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# THE IMPACT OF THE CAPITAL MARKET ON ECONOMIC GROWTH IN LUXEMBOURG

***Abstract***
*In this article, a detailed analysis of the impact of capital markets on economic growth in Luxembourg is presented, utilizing annual economic data. The study spanned from 1975 to 2020. As part of the analysis, an econometric model was constructed and estimated using the GRETL software. The results obtained confirm that the capital market has a statistically significant impact on Luxembourg's economic development. This research provides new insights into the role of capital markets in shaping economic growth dynamics, which is crucial for understanding the economic mechanisms in small, open economies like Luxembourg.*

***Keywords****:* GRETL, GARCH, OLS, economic growth, capital market.

***JEL classification****:* G10

***Paper type:*** Research article.

## 1. Introduction

The capital market serves as a vital conduit for amassing financial resources. In this process, issuers of financial instruments acquire capital that can be channeled into further corporate growth, while security purchasers have the opportunity to invest their surplus funds in ventures that

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promise future returns (Hartana, 2019, p. 41-42). For issuers, this mechanism is advantageous as it targets a broad spectrum of potential investors. Conversely, investors often possess a deep understanding of both the issuer and the market context, enabling them to make well-informed decisions about their investments, including evaluations of potential returns and prevailing investment trends within specific sectors (Omonov, 2021, p. 1-5).

The capital market predominantly deals with medium to long-term financial instruments, indicating that the timeframe for investment returns extends significantly beyond the initial capital transfer, typically exceeding one year. This characteristic fosters the aggregation of substantial capital within this market, significantly influencing economic processes (Tan, Yu and Ma, 2018, p. 3539-3545).

Economic growth encompasses a range of aspects: economic outcomes, the quantitative dynamics of input and output enhancement, and the underlying mechanisms driving growth, including societal interactions that maintain systemic stability. Consequently, the growth process incorporates both the functional architecture and the social interest system, as well as the institutional framework of the economy. Moreover, temporal shifts in production levels are also pivotal considerations (Bosma, Content and Sanders, 2018, p. 483-487; Kuznets, 2019, p. 25-29; McClelland, 2019, p. 53-63).

This article delves into the interplay between the capital market and economic growth, a subject that ignites considerable public debate. Opinions on this topic vary widely, with some emphasizing the detrimental effects of financial development on economic stability, while others highlight its beneficial role in capital allocation and productivity enhancement. Given the significant impact of the 2007-2011 financial crisis on perceptions of the capital market's benefits, this investigation is particularly salient (Alshubiri, 2021, p. 2-4).

The objective of this study is to assess the extent to which the development of the capital market influences long-term economic growth in Luxembourg, focusing on the period from 1975 to 2020. The research methodology commenced with a comprehensive review of pertinent literature, encompassing a broad array of sources and empirical data. The subsequent phase involved the collection and selection of essential statistical data. The final stage encompasses an econometric analysis, utilizing a specially developed econometric model for estimation purposes. This multifaceted approach aims to provide a thorough understanding of the capital market's role in shaping Luxembourg's economic landscape over this extended period.

## 2. The Impact of Capital Markets on Economic Development as Explored Through Scholarly Investigations.

The study of the capital market's influence on economic growth, as revealed through scientific investigations, provides a multifaceted view

of the interconnections between these two areas. Theoretical analyses have consistently pointed to a linkage between capital markets and economic growth, a connection that is further substantiated by empirical research into the financial markets' impact on economic development. Various theoretical frameworks support the hypothesis of a correlation between capital markets and economic growth (Pan and Mishra, 2018, p. 661-666; Guru and Yadav, 2019, p. 113-119; Batuo, Mlambo and Asongu, 2018, p. 168-172; Asteriou and Spanos, 2019, p. 238-243; Durusu-Ciftci, Ispir and Yetkiner, 2017, p. 290-305; Caporale, Rault, Sova and Sova, 2015, p. 48-57). According to the expanded Q- Tobin theory by W. Brainard, favorable stock market conditions are influential in boosting investment levels (Brainard, Tobin, 1968). This theory is supported by the causality derived from higher stock prices. B. Malkiel posits that the overall effect of stock exchanges on economic growth manifests through the wealth effect, which in turn triggers an increase in consumption levels (Malkiel, 1999). Additionally, literature in this field also suggests that a thriving economy positively interacts with stock exchanges, enhancing corporate credibility in capital markets and leading to a rise in individual share prices.
To delve deeper into this subject, the authors devised an econometric model, which was subsequently estimated using select research methodologies (Stulz, 2004, p. 146-147). A recurring theme in many published studies is the examination of relationships within specific country groups, taking into account factors such as:

- The maturity of the capital market;
- The level of economic development;
- Participation in the international community;
- The existing financial system.

The prognostic model proposed by R. Levin and R.G. King is a foundational econometric framework for analyzing the interplay between financial market development and the economic growth of various countries. This model, illustrated in Equation 1, is a regression model for economic growth (King, Levine, 1993, p. 717-736).

**Equation 1: Economic Growth Regression Model Formula**

$$Y_{it} = \alpha_0 + \alpha F_{it} + \beta X_{it} + u_{it}$$

Where:
$Y_{it}$ – represents the real GDP growth rate per capita of the i-th country in period t;
$F_{it}$ – is an indicator of the financial development of the i-th country in period t, encompassing metrics like the ratio of non-financial private sector loans

to total domestic loans, the ratio of the financial sector's current liabilities to GDP, and the ratio of domestic deposits to bank assets;

$X_{it}$ – includes specific explanatory variables influencing the economic growth of the i-th country in period t, such as the ratio of foreign trade turnover to GDP, budget deficit to GDP ratio, and government consumption to GDP.

This model was estimated using the double least squares method. By substituting GDP per capita in the equation with other indicators, such as the rate of investment in GDP or the rate of capital per capita growth, the influence of individual financial development indicators on other variables can be examined. After analyzing data from 80 countries spanning 1960-1989, the authors utilized panel data to demonstrate a robust relationship between financial development and economic growth in individual countries (Caporale, Howells and Soliman, 2005, p. 166-175).

However, the impact of capital markets on economic growth is not universally positive. Some literature suggests that the liquidity of buying and selling shares on capital markets might negatively affect corporate governance, potentially leading to economic growth stagnation. Despite these mixed assessments, the majority of literature supports a positive correlation between capital markets and economic growth.

Over time, various models have been employed to understand the influence of financial/capital markets on different countries' economies (Jin and Boubakari, 2010, p. 14-19). From these studies, a pattern of observations emerges, leading to several collective conclusions about the tested model:

- Stock market capitalization has a strong and statistically significant positive impact on the growth of real GDP and physical capital, underscoring the need for firms to invest in long-term ventures within the real sector,
- A statistically significant correlation exists between financial market development and economic growth in the analyzed period,
- The relationship between total bank assets and the exchange rate has a substantial and statistically significant positive effect on real GDP growth.

## 3. A Detailed Empirical Examination of the Correlation Between Capital Market and Economic Growth

For the purpose of examining the influence of capital market progressions on the economic growth of Luxembourg, data were sourced from the following repositories:

- The World Bank;
- The Statistics Portal of the Grand Duchy of Luxembourg.

In the empirical investigation, annual datasets spanning from 1975 to 2020 were utilized. The inclusion of data prior to 1975 was not feasible as datasets suitable for econometric scrutiny were only available starting from 1975. Moreover, the research did not extend beyond 2020, a decision primarily driven by the unavailability of certain critical statistics in the recent years. This unavailability would necessitate the omission of other pivotal variables, potentially skewing the research findings.

Further, the decision to limit the data analysis up to 2020 was reinforced by the onset of the COVID-19 pandemic and the subsequent military invasion of Ukraine by the Russian Federation. These significant global events introduced unprecedented economic disruptions and uncertainties. Including data from the period affected by these events could potentially distort the research outcomes, given the atypical and extraordinary economic conditions imposed by the pandemic and geopolitical tensions.

Given the 46-year span of the study, the chosen temporal boundaries ensure a consistent and undistorted analysis of the capital market's impact on Luxembourg's economic growth. This period allows for a comprehensive understanding of the capital market dynamics and their correlation with economic development, while circumventing the confounding effects of recent global crises.

The following statistics were used:

1. GDP- Gross Domestic Product;
2. CAPINV- capital investments;
3. HOUCON- consumption of households;
4. EX- export of goods and services;
5. IM- import of goods and services;
6. GOV- government expenditure;
7. KAP- stock market capitalization;
8. NUMCOM- number of listed companies;
9. POP- number of population.

The financial data obtained are unified, and the unit of account is US dollars. Also, applying the deflator (2015) to them to get the true value, which is crucial when analyzing long-term data. Additionally, the collected data were converted to logarithmic form for computational purposes.

The foundational econometric framework employed for investigating the nexus between financial development and economic growth is the model formulated by R. Levin, R.G. King, and R. Barro, known as the Economic Growth Regression Model. This particular model lays the groundwork for the construction of customized models aimed at exploring the interplay between capital markets and economic growth (Filipowicz, 2019, p. 18-35). For the computational aspects of this research, the GRETL software was utilized, a choice driven by its robustness in econometric analysis.

The model specifically developed for this study focuses on assessing the influence of capital markets on Luxembourg's economic progression. In this model, the dependent variable is represented by the natural logarithm of real GDP, a standard approach in economic modeling that allows for a more nuanced understanding of economic growth patterns. This choice is underpinned by the log-linear model's ability to transform non-linear relationships into linear ones, making it easier to interpret the impact of independent variables on economic growth.

**Equation 2: Author's econometric model examining the influence of the capital market on economic growth in Luxembourg**

$$lnGDP_t = a_0 + a_1 lnCAPINV_t + a_2 lnKAP_t + a_3 lnPOP_t + u_t$$

Where:
lnGDPt – stands for the natural logarithm of the real Gross Domestic Product.
lnCAPINVt – is the natural logarithm of capital investments.
lnKAPt – is the natural logarithm of real stock market capitalization.
lnPOPt – is the natural logarithm of the number of population.

In the construction of the model, the method of stepwise backward regression was employed. The estimation of structural parameters utilizing the least squares method is contingent on the advantageous characteristics of the estimators derived from the Classical Linear Regression Model (CLRM). Consequently, the Ordinary Least Squares (OLS) model was employed for estimation, with the outcomes presented in Table 1.

**Table 1. The results of the OLS model estimation**

OLS, using observations 1975-2020 (T = 46)
Dependent variable: l_GDP
HAC standard errors, bandwidth 2 (Bartlett kernel)

| name | **coefficient** | **std. error** | **t-ratio** | **p-value** | **significance level** |
|---|---|---|---|---|---|
| const | 2.82591 | 0.118185 | 23.91 | 4.40e-26 | *** |
| l_CAPINV | 0.661781 | 0.0454424 | 14.56 | 5.11e-18 | *** |
| l_KAP | 0.131661 | 0.0259702 | 5.070 | 8.49e-06 | *** |
| l_POP | 1.48904 | 0.140666 | 10.59 | 2.00e-13 | *** |
| Mean dependent var | | 2.539320 | **S.D. dependent var** | | 1.390739 |
| Sum squared resid | | 0.144504 | **S.E. of regression** | | 0.058656 |
| R-squared | | 0.998340 | **Adjusted R-squared** | | 0.998221 |
| F(3, 41) | | 7290.274 | **P-value(F)** | | 4.51e-57 |
| Log-likelihood | | 67.27990 | **Akaike criterion** | | −126.5598 |
| Schwarz criterion | | −119.2452 | **Hannan-Quinn** | | −123.8197 |
| rho | | 0.423550 | **Durbin-Watson** | | 1.116825 |

White's test for heteroskedasticity -
Null hypothesis: heteroskedasticity not present
Test statistic: LM = 9.10819
with p-value = P(Chi-square(9) > 9.10819) = 0.427348

Test for normality of residual -
Null hypothesis: error is normally distributed
Test statistic: Chi-square(2) = 0.161883
with p-value = 0.922248

Test for ARCH of order 1 -
Null hypothesis: no ARCH effect is present
Test statistic: LM = 0.948393
with p-value = P(Chi-square(1) > 0.948393) = 0.330129

*** - the variable is significant at the significance level of 0.01,
** - the variable is significant at the significance level of 0.05,
* - the variable is significant at the significance level of 0.1.
Source: Own study based on the GRETL program.=

The analysis conducted indicates that the estimated model exhibits heteroscedasticity, characterized by the Autoregressive Conditional Heteroskedasticity (ARCH) effect. Additionally, the p-value for the normality test of the residuals exceeds 0.1, suggesting an abnormal distribution of residuals, evidenced by a pronounced 'long tail' in the empirical distribution. This implies that models relying on this estimation method do not conform to the conventional assumptions of classical regression.

Efforts to estimate the model using alternative methods like the Cochran-Orcutt, Prais, and Generalized Least Squares (GLS) approaches were unsuccessful in yielding satisfactory results during testing. These findings underscore that the random component in the model, particularly for financial

series estimation, might not adhere to the normal distribution assumption, rendering the least squares estimate inaccurate. In most instances, the variance estimates proved to be flawed, leading to a weakened efficacy of commonly employed statistical tests. Consequently, it becomes imperative to identify an alternative estimation method that is more suited for the problem being studied (Maciejewska, 2008, 534-536).

The Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model emerges as a viable alternative for predicting the volatility of financial time series, especially in scenarios marked by fat tails or variance clustering in rate-of-change distributions. This phenomenon is often attributable to the presence of outliers in financial time series. One-time anomalies are particularly critical as they represent significant, isolated deviations in the predicted value of the phenomenon being studied within a single period, without influencing the values in subsequent periods (Domańska, 2020, p. 122-128). The results derived from the GARCH model estimations are detailed in Table 2.

**Table 2. Model: GARCH estimation, observations used 1975-2020 (T=46). Dependent variable (Y): lnGDP. Standard errors of Quasi-Maximum Likelihood**

GARCH, using observations 1975-2019 (T = 45)
Dependent variable: l_GDP
QML standard errors

| name | coefficient | std. error | z | p-value | significance level |
|---|---|---|---|---|---|
| const | 2.81582 | 0.124681 | 22.58 | 6.20e-113 | *** |
| l_CAPINV | 0.642165 | 0.0644467 | 9.964 | 2.18e-23 | *** |
| l_KAP | 0.144600 | 0.0374041 | 3.866 | 0.0001 | *** |
| l_POP | 1.48705 | 0.155694 | 9.551 | 1.28e-21 | *** |
| alpha (0) | 0.00226544 | 0.00102692 | 2.206 | 0.0274 | ** |
| Alpha (1) | 0.294209 | 0.408320 | 0.7205 | 0.4712 | |

| | | | |
|---|---|---|---|
| Mean dependent var | 2.539320 | **S.D. dependent var** | 1.390739 |
| Log-likelihood | 67.87982 | **Akaike criterion** | −121.7596 |
| Schwarz criterion | −108.9592 | **Hannan-Quinn** | −116.9645 |

Unconditional error variance = 0.00320979

Test for normality of residual -
Null hypothesis: error is normally distributed
Test statistic: Chi-square (2) = 0.175263
with p-value = 0.916098

*** - the variable is significant at the significance level of 0.01,
** - the variable is significant at the significance level of 0.05,
* - the variable is significant at the significance level of 0.1.
Source: Own study based on the GRETL program

The estimation of model parameters can effectively be performed using the maximum likelihood estimation method. This technique enables the derivation of asymptotically efficient parameter estimates, provided the distribution's normality assumptions are met. For estimating GARCH models, the Quasi-maximum-likelihood (QML) methods are typically the standard. What's advantageous about this approach is its ability to yield consistent parameter estimates, even in instances where the distribution deviates from normality (Fiszeder, 2009, p. 21-24). This contrasts with the outcomes of normality tests for distributions in model estimations utilizing Ordinary Least Squares (OLS), where GARCH models distinctly address the characteristic "fat tail" phenomenon often observed in financial data time series analysis.

Upon examining the data presented in Table 2, it's evident that all the explanatory variables hold statistical significance. Notably, variations in capital investment exhibit a substantial positive influence on the fluctuations of the economic growth rate. Additionally, alterations in market capitalization demonstrate nuanced positive impacts on the economic growth rate's variability. From these observations, it is plausible to infer that the necessary conditions for affirming the capital market's positive influence on Luxembourg's economic growth are established. This conclusion is underpinned by the statistical significance and nature of the impacts observed from the capital market variables in the analysis.

## Conclusion

The empirical analysis conducted provides clear evidence of a correlation between the evolution of capital markets and the economic growth of Luxembourg. In the interpretation of the developed model, it is observed that under the condition of constancy in other variables, an incremental rise of one percentage point in capital investment is associated with an approximate 0.64 percentage point increase in the GDP's value. This indicates a notable and direct impact of capital investments on the country's economic output.

Similarly, with other factors held constant, a one percentage point escalation in market capitalization is linked to an estimated 0.15 percentage point growth in GDP. This relationship underscores the significant role that market capitalization plays in bolstering the national economy, albeit with a less pronounced effect compared to direct capital investments.

Moreover, the analysis reveals that a one percentage point rise in the population correlates with an approximate 1.49 percentage point increase in GDP. This suggests that population growth in Luxembourg has a substantial and positive impact on economic expansion, potentially due to increased labor force participation, consumer spending, and demand for goods and services.

The assumption of stability in other variables is crucial for isolating the specific impacts of capital investment, market capitalization, and population growth on GDP. However, it's important to recognize that in real-world scenarios, these variables often interact with each other and with other economic factors, potentially leading to complex and multifaceted impacts on economic growth.

Overall, these findings contribute valuable insights into the dynamics of Luxembourg's economy, particularly highlighting the influential role of capital market development and demographic changes in shaping the country's economic trajectory. The results underscore the importance of fostering a robust capital market and managing demographic trends as key strategies for economic development.

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