The Swedish economy is doing well thanks to innovation: an analysis from ARDL approach

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Abstract

Economic reforms in Sweden in the early 1990s would have achieved economic performance, social justice and sound public finances. This study aims to empirically verify the impact of innovation, human capital and taxation on the growth of the Swedish economy. Using the ARDL and cointegration approach, we find evidence that 40% of long-term GDP growth is explained by innovation. In addition, we present the evidence that human capital, through its component that represents health, promotes long-term growth. However, the component that represents higher education is a hindrance to short-term growth over the long term.

Keywords

Growth, Innovation, Human Capital, Taxation, Sweden, ARDL

1. Introduction

Sweden has excellent macroeconomic performance, with a high growth rate and well-ranked human development indicators. The global ranking of countries according to their openness to Corporate Social Responsibility puts Sweden in 1st position for the year 2018. In addition, in its 2017 study of the Swedish economy, the OECD welcomes the good management authorities and calls on them to continue their prudent fiscal policies. The Secretary-General of the OECD, Angel Gurría, said: «Sweden has enjoyed a solid economic performance in recent years, with growth out-pacing both the major advanced economies and its Nordic neighbours » [1].Also, a thorough examination of countries that have adopted effective strategies for innovation and human capital development published by WIPO in 2018, has ranked Sweden among the leading sons of the most innovative countries[2].

Based on these testimonials, this study aims to empirically verify the impact of innovation, human capital and taxation on the growth of the Swedish economy.

The paper is structured as follows. In Section 2, I describe the A literature review on the relationship between economic growth, innovation, human capital and taxation. In Section 3, I present the Methodology and description of the data. In Section 4, I apply these results to a ARDL model of economic growth, innovation, human capital and taxation in order to explain the causes of the performance of the Swedish economic model. In Section 5, I guess between the short-term effect and the long-run effect of the study variables on economic growth. In Section 6, I interpret and discuss the results found. In Section 7, I test the robustness of the model. Section 8, presents the overall conclusions and lists our recommendations.

2. Theoretical background

The new theory of growth refers to a current thinking that has developed in the United States since the mid-eighties. The two founding articles of this current are those of 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 play only a small role in the theory of growth inherited from the past (Solow (1956)). Increasing returns, human capital, productive public capital, research and development, experiential learning and externalities are at the center of analyzes of economic growth.

The heart of endogenous growth lies in the assumption that the marginal productivity of capital does not vanish when the stock of capital becomes large. This is the main characteristic of endogenous growth models, without which it is impossible to generate

[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

positive self-sustaining growth. This new research perspective takes its starting point in a critique of Solow's (1956) model.

In the Solow model, the state cannot play any particular role in the growth process, since the latter is exogenous. Proponents of endogenous growth, on the contrary, show that state intervention can stimulate growth by encouraging agents to invest more in technical progress. The state can thus be led to encourage innovators to increase their efforts, by strengthening patent legislation or by encouraging cooperation between firms. If it is rather generic research (which is not patentable by definition), the State can finance on public funds. It is a matter of favoring no less state, but better state.

For the neoclassical theory of growth, returns to scale are constant, while Romer explains economic growth through the existence of increasing returns to scale. While the Solow model considers that there is convergence between countries, the theory of endogenous growth emphasizes the heterogeneity of growth rates between countries, which seems to conform to observation, because more to a divergence of income between rich and poor countries than the opposite. This new theory also considers that the accumulation of physical capital is not enough to explain growth. It emphasizes the role of human capital, which is defined as the store of economically important knowledge incorporated into individuals. In addition, the private productivity of human capital has a positive external effect. For, by improving one's level of education and training, each individual 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 first of all be seen as the basis of the justification for state intervention.

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

2.1.The accumulation of knowledge and technological capital

The first model of endogenous growth is the model of Romer (1986) which relies on the accumulation of knowledge. Assuming that knowledge and physical capital are comparable to one another, we can also speak of growth based on the accumulation of productive equipment incorporating the latest technical knowledge discovered.

Aghion and Howitt (1992) incorporate in their model an idea that goes back to J. Schumpeter, under which industrial innovations, while improving the quality of the goods produced, are factors of growth.

The work of Grossman and Helpman (1991) and Aghion and Howitt (1992) gave rise to a category of models that incorporate a qualitative representation of innovation. This category of so-called "creative destruction" models has its origins in work on the patent race. Caballero and Jaffe (1993) have developed a model that is both an important theoretical and empirical contribution to establishing a relationship between patenting, innovation and growth.

2.2.The accumulation of human capital

Since the Mankiw, Romer and Weil model, the new theories of growth have helped to refine the measure of the stock of human capital and its role in growth, especially that of developing countries. This model distinguishes among other things the accumulation of human capital and the accumulation of physical capital. It also considers human capital as a set of capabilities, skills and knowledge of individual workers.

This model shows that relatively small variations in resources devoted to the accumulation of physical and human capital can lead to significant variations in output per worker. It therefore helps to explain the significant differences in income per capita real levels between countries.

Pierre-Yves Hénin and Pierre Ralle (1994) argue from the same perspective that human capital generates strong positive externalities when it is possible to communicate and interact with other people with the same level of knowledge; what we call, we mentioned, network externalities.

Romer (1990) and Lucas (1988) have emphasized the endogenous nature of the choices made by actors both in terms of investment in human capital and in terms of research for the explanation of a long-term sustained growth rate. .

2.3.L'accumulation en dépenses publiques

By incorporating public expenditure into the standard endogenous growth model, Barro's model (1990) considers that pure public goods intervene alongside private inputs in the determination of output. Productive public expenditure assimilated to public infrastructure capital (roads, airports, ports, security, etc.) plays a driving role in the long-term self-sustaining growth process.

In order to analyze the impact of government policy on long-term growth, Barro (1990), King and Rebelo (1990) and Rebelo (1991) incorporated taxation as an explanatory variable in their models. Romer (1986), Lucas (1988) and Aghion and Howitt (1992) concluded that taxation has an influence on the long-term growth rate.

3. Methodology and description of the data

3.1. Model

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

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

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:

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

3.2.Data

The data used in this study come from the World Bank database. We use a sample of annual data from 1970 to 2017 on the Swedish economy. Table 1 provides definitions of variables and their sources. The data is processed via EViews software in addition to the Microsoft Excel spreadsheet.

Table 1

Variable definition

Variables	Definition	Sources
GDP	Gross Domestic Product (constant 2010 US$)	BM, 2019
LEB	Life expectancy at birth total (years)	BM, 2019
SET	School enrollment tertiary (% Gross)	BM, 2019
PAR	Patent applications, residents	BM, 2019
TR	Tax revenue (% Of GDP)	BM, 2019
GFCF	Gross fixed capital formation (constant 2010 US$)	BM, 2019

3.3.Descriptive characteristics of the variables

Table 2 above shows that School enrollment, tertiary is more volatile than other variables (std Dev = 0.426304), and Life expectancy at birth is less (Dev st = 0.030826). Also, we note that all variables are normally distributed (Prob Jarque-Bera > 5%).

Table 2

Descriptive characteristics of the variables

	LGDP	LLEB	LSET	LPAR	LTR	LGFCF
Mean	26.56703	4.362336	3.795280	8.110735	3.112026	25.08751
Median	26.49492	4.365011	3.683564	8.232174	3.090240	25.00468
Maximum	27.05189	4.409808	4.427976	8.489822	3.416646	25.67592
Minimum	26.11587	4.313722	3.093631	7.592870	2.709063	24.61257
Std. Dev.	**0.278868**	**0.030826**	**0.426304**	**0.269961**	**0.220438**	**0.292018**
Skewness	0.144082	-0.018362	0.035592	-0.641382	-0.254762	0.344909
Kurtosis	1.715610	1.702421	1.550508	2.026762	1.517944	1.959203
Jarque-Bera	3.248805	3.159485	3.948929	4.861264	4.605197	2.923327
Probability	**0.197029**	**0.206028**	**0.138836**	**0.087981**	**0.099999**	**0.231850**
Sum	1195.517	196.3051	170.7876	364.9831	140.0412	1128.938
Sum Sq. Dev.	3.421775	0.041812	7.996329	3.206682	2.138093	3.752081
Observations	45	45	45	45	45	45

Source: author (our estimates in eviews)

3.4.Methodology

In order to empirically test the impact of innovation, human capital and taxation on Sweden's macroeconomic performance, we use an Auto Regressive Distributed Lag model (ARDL). The choice of this model is based on the fact that it takes into account both the short-term and long-term relationships of the study variables and it also makes it possible to estimate different integration level variables (I(1) and I(0)). This model was developed by Pesaran and Shin (1999) and expanded with 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:

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

With Y is the vector that carries 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:

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

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.

4. Estimation process

Before the implementation of the ARDL models it is necessary to study the stationarity of the variables. Indeed, we are adopting the augmented Dickey-Fuller test (ADF). It is therefore essential to start by determining the optimal lag.

4.1. Stationarity tests

The following graph associated with about twenty competing models shows that the model ARDL (1,2,3,4,4,4) is the best (offers the smallest value Akaike). Each ARDL lag relates to a specific variable according to their rank in the output (gross domestic product (LGDP), Life expectancy at birth (LLEB), School enrollment tertiary (LSET), Patent applications, residents (LPAR), Tax revenue (LTR), Gross fixed capital formation (LGFCF)).

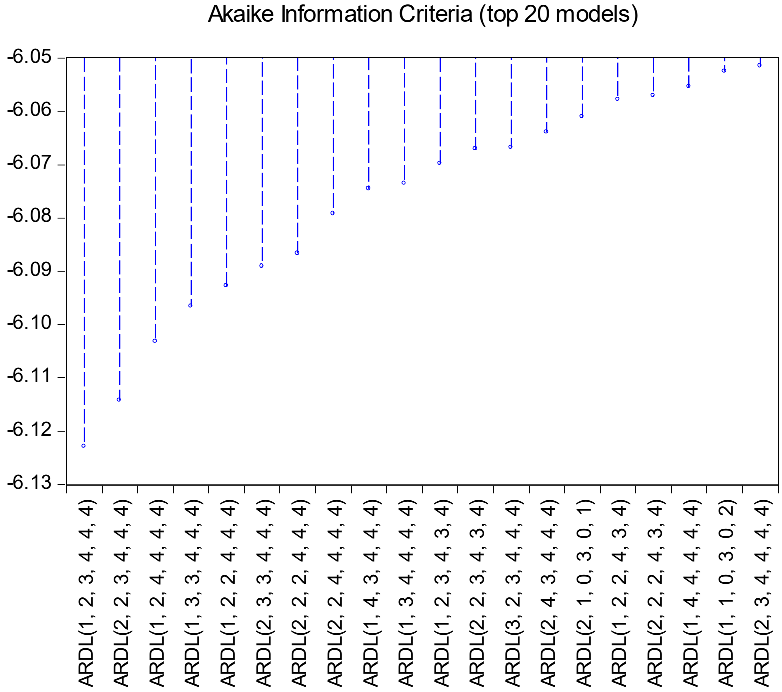


Fig. 1. Akaike information Criteria (top 20 models)

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

Table 3

Stationeries des variables

LGDP	stationary in first difference, at the threshold of 5%	I(1)
LLEB	stationary in level, at the threshold of 5%	I(0)
LSET	stationary in first difference, at the threshold of 5%	I(1)
LPAR	stationary in first difference, at the threshold of 5%	I(1)
LTR	stationary in first difference, at the threshold of 5%	I(1)
LGFCF	stationary in first difference, at the threshold of 5%	I(1)

Source: author (our estimates on eviews).

These tests show that the time series studied in logarithm are all integrated of order 1 (I (1)), except life expectancy at birth is stationary in level (I (0)). As a result, we apply the ARDL model to estimate a possible cointegration relationship between GDP growth and the different explanatory variables.

4.2. ARDL Estimation Results

We apply the ARDL model to estimate a possible wedge between economic growth and explanatory variables. The following table shows the estimation results of this optimal ARDL model:

Table 4
The estimation results of ARDL model

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LGDP(-1)	0.396809	0.201534	1.968938	0.0655
LLEB	-1.286131	0.950488	-1.353127	0.1937
LLEB(-1)	2.332544	1.127619	2.068557	0.0541
LLEB(-2)	2.823014	1.223940	2.306496	**0.0339**
LSET	-0.206584	0.068878	-2.999283	**0.0081**
LSET(-1)	-0.006990	0.051247	-0.136398	0.8931
LSET(-2)	0.134454	0.056201	2.392373	**0.0286**
LSET(-3)	0.044907	0.038002	1.181688	0.2536
LPAR	0.074348	0.043503	1.709026	0.1056
LPAR(-1)	0.025042	0.043409	0.576874	0.5716
LPAR(-2)	-0.057234	0.048506	-1.179934	0.2543
LPAR(-3)	0.100877	0.051083	1.974762	0.0648
LPAR(-4)	0.098477	0.043933	2.241495	**0.0386**
LTR	0.072785	0.036910	1.971985	0.0651
LTR(-1)	-1.72E-06	0.025614	-6.70E-05	0.9999
LTR(-2)	0.021671	0.025699	0.843254	0.4108
LTR(-3)	-0.067323	0.028068	-2.398563	**0.0282**
LTR(-4)	0.031755	0.023511	1.350660	0.1945
LGFCF	0.224074	0.033151	6.759210	**0.0000**
LGFCF(-1)	-0.151024	0.053969	-2.798365	**0.0123**
LGFCF(-2)	0.050688	0.033302	1.522060	0.1464
LGFCF(-3)	0.075678	0.043210	1.751398	0.0979
LGFCF(-4)	0.162474	0.057634	2.819068	**0.0118**
C	-11.90202	3.688509	-3.226783	**0.0050**

R-squared	0.999399	Mean dependent var	26.60605
Adjusted R-squared	0.998585	S.D. dependent var	0.260502
S.E. of regression	0.009798	Akaike info criterion	-6.122913
Sum squared resid	0.001632	Schwarz criterion	-5.119846
Log likelihood	149.5197	Hannan-Quinn criter.	-5.757651
F-statistic	1228.635	Durbin-Watson stat	1.721307
Prob(F-statistic)	0.000000		

Source: author (our estimates in eviews)

All coefficients with probabilities below 5% (reported in bold) are statistically significant. The associated Fisher statistic (1228.635) is much larger than the value read in the Fisher table at the 5% threshold, with a probability of 0.000000; the model is therefore globally significant. This result is consistent with the value of the R2 (0.999) and adjusted R2 (0.998) statistics, which also provide information on the quality of the econometric model (R2 tends to unity). The adjustment quality of the model is 99.9%, ie the total variability of GDP is explained almost 100% by the selected variables. In addition, according to the Granger rule ($R^2 = 0.99 < DW = 1.72$) the model is of good regression and the variables used are well stationary.

4.3.Cointegration test: Bounds-test

We adopt the cointegration test of Pesaran et al. (2001), which makes it possible to test long-term relationships on series that are not integrated in the same order. This cointegration approach is posterior to the estimation of the ARDL model. The statistic of the calculated Fisher test (F) must be compared to the critical values (the bounds), and interpreted as follows:
If F > upper bound, there is cointegration.
If F < lower bound, not cointegration.

If lower terminal < F < upper bound, we cannot conclude.

As shown in the following table, the results of this test confirm the existence of a cointegration relationship between the variables studied (F = 3.544113> upper bound = 3.35). Hence the possibility of estimating the long-term effects of the variables.

Table 5

The results of **Bounds-test**

ARDL Bounds Test
Sample: 1976 2016
Included observations: 41
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	3.544113	5

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.26	3.35
5%	2.62	3.79
2.5%	2.96	4.18
1%	3.41	4.68

Source: author (our estimates in eviews)

4.4.Correlation and Causality between variables

First, it is interesting to take a look at the correlation and causality between the variables.

Correlation between variables

The following table represents the simple correlation matrix between variables. It shows the existence of a strong correlation between the dependent variable (LGDP) and the explanatory variables, the degree of association close to 1 over the entire first column. All relationships are positive except LPAR. It seems that all the variables of the study are correlated among them (the degree of association > 0.5, for the whole matrix). The causality test gives us more information on the sense of causality between these different variables.

Table 6

The simple correlation matrix between variables

	LGDP	LLEB	LSET	LPAR	LTR	LGFCF
LGDP	1	0.989129	0.906446	-0.875575	0.804222	0.947798
LLEB		1	0.905302	-0.838218	0.793620	0.905453
LSET			1	-0.678087	0.817985	0.794712
LPAR				1	-0.551069	-0.891738
LTR					1	0.784327
LGFCF						1

Source: author (our estimates in eviews)

Causality between variables

In our study variables are embedded in different orders, making the traditional Granger causality test ineffective. We thus adopt the test of causality in the sense of Toda-Yamamoto (1995) which is based on the statistic (W) of Wald. This statistic is distributed according to a chi-square. The null hypothesis of this test supposes the absence of causality between the variables (probability chi-square > 5%). This test shows three unidirectional causalities (significant at 5%) and three other unidirectional causalities (significant at 10%), in the sense of Toda-Yamamoto:

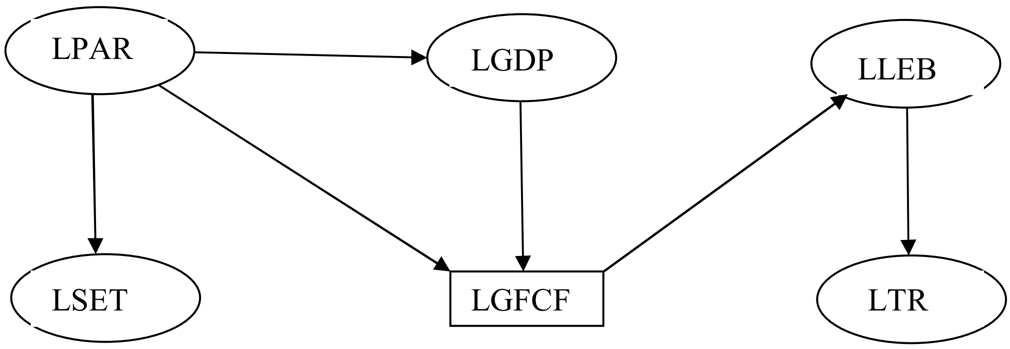
✓ ***Significant unidirectional causalities at 5%:***

- LPAR to LGDP: The gross domestic product is caused by the pace of innovation by residents.
- LPAR to LSET: the rate of innovation achieved by residents influences the rate School enrollment, tertiary.
- LGDP to LGFCF: the gross domestic product has an impact on investments.

✓ ***Significant unidirectional causalities at 5%:***

- LGFCF to LLEB: investment influences Life expectancy at birth.
- LLEB to LTR: Tax revenue is caused by Life expectancy at birth.
- LPAR to LGFCF: the pace of innovation by residents has an effect on the dynamics of the investment.

We summarize the causal links found between the variables in the following schema:



5. Long-term and short-term relationships

5.1. Long-term relationship between study variables

Table 7 represents the estimated coefficients of the long-term relationship.

Table 7
Results of estimation of the long-term relationship

Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LLEB	6.414927	0.610440	10.508694	**0.0000**
LSET	-0.056720	0.055894	-1.014786	0.3244
LPAR	0.400386	0.177572	2.254779	**0.0376**
LTR	0.097624	0.103863	0.939930	0.3604
LGFCF	0.599960	0.167649	3.578659	**0.0023**
C	-19.731755	6.844322	-2.882938	**0.0103**

Source: author (our estimates in eviews)

Normalization with respect to the dependent variable GDP allows us to rewrite the long-term equation in the following way:

$$LGDP = 6.414927 \times LLEB - 0.056720 \times LSET + 0.400386 \times LPAR + 0.097624 \times LTR + 0.599960 \times LGFCF - 19.731755$$

In this long-term equation the estimated coefficients are elasticities because the variables of the model are taken in logarithm. We note a negative relationship between the higher education variable (SET) and economic growth (GDP). But this coefficient is statistically insignificant. All other variables LEB, PAR, LTR and GFCF positively affect the economic growth (GDP), with degrees respectively 6.41, 0.4, 0.09 and 0.59.

5.2. Short-term relationship between study variables

The results of the estimation of the short-term dynamics, ARDL model with error correction, show a coefficient of adjustment (restoring force (-0.603191)) statistically significant, negative and between zero and one in absolute value. These conditions ensured a mechanism for error correction, hence the existence of a long-term relationship (cointegration) between the variables.

Table 8

Results of estimation of the short-term relationship

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LLEB)	-1.286131	0.950488	-1.353127	0.1937
D(LLEB(-1))	-2.823014	1.223940	-2.306496	**0.0339**
D(LSET)	-0.206584	0.068878	-2.999283	**0.0081**
D(LSET(-1))	-0.134454	0.056201	-2.392373	**0.0286**
D(LSET(-2))	-0.044907	0.038002	-1.181688	0.2536
D(LPAR)	0.074348	0.043503	1.709026	0.1056
D(LPAR(-1))	0.057234	0.048506	1.179934	0.2543
D(LPAR(-2))	-0.100877	0.051083	-1.974762	0.0648
D(LPAR(-3))	-0.098477	0.043933	-2.241495	**0.0386**
D(LTR)	0.072785	0.036910	1.971985	0.0651
D(LTR(-1))	-0.021671	0.025699	-0.843254	0.4108
D(LTR(-2))	0.067323	0.028068	2.398563	**0.0282**
D(LTR(-3))	-0.031755	0.023511	-1.350660	0.1945
D(LGFCF)	0.224074	0.033151	6.759210	**0.0000**
D(LGFCF(-1))	-0.050688	0.033302	-1.522060	0.1464
D(LGFCF(-2))	-0.075678	0.043210	-1.751398	0.0979
D(LGFCF(-3))	-0.162474	0.057634	-2.819068	**0.0118**
CointEq(-1)	**-0.603191**	**0.201534**	**-2.992992**	**0.0082**

Cointeq = LGDP - (6.4149*LLEB -0.0567*LSET + 0.4004*LPAR + 0.0976 *LTR + 0.6000*LGFCF -19.7318)

Source: author (our estimates in eviews)

6. Economic interpretations and discussion

We notice that innovation affects all variables, directly or indirectly. This is linked to the efforts of the Swedish state in research. The table 9 shows research and development spending as a percentage of GDP, showing that Sweden is highly impotent to innovation. According to Eurostat (December 2017), in 2016, the highest R&D intensities were recorded in Sweden (3.25%). However, we notice that no variable or cause innovation. Despite the efforts made to human capital, (80% of the research takes place in higher education: universities, colleges including KTH in Stockholm and Chalmers in Gothenburg, polytechnics) SET variable does not have a causal effect on the dynamics of patent filing. What pushes some like to say that the inventors are rarely visionary, but rather ingenious handymen.

Table n 9

Expenditures on research and development

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
3,61093	3,38544	3,38392	3,49928	3,2537	3,49277	3,44809	3,21611	3,24615	3,28562	3,30597	3,14335	3,26285

Source: World Bank

LLEB, LSET and LPAR do not display the expected effects (positive) in the short term. The two components that represent human capital (LLEB and LSET) and the innovation-reflecting variable (LPAR) are a drag on short-term economic growth. Here must be noted the importance of the temporal dimension. The long-run equation shows a statistically significant positive effect of two LPAR and LLEB variables on economic growth.

As for taxation, it promotes short-term growth (D (LTR (-2)), Table 8), but has no long-term effect on growth dynamics (non-significant LTR, Table 7) . According to an OECD Economic Survey (2007/4), Sweden remains the OECD country with the highest tax burden: in 2005, total tax revenues reached 51% of GDP, compared with an average of 36% for the OECD area and 40% for the EU15 (OECD, 2006). Indeed, since a high tax-to-GDP ratio leads to exclusion from the labor market and discourages entrepreneurship, Sweden is asked to gradually reduce the tax wedges on labor as well as other marginal rates with distortion.

Sweden's Economic Survey (OECD, February 2017) shows that the favorable taxation of owner-occupied housing favors household debt and is regressive. It is recommended to reform periodic property taxes in order to better match the tax levy to the good market value. Gradually eliminate the tax deductibility of loan interest paid. Also, fiscal policy is moderately expansionary because of immigration-related spending. Substantial investment is needed in education and refugee integration, and Sweden's low public debt leaves a margin of maneuver. However, strong fiscal security should be provided to cushion external shocks in a small open economy. We must therefore continue on the path of a prudent fiscal policy while allowing the assumption of temporary expenses related to immigration to facilitate the integration of the people concerned.

The investment (represented by GFCF) has no effect on growth in the short term. However, it favors long-term growth dynamics (+0.59 with a probability of 0.0023). According to the World Bank, Sweden is the 10th country where it is easier to do business. Economic policies are aimed at developing investment, focusing on key sectors (biotechnology and food processing) as well as fast growing markets (Baltic countries, India, Brazil, etc.). According to Coface (February 2019) the strength of Swedish production activity in recent years has led to full utilization of production capacity. The strong demand for goods and services, the overuse of production capacity has supported investment, particularly in the manufacturing sector. As part of the regulatory reform process that has been initiated in the OECD area, Sweden has adopted a liberalization policy for several important service sectors. In addition, with the increased market opening, the integration associated with EU membership and the gradual consolidation of the internal market, these reforms have led to vigorous growth after a few years (IEA, 2005).

7. Validation of the model: Residue test

In order to test the validity of our model, we perform the test of normality of residues. The following chart displays a Jarque-Bera 1.905 statistic greater than 0.05. The hypothesis of normality of the residues is thus verified.

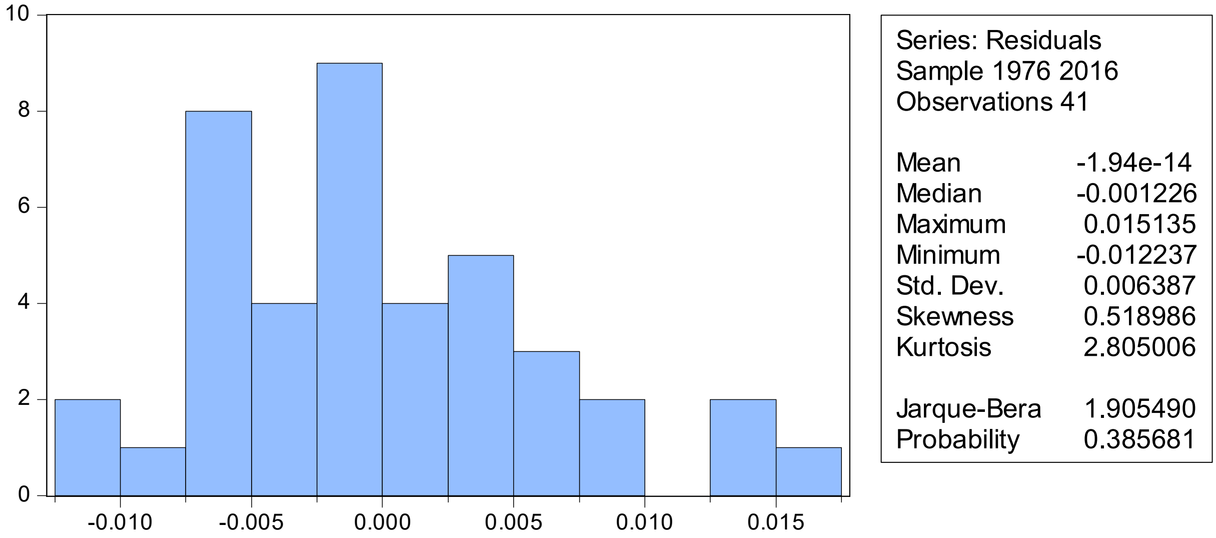


Fig. 2: test of normality of residues

8. Conclusion

In the early 1990s, in the context of an acute economic crisis, the Swedish authority made several economic choices of considerable importance. Openness to international trade, support for innovation and supply-side policy have allowed Sweden to take advantage of the globalization phase of the 1990s and 2000s. Today, the Swedish economy displays important indicators: economic growth of 2.288% in 2017, inflation of 1.9% in 2018, an unemployment rate of 6.2% in 2018 and a surplus of public finances of 1.1% of GDP and public debt 40.9% GDP in 2017. On the basis of our study, we consider innovation as a key element of the Swedish economy. Resident patent dynamics largely promote long-term economic growth (40% of long-term growth is explained by innovation). Patents have a direct causal effect on GDP growth and investment. Also, tax policy favors growth in the short term. Indeed, Sweden is asked to give importance to an industrial policy based on innovation and to continue their prudent fiscal policy.

Human capital, through its component that represents health, promotes long-term growth. However, the component of higher education hinders growth in both the short and long term. This is despite Sweden's efforts to modernize, decentralize, equity, improve quality, competitiveness and internationalize studies since the 1970s.

In short, the Swedish economic model has proved its effectiveness thanks to the political choices that have favored the emergence of a business climate conducive to the start-up of technology companies. If this is the case, the positive effects of innovation on the Swedish economy are reinforced by the choice of adequate fiscal and social policies.

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