Public Expenditure Policy in Bolivia, Growth and Welfare

RESEARCH PROPOSAL
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By

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Abstract

It has been widely documented that public expenditure is important for economic growth, but little work has been done, in Bolivia, in relation to the macroeconomic impact of increasing public investment in infrastructure. This proposal aims to develop a Dynamic Stochastic General Equilibrium (DSGE) model for a small open economy that has four sectors: Non-tradable or services, importable or manufacturing, exportable intensive in capital or hydrocarbons, and exportable and less intensive in capital or mining. The model will be parameterized and solved for the Bolivian economy and several interesting scenarios will be performed by changing government expenditure, country risk, Total Factor Productivity, public capital elasticities, among others. Actually, the government is retrieving fiscal policy as its main tool to attack poverty and aims to put government expenditure and investment as the foremost instruments to promote growth and welfare. The second-order approximation technique will be used to solve the model. The benefit of using this technique is that it allows considering second-order effects (uncertainty) and in particular it allows measurement of welfare and growth effects more precisely.

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I. Introduction

Although infrastructure was incorporated in the theory of growth literature by Arrow and Kurz (1970) and Weitzman (1970), people began to study the theme seriously after the seminal work of Barro (1990). Barro’s model is well known, because he introduces government spending as a variable in the production function. The existence of constant returns to capital and government spending imply that the economy is capable of endogenous growth.

Coinciding with this new born of the growth literature, there is also the showing up of an empirical literature related to infrastructure. Infrastructure becomes an important source of growth as shown by Aschauer (1989a, 1989b). These works concentrated in the estimation of the production elasticities of government expenditure, using aggregated data for countries, mainly the U.S.¹ There are also cross-country studies that emphasize the role of infrastructure for a country’s growth.²

Papers in this literature have typically used regression analysis on either “growth accounting” or steady state equations. While these papers have been useful in pointing out the importance of infrastructure, their methodology does not allow for the analysis of important general equilibrium feedback effects among key macroeconomic variables and welfare.

In this sense, the following proposal aims to examine the impact of public investment in infrastructure among output, consumption, private investment and foreign trade, using a Dynamic Stochastic General Equilibrium (DSGE) model for a small open economy with four sectors. These sectors which are the non-tradable sector (services), the importable sector (manufacturing), the exportable sector intensive in capital (hydrocarbons) and the exportable sector less intensive in capital (mining), are representative of the Bolivian economy. In particular the hydrocarbons sector which is conceived as the strategic and transformation sector, and the sector that will generate all the necessary resources to attack poverty and underdevelopment.

We propose to answer the following main research question:

What is the impact of public expenditure policy on growth and welfare in Bolivia?

This type of new generation model will allow us also to analyze and simulate numerous and interesting scenarios related to the dynamics of public spending policy, change in tax rates, change in import tariffs, fall in the relative price of exportable goods, increase in the country-risk premium together with its relationship with the debt that finances private investment, and variation in productivity in each or all sectors. In sum, we will perform sensitivity analysis with the key parameters of the model combining them in different scenarios with public investment in infrastructure.

First, we will set up our four-sector dynamic general equilibrium model for a small open economy like Bolivia, inhabited by a representative infinitely-lived agent that faces an upward-sloping supply of foreign capital, reflecting an endogenous country risk premium. The model will be based on Chumacero, Fuentes and Schmidt-Hebbel (2004) but modified to include public investment in infrastructure in a way similar to Rioja (2001) and sector division for the exportable sector as in Estrada (2006). Second, we will carefully calibrate the model for the Bolivian economy. The model will be solved using the second-order-approximation technique developed by Schmitt-Grohé and Uribe (2004a). The advantage in using this perturbation method is that it allows considering second-order effects, which arise as important features in an economy with high levels of uncertainty.\(^3\)

An important fact is that the model will permit us to extract precise quantitative implications, because we will examine the effects of a range of different scenarios on growth and welfare, as well as on the main macroeconomic variables (consumption and investment). Model simulation results will be reported first, for steady-state effects and then for the dynamic effects on the composition of these variables.

In this regard, it will be important to calibrate the model accurately and exactly to the Bolivian economy. This will allow us to be in a position to realistically assess the effects of public spending policy on growth and welfare. Moreover, we will be able to give hints to policymakers on how to conceive and redesign the fiscal policy in Bolivia, with emphasis on public investment decisions.

### II. Core research objectives

The two main objectives of this study are:

A) to analyze the macroeconomic impact of public infrastructure on GDP, consumption, private investment and trade balance.

B) to capture important dynamics involving public expenditure policy, external debt, performance of the exportable, non-tradable and importable sectors and the needed infrastructure expenditures/improvement.

There are four secondary objectives:

C) to simulate several interesting scenarios related to fiscal deficit management, political and institutional instability (country risk), productivity shocks, and external price shocks.

D) to design a simple neoclassical Dynamic Stochastic General Equilibrium model, suitable for the analysis of fiscal policy as an alternative to the already existing CGE models.

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\(^3\) In a second round we plan to include the education and health modules to analyze the macroeconomic impact of public spending on these issues.
E) to yield quantitative predictions that can be used for policy analysis.

F) to promote a long-term research project in Bolivia consisting in the build up of more elaborated DSGE models. We expect to put the seed for the evolution of more complicated models like the new-Keynesian DSGE models.

III. Knowledge gaps and scientific contribution of the research

DSGE models have been rarely used in Bolivia. Furthermore the few DSGE models calibrated for the Bolivian economy have concentrated in the analysis of economic policy issues, but not as deeply as it is needed in a context where the State is assuming the main role in the economy and several transformations are being implemented with the implementation of the New Constitution.

The first DSGE model calibrated for Bolivia corresponds to Quiroz, et. al. (1991). The authors analyze the business cycle properties of the Bolivian economy. Machicado (2006) calibrates a DSGE model taking into account that the Bolivian economy is a partially dollarized economy. He analyzes the welfare gains attributed to optimal fiscal and monetary policy. Estrada (2006) studies the effects of changes in external policies on the hydrocarbon and agricultural sectors for an open economy. Finally Valdivia and Montenegro (2008) analyze fiscal policy rules using a New-Keynesian general equilibrium model.

The other strand of General Equilibrium models which corresponds to CGE models, have been used amply since middle of the 90’s, to analyze macroeconomic policies and policy shocks. Jemio (1994) proposes an analytical model based in a Social Accounting Matrix to analyze the macroeconomic adjustment of the Bolivian Economy during the period 1970-1989. Jemio and Wiebelt (2002) also concentrate on macroeconomic issues and anti-shock policies using a modified CGE model, constructed with the support of Kiel Institute of World Economics.

The first time poverty issues are being analyzed with CGE models is in the paper of Andersen and Faris (2002). Also, Thiele and Wiebelt (2003) using the Kiel model, review Bolivia’s economic and social development over the period 1985–1999, and investigate the country’s future prospects for pro-poor growth. Recently, Jiménez, Mariscal and Canavire (2008) use a CGE model to analyze policies to reach the Objectives of the Millennium.

The problem with these types of structural models is that they rely heavily in a Social Accounting Matrix. The National Institute of Statistics which is the institution in charge of the construction of that matrix, has stopped to construct it since 1997, and does not have any plans to continue with this project.4

This fact opens the need to analyze the economy in a general equilibrium context, but using simple, complete and up to date models. These models are certainly the dynamic neo-

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4 Thiele and Piazolo (2003) build up a Social Accounting Matrix for Bolivia featuring formal and informal activities.
classical or new-Keynesian models. Furthermore, most of the Central Banks in the region are also changing their structural models with this new type of DSGE models, because they are flexible and relatively easy to modify.

Jemio (2006) stresses the importance of using general equilibrium models to analyze the impact of infrastructure. He uses a Computable General Equilibrium (CGE) model for Bolivia, to evaluate ex-ante, the macroeconomic and sectorial effects of two investment projects in infrastructure. The problem with these types of models is that as they consist of many equations, they are hard to modify, and do not capture the dynamics of the economy very well. The objective is to fill this gap, building a simple model and introducing a methodology to solve it and compute welfare gains never used before in Bolivia.

In sum, the scientific contribution will be the analysis in deep of fiscal policy, for the first time, using a DSGE model. The knowledge gap to close is the design of an efficient fiscal policy strategy aimed to maximize growth and/or welfare.

IV. Policy Relevance

In the last two years, Bolivia achieved a fiscal surplus, partly explained by the international economic boom (high commodity prices) and partly by the State management transformations that are being taken since the upcoming of the first indigenous president (Evo Morales). The government is assigning a central role to state-owned enterprises, in particular in the hydrocarbons sector and taxing extractive activities.

The following graph shows that Bolivia achieved a fiscal surplus of 5.1 percent of GDP in year 2006 and 1.8 percent of GDP in year 2007. It is also shown the rate of growth of GDP, which increased from a value of 1.68 percent in 2001 to a value of 4.63 percent in 2006.

Graph No.1
Fiscal Surplus and Economic Growth
(Percentages)
Notice that in the last four years the rate of growth of GDP has been on average 4 percent. This rate of growth is low compared with other countries’ rates of growth in the region. For example Perú has been growing at rates higher than 7 percent in the last years. The same occurs in Uruguay, Argentina and Colombia. Many reasons can explain this low rate of growth. We think that one of the reasons is that public expenditure is not being devoted in the magnitudes necessary to enhance growth. As it can be seen in graph 2, in the last years, the government has increased its investment in infrastructure (as percentage of GDP) and has decreased its investment in social issues like education and health.

![Graph No.2 Public Investment (Percentage of GDP)](image)

Source: UDAPE

Therefore, it is of great relevance to analyze the dynamic impact of investment in infrastructure on growth and welfare as well as on other key macroeconomic variables like consumption, private investment and the current account. To quantify the long run level effects of public investment, we will concentrate on comparisons between different steady-states. Some issues can be overlooked in the long run analysis; therefore we will compare also the transitional dynamics of the variable of interest under different scenarios. We expect to show that the government will be able to enhance growth by investing much more in infrastructure and doing it in a more efficient manner.

Graph 3 displays the public investment by sectors (programmed and executed) for the year 2007. It can be seen that public investment in infrastructure has been almost the double of investment in social issues, both the programmed and the executed. The investment in infrastructure executed in year 2007 has been of USD 550.9 millions, while the investment
programmed for production support has been only of USD 249.6 millions. Public investment in infrastructure is certainly the main type of public investment in Bolivia.

Graph No.3
Public Investment by Sectors: Programmed and Executed in 2007
(Thousands of U.S. Dollars)

Source: UDAPE

Looking at infrastructure investment, specifically (graph 4), we can identify that around 90 percent on average of total public investment in infrastructure has been executed in transportation (roads) in the last years. In second place, the government has invested in energy and water resources, but never in proportions larger than 20 percent.

Graph No.4
Public Investment in Infrastructure (as percentage of total)

Source: UDAPE
Notice that in the last two years the public infrastructure investment in energy has increased its share. Specifically it has increased from USD 44.1 millions in 2006 to USD 69.6 millions in 2007, which represents an increase of 57.8 percent. This happened because the government is investing more in hydrocarbons as the main hydrocarbon’s company (YPFB) has been nationalized in year 2007. Moreover the government is visualizing the hydrocarbons sector as key for the economic, political and social transformations that are planned to be implemented in the next years.

According to the New Constitution approved a few weeks ago, the article 360 states: “The State will define the hydrocarbon policy, it will promote his integral, viable and equitable development, and will guarantee the sovereignty of energy resources.”

Next, we show how the government has been financing its expenditures in the last years. The following graph displays the composition of government current income for the last seven years. It is remarkable that tax revenues are the main sources of income, although they have decreased their participation since 2004.

The income from taxes on hydrocarbons has been important in the years 2005 and 2006, due to the transformation in the tax structure in this sector. In 2005, there is an increase in the tax rate for the production of hydrocarbons, from 31 percent to 50 percent (Law 2749 of May, 2005). Then in 2006, this tax rate is increased again to 82 percent (D.S. 28701 of May, 2006). In 2007, the income from taxes is substituted by the income from hydrocarbons sales, because, as stated above, the government started the nationalization of the hydrocarbons. It will be important to analyze the effects of these changes in the tax structure and in the hydrocarbons sector itself.

Finally, in graph 5 we present the evolution of the sources of financing of public investment. Internal resources were higher during the 1990’s when the Bolivian economy
experienced an economic boom due to the implementation of the market liberalization reforms. But then, in the 2000’s internal resources decreased along with the economic, political and social crisis. Since 2005, Bolivia has been experiencing an economic boom, due to the excellent international economic situation (until mid 2008) and notice how important has been the increase in internal resources for public investment. Internal resources experienced an outstanding growth, never seen before.

Graph No.5
Public Investment by Source of Financing
(in thousands of dollars)

Source: UDAPE

We are sure that the results of the research will lead to a serious debate related to public policies and it will contribute in terms of a quantitative analysis. The absence of appropriate macroeconomic tools has penalized quantitative analyses in the last years. More generally, it must be recognized that there are few instruments which can relate macroeconomic policy and microeconomic behavior. DSGE models are however the exception in this area.

V. Methodology

The goal of this study is to build a simple neoclassical DSGE model of an open economy and calibrate it for the Bolivian economy. Recent years have witnessed the development of a new generation of DSGE models that build on explicit microfoundations with optimizing agents. Major advances in estimation methodology allowed estimating variants of these models that are able to compete with more standard econometric models. Accordingly, the new generation of microfounded DSGE models provides a framework that appears particularly suited for evaluating the consequences of public spending in infrastructure in an economy with four sectors and a government that receives its income from taxes and profits of one of the sectors. In addition the economy is opened to External Debt.5

5 External debt will be considered also as a proxy for Foreign Direct Investment (FDI) as it is the private sector which has access to external debt.
We will construct a DSGE model of an open economy with four sectors. The model will be based on Chumacero, Fuentes and Schmidt-Hebbel (2004), but modified to include public investment in infrastructure as in Rioja (2001) and the partition of the exportable sector in a sector that is intensive in capital and another that is less intensive in capital as in Estrada (2006). The model will be suitable to perform numerous and interesting scenarios related to fiscal policy (increase or decrease of taxes, current spending, public investment), shortage of external debt, fall in the price of energy-goods and commodities (minerals), variation in country-risk, among others.

The economy is inhabited by a representative agent who maximizes the expected value of lifetime utility as given by

\[ E_0 \sum_{t=0}^{\infty} \beta^t u(c_{m,t}, c_{n,t}) \]  

where \( c_{m,t} \) represents consumption of importable goods (m) and \( c_{n,t} \) represents consumption of non-tradable goods (n) in period \( t \). The other goods that are produced in the economy are exportable goods which we denote (xh) as the hydrocarbon good (natural gas) and (xm) as the mineral good (zinc, gold, silver or tin).

Each household receives interest income \( r_k \), lump-sum transfers from the Government \( F \), profits from the importable, non-tradable and mineral firms \( \pi_m, \pi_n \) and \( \pi_{xm} \) respectively and can also contract foreign debt abroad, \( b \). So, the household’s budget constraint is

\[
(1 + \tau_m)(1 + \tau_{cm})c_m + (1 + \tau_{cm})(1 + \tau_m)i + (1 + \rho)b \leq (1 - \tau_k)(1 + \tau_m)(1 + \tau_{cm})r_k + b_{t+1} + F + \pi_m + \pi_n + \pi_{xm} \]  

where \( \tau_m \) is an import tariff, \( \tau_k \) is the tax on capital income, \( \tau_{cm} \) and \( \tau_{cm} \) represent the tax rates on consumption of importables and non-tradables, \( p \) is the relative price on the non-tradable good in terms of the importable good and \( \rho \) is the (net) interest rate paid on foreign debt. Private investment, which we denote by \( i \), follows the standard law of motion for private capital:

\[ k_{i,t} = (1 - \delta)k + i \]  

There are four sectors in the economy: importable, non-tradable, exportable intensive in capital and exportable less intensive in capital. In each sector there is an equal number of representative firms that require private capital (k) and public capital (k*) to produce their goods. We assume that labor is sector specific.

The profits in the importable good’s sector are determined by

\[ \pi_m = (1 + \tau_m)f(z_m, k_m, k^*) - (1 + \tau_m)(1 + \tau_{cm})r_k \]  

\[ m \]
where \( z_m \) is a productive shock and \( k_m \) is the amount of private capital demanded.\(^6\) We can think as this sector represents the manufacturing sector.

Profits for the non-tradable good’s sector are given by

\[
\pi_n = pf(z_n, k_n, k^*) - (1 + \tau_m)(1 + \tau_{cm})r k_n
\]  
\[\text{(5)}\]

where \( z_n \) is a productive shock, and \( k_n \) is the amount of (importable) capital demanded by the sector, which we can assume that it is the service’s sector.

There is a hydrocarbon’s sector which is intensive in capital and whose profits are given by:

\[
\pi_{sh} = q_{sh} f(z_{sh}, k_{sh}, k^*) - (1 + \tau_m)(1 + \tau_{cm})r k_{sh}
\]  
\[\text{(6)}\]

where \( q_{sh} \) is the relative price of the exportable good intensive in capital in terms of the importable good.

The other exportable sector (mining) is less intensive in capital and has a similar profit’s function:

\[
\pi_m = q_{xm} f(z_{xm}, k_{xm}, k^*) - (1 + \tau_m)(1 + \tau_{cm})r k_{xm}
\]  
\[\text{(7)}\]

where again \( q_{xm} \) is the relative price of minerals in terms of importable goods.

The government invests in infrastructure \((I)\), has current expenditure consumption \((g)\) and provides lump-sum transfers to households \((F)\).\(^7\)

It satisfies the following constraint:

\[
g + F + I = \tau_m (c_m + i - f(z_m, k_m, k^*)) + \tau_{cm} (1 + \tau_m)(1 + \tau_{cm})r_k k + \pi_{sh}
\]  
\[\text{(8)}\]

Notice that in the right hand side of equation (8) we include all the taxes but also the profits from the hydrocarbons sector. This is in concordance with the nationalization of the hydrocarbon’s sector that took place in year 2007, with the new administration of President Evo Morales. In fact the hydrocarbon’s sector is meant as the strategic sector for the Bolivian economy and the main source of resources for the State.

As an extension we can further disaggregate some of the variables of the government budget constraint in the following manner:

\(^6\) Public capital \( k^* \) is the same for all sectors.

\(^7\) In the last years lump-sum transfers as the Bono Juancito Pinto for the kids and Renta Dignidad for the old people have become popular in Bolivia.
• On the expenditure side, we can explicitly include the capital provided by the government to the state oil company \(k_{oh}\) (it can be thought as the investment made in the hydrocarbon sector). Additionally, we can disaggregate public expenditure in current expenditure \(g\), and other expenditures \(g_o\) which represents expenditures in public health and education.

• On the revenue side, it is possible to include the collection of capital taxes on “investment” made by the government in the state-owned hydrocarbon’s sector. The usefulness of explicitly modelling the collection of taxes and profits from the oil company is that we can see more clearly how these revenues finance government expenditures, especially those intended for infrastructure, transfers to households and reinvestment in the hydrocarbon’s sector.\(^8\)

Public capital evolves according to

\[
k_{g,t+1} = I + (1 - \delta_g)k_g
\]

where \(0 \leq \delta_g \leq 1\) is a constant depreciation rate of public capital.

As in Rioja (2003) we assume that only the effective measure of the stock of public capital \(k_g\) is useful for private production. That is,

\[
k^* = \theta k_g
\]

where \(0 < \theta < 1\) is an infrastructure effectiveness index. The closer \(\theta\) is to 1, the more effective the public capital stock, and the larger the benefit that firms get.

The foreign sector determines the relative prices of the exportable goods in terms of the importables, i.e. the terms of trade. Terms of trade are assumed to follow the following law of motions:

\[
\ln q_{i,t+1} = (1 - \rho_{q_i})q_i + \rho_{q_i} \ln q_{i,t} + v_{q_{i,t+1}}; \quad v_{q_{i,t+1}} \sim N(0, \sigma^2_{q_i})
\]

We assume also that the country faces an upward-sloping supply schedule for debt and model it as:\(^9\):

\[
\bar{r}_{t+1} = (1 - \rho_r)\bar{r}_{t+1} + (1 - \rho_r)\frac{b_t^i}{y^i} + \rho_r \bar{r}_t + v_{r_{t+1}}
\]
where $\varphi > 0$ and $r_{it}$ is the country risk premium. Notice that this debt schedule depends on the ratio of external debt $b_t$ over output $y_t$. This is to avoid having to model the world credit market.

Finally, the market clearing conditions imply that consumption of non-tradables will be equal to the production of non-tradables, $p_y n = p c_n$, and the current account balance will be equal to:

$$CA = -(b_{t+1} - b) = q_{xh} y_{xh} + q_{xm} y_{xm} + y_m - c_m - g - i - I - \bar{r} b$$  \hspace{1cm} (13)

Equation (13) shows that the current account balance must be compensated by the capital account balance. Recall that the capital account is the registry of External Debt in our economy, in other words it shows how external resources for private investment and consumption flow into the economy.

These models are difficult to solve analytically. The alternative is to use numerical methods. Therefore, we will adopt functional forms for the utility and productions functions and give values to the parameters of the model to match exactly real data of Bolivia. Failure to exactly match the National Account ratios and key indicators will result in the extraction of inadequate results and not precise policy implications. Most of the parameters will be calibrated. Other parameters will be calculated, for instance the parameter $\theta$ will be calculated using infrastructure loss indicators as in Rioja (2003)

In particular for the production functions we will employ the following specification:

$$f(z_{i,t}, k_{i,t}^*, k^*) = e^{z_{i,t}} k_{i,t}^{\alpha_i} (k_{i,t}^*)^{\phi_i(\theta)}; \hspace{0.5cm} i = xh, xa, m, n$$

It is a typical Cobb-Douglas where $\alpha_i$ is the compensation for private capital as a share of output of each sector and $\phi_i(\theta)$ is the compensation for public capital as a share of output which is modelled as a function of effectiveness $\theta$. The rationale is that new public investment is more productive the higher the degree of effectiveness. This effect is sector specific, which means that an increase in public investment will have different impact depending of the value of $\phi$.

The solution to the DSGE model and the simulations will be approximated using the second-order approximation method proposed by Schmitt-Grohé and Uribe (2004a). The main advantage of this method is that it takes into account second-order terms or volatilities which enriches the analysis, since it represents uncertainty in the economy.

The welfare gains associated with an increase in infrastructure investment will be computed as in Schmitt-Grohé and Uribe (2004b). We will measure welfare as the conditional expectation of lifetime utility as of time zero, that is,

$$welfare = V_0 = E_0 \sum_{t=0}^{\infty} \beta^t u(x_t)$$  \hspace{1cm} (14)
where $x^j_t$ is the contingent plan for any argument in the utility function. Basically we will compare two regimes, a reference policy regime and an alternative regime and compute the gains (costs) between both regimes.

Another advantage of using second-order approximations to solve the model is that welfare gains are measured more precisely. Kim and Kim (2003) criticize methods based on first-order approximations, like linear-quadratic and others, because they are so inaccurate as to generate even spurious welfare reversals.

The analysis will concentrate in the solution of the second-order approximation of the model around the deterministic steady state. We will examine the general equilibrium effects on steady-state growth and welfare of increasing the share of public investment in infrastructure. Besides simulating the model in steady state, we will analyze the dynamic transition effects, on the composition of output and consumption, trade, the real exchange rate, aggregate consumption, output and welfare.

Using the DSGE model we can simulate different scenarios for the Bolivian economy, by changing the values of key parameters. We propose to simulate the following scenarios:

- Reducing the import tariffs.
- Increasing in the capital tax (value-added tax).
- Increasing government current expenditures.
- Increasing the consumption tax on importables.
- Increasing Total Factor Productivity (TFP) in some and all sectors.
- Increasing country risk due to political instability.
- Decreasing or eliminating hydrocarbon’s sector profits as a source of income for the government.
- Changes in external debt and its effects on financing private investment, for example caused by changes in country risk.
- Change in government transfer programmes (Bono Juancito Pinto, Renta Dignidad, or others)
- Fall in the relative price of exportables (natural gas and/or minerals).
- Sensibility analysis with the parameters $\phi$ and $\theta$.

VI. Data requirements and sources

One of the main advantages of DSGE models is that data requirements in terms of time series are few, since most of the parameters are calibrated. As it is a macroeconomic model, primal sources of information will be the National Institute of Statistics (INE), the Unity of Analysis of Economic Policies (UDAPE) and the Central Bank of Bolivia (BCB) from where we will extract all data related to the National Accounts, interest rates and external debt. We will employ quarterly data.

For instance the capital shares ($\alpha_{xi}$) of the exportable sectors will be extracted from the input-output matrix. The parameters of external prices ($q_{xi}$) of these sectors that follow
AR(1) processes will be estimated using OLS regression. The data for these regressions will be extracted from the World Development Indicators (World Bank). The tax rates on consumption of importable goods and non-tradable goods will be approximated by the tax rate of the Value-Added tax which is 13 percent. The tax rate on capital income will be approximated by the Profits Tax which is 25 percent.

The effectiveness parameter $\theta$ will be estimated using the infrastructure loss indicators provided by the World Bank (World Development Report 1994) actualized with data from the Regulatory System in Bolivia. The coefficient of public infrastructure in production, $\phi$, will be calibrated according to the different usage of public infrastructure in each sector.

Finally, the country-risk premium will be approximated as the difference between the quarterly interest rate on treasury bonds in Bolivia and the corresponding treasury values of the U.S. The U.S. treasury bond rates will be extracted from the Federal Reserve Bank statistics.

VII. Dissemination strategy

The relevance and impact of this work will depend also on activities intended to discuss and disseminate the preliminary and final results. This research is circumscribed in the area of Modeling and Policy Impact Analysis (MPIA), so it will be important to disseminate the results primarily to policy makers working in the fiscal sector in Bolivia. In addition, we will disseminate the results among the academia and civil society.

Few weeks ago, Bolivia has approved its New Constitution. In the New Constitution a central role in the economy is given to the State. Therefore, the government is changing the State structure in Bolivia by incorporating new roles for it and expanding the attributions of fiscal policy. The study will be useful as a guide for fiscal income management, efficient current spending and public investment. Therefore, we will disseminate the results among policymakers of the Ministries of Economics and Public Finance, and Planning, who are the people in charge of implementing the economic reforms proposed in the New Constitution.

The direct contact with policy makers is one of our foremost objectives. The senior researcher (Carlos Gustavo Machicado) is a formerly researcher from UDAPE, which is the Research Office of the Ministry of Planning. He has a direct and close contact with the actual Executive Director of UDAPE (Lic. Viviana Caro), so it will be easy to establish a regular contact and interact with their fiscal policy researchers, through meetings, workshops and discussion tables.

Paul Estrada is a consultant in the Ministry of Economics and Public Finance and he has already established contact with technicians and authorities of the Ministry. They expressed their interest in the results of the paper and are awaiting for use them in the future to guide the public investment and expenditure policy.
In addition, Carlos Gustavo Machicado teaches at the Bolivian Catholic University (UCB), the Bolivian Private University (UPB) and the Andean University “Simón Bolívar”. These universities are very interested in disseminate these results among the academy. Academic seminars will be organized jointly by INESAD and the mentioned universities. In addition, the Andean University has some executive master’s degree programs directed to people that work in the public sector. Therefore, seminars will be organized in this university to influence not only policy makers, but also public sector officials who implement day to day the public policies.

The institution where we belong (INESAD) is one of the leading research institutes in Bolivia, with some of their members working in the public sector. One of the main researchers, Osvaldo Nina, is the actual Vice-President of the Bolivian Central Bank. Therefore, it will be possible to present the results to Central Bank executives and organize open seminars with the Central Bank in order to disseminate the results to the civil society.

At the INESAD, we work also with Luis Carlos Jemio, who is an expert in CGE models and a former Minister of Finance. We will be able to learn a lot from his experience (academic and empirical) by interacting continuously with him and sending preliminary reports about the progress of the research and organizing discussion seminars with former policy makers. INESAD’s Director –Lykke Andersen- will provide also technical support.

Related to publications and media to disseminate the results, INESAD is the first institution in Bolivia to have its Working Paper Series included in the World’s largest on-line database of economics working papers and journal articles (EconPapers). The final version of the research will be published as a Development Research Working Paper (http://www.inesad.edu.bo/wps.htm).

Preliminary results will be transmitted through our institutional blog, the Monday Morning Development Newsletter (MMDN) (http://www.inesad.edu.bo/mmblog.htm). The brief MMDN is intended as a “snack for thought” for the development community and other policy makers in Bolivia. These brief articles are distributed by mail, every Monday, to more than 400 people around the world.

Finally, we plan to organize a big national seminar to present the final draft of the paper, where we will invite other PEP researchers. We hope PEP, could give us a grant for the organization. The aim of this seminar is to disseminate not only our work, but also PEP’s network in poverty research.

All of these dissemination activities aim not only to present the results, they also aim to get a feedback from the audiences and people with whom we will interact. This will be of great relevance to ensure the quality of the paper.

VIII. Research team and institutional background

The research team consists of the following three members:
Senior Researcher: Ph.D. Carlos Gustavo Machicado, Institute for Advanced Development Studies (INESAD), La Paz, Bolivia.
Researcher 1: MSc Paul Estrada, Institute for Advanced Development Studies (INESAD), La Paz, Bolivia.
Researcher 2: MSc(c) Ximena Flores, Institute for Advanced Development Studies (INESAD), La Paz, Bolivia.

Carlos Gustavo Machicado works as researcher at INESAD. He holds a Ph.D. in Economics from the Doctorado Latinoamericano (University of Chile). He is also professor at the Bolivian Catholic University (graduate level) and at the Bolivian Private University (undergraduate level). His recent research has focused on General Equilibrium Models, in particular DSGE models. He has developed a model that analyzes the dollarization process in Bolivia and recently he worked on a paper related to infrastructure investments in five Latin American countries (paper elaborated for the CAF).

Paul Estrada works as consultant at the Bolivian Ministry of Economics and Public Finance. He holds a Master's Degree in Economics at the University of Chile. He has interest in research on general equilibrium models. He calibrated a DSGE model for Bolivia in his M.Sc. thesis. Paul also is teacher at the University “Nuestra Señora de La Paz” in the course Theory and Fiscal Policy.

Ximena Flores is a former junior researcher at INESAD. She finished her Master’s Degree studies in economics at the University of Chile. She worked as research assistant at the Unity of Analysis of Economic Policy (UDAPE) and made an internship at the Andean Community of Nations (CAN). She worked as economic advisor in the State Oil Company (YPFB) and now works as consultant at the Ministry of Hydrocarbons.

For further information, please consult the CVs in Appendix.

The research project will be based at the Institute for Advanced Development Studies (INESAD) in La Paz, Bolivia. INESAD was created in 2003, and quickly became Bolivia’s leading development research institute, with close to 50 working papers and a regular Monday Morning Development Newsletter, several of which are on the topic of education (see www.inesad.edu.bo). The institute will provide office space, computers, Internet access, telephone services, and all the stuff necessary to assist the researcher and the research assistant with practical matters.

**IX. Expected Capacity Building**

The Institute for Advanced Development Studies (INESAD) was created to analyze particular problems of underdevelopment countries, with particular attention in Bolivia. One of the main topics that should and is effectively being analyzed is the problem of development and growth. As part of this area, particular attention is put in fiscal policy analysis and its impact on development.

As researchers from the INESAD, we want to improve the use of general equilibrium models to analyze economic issues like growth, optimal policies, poverty, natural resources
management and other themes. In previous years, researchers Lykke Andersen and Luis Carlos Jemio have trained junior researchers in the use of CGE models. See for example the paper by Andersen et al. (2006).

Our main objective is to train now, other junior researchers in the use of this other type of general equilibrium models which are the DSGE models. New computational tools and easy to work with them have been developed in the last years. See for instance the toolkits of Uhlig (1997), Schmitt-Grohé and Uribe (2004a) and Mancini Griffoli (2007). In this research it will be shown how to work with all of these toolkits, paying special attention to second-order approximation techniques or perturbation methods.  

Carlos Gustavo Machicado is specialist in Dynamic Stochastic General Equilibrium Models. In fact, one of his Dissertation papers consisted in building up a DSGE model for a partially dollarized economy. The model has been calibrated for Bolivia. Recently, he finished also a paper where he calibrates another DSGE model for five Latin American countries (Machicado, 2007). In that model, he analyzes the macroeconomic effects of raising public investment in infrastructure (as a share of GDP) in those countries. As specialist in this area and as professor he will train people in building up DSGE models and programming in Matlab. The trainees will be the research assistants from INESAD, but also people from the Central Bank and the Private University in Bolivia which are the two institutions where he gives lectures in DSGE models.

Paul Estrada is a researcher in Dynamic Stochastic General Equilibrium Models, works as consultant at the Ministry of Finance of Bolivia. He wrote the paper “Economía Pequeña, Abierta, Exportadora de Gas y Soya, con Shocks Internos y Externos: Cambios que Bolivia no esperaba” presented at the annual meeting of the Economics Society of Chile (September 2006).

Ximena Flores has specialized in the hydrocarbons sector. After working for the State Oil Company (YPFB), she joined the Ministry of Hydrocarbons, where she works as consultant. She also has experience in education topics. While she was doing her MSc, she built up an interesting and complete data base on education indicators, in order to analyze education quality in Latin America. This experience will be also important in the second stage of the study, where we plan to introduce education and health in the model.

Theoretically, the paper contributes to the growth literature. In particular to the literature initiated by Romer (1986), Easterly and Rebelo (1993), Canning and Fay (1993) and Canning (1999) where it is generally found that public infrastructure has positive effects on a country’s productive performance. One of the main implications of this literature is that developing countries need additional public investment in order to grow. We aim to expand our capacity in this area.

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10 In the team we will include our research assistants as junior researchers, they are: Soraya Román, Mauricio Villalba and Horacio Valencia.  
11 Actually, the Central Bank and the Private University of Bolivia are the unique institutions that have Diplomas in General Equilibrium models.  
12 See, e.g. Barro and Sala-i-Martin (2004), and Aghion and Howitt (1999) for references as well as Romer (1990) for an excellent review paper.
In sum, we aim to strengthen the INESAD as the reference institution in Bolivia for General Equilibrium Models (CGE and DSGE models). We want to show and widespread the advantages of micro founded forward-looking rational expectations models as a powerful tool to analyze key relations and variables. In addition, we hope to put the seed for a wide use of this type of models in the policy making process in public institutions.

X. Any ethical, social, gender or environmental issues or risks which should be noted

There is no ethical, social, gender or environmental issues or risks related to this research project. Bolivia is a democratic country, so everybody is free to express his opinion and to develop his ideas in a scientific way, as this research is going to be.

XI. List of past, current or pending projects in related areas involving team members

As already mentioned, Carlos Gustavo Machicado is specialist in this type of general equilibrium models and in general equilibrium models in general. He already has two calibrated DSGE neoclassical models for the Bolivian economy. Although those models are simple, they provide important insights related to macroeconomic impacts of monetary and public investment policies.

Actually, he is working in a general equilibrium model of industrialization. He with two coauthors plan to analyze the impact of big changes in institutional arrangements like an agricultural reform in the process of capital accumulation. We plan to show that an important increase in productivity in the agricultural sector is a key ingredient for an industrialization process. This project is in line with the papers of Hansen and Prescott (2002) and Gollin, Parente and Rogerson (2002).

Paul Estrada is actually working as consultant at the Ministry of Finance of Bolivia develop a methodology for sub-national fiscal performance. Paul is also a member of INESAD team working on this research proposal.

Ximena Flores is actually working as consultant at the Ministry of Hydrocabons. She has ample experience in the hydrocarbon sector, because she worked as economic advisor for the State Oil Company (YPFB). Between 2006 – 2007, she was a member of the economic staff that gave technical support to the renegotiation of the new Operation Contracts with private and foreign oil companies.

XII. References


Appendix : CVs of Researchers

Carlos Gustavo Machicado Salas
Institute for Advanced Development Studies (INESAD)
Calle 21, No. 8350, Piso 7, La Paz – Bolivia
Telephone: 591-2-2146069, 591-77231809
cmachicado@inesad.edu.bo

PERSONAL INFORMATION:
Date of Birth: June 5th 1973
Citizenship: Bolivian

EDUCATION:

Universidad de Chile – Santiago (Chile), Ph.D., Economics\textsuperscript{13} 2006
Pontifical Catholic University - Rio de Janeiro (Brazil), M.Sc., Economics 2000.
Bolivian Catholic University - La Paz (Bolivia), B.A., Economics 1997.
German School “Mariscal Braun” – La Paz (Bolivia), B.Humanities 1991

PROFESSIONAL EXPERIENCE:

- Professor, Department of Economics, Bolivian Catholic University, La Paz – Bolivia, 2007-2009.
- Professor, Department of Economics, Bolivian Private University, La Paz – Bolivia, 2006-2009.
- Professor, Department of Economics, University of Chile, Santiago de Chile, 2005.
- Professor, Department of Economics, Bolivian Catholic University, La Paz – Bolivia, 2000 – 2002.
- Teaching Assistant, Department of Economics, Bolivian Catholic University, La Paz – Bolivia, 1996 – 1997

COURSES TAUGHT:

- Macroeconomics in Developing Countries, Bolivian Catholic University (graduate), fall 2007.

\textsuperscript{13} Doctorado Latinoamericano – Universidad de Chile (Chile), ITAM (México) and Universidad Torcuato di Tella (Argentina).
• Macroeconomics II, Bolivian Catholic University (undergraduate), fall 2008 and 2009.
• Economic Policy, Bolivian Private University (undergraduate), fall 2007 and 2008.
• Monetary Theory and Policy, Bolivian Private University (undergraduate), spring 2007.
• Econometrics I and II, Bolivian Private University (undergraduate), spring 2006.
• Macroeconomics I, University of Chile (undergraduate), 2005.
• Monetary Economics, Bolivian Catholic University (undergraduate), spring 2000 – spring 2002.

CHAPTERS IN BOOKS:


PUBLICATIONS:

• “Macroeconomic and Welfare Effects of Public Infrastructure in Five Latin American Countries,” (forthcoming Revista Perspectivas, CAF).
• “Essays on Partially Dollarized Economies” Thesis submitted to the Doctorado Latinoamericano (Universidad de Chile) in fulfillment of the requirements for the degree of Doctor of Philosophy, Santiago de Chile, 2006.
• “La dolarización y el déficit fiscal en Bolivia” Documento de Trabajo 04/97 IISEC, Bolivian Catholic University, La Paz – Bolivia, 1997
• “Señoriaje: Financiamiento Monetario del Déficit Fiscal” Thesis submitted to the Department of Economics of the Bolivian Catholic University in fulfillment of the requirements for the degree of Bachelor in Economics, La Paz - Bolivia, October 1997.

WORK IN PROGRESS

• “The role of productivity in Latin American development” (joint with Antonio Saravia and Felix Rioja).
• Misallocation and Manufacturing TFP in the Market Liberalization Period of Bolivia
• Technological Progress and Productivity in the Quinoa Sector
• Understanding Productivity Levels, Dispersion and Growth in the Leather Shoe Industry: Effects of Size and Informality.

CONFERENCE AND SEMINAR PRESENTATIONS:

• 2008/11: Latin American Meetings LACEA-LAMES, Rio de Janeiro - Brazil, November 20-22, 2008, organized by Fundação Getulio Vargas, Graduate School of Economics (FGV/EGPE) and Instituto Nacional de Matemática Pura e Aplicada (IMPA).
• 2007/10: Latin American Meetings LACEA-LAMES, Bogotá - Colombia, October 4-6, 2007, organized by Fedesarrollo and the Department of Economics, Universidad de los Andes.
• 2007/05: Bolivian Catholic University, Department of Economics Seminar, organized by Institute for Advanced Development Studies.
• 2006/11: Latin American Meetings LACEA-LAMES, Mexico City, November 2-4, 2006, organized by ITAM.
• 2006/04: Center for Applied Economics (CEA), Universidad de Chile.
• 2005/04: Center for Applied Economics (CEA) Universidad de Chile.

CONSULTING:

• Análisis de Situación y Tendencias de los Principales Sectores Económicos y el Impacto en el Sistema Financiero (SBEF – PROFIN), November 2008 – November 2009.
• Modelo de Evaluación de Propuestas de Descentralización (CEPAL – GTZ), November, 2006.
• Eficiencia y Equidad: El Reto de la Descentralización (CEPAL-GTZ), October 2006.
• Lineamientos de Política Macroeconómica (UDAPE – PNUD), January 2006.

PRESS ARTICLES:

• ¿Contagio entre Bolivia y Argentina?. Nueva Economía, pp. 8, N° 438, July 2002 (joint with Jorge Escobari).
• ¿Qué señales quiere dar el FMI con Argentina?. Nueva Economía, pp. 4, N° 413, February 2002.

AWARDS AND FELLOWSHIPS:

• Award for the best undergraduate thesis - Asociación de Esposas de Diplomados en Altos Estudios Nacionales – April 1999.

LANGUAGES AND COMPUTER SKILLS

• Spanish (native), English (fluent), German (fluent) and Portuguese (fluent).
• Matlab, Stata, E-views, SWP, Tex.

REFERENCES

Todd Keister, Senior Economist, Macroeconomic and Monetary Studies Function Research and Statistics Group, Federal Reserve Bank of New York, 33 Liberty Street New York, NY 10045, Phone: (212) 720-2267, Todd.Keister@ny.frb.org.

Romulo Chumacero, Director - PhD in Economics, Department of Economics – Universidad de Chile, Central Bank of Chile, Av. Diagonal Paraguay 257 – Ofic. 1603-c Santiago de Chile, Phone: (56-2) 678-3436, (56-2) 678-3413, rchumace@econ.uchile.cl.

Juan Antonio Morales, Director, Department of Economics, Bolivian Catholic University, Maestrías para el Desarrollo, Campus UCB, Av. 14 de Septiembre esq. calle 2, Obrajes, La Paz – Bolivia, Phone: (591-2) 278-2222, fax (591-2) 276-6707, jamorales@ucb.edu.bo.
Paul Estrada Céspedes

Personal Data:

Date of Birth: August 1, 1978.
Nationality: Bolivian.
Cell: (591) 7 7572341.
Email: paulestrada2@gmail.com

Education:

Universidad de Chile, Faculty of Economics and Business
Santiago, Chile (2004 – 2005)
• Graduate Studies Program at the Masters in Economics.
• Grade: Magíster in Economics.

Bolivian Catholic University, Department of Economics
La Paz, Bolivia (August 1996 – May 2003)
• Grade: B.A. Economics.

Professional Experience:

Institute for Advanced Development Studies (INESAD)
Researcher
La Paz, Bolivia (Present)

Ministry of Economics and Public Finance
Consultant
La Paz, Bolivia (Present)

Unit of Analysis for Social and Economic Policies UDAPE
 Economist II, Fiscal Sector – Sub direction Macroeconomic
La Paz, Bolivia (May 2007 – March 2008)

University of Chile
Research Assistant
Santiago, Chile (August 2006 - February 2007)

Interamerican Institute for Cooperation on Agriculture IICA, Representation in Bolivia
Technical and trade policies
La Paz, Bolivia (August 2002 - February 2004)

Teaching experience
University Nuestra Señora de La Paz.
Teaching Theory and Fiscal Policy
La Paz, Bolivia (Present)

Technical University of Oruro, Faculty of Economics and Financial Management
Teaching Seminar Terminal Thesis I of Commercial Engineering
Teaching Seminar Terminal Thesis II
Oruro, Bolivia (2007)

Bolivian Catholic University
Assistant professor and assistant to the Department of Economics
Assistant professorship Macroeconomics
La Paz, Bolivia (July 2000 – December 2001)

Publications and Presentations:


Courses Specialization:

Bolivian Catholic University
La Paz, Bolivia (February – June 2008)
Diploma in Teacher Education for higher education.

CEPROBOL
La Paz, Bolivia (2002)
Course on International Trade "Management of exports."
Module: Rules of International Trade.

Bolivian Catholic University
La Paz, Bolivia (1999)
Management Programs Econometric.
Module: Classics regression models.

Honors and Awards:

• Distinction Honor, for having obtained 100% rating in public undergraduate thesis: Bolivian Catholic University. 2003.
• Gold Medal, for being the best management Bachelor of 1995, College Ignacio León, Oruro - Bolivia.

**Languages and Computer Skills:**

• Spanish (native), English (intermediate) and Portuguese (Basic).
• Matlab, E-views, Gauss.
Ximena Patricia Flores Orellana

I. PERSONAL INFORMATION

» DATE OF BIRTH : December 29, 1976
» CITIZENSHIP : Bolivian
» PHONES : (591-2) 2226065 – (591) 70571775
» E-MAILS : ximenaflores3@gmail.com
            xflores@inesad.edu.bo

II. EDUCATION

Universidad de Chile – Santiago (Chile), M. Sc.(c) , Economics 2004.
Bolivian Catholic University - La Paz (Bolivia), B.A., Economics 1998.

III. EMPLOYMENT HISTORY

Area Chief, Unit of Public Credit, Direction of Finance, Municipal Government of La Paz
(GMLP), La Paz – Bolivia, 2007-2008.

Economic Analyst (Integrant of Economic Staff as technical support of the renegotiation of
the new Operation Contracts), Yacimientos Petrolíferos Fiscales Bolivianos (YPFB), La

Technical Assistance of the Macroeconomic Division, Unit of Analysis of Social and

IV. WORK IN PROGRESS

“Una aplicación de la descomposición de Juhn, Murphy y Pierce en el Segundo Estudio
Regional Comparativo y Explicativo (SERCE)”. SERCE is a regionally designed and
operated educational assessment that was conducted in 13 Latin American countries by the
Laboratorio Latinoamericano de Evaluación de la Calidad de la Educación (LLECE) from
the UNESCO.

V. CONSULTING


VI. PUBLICATIONS


“Fuentes de las fluctuaciones económicas en Bolivia en la década de los noventa” Thesis submitted to the Department of Economics of the Bolivian Catholic University in fulfillment of the requirements for the degree of Bachelor in Economics, La Paz - Bolivia, 2002.

VII. AWARDS

2000 Selected to represent to Bolivia (internship), Fourth Program of Trade Negotiations, Secretaría General de la Comunidad Andina de Naciones (CAN), Lima – Perú
2003 – 2004 M. Sc.’s Fellowship, Universidad de Chile, 2003-2004

V. LANGUAGES AND COMPUTER SKILLS

» Spanish (native), English (fluent)
» Eviews, Stata, Gauss.

VI. REFERENCES

» Fernando Jiménez
  Director of External Financing, Vice-Ministry of Public Investment and External Financing, Ministry of Development Planning.
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» Rómulo Chumacero Escudero
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