play a key role in driving economic development.

2. METHODOLOGY AND DATA DESCRIPTION

2.1 Model

Using the method of Mankiw, Romer and Weil (1992) based on Solow's (1956) model extended to human capital, innovation, government spending and taxation, we obtain the following Cobb-Douglas production function:

$$\mathrm{Y}=\mathrm{A}\prod_{i=1}^{k} X_i^{\alpha_i}, \quad (1)$$

Where Y is the output (GDP), A is the level of autonomous progress, t indicates the time variable expressing the influence of technological progress, k is the number of factors of production, X is a matrix of factors of production and α_i is the parameter of factor of production (share of the variable X_i in the production).

Applying the logarithm to this function we will have the mathematical equation estimated in this study:

$$LogY = L\log A + \sum_{i=1}^{k} \alpha_i LogX_k, \quad (2)$$

2.2 Data

The data used in this study are from the World Bank database. We use a sample of annual data from 1980 to 2022 on the Swedish economy. Table 1 shows the definitions of the variables and their sources. The data are processed using EViews software in addition to the Microsoft Excel spreadsheet.

Table 1. Variable definition

Variables	*Definition*	*Sources*
GDP	Gross Domestic Product (constant 2010 US$)	BM, 2023
LEB	Life expectancy at birth total (years)	BM, 2023
SET	School enrollment tertiary(% Gross)	BM, 2023
PA	Patent applications, residents	BM, 2023
TR	Tax revenue(% Of GDP)	BM, 2023
GGE	General government final consumption expenditure (% of GDP)	BM, 2023

2.3 Descriptive characteristics of the variables

The results presented in Table 2 provide an overview of the characteristics of six variables examined: GDP (gross domestic product), GGE (government final consumption expenditure), LEB (life expectancy at birth), SET (school enrollment, tertiary), PA (patent applications, residents) and GFCF (gross fixed capital

formation). The average GDP is about $3.82E+11, with a slightly lower median of about $3.70E+11. GDP shows considerable dispersion with a standard deviation of about $1.06E+11. Life expectancy at birth averages about 79.70 years, with a median close to 79.80 years. The coefficient of skewness is generally close to zero for most variables, indicating relatively symmetric distributions. However, the distribution of tertiary enrollment (SET) shows a more pronounced negative skewness. The kurtosis is relatively moderate for all variables, indicating slightly flatter than normal distributions. The Jarque-Bera test shows that the data for each variable do not necessarily follow a normal distribution, as the associated probabilities are often less than 0.1.

Table 2. Descriptive characteristics of variables-level

	GDP	*GFCF*	*GGE*	*LEB*	*PA*	*SET*
Mean	3.82E+11	8.79E+10	25.63420	79.69770	3040.256	56.49086
Median	3.70E+11	8.07E+10	25.71270	79.79512	3147.000	63.21716
Maximum	5.82E+11	1.51E+11	27.51749	83.15610	4283.000	84.51622
Minimum	2.38E+11	5.08E+10	23.84787	75.74098	1764.000	29.80554
Std. Dev.	1.06E+11	2.86E+10	0.900780	2.244507	879.7741	20.00549
Skewness	0.292044	0.538697	0.247549	-0.131740	-0.079922	-0.150665
Kurtosis	1.759696	2.164161	2.623931	1.720019	1.455362	1.409888
Jarque-Bera	3.367462	3.331430	0.692570	3.059758	4.320527	4.692835
Probability	0.185680	0.189055	0.707311	0.216562	0.115295	0.095711
Sum	1.64E+13	3.78E+12	1102.271	3427.001	130731.0	2429.107
Sum Sq. Dev.	4.68E+23	3.44E+22	34.07900	211.5880	32508104	16809.23

Source: authors

2.4 Methodology

To empirically investigate the influence of innovation, human capital and government spending on Sweden's macroeconomic performance, we use an autoregressive distributed lag (ARDL) model. This model is chosen for its ability to account for both short-run and long-run relationships between the variables under study. In addition, it allows us to estimate different levels of integration of the variables (I(1) and I(0)). The ARDL model was originally developed by Pesaran and Shin (1999) and later extended by Pesaran et al. (2001).

The theoretical basis of ARDL modeling is partially based on VAR (Autoregressive Vector) modeling. The VAR model can be explained by formulating the vector by the following equation:

$$Y_t = \delta + \theta_1 Y_{t-1} + \theta_2 Y_{t-2} ..... + \theta p Y_{t-p} + V_t$$

Where Y is the vector that contains both the explanatory variable and the explained variable. In this type of dynamic modeling, among the exogenous variables is the endogenous offset variable. The ARDL model uses the present values of the explanatory variables and their values shifted in time.

An ARDL model can be expressed as follows:

$$Y_t = \delta + \theta_1 Y_{t-1} + \theta_2 Y_{t-2} + ... + \theta p Y_{t-p} + \beta_0 X_t + \beta_1 X_{t-1} + ... + \beta q X_{t-q} + V_t$$

Here, the coefficient β_0 reflects the short-term effect of X over Y. The estimation of such a model requires the stationarity of the different variables. This implies that the random vectors Y_t and X_t have a constant expectation over time and the covariance matrices between Y_t and $Y_t + h$ and between X_t and $X_t + h$ depend only on h and not on time (h = 0.1, ...) , which means for h = 0, cov(Y_t) and cov(X_t) do not change over time.

3. ESTIMATION PROCESS

Before implementing the ARDL models, it is necessary to study the stationarity of the variables. In fact, we use the Augmented Dickey-Fuller test (ADF). Therefore, it is essential to start by determining the optimal lag.

3.1 Stationarity tests

The following graph, associated with about twenty competing models, shows that the model ARDL (1, 1, 3, 1, 0, 3, 2) is the best (offers the smallest value of Akaike). Each ARDL lag refers to a specific variable according to its rank in the output (GDP GGE LEB PA SET TR GFCF).

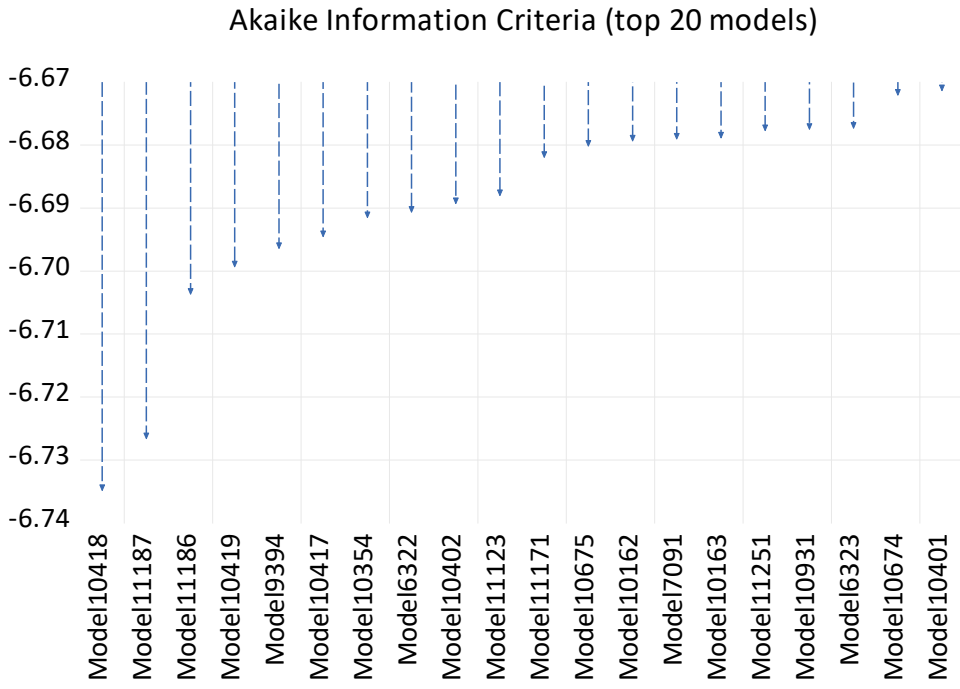

Figure 1. Akaike information Criteria (top 20 models)

After determining the number of lags for each variable, the stationarity test should be applied to each series using the unit root test, ADF. Table 3 shows the results obtained.

Table 3. ADF Test Results

LnGDP	stationary in first difference, at the threshold of 5%	I(1)
LnLEB	stationary in level, at the threshold of 5%	I(0)
LnSET	stationary in first difference, at the threshold of 5%	I(1)
LnPA	stationary in first difference, at the threshold of 5%	I(1)
LnTR	stationary in first difference, at the threshold of 5%	I(1)
LnGGE	stationary in level, at the threshold of 5%	I(0)
LnGFCF	stationary in first difference, at the threshold of 5%	I(1)

Source: authors

These tests show that the time series examined in logarithm are all integrated of order 1 (I (1)), except for life expectancy at birth and government consumption expenditure, which are stationary at the level (I

(0)). Accordingly, we apply the ARDL model to estimate a possible cointegrating relationship between GDP growth and the different explanatory variables.

3.2 ARDL estimation results: Cointegration Bounds Test

Table 4 presents the results of an F-bounds test, which is used to test for the presence of cointegration (also known as long-run relationship) among the variables under study. Cointegration implies that the time series are related in the long run, despite short-term fluctuations. The test evaluates the null hypothesis that there is no level relationship between the variables. The F-test statistic (8.713439) exceeds the critical values at the 5%, 2.5% and 1% levels of significance. Therefore, we reject the null hypothesis that there is no level relationship (cointegration) among the variables under study. This indicates that there is a cointegration relationship among the variables, which means that they are related in the long run despite short-term fluctuations.

Table 4. Bounds test results

F-Bounds Test		*Null Hypothesis: No levels relationship*		
Test Statistic	*Value*	*Signif.*	*I(0)*	*I(1)*
			Asymptotic: n=1000	
F-statistic	8.713439	10%	1.75	2.87
k	6	5%	2.04	3.24
		2.5%	2.32	3.59

Source: authors

3.3 The long-term relationship

Table 5 presents the results of the estimation of the long-run relationship between the variables.The normalization with respect to the dependent variable GDP allows us to rewrite the long-run equation as follows:

$$LnGDP = 0.2220 * LnGGE + 4.9429 * LnLEB + 0.1266 * LnPA + 0.0556 * LnSET + 0.1494 * LnTR + 0.1840 * LnGFCF$$

In this long-run equation, the estimated coefficients are elasticities, since the variables of the model are taken in logarithm. We find a positive relationship between economic growth (GDP) and all the explanatory variables of the model. All the coefficients are statistically significant at the 5% level, with the exception of the coefficient for general government consumption expenditure, which is statistically significant.

Table 5. Results of estimation of the long-term relationship

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
LNGGE	0.221985	0.163366	1.358815	0.1874
LNLEB	4.942933	0.474490	10.41735	0.0000
LNPA	0.126650	0.029350	4.315152	0.0003
LNSET	0.055563	0.024172	2.298636	0.0309
LNTR	0.149413	0.067301	2.220080	0.0365
LNGFCF	0.183998	0.069867	2.633555	0.0148
EC = LNGDP - (0.2220*LNGGE + 4.9429*LNLEB + 0.1266*LNPA + 0.0556*LNSET + 0.1494*LNTR + 0.1840*LNGFCF)				

Source: authors

4. INTERPRETATION OF RESULTS AND DISCUSSION

Sweden is one of the most innovative countries in the world, and its investment in research is among the highest in the world relative to GDP. Our results show that innovation (represented by invention patents) and two aspects of human capital, namely education (represented by tertiary enrollment) and health (represented by life expectancy at birth), promote Sweden's economic growth. This is explained by the country's efforts in education and research and development. The government invests heavily in education, and more than 3% of Sweden's GDP goes to research and development (3.53% in 2020, according to the World Bank database). Sweden's long-term focus on education and research has a significant impact on the country's innovation capacity. In 2021, Sweden holds the top position within the EU in the European Commission's innovation ranking. According to WIPO (2022), Sweden ranks third in the world in terms of infrastructure and business sophistication, with indicators such as researchers, R&D expenditure and highly skilled employment. Sweden recorded 597 patent applications per million inhabitants, ranking 9th in the world (WIPO, 2020).

According to Sweden.se (the official website of Sweden), an active research policy has enabled Sweden to become a leader in several fields, including environmental technology and life sciences. Sweden also has a high level of expertise in nanotechnology, with applications in a wide range of research areas - from medicine to sustainable energy. The majority of research in Sweden, around 70%, is funded by the private sector. This investment has helped companies such as ABB, Ericsson, Sandvik and the Volvo Group become leaders in their fields. The remaining 30% of research is financed by the public sector.

The European Commission notes thatSweden's human capital is one of its greatest competitive advantages, with 72% of the population having at least basic digital skills, including 46% with advanced skills, well above the European average (56% and 31%, respectively).

Regarding government spending and taxes, according to riksdagen.se, the central government budget includes all revenues and expenditures of the central administration, except for the cost of the old-age pension system. About 90% of the central government's revenue comes from taxes, including income tax, social security contributions, VAT on purchased goods and customs duties on imported goods. Government revenue also includes income from the activities of the central administration, sales of assets such as shares and real estate, and grants from the EU. On the expenditure side, a significant portion, about 20%, is allocated to social security contributions for items such as sickness benefits, while about 10% is allocated to general public subsidies to municipalities. Central government spending is spread across 27 areas, including the labor market, defense, communications, migration, and financial aid for students. All of these financial aspects play a role in determining the amount of money the government needs to borrow.

The size of government and public spending have a significant impact on economic growth. While social investment can improve human capital and foster innovation, an expanded public sector can also pose challenges to economic competitiveness. Ongoing research and prudent management of public finances are crucial to strike a balance between the advantages and disadvantages of public spending and to promote sustainable and balanced economic growth in Sweden. Another possible reason is that the current level of public spending in Sweden may already be high or at an optimal point. If the government already allocates a substantial part of its budget to essential services, infrastructure, education and other development projects, further increases in spending may not bring substantial additional benefits for economic growth. Peter's (2003) study of the effect of government spending on economic growth in Sweden during the period 1960-2001 suggests that, according to growth theory, the Swedish government may be spending excessively, which could potentially hinder economic growth.

Our results clearly indicate a positive impact of environmental taxes on economic growth in Sweden. Despite a significant environmental investment of about SEK 12.5 billion in 2010, or about 10% of total tax revenue, the country's economic growth was not hindered. Sweden has successfully established a model of exemplary green taxation by introducing various taxes on electricity, carbon, fossil fuels, waste, pesticides, sulphur products, congestion charges and vehicle stickers. This tax approach, combined with labor tax cuts for companies and a partially capitalized pension system, has allowed the country to maintain economic competitiveness while supporting important environmental initiatives.

The transformation of the Swedish tax system in 1991, often referred to as the "reform of the century," has also played a crucial role in the success of this economic model. By significantly reducing direct taxes on taxpayers while broadening the VAT base, Sweden has promoted economic growth while preserving its welfare state model. The country has been able to maintain a relatively high, but balanced and environmentally oriented taxation, which has had a positive impact on economic growth while ensuring the social well-being of its citizens.

5. VALIDATION OF THE MODEL: RESIDUE TEST

To test the validity of our model, we perform the test of normality of the residuals. The following table shows a Jarque-Bera 0.0513 statistic greater than 0.05. The hypothesis of normality of the residuals is therefore verified.

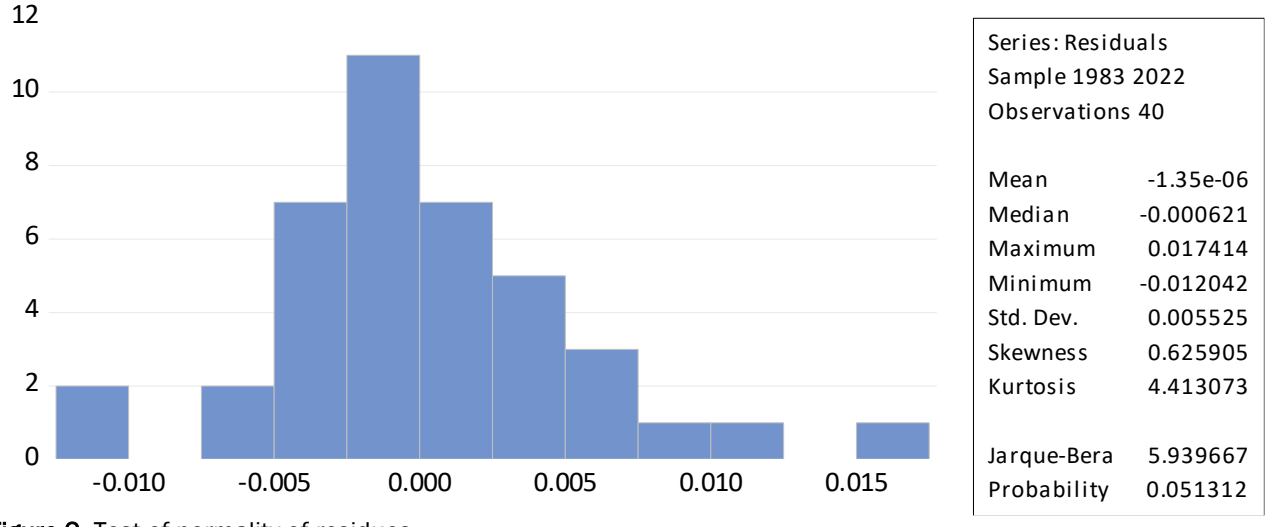

Figure 2. Test of normality of residues

CONCLUSION AND RECOMMENDATIONS

At the beginning of the 1990s, in a context of acute economic crisis, the Swedish authorities made several economic choices of considerable importance. Openness to international trade, support for innovation, tax reform and supply-side policies enabled Sweden to benefit from the globalization phase of the 1990s and 2000s. Today, the Swedish economy shows important indicators: economic growth of 5.4% in 2021 and 2.6% in 2022, an unemployment rate of 7.4% in 2012, and a human capital index of 0.8 out of 1. Based on our study, we consider innovation as a key part of the Swedish economy. The dynamism of resident patents is highly conducive to long-term economic growth. In addition, tax policy is conducive to long-term growth. Indeed, Sweden is urged to emphasize an industrial policy based on innovation and to continue its prudent fiscal and budgetary policies.

Human capital fosters long-term growth. This is due to Sweden's efforts since the 1970s to modernize, decentralize, promote equity, improve quality, increase competitiveness, and internationalize studies.

In short, the Swedish economic model has proven its effectiveness thanks to policy choices that have fostered the emergence of a business climate conducive to the creation of technology companies. If this is the case, the positive effects of innovation on the Swedish economy are reinforced by the choice of appropriate fiscal and social policies.

By following these recommendations, Sweden can sustain its economic growth, maintain its status as an innovative nation, and achieve a balance between social welfare and economic competitiveness.

- Human capital formation: Continue to invest in education and research and development to foster human capital development. Sweden's strong focus on education and research has been a key driver of its innovation capacity. Emphasize modernization, quality improvement and internationalization of studies to further enhance human capital. In addition, promote digital literacy among the population to maintain competitive advantage in this area.
- Innovation: Maintain and strengthen the enabling environment for innovation. Encourage collaboration between the private sector and research institutions to leverage the majority of research funding that comes from private investment. Continue to prioritize investment in R&D, as Sweden's high research spending has contributed significantly to its innovative capacity. In addition, support emerging fields such as environmental technology and nanotechnology in order to remain at the forefront of technological progress.
- Public expenditure and fiscal policy: Ensure prudent management of public finances to balance social investment and economic competitiveness. Continue to allocate resources to essential services, infrastructure and education, while carefully monitoring the impact of public spending on economic growth. Evaluate the effectiveness of existing public spending initiatives to ensure optimal allocation of resources. Consider targeted spending in areas that can further promote innovation and human capital development.
- Environmental taxes: Maintain and expand the successful model of environmental taxation. Sweden's positive experience with environmental taxes shows that it is possible to promote sustainable practices without hampering economic growth. Consideration should be given to further refining environmental tax policies to address emerging environmental challenges and to provide incentives for environmentally friendly practices in different sectors.
- Monetary policy: Given the potential risks of high inflation, continue to implement prudent monetary policies to ensure price stability and avoid long-term adverse effects on real wages and borrowing costs. Regularly assess macroeconomic conditions and adjust monetary policy accordingly to maintain a stable economic environment.

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