



Journal of Economics and Business

Ghalayini, Latife, and Saade, Fabienne. (2019), Modeling and Forecasting the Infrastructure Investments Needs in Lebanon. In: *Journal of Economics and Business*, Vol.2, No.3, 843-854.

ISSN 2615-3726

DOI: 10.31014/aior.1992.02.03.131

The online version of this article can be found at:
<https://www.asianinstituteofresearch.org/>

Published by:
The Asian Institute of Research

The *Journal of Economics and Business* is an Open Access publication. It may be read, copied, and distributed free of charge according to the conditions of the Creative Commons Attribution 4.0 International license.

The Asian Institute of Research *Journal of Economics and Business* is a peer-reviewed International Journal. The journal covers scholarly articles in the fields of Economics and Business, which includes, but not limited to, Business Economics (Micro and Macro), Finance, Management, Marketing, Business Law, Entrepreneurship, Behavioral and Health Economics, Government Taxation and Regulations, Financial Markets, International Economics, Investment, and Economic Development. As the journal is Open Access, it ensures high visibility and the increase of citations for all research articles published. The *Journal of Economics and Business* aims to facilitate scholarly work on recent theoretical and practical aspects of Economics and Business.



ASIAN INSTITUTE OF RESEARCH
Connecting Scholars Worldwide



Modeling and Forecasting the Infrastructure Investments Needs in Lebanon

Pr. Dr. Latife Ghalayini¹, Dr. Fabienne Saade²

¹ Faculty of Economics and Business Administration, Lebanese University, Branch 1, Lebanon

¹ Faculty of Economics and Business Administration, Lebanese University, Branch 6, Lebanon

Correspondence: Fabienne Saade, Faculty of Economics and Business Administration, Lebanese University, Branch 6, Lebanon Tel: 96181604504-. E-mail: fabiennessaade@hotmail.com

Abstract

The aim of this paper is to model and forecast the infrastructure investment needs in Lebanon. It divides the Lebanese infrastructure into ten main sectors, and it represents an analysis of each sector. The article collects data of the government expenditures on projects for each sector from the Lebanese council of development and reconstruction. The expenditure on each sector represents a different impact on the Lebanese growth and the Gross Domestic Product, the article analyses the impact in an assessment approach. Findings emphasize the importance of social infrastructure in promoting growth, especially Education sector. Furthermore, findings stress the high volume of expenditure on waste water and solid waste management sector. The article proceeds by modeling the infrastructure investment need using Dynamic OLS equilibrium. The study encloses ten Dynamic OLS models, one for each sector, having the investment needs as the dependent variable, and as independent variables the Lebanese Gross Domestic Product and the Lebanese population. Eventually, the paper forecasts the Lebanese infrastructure investment needs for each sector until the year 2025. Results emphasize the unfair low expenditure on Education and other social infrastructures, and the high expenditures on inefficient sectors such as the waste water and solid waste sector, and the electricity sector. The study eventually recommends a better distribution of infrastructure investments within the Lebanese expenditures.

Keywords: Lebanese Infrastructure, Education, Investment Needs, Government Expenditures, Dynamic OLS, Solid Waste

1. Introduction

The term "infrastructure" originated in the 19th century, referring mainly to military installation. However, the economy encountered the importance of infrastructure in the new era that started during the great depression in 1929, within the framework of the new business theories of J. M. Keynes (Keynes, 1936). Since this era, the importance of what defines "below" and "structure" grows significantly. Over the last decade, actualities proved the strong relation between investing in infrastructure and sustainable business growth (Aschauer, 1989). It is the essential facilities and systems serving a country and an effective way to create jobs and restore growth. Therefore, the place of infrastructure in business is crucial to the business development. The growth of a country goes hand in hand with the development of its infrastructure.

Infrastructure refers to any type of permanent installations, which generates and helps operating other services and commodities over a long period. It includes technical, physical structures and basic services such as transportation, water and electric systems, and telecommunication. It also includes social Infrastructure, that are services essential to enable, sustain, or enhance social living conditions; such as Education, Public Health and Environmental planning.

The main objective of this article is to estimate and forecast the infrastructure investment needs in Lebanon. This interpretation is set to analyze the infrastructure sectors in Lebanon, and to estimate the demand until 2025. Based on the resulted needs, the study recommends a better distribution of expenditures. The data collected are from the Lebanese Council for development and reconstruction covering expenditures on all projects granted for each sector since the year 1992 after the civil war until the year 2016. For this purpose, the paper includes 6 sections, section 1 is the introduction, and section 2 represents the literature review. Followed by section 3 that analyses the ten main infrastructure sectors. In section 4, the paper builds ten Dynamic OLS models, one for each sector. Section 5 forecasts the investment needs, and section 6 concludes.

2. Literature Review

During the last decade, the ownership of the world's economic infrastructure shifted from the public sector to the hands of specialist private investors after acquisitions and privatization transactions. The global population will witness a 25% increase by the year 2040, meaning an almost 2 billion people. Rural to urban migration will continue with the urban population growing by 46%, triggering massive demand for infrastructure support (Heathcote, 2017). Moreover, infrastructure is a very lucrative area for investment (Heintz, Pollin, & Garret-peltier, 2009). This applies in developed countries and in emerging countries.

In general, infrastructure is an investment that is, in most cases, a public good. The main characteristic of infrastructure is that it is neither rivalry nor exclusive, meaning that it does not hold a competition of usage between a person and another. The Return on Investment differs between projects and between types of infrastructure. The cost and the profit aimed for variables upon each project distinctly. Economies of scale represent the production function of infrastructure, the higher volume of projects, the cheaper the marginal cost of the production.

Based on predicted GDP growth, Fay & Tito Yepes estimated worldwide infrastructure investment requirements by region and income group (Fay & Tito, 2003). The estimation is based on a dynamic model that relates demand for infrastructure with the structural change and growth in income. This method provides an indication of the investment required to satisfy the consumer and the producer demand. The succeeding researches present a modification to Fay & Yepes's estimations, namely Yepes (Yepes, 2004) for East Asia and the Pacific, Estache (Estache, 2004) for Sub Saharan Africa, and Fay & Morrison (Fay & Morrison, 2005) for Latin America.

Furthermore, Isabel Chatterton and Olga Susana Puerto Estimate the infrastructure investment needs in the south Asia region. Using forecasting equations, their study concludes that for the next decade, South Asia will need large investments in infrastructure to encounter the needs of its regional economy. The estimated results of their model suggest that electricity and roads will demand the largest proportion of investment, followed by telecommunication and water and sanitation (Chatterton & Susana, 2011).

In a clear vision, and backed by statistical numbers, Salameh studies the importance of Iraq's oil reserves, and its low-cost production yet explains how the Iraqi infrastructure represent a constraint to the Oil and Gas sector and to the country's development. The reasons according to Salameh are the lack of a well-organized development, geopolitical issues, incorrect governmental decisions, political instability, wars since 1979, and the lack of technologies such as 3D seismic survey (Salameh, 2013).

Furthermore, there are many theoretical and empirical evidence suggesting the strong correlation between education and business growth. For instance, (Aghion, Boustan, Hoxby, & Vandebussche, 2009) studied and proved the causal impact of Education on business growth and presented empirical evidence from the U.S. as statistical data. Sapir and Guntram justify the slow growth in the European Union's comparing to the US, as a

result of investing only 1.1 percent of its gross domestic product in higher education, compared to 3 percent in the U.S (Sapir & Guntram, 2013). Bader and Yaacoub analyzed the education sector in Lebanon, as a study in the central administrative of statistics and EU twinning project, and Bank Med issued an analysis emphasizing the importance of the Lebanese Education and presented highlights of its main aspects (Bader & Yaacoub, 2012).

Sharma and Bhanumurthy concluded that the Indian economy has been growing at an average of 8%, accompanying such a growth; there will be an increase in demand for infrastructure services, for consumption and for production. This fact can be due to the strong link between infrastructure and growth, productivity, equity and poverty in India. One of the main obstacles of the development in the country is the infrastructure deficit (Sharma & Bhanumurthy, 2017). The study proves the long-run linkage between income and infrastructure variables by applying the co-integration technique, and the long-run demand is estimated by using the Stock and Watson's dynamic OLS technique.

3. Overview of the Lebanese ten main infrastructure sectors

The economy in Lebanon survives on an aging infrastructure, heavily damaged during the civil war, and after the July 2006 war. One of the biggest obstacles facing the Lebanese industry in their expansion path is the infrastructure deficit. In 1992, shortly after the Lebanese Civil war, the Lebanese government formed the Council of Development and reconstruction (CDR). The council covers the various infrastructure sectors. The council works in accordance with the Lebanese government, and in conjunction with the various ministries related to each sector. The council conducts studies, assigns projects for each sector, and awards contracts to achieve the development and reconstruction projects.

According to the data collected from the CDR, the distribution of contracts over the main sectorial groups are close to a 25% for transportation, 17% for solid waste, 15% for water supply and wastewater, 12% for electricity and 10% for education. Every project granted can be funded nationally, from the Lebanese treasury, or from foreign funding, that also can be as loans or as grants (infrastructure Contracts awarded, 2017).

From the year 1992, after the creation of the CDR, and shortly after the end of the Lebanese civil war, the Lebanese government and CDR created several projects, of which some are implemented and others under process. This article divides the infrastructure into ten main sectors, and collects the total expenditure spent on each. The ten main sectors are: Electricity, telecommunication, transportation, education, public health, environmental planning, Agriculture, Water Supply, Waste water and Solid Waste, and finally a sector including all other projects.

3.1. Electricity sector:

Electricity is a key infrastructure in the country, and it fuels several daily activities. Many Problems face the Electricity sector, of which financial, institutional and technical. The operational expenses are relatively high, the electricity links between the old and new grid are not flexible, and some distribution poles are rusty and old. Numerous accumulated problems and chronicle difficulties linked to the technical, administrative as well as financial shortage appear when dealing with the electricity sector. Electricité du Liban (EDL) or Electricity of Lebanon is a public institution under the control of the Ministry of Energy and Water. This public enterprise is unable to meet the Lebanese demand for electricity, and it is fronting a critical stage. Founded in 1964, and delegated the duty to generate, transmit and distribute electrical energy in Lebanon. EDL currently controls over 90% of the Lebanese Electricity sector, according to the UNDP. EDL lacks effective management, monitoring, and strategic decision-making. In addition, the Human resources face a huge deficiency, and the sector needs new qualified employees and managers. This public institution needs electronic accounting programs, and standby systems, to prevent thefts aggressions, and monitor the billing and payment processes.

3.2. Telecommunication sector:

Lebanon has several communication systems, mostly telephone landline system, mobile, Radio, and television broadcasting, and internet services. It is notable, that the telecommunication infrastructure consists widely on being well connected internationally as well as locally. For this purpose, the government installed two submarine fiber

optic cable; One to connect Lebanon with Syria and Egypt, and the other to connect Lebanon with Cyprus, Crete, and France.

The development of the internet is principally poor, due to corruption, and illegal supply of internet services, in many regions. The connection is mostly very slow, and with limited storage comparing to other countries. Moreover, posts sector is young in Lebanon, and With "LibanPost" as the national post office in Lebanon, it is founded in 1998. It is a private institution, and it operates in many regions in the country, covering almost all of Lebanon. Posts services in Lebanon, requires numbering of Lebanese streets and properties, installing mailboxes, rehabilitating the post offices with proper equipment.

3.3. Transportation sector:

The slow public transportation system in Lebanon strongly deters the business status, mostly after the Lebanese civil war. Moreover, due to population growth and the refugees' crisis, the situation is getting more critical. After the Lebanese war, specifically after the year 1992, The Lebanese government, presented and implemented many programs and plans for the reconstruction of Lebanon's transportation System. It consists on main and secondary roads as well as penetrator roads, bridges, and roundabouts, tunnels and highways.

However, the country faces a significant absence of metros, trains, and subways, although there is a vital need for them, especially in the greater Beirut area. One of the main problems, caused by the inefficient transportation System, is the traffic occurring mainly in Beirut, and its suburbs. Lebanon ranks high worldwide in a number of cars, with a ratio of 434 cars per 1000 persons. Distribution of vehicles is by 90% cars, and only 2% buses (Vehicle distribution, 2015).

3.4. Education sector:

Education sector represents one of the most important infrastructures in every community. It is the key for a better future, and for assuring the healthy development and progress of the society. The Education sector is a main contributor to the Lebanese GDP, and its contribution is consistently expanding. During the year 2014, Public Expenditures stand at approximately at 641 million USD, 1.6% of the GDP while private education contributed of about 4.4% of the GDP (Lebanon's National Accounts, 2015).

Although spending on education is an investment for the future, and a catalyst for the progress and development of all other sectors of the economy, the total expenditure on education in Lebanon is still low relatively to the Middle East region. It represents only 7% of public expenditures, comparing to an 18.6% in the Middle East and North Africa, and a 14.2% worldwide. According to statistics from the World Bank Development indicators, concerning the Public Education, and comparing with other Arab Countries, where Oman spend 5.4% of their GDP on the education sector, and Tunisia spend 6.2%, Lebanon in 2012 only spent 1.6% of its GDP public expenditures on education (Lebanon National Accounts, 2015), a percentage that has been decreasing since 2006 (Public Education statistics, 2015).

3.5. Public health sector:

In Lebanon, the expenditure on Health per capita has been increasing since 2005, representing both public and private expenditures. According to the CDR, the percentage of the governmental share of the total private, public expenditures is increasing as well. It represented a low 35.8 % of the total healthcare expenditures in 2007, but witnessed an increase into reaching more than half of the total expenditures by the year 2013, (CDR Expenditures on Health, 2014).

Ministry of health adopted many goals to improve the performance of hospitals and health hubs in all regions. The government should provide health services provision as an alternative to the expensive private health system. According to the World Economic Forum for the 2016-2017, Lebanon ranked 34 in Healthcare in the Global Competitive Index, out of 138 economies.

3.6. Environmental planning sector:

Lebanon witnesses several environmental problems, such as air pollution, sea, rivers and ground water pollution, Bad protection of touristic and archaeological sites, and others. Lebanon has very weak anti-pollution measures and poor management of the present and future environmental crisis. The problems increased during the civil war and remained until today. Furthermore, the garbage crisis of the year 2015 left Lebanon's streets filled with rotting trash. Environment and regional planning should recover from the continuing problems and worries, to protect what is left of touristic sites, as well as providing a clean environment to the coming generations.

Moreover, in 2014, Lebanon ranked fifth worldwide in Pollution index, which is an estimation of overall pollutions, with the biggest weight given to the air pollution, then to water pollution, and with a slight weight to other pollutions. The country also ranks second in 2014, in drinking water pollution worldwide, according to the CIA factbook. Noting that the environmental planning goes hand in hand with the GDP per capita growth.

3.7. Agriculture sector:

In Lebanon, the agriculture sector contributes in about 17% of the total value of exports, while the sector only contributes to 6.3% of the GDP. According to the Food and Agriculture Organization in 2010, 67% of the Lebanese territory is agriculture areas. The state can help the sector, by implementing laws and regulations to prevent foreign competitors in the Lebanese markets. The agriculture market is not stable, due to many economic, environment and climate factors, the state should take cautions and help the national farms and agricultural entities. Moreover, additional water resources should be built, like lakes, dams and irrigation facilities. Lebanon geographical location and climate are a good advantage for the production. With the help of the state, the sector of agriculture can limit the obstacles, be more profitable and contribute in a higher percentage of export, while protecting the environment.

3.8. Water Supply sector:

Lebanon does not use non-conventional water resources and almost no reuse whatsoever of treated wastewater. The country has 40 rivers of which 17 are considered permanent, and about half of Lebanon's water supply is sourced from groundwater. The major aquifers in Lebanon are contained in limestone, which means that rainwater and snowmelt are rapidly absorbed into the subsurface.

The Lebanese government expenditures on water supply and management witnessed a high increase since the year after the Lebanese war, and until 2016. The percentage of expenditure on water supply projects over the total government expenditure on all infrastructures grew from 0.6% in 1992 and reached more than 9% at the year 1997, as of numbers collected from the CDR. The ratio remained almost the same since 1997 until 2016, which emphasize the continuous investments and interest of the Lebanese government to ensure better water supply management to the country.

3.9. Waste water and the solid waste sector:

Until the early nineties, wastewater facilities in Lebanon were incomplete and lacked any treatment plants. Therefore, the water pollution in the country kept worsening, polluting the sea, the beaches and threatening the sanitary environment. The insufficiency of wastewater services is due to the insufficient spending to this sector, to the absence of proper management and structure, and the absence of any modern methods for wastewater disposals. Solid waste refers to any garbage due to items consumed and left behind after a human activity, and which hold no value and therefore neglected and need to be disposed of. Solid wastes can be solid, liquid, and semi-solid or containerized gaseous material.

Moreover, proper management of the wastewater and solid waste management is very critical and urgent in Lebanon. The country is suffering from poor infrastructure and disposal of waste, to the point, it reached a garbage crisis in 2015. The severe trash crisis left the capital Beirut, and many other cities drawn in solid waste and garbage for many months, with no sight of healthy solutions.

Projects granted to the solid waste and water waste sector had very little interest in the years following the war, which explains the problems the country is facing today. However, recent expenditures to the sector gain more insight and more percentage of the total government expenditures. In 1992, only 5% of the government expenditure

was to the solid waste and water waste sector, but accumulated projects from 1992 until 2016 reached more than 25% of the total government spending according to the projects granted by the CDR (The solid waste and water waste report, 2017). The biggest challenges facing the household waste in Lebanon is dealing with waste by recycling and sorting, and finding landfill locations, ordinary dumps or landfill sites for final dumping.

3.10. Other sectors:

Other sectors include projects granted for sovereign services, Public buildings, management, and implementation and oil and gas industry. The need of the Lebanese public institutions resides on the construction or renovation of government facilities. The public spending on these other sectors represents 6.6% of the total government spending, from 1992 until the end of 2016, as of data from the CDR (Other sectors reports, 2017). Furthermore, any project granted needs management, researching, and implementation, regarding the importance of specialization, integrity, training, and experience.

4. Infrastructure investment needs models

This study aims the projection of the Lebanese infrastructure investments needs for the future. Following Fay (2001) and Fay and Yepes (2003), the study utilizes time-series data and estimate separate demand functions for each infrastructure sector mentioned earlier. Using the estimated income elasticity, the study will eventually project the investment need for each sector up to 2025, based on estimated Lebanese GDP by the IMF.

Studies that are specific for studying a country's GDP and infrastructure demands used the Dynamic OLS (DOLS) methodology developed by (Stock & Watson, 1993). This methodology initiates more robust estimators for small samples and corrects the bias, simultaneity and serial correlation problems. For instance, (Masih & Masih, 1996) for China, (Al Azzam & Hawdon, 1999) for Jordan, as well as (Sharma & Bhamumurthy, 2014) for India. Knowing that variables in this study might encounter similar problems, it is appropriate to employ DOLS methodology to estimate the elasticity.

4.1. Variables:

The variables in log form are the government infrastructure investments in each sector as dependent variable collected from the Lebanese CDR, and the GDP and population growth as independent variables collected from the IMF. Variables cover yearly data from 1992 until 2016 included.

Table 1. Model Variables and description

Variable	Description	Source
Lgdp	Lebanese Real GDP growth	IMF
Lpop	Lebanese Population	IMF
Lelec	Expenditures on Electricity - in millions of USD	CDR
Ledu	Expenditures on Education - in millions of USD	CDR
Lenv	Expenditures on Environmental planning - in millions of USD	CDR
lpbheal	Expenditures on Public health - in millions of USD	CDR
lwaste	Expenditures on Waste water - in millions of USD	CDR
ltelecom	Expenditures on Telecommunication - in millions of USD	CDR
Ltran	Expenditures on Transportation - in millions of USD	CDR
lother	Expenditures on all other sectors - in millions of USD	CDR
Lagr	Expenditures on agriculture - in millions of USD	CDR
lwtrsup	Expenditures on water supply - in millions of USD	CDR

4.2. Augmented Dickey-Fuller test:

The study estimates the unit root of the series by applying the augmented dickey and Fuller tests (ADF). The table 2 shows the results, suggesting that most infrastructure variables are at level. However, GDP and the population independent variables are integrated to the order 1.

Table 2. ADF test results

	At level		At first difference		Lag
	t-Statistic	Prob.	t-Statistic	Prob.	
Lgdp	-0.15017	0.9326	-4.01922	0.0055*	0
Lelec	-10.3075	0.0000*	-1.94389	0.3077	0
Lpop	0.812505	0.9917	-4.10504	0.005*	2
Ledu	-4.80565	0.0008*	-3.47672	0.0184*	0
Lenv	-4.10386	0.0043*	-4.10386	0.0043*	0
lpbheal	-12.8202	0.0000*	-1.83563	0.3549	0
lwaste	-5.69349	0.0001*	-1.97053	0.2967	0
ltelecom	-7.46009	0.0000*	-0.95895	0.75	0
Ltran	-5.08504	0.0004*	-3.47719	0.0183*	0
lother	-0.12101	0.9362	-4.59326	0.0015*	0
Lagr	-2.07144	0.2569	-4.44959	0.0021*	0
lwtrsup	-7.81207	0.0000*	-2.06394	0.2598	0

ADF test results for yearly data expressed in log, from 1992 until 2016. Source: Calculated by the author using Eviews data collected from the Lebanese CDR and IMF. *significant at 5%

4.3. Lag Length criteria and Co-integration:

The paper proceeds by applying the lag length criteria and accordingly the co-integration analysis, using the Johansen and Juselius (1990) multivariate co-integration analysis. The study takes into consideration which variables are at level, and which is integrated at first difference before applying the co-integration testing. Table 3 represents the results of Johansen co-integration test (Trace Statistics) for each model. Furthermore, the table represents the Lags and leads that justify the co-integration between the variables. Moreover, the results suggest having a co-integration relation in all the models, between the dependent variable and the independent variables at specific lags and leads.

Table 3. Co-integration test results for the ten models

Model 1 (electricity)	Hypothesized No. of CE(s)	Eigenvalue	Trace	0.05 Critical Value	Prob.**
Lag and Lead : 1 2	None *	0.981307	95.21002	29.79707	0
	At most 1	0.194869	7.659249	15.49471	0.5025
Model 2 (telecom)	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
Lag and Lead : 1 2	None *	0.753957	44.01494	29.79707	0.0006
	At most 1	0.377001	14.56773	15.49471	0.0686
Model 3 (transportation)	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
Lag and Lead : 1 2	0.721625	44.41063	29.79707	0.0005	0.0006
	0.409836	14.99852	15.49471	0.0593	0.0686
Model 4 (Education)	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
Lag and Lead : 1 2	None *	0.981307	95.21002	29.79707	0

	At most 1	0.194869	7.659249	15.49471	0.5025
Model 5 (public health)	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
Lag and Lead : 1 2	None *	0.786425	44.41727	29.79707	0.0005
	At most 1	0.46378	13.5419	15.49471	0.0964
Model 6 (Environment)	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
Lag and Lead : 1 2	None *	0.637071	27.96252	29.79707	0.0288
	At most 1	0.14482	4.650944	15.49471	0.096
Model 7 (Agriculture)	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
Lag and Lead : 1 1	None *	0.680145	37.09998	29.79707	0.006
	At most 1	0.364234	10.88259	15.49471	0.2188
Model 8 (water Supply)	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
Lag and Lead : 1 2	None *	0.810821	45.2569	21.13162	0
	At most 1	0.340364	8.546617	14.2646	0.3258
Model 9 (Waste)	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
Lag and Lead : 1 1	None *	0.786719	43.39518	29.79707	0.0008
	At most 1	0.464357	12.49227	15.49471	0.1348
Model 10 (Others)	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
Lag and Lead : 1 2	None *	0.860221	54.7484	29.79707	0
	At most 1	0.310364	9.491491	15.49471	0.3219

Trace Statistic and lag and lead test results for each of the ten models. Prepared by the author using eviews and excel. Data collected from the Lebanese CDR and the IMF

4.4. Stock-Watson Dynamic OLS models:

After the unit root testing and after establishing the presence of co-integration for each sector model, the study estimate the long-run elasticity of these models using the Dynamic OLS technique developed by Saikkonen (Saikkonen, 1991) and Stock and Watson (Stock & Watson, 1993).

$$\begin{aligned} \text{LELEC} &= C(1)*\text{LGDP} + C(2)*\text{LPOP} + C(3) & (1) \\ \text{LTELECOM} &= C(1)*\text{LPOP} + C(2)*\text{LGDP} + C(3) & (2) \\ \text{LTRAN} &= C(1)*\text{LGDP} + C(2)*\text{LPOP} + C(3)*\text{LTRAN}(-1) + C(4) & (3) \\ \text{LEDU} &= C(1)*\text{LGDP} + C(2)*\text{LPOP} + C(3) & (4) \\ \text{LPBHEAL} &= C(1)*\text{LGDP} + C(2)*\text{LPOP} + C(3)*\text{LPBHEAL}(-1) + C(4) & (5) \\ \text{LENV} &= C(1)*\text{LGDP} + C(2)*\text{LPOP} + C(3) & (6) \\ \text{LAGR} &= C(1)*\text{LGDP} + C(2)*\text{LPOP} + C(3) & (7) \\ \text{LWTRSP} &= C(1)*\text{LPOP} + C(2)*\text{LGDP} + C(3)*\text{LWTRSP}(-1) + C(4) & (8) \\ \text{LWASTE} &= C(1)*\text{LGDP} + C(2)*\text{LPOP} + C(3)*\text{LWASTE}(-1) + C(4) & (9) \\ \text{LOTHERS} &= C(1)*\text{LPOP} + C(2)*\text{LGDP} + C(3) & (10) \end{aligned}$$

This technique improves the robustness of the model because the endogeneity of any of the regressors will not have any asymptotic effect on the estimates. Therefore, the DOLS equations are as follow from equation (1) until (10) for each infrastructure as follow:

4.4. Result of the Dynamic OLS estimation models:

The forecasted values for log (electricity) represent low root mean error (0.23), and a low mean absolute error (0.23) as well as a minimal Theil Inequality coefficient (0.02), which validates the accuracy and efficiency of the model again. Furthermore, the Electricity estimation model is represented in equation (11) with the probability of each coefficient and the model characteristics:

$$\text{LELEC} = -2.23806574309*\text{LGDP} + 4.64935158488*\text{LPOP} - 43.1062867912 \quad (11)$$

P: 0.0514 P: 0.0308 P: 0.0458

R-squared: 0.81 S.E. of regression: 0.0922 Durbin-Watson: 1.242

The forecasted values for log (telecommunication) have a low root mean error (0.014), low mean absolute error (0.012) as well as a minimal Theil Inequality coefficient (0.001), with a correlation of +99.5% between the values. Telecommunication estimation model is represented in equation (12)

$$\text{LTELECOM} = 3.41634633494*\text{LPOP} - 1.53984680348*\text{LGDP} - 31.3670682282 \quad (12)$$

P: 0.0044 P: 0.013 P: 0.008

R-squared: 0.94 S.E. of regression: 0.047 Durbin-Watson: 1.042

The forecasted values for log (transportation) sector represent slightly low root mean error (0.03), and a low mean absolute error (0.012) as well as a minimal Theil Inequality coefficient (0.002). The correlation between the forecasted data and the actual data stands at 99.3%. The Transportation estimation model is in equation (13):

$$\text{LTRAN} = -0.18975565*\text{LGDP} + 0.34915036*\text{LPOP} + 0.90805249*\text{LTRAN}(-1) - 2.836672 \quad (13)$$

P: 0.21 P: 0.301 P: 0.00 P: 0.44

R-squared: 0.99 S.E. of regression: 0.049 Durbin-Watson: 2.64

The forecasted numbers for log (Education) represent fair equations of estimation with a root mean squared Error of 0.22, Mean absolute Error of 0.19 and a Theil Inequality Coefficient of 0.017. However, the correlation constant is a positive 86%. The Education equation along with substitute coefficient is in equation (14):

$$\text{LEDU} = -15.3354198654*\text{LGDP} + 32.8075467524*\text{LPOP} - 352.360087336 \quad (14)$$

P: 0.075 P: 0.043 P: 0.035

R-squared: 0.792 S.E. of regression: 0.732 Durbin-Watson: 1.04

The forecasted values for log (Public Health) are accurate, with very low mean squared Error (0.03), Mean Absolute Error (0.02) and very low Theil Inequality (0.003). The public health equation of estimation with the probabilities of each coefficient is represented in equation (15).

$$\text{LPBHEAL} = 0.22853*\text{LGDP} - 0.5124087*\text{LPOP} + 0.8486695*\text{LPBHEAL}(-1) + 6.641195 \quad (15)$$

P: 0.27 P: 0.19 P: 0.00 P: 0.118

R-squared: 0.99 S.E. of regression: 0.06 Durbin-Watson: 1.11

The forecasting results represent high efficiency in estimating future needs of environmental planning. Having low Root mean Squared Error (0.11), low Mean absolute error (0.05) and low Theil inequality coefficient (0.01), The DOLS estimation equation substituted with its coefficient is presented in equation (16).

$$\text{LENV} = -8.9174997069*\text{LGDP} + 21.3725875798*\text{LPOP} - 240.04110061 \quad (16)$$

P: 0.003 P: 0.006 P: 0.0003

R-squared: 0.97 S.E. of regression: 0.21 Durbin-Watson: 1.06

The forecasted values for log (agriculture) represent fair root mean error (0.3), and a fair mean absolute error (0.22) as well as a slightly low Theil Inequality coefficient (0.003), which validates the accuracy and efficiency of the model. After implementing the coefficients, the DOLS equation (17) is, therefore:

$$\text{LAGR} = -4.44173814388 * \text{LGDP} + 13.0624472445 * \text{LPOP} - 153.464915062 \quad (17)$$

P: 0.05 P: 0.003 P: 0.001

R-squared: 0.92 S.E. of regression: 0.34 Durbin-Watson: 1.41

The estimation equation (18) for log (WaterSupply) represents Root mean squared error of (0.23), low Mean Absolute Error (0.19) and a low Theil inequality Coefficient (0.01).

$$\text{LWTRSP} = -0.16705122 * \text{LPOP} + 0.31768 * \text{LGDP} + 0.7693391 * \text{LWTRSP}(-1) + 1.26958 \quad (18)$$

P: 0.83 P: 0.47 P: 0.00 P: 0.88

R-squared: 0.98 S.E. of regression: 0.14 Durbin-Watson: 1.15

The forecasted test statistics of the Waste water and solid waste equation (19) have low Root mean squared error (0.03), low Mean Absolute Error (0.02) and a Theil inequality Coefficient of (0.002).

$$\text{LWASTE} = 0.10680103 * \text{LGDP} - 0.26700073 * \text{LPOP} + 0.94386 * \text{LWASTE}(-1) + 3.630151 \quad (19)$$

P: 0.83 P: 0.47 P: 0.000 P: 0.883

R-squared: 0.99 S.E. of regression: 0.06 Durbin-Watson: 1.20

Finally, the other sectors estimation equation (20) has low Root mean squared error (0.15), low Mean Absolute Error (0.12) and a low Theil inequality Coefficient (0.01).

$$\text{Lothers} = 0.0648970296948 * \text{LPOP} + 1.83056995581 * \text{LGDP} - 11.2853407935 \quad (20)$$

P: 0.91 P: 0.0001 P: 0.089

R-squared: 0.98 S.E. of regression: 0.07 Durbin-Watson: 2.36

5. Forecasted Infrastructure investment needs until 2025

After conducting the Dynamic OLS estimation for each sector, the article uses the DOLS estimation equations along with the IMF data for the Lebanese projected GDP growth and projected population growth until 2025. The article hence forecasts the infrastructure investment needs in Lebanon. Results are shown in table 4, showing the ten sectors with the projected demand for investment for each until 2025, numbers as the percentage of each sector out of the total investment needs.

Table 4. Forecasted Percentage of each infrastructure investment needs until 2025

Forecasted data of:	2019	2020	2021	2022	2023	2024	2025
Electricity investment needs	10%	9%	8%	8%	7%	7%	7%
Telecommunication Investments needs	6%	5%	5%	5%	5%	5%	5%
Transportation Investments needs	24%	24%	24%	25%	23%	23%	23%
Education Investment needs	9%	8%	8%	8%	9%	9%	9%
Public Health Investment needs	2%	2%	2%	2%	2%	2%	2%
Environmental Planning Investment needs	1%	1%	1%	1%	1%	1%	1%
Agriculture Investment Needs	3%	3%	3%	3%	3%	3%	3%
Water supply Investment needs	8%	8%	8%	8%	8%	8%	8%
water and solid Waste Investment needs	30%	33%	33%	33%	35%	36%	35%
Other investment needs	7%	7%	7%	7%	7%	7%	7%

Projected infrastructure investment needs using estimation equations, unit is the percentage of each sector out of the total investment needs. Data collected from IMF. Prepared by the author

5.1. Results Analysis:

The government expenditure on infrastructure ends with inefficient distribution of projects and an unfair financing to a different sector. In more details, since 1992, the water and solid waste sector absorb the highest percentage of the expenditure (almost 27%); and the second-highest sector is the transportation sector. Together, the two sectors aggregate more than 50% of the Lebanese government expenditures. Despite that, the government could not organize the transportation sector, which still holds several problems. On the same subject, the Waste management sector should not absorb such a high amount of financing and percentage of expenditure, knowing that the government can implement innovative and technical strategies and researches to ensure proper management of waste without having such high cost. If the country continues using same strategies the transportation and the waste management sector will continue holding the highest percentage of expenditures. Lebanon, might spend more than 58% of its total expenditures on wastewater and transportation, and therefore, widen the problem of inefficient distribution.

Moreover, the educational and agriculture sectors are heavily undervalued, and do not absorb their fair percentage of expenditure. First, the Agriculture sector currently represents 6% only of the Lebanese GDP, and the government transfers only 3.5% of the total expenditure to the agriculture sector. To add, according to the estimations, if the government continues with the same strategy, the percentage might drop to a critical level of less than 2.8% in 2025. Second, the most positively correlated sector with the Lebanese GDP/capita growth is the education sector, with a significant 95% correlation. Despite this fact, the Lebanese Government distributes less than 8% of its total expenditures on the Education sector, and as per the estimations, the percentage will not change significantly. The same applies for all vital social infrastructure, namely environmental planning and public health.

5.2. Recommendations:

Lebanon needs improvements in its distribution strategies, which might lead to business growth and sustainability. The country needs to manage the waste sector properly, by lowering its share of expenditures significantly, and by performing better management and control. On another hand, the country might not be spending fair enough on its education sector, and it also has no proper research and development studies. Therefore, the paper highly recommends increasing the expenditure on Education. Likewise, the country needs spending more on other social infrastructures such as the public health and the environmental planning.

Furthermore, expenditures on the electricity sector seem not efficient, and the EDL is not capable of supplying the Lebanese market, due to technical losses, aging plants, and improper management. The paper suggests a decrease of expenditures on electricity, and an increase in its management and control. Finally, the agriculture seems lacking the fair share of expenditures, knowing that the country holds high potential in this key infrastructure field.

6. Conclusion

This paper aimed a proper estimation of the infrastructure investment needs in Lebanon. First, the analysis showed the importance of Education among other social infrastructures that are not having their sufficient share of expenditures from the Lebanese government. However, the study showed the high spending on waste water and solid waste sector, knowing that despite this immense expenditure on it, this sector is incapable of finding a solution to the garbage crisis, nor to sewers problem. The study also showed the inefficiency of the Electricity sector to supply energy to the market, as well the unfair spending to the agriculture sector with its outdated technologies.

Furthermore, the paper built Dynamic OLS models, one for each of the ten main infrastructures. The estimation equation used the data of expenditures from the CDR as amount of projects granted in millions of dollars. It also collected the real and projected numbers of GDP and population from the IMF. The DOLS equations are then used to forecast the infrastructure investments need in Lebanon until the year 2025.

Results proved the immense share of the waste water and solid waste sector despite its efficiency. It also showed the unfair low expenditure on education, public health, and environmental planning sectors. Therefore, it is

recommended to gain better management in the lagging sectors of waste and electricity, and to have higher expenditures on Education and social sectors.

References

- Keynes, J. (1936). The general theory of employment, investment, and money.
- Aschauer, D. (1989). *Is public expenditure productive?* (2 ed., Vol. 23). Journal of Monetary economics
- Heathcote, C. (2017). Forecasting infrastructure investment needs for 50 countries, 7 sectors through 2040. World Bank. Infrastructure and public private partnership BLOG.
- Heintz, J., Pollin, R., & Garret-peltier, H. (2009). How Infrastructure Investments Support the U.S. Economy: Employment, Productivity and Growth. Political Economy Research Institute (PERI).
- Fay, M., & Tito, Y. (2003). Investing in infrastructure: what is needed from 2000 to 2010? The World Bank.
- Yepes, T. (2004). *Expenditure on Infrastructure in East Asia Region*. The World Bank.
- Estache, A. (2004). *Infrastructure services in developing countries: Access, Quality, Costs and Policy Reform*. policy research working papers
- Fay, M., & Morisson, M. (2005). *Infrastructure and Sustainable development*. World Bank.
- Chatterton, I., & Susana, P. (2011). *Estimation of infrastructure investment needs in the south asia region executive summary*.
- Salameh, G. (2013). *Iraq: An Oil Giant Constrained by Infrastructure & Geopolitics*. USAEE / IAEE Working Paper Series.
- Aghion, P., Boustan, L., Hoxby, C., & Vandenbussche, J. (2009). *The Casual Impact of Education on Economic Growth: Evidence from U.S.* 2009. Cambridge, Massachusetts: Harvard University.
- Sapir, A., & Guntram, B. (2013). *European Macroeconomics & Governance*.
- Bader, L., & Yaacoub, N. (2012). *Education in Lebanon*. Beirut: Central administrative of statistics and EU twining project.
- Sharma, C., & Bhanumurthy, N. (2017). *Estimating infrastructure needs for India*. (2015). Public Education statistics. World Bank.
- (2017). *infrastructure Contracts awarded* . Council of development and reconstruction .
- (2011). *Telecommunication sector*. CIA factbook.
- (2015). *Vehicule distribution* . CIA factbook.
- (2015). *Lebanon National Accounts* . World Bank Development Indicators.
- (2014). *CDR Expenditures on Health*. Council for development and reconstruction.
- Fay, M., & Tito, Y. (2003). *Investing in infrastructure: what is needed from 2000 to 2010?* The World Bank.
- Stock, J., & Watson, M. (1993). *A Simple Estimator of Cointegrating Vectors in Higher Order Integrated Systems*. Econometrica.
- Masih, R., & Masih, A. (1996). *Stock-Watson Dynamic OLS (DOLS) and Error Correction Modeling Approaches to Estimating Long and Short Run Elasticities in a Demand Function* (Vol. 20). Mainland China Energy Economics.
- Al Azzam, A., & Hawdon, D. (1999). *Estimating the demand for energy in Jordan: a stock-watson dynamic OLS (DOLS) approach*. Amman: Surrey Energy Economics Center (SEEC).