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THE CHILEAN ECONOMY EXPERIENCE: THE WEAKNESS OF THE SOLOW MODEL

Abstract

The lost decade (1980-1990) for Latin American economies, required an alternative economic model. The Chilean economy case came from a free market economy whose main theoretical support concerning output performance was the Solow Model, with positive macro empirical evidence in advanced economies (USA). But, Solow's growth model is based on the unrealistic assumption of homogeneous capital, despite the fact that capital goods are highly heterogeneous. Consequently, it is not easy to arrive at a steady growth path when there is heterogeneity of capital goods. Besides, its assumption about full employment leads to overestimating output expansion and a negatively biased social policies efficiency due to a lagged response arising from the gap between actual and expected (overestimated) output growth.

This paper will review some fundamental weaknesses of that model when applied to less developed economies, such that despite its simplicity in explaining economic growth performance, it lacks the microeconomics foundations to understand the nature of economic growth and its implications for social policies. The main conclusion of this essay deals with the consequences for an LDC's economy to overestimate its output growth trend for setting social policies, business decisions and strategies for internationalization, and the Government's effort to play a reliable fiscal rule policy.

Keywords: *Microeconomics fundaments. Solow Model, economic growth, policy weakness*

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1. Introduction

The economic model implemented in Chile since the mid-seventies has been under the scrutiny of t™hose who thought it was a benchmark, as well as those who have been its critics. It should be considered that between 1975-1980, Chile and many Latin American economies were in the last stage of an import substitution model, which through tariffs and exchange controls, nullified exports as the source of expansion and growth. Without an increase in exports, it was not possible to get the aim to reduce foreign dependence. Entirely on the contrary, there wasn't another choice but to increase public debt not only with international organizations (World Bank, IMF) but also with private Banks. The outcome was the External Debt Crisis and the Lost decade (1980-1990). Thus, it increased the systemic risk level such that it became harder to get new investments flow unless big change in the fundamentals of the economic model in place.

The Chilean economic model had already corrected the key flaws of the import substitution approach applying the new fundamentals such as: increasing the role of the private sector and markets, more efficient financial markets, and openness to the world and international trade, all leading to boost economic growth. The comparative advantage theory suggested that better use of resources was possible. At the same time, the economy increased its trade flows with the rest of the world instead of focusing only on its smaller domestic market.

Free markets became the source for services like social security, health, and education, as well as the provision of natural resources like water and energy, opening up a space to develop further on the premise that reducing poverty requires a necessary condition to increase wealth. At the same time, the State played a subsidiary role: leading from behind the private sector.

The theoretical support concerning output performance was the Solow Model, with overall positive macro empirical evidence in advanced economies (USA). But, based on the unrealistic assumption of hom§§§§wogeneous capital, even though capital goods are highly heterogeneous. Durlauf, Kourtellos, Minkin (2001), Nkalu, Edeme, Chukuruma (2018). Consequently, it is not easy to arrive at a steady growth path when there are heterogeneity of capital goods and endogenous variables. Caselli, Esquivel, Lefort (1996), Closed economy; Barossi-Filho, Goncalves, Martins (2005), either low convergence rate Barossi-Filho et al (2004) or Lack of convergence (1960-2008) Hendricks (2023).

Furthermore, the Solow model has additional important limitations dealing with the lack of human capital; Mankiw, Romer, Weil (1992), Constant return of scale; Solow(1994), Lack of endogenous variables; Caselli ,et al (1996), Production function specifications; Duffy and Papageorgiou (2000), Durlauf ,et al (2001),Wulf (2020), the share of income share does not match national accounting data Barossi-Filho et al, (2004), mismatch between growth rate and the data.Hendricks(2023).Full employment assumption and investment independence from firms Magnani,(2015), capital homogeneity Nkalu , et al (2018).

2. Material and methods

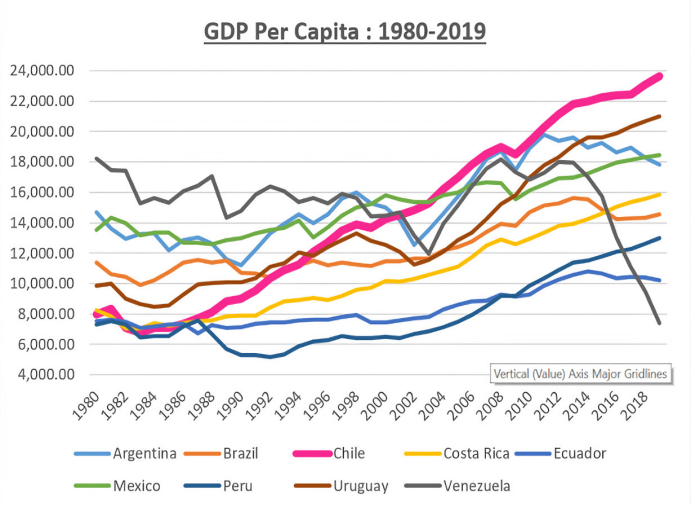
2.1. Macroempirical outcome of the Chilean economy and the empiric of the Solow model

In the 1990s; the participation of the private sector moved forward to granting public infrastructure services (roads, ports, airports, water reservoirs, telecommunications networks), and co-finance of university loans, and in the 2000s, it was extended further to the construction of hospitals and state prisons. The impact was decisive to increase the potential output and productivity in such a way that in the period 1986-1997, the average economic growth rate was 6,7%(y/y),and 1/3 of it, was due to higher total productivity Selaive (2018). Following methodological adjustment, it turned out to be the

case that, like other cases of growth performance, the capital contribution became the most relevant variable. Durlauf, Kaurtellos & Minkin (2001), Nkalu, Edeme, & Chukuruma (2018), Ffrench-Davis (2019).

The overall performance between 1980-2019 (Figure Nº1) lead the Chilean economy to become the benchmark to follow for other countries of Latin America to get the goal of development.

Figure Nº1



Source: GDP per capita of Selected Latin American countries. IMF (2019) www.promarket.org

The model and its market-based premises fulfilled the preliminary expectations, which it was reinforced in the following years (2000-2018), when the poverty index was reduced to 8.5%, and inflation (a variable which generates poverty), stabilized in a range of 2%-4%. Furthermore, economic growth allowed Chile to increase its per capita income level from USD 4500 in 1990s to almost USD 26000 in 2018. The expectation for the following years (2021-2022), assuming a steady economic growth, was to reach out to USD 30000, close to 60% of Spain's per capita income and more than 80% of Greece's per capita income, measured in terms of purchasing power parity (PPP). (Wulf, 2021).

Higher-income has generated an impact on quality of life conditions in terms of the opportunity to choose a wider variety of alternatives, facilitating massive access to new kinds of goods and services, and improving the human development index up to 0,843 (UNDP,2017). Let's take the case of modern technologies; with almost 1,5 cell phones per habitant, and an average use of the internet of 37 hours a week, connectivity has reached 60% coverage in the 4G LTE mode, transforming Chile as the most technologically advanced nation of Latin America, placed it 25 among 50 countries. (Global connectivity index, Huawei, 2017).

On the social side and despite criticism, the private pension system has been a key instrument to sustain financial markets with its resources endowment equivalent to 80% of GDP, which complements and eventually offsets external resources necessary for investment, as was the case in the Asian crisis of 1997. Besides, a reliable financial system and a strong institutional framework (Autonomous Central Banks) have become important assets for business options due to the expectation of sustained long-term economic growth.

3. Theoretical background

The proposed model followed a neoclassical approach well known as the Solow Economic growth model, which is based on simple assumptions concerning saving and investment as the key variables to sustain economic growth.

The main theoretical lines go as follows:

The Neoclassical Production function is the key to understanding the Chilean economies' difficulties along the way.

$$Yt=F(Kt,Lt) \tag{1}$$

Which becomes the Cobb Douglas production function

$$Yt=A\ t(Kt^{\varphi},Lt^{1-\varphi}) \tag{2}$$

"A" is a technological parameter, Ψ is the share of capital, and 1 – Ψ the labor share in output. $0<\Psi\leq 1$.

The constraint with this approach, is that both production functions (1) and (2) have important limitations as a reliable source for production decisions in emerging economies: Duffy and Papageorgiou (2000), Durlauf et al (2001), Wulf (2020):

a. As the model uses exogenous variables, it does not take into consideration the role of the management to sustain the decisions making concerning productivity, investment efficiency and technology improvement. It all comes down from the growth dynamic equilibrium on its own. In other words, the driver for efficiency is competition.-
b. Total factor productivity factor (At) does not increase instantaneously only because of competition but because of decision-making at all level of the firms about innovation and the economy as a whole which requires considering the institutional factors dealing with efficiency and transaction costs.
c. The way it is set the production function; better represent the advanced economies, which have faster technology development leading to productivity gains.

Besides, the format for labour changes linked to population growth is rather a weak setting given that it does not take into consideration the complexities of the individual who maximizes their utility when it comes to choosing between labour and other activities, leading to unemployment. Magnani (2015) and Wulf (2020).

The basic labour equation in the Solow Model is as follows:

$$\Delta Lt=nLt \tag{3}$$

Which says that over time; labour force (Lt) changes as population growth (n). It follows, that there were not labour shortages, and no consideration to labour quality at all, as a key determinant of labour productivity. Moreover, it make a fact of policy target to have full employment such that the quantity of labour was enough to sustain increasing output expansion. But as it was the Chilean

economy case, the level of labour force skills turned out to be below average in key abilities such as understanding and reading skills, foreign languages communications and effective decisions, which set a restriction to get steady productivity increase, therefore a natural trend to unemployment. Magnani (2015). In Chile, a mining worker produce 65% of his counterpart in USA, while in the industry sector produce 28%, and in banking activities 61%. Selaive (2018).

Besides, it leaves aside the fact that individuals have a rational approach to labour decisions, which leads them to choose between different alternatives concerning the most efficient use of their human capital endowment to maximize their welfare, being into the labour force, one of many other options. Wulf (2020).

The equation for capital stock changes (Kt) is as follows:

$$\Delta Kt = St - \delta Kt \tag{4}$$

Which says that capital stock increase with saving (S) and decrease due to depreciation (). Saving comes out as a fraction of income increases:

$$St = sYt \tag{5}$$

Thus, the Solow model proposes a relation between saving and investment as the main conditions for economic growth. As saving increases, so will investment and the capital stock out of management decisions; therefore given L, it will lead to national income and output increases. So, a key issue for policymakers was how to get saving and investment increases, especially in the short run.

$$Yt = Ct + St \quad or \quad Yt = Ct + It \tag{6}$$

Which leads to $Yt - Ct = St$ (7)

Equation (6) leads up to the condition, assuming that:

$$G = 0 \tag{8}$$

And ;

$$NX=0 \tag{9}$$

$$St=It \tag{10}$$

This is the equilibrium condition for a closed economy, without Government (G=0), taking the NX =0 and leaving out management business decisions.

These equations make the framework for the initial reforms of the Chilean economy done in the late seventies. Concerning total productivity increases, a labour reform was done in 1979 to make the labour market more flexible. On the other side, to increase savings, a reform for private pensions was done in 1982, applying a capitalization model to give a boost to the domestic financial market.

At a macro level, the private sector expanded in a whole variety of sectors (Health, Education, infrastructure, communications, banking, energy), all leading to reduce government intervention in the economy as the principal source of further productivity gains.

Less government intervention in the economy was assumed to be a matter of quantity (Reduction in public spending as a share of GDP) to avoid crowding out, leaving aside its quality as a variable to keep the scrutiny on, especially the public services policies, as well as the supply of public goods of higher quality (policies rules, effective tax policies, long run setting for productivity growth, public infrastructure).

Thus, there were a set of underestimated limitations with implementing the standard Solow Model in a less developed economy. Mankiw, et al (1992), Dufy et al (2000), Durlauf (2001), and Wulf (2020). Let's review the production function setting:

a. Equations (1) and (2) lack variables dealing with both private and public management decisions, such as the one it is proposed in its general form (Wulf,2020).

$$Yt=Mt(b)^{f}(Kt,Lt) \tag{11}$$

Where "M" represent management, which represents the ability to improve efficiency and productivity both within firms and the economy, to sustain economic growth given the resources endowment. "b" is an efficiency parameter and "f"> 0, which means that the expected output outcome, would be the highest possible given the constraint arising from institutional variables, capital endowment, and individual preferences between labour and alternatives activities In other words, a setting like the one proposed, would have given better signal both to business and policymakers, about the real performance of output growth. Wulf (2020), Fuentes (2021).

The implication of lacking a management variable meant that the economy, on its own, would not be capable of coping with all the requirements to sustain economic growth path. In particular, those ones related to institutional setting to make sure markets were in fact, competitive, controlling price collusion risk and market concentration, to improve consumer's protection, as well as business practices as well as property rights to improve innovation and new technology. Equations (1) and (2) suggest that there is not such constraint both, at the firm and economy level.

b. It follow that the Solow Model standard formulation had important limitations for a less developed economy which is more dependent of efficiency to close the gap with its steady State. In fact, given an expected output expansion path, equation (3), implies an overestimation of growth over time. In fact, when the Chilean Government implemented the fiscal policy rule (2001), the average ex-ante output trend based upon the Solow model exceeded the ex-post output growth by 0,7% per year, during a long period of time (2003-2019). Taking the year 2001 as a reference, the projected GDP growth was higher than the effective by 0,8%.Therefore, to have overestimated the government revenues above its real level became a regular mismatch between the expected fiscal surplus as a target and the ex-post measured one leading to overspending and undersaving, placing a distortion in the macroeconomic stability setting. Fuentes (2021).

This output overestimation also leads to business decisions based upon higher expectations about investment and growth in domestic markets, inducing the expansion to foreign regional markets once it proved that investment was also overestimated. This is so because there is a positive correlation between output growth and investment increases. Ffrench-Davis, Diaz (2019).

Thus, while in the period 1990-1998, the Net investment/ GDP ratio was 21,05%, the following period, 1999-2003, it went down to 17,5% (similar to the period 1974-1989 of 17,2%), and in 2004-2007, it felt to 15,6%, to increase again in 2008-2013 (16.4%), which look like an investment cycle as it adjusts to the gap between the expected and actual (lower) growth. Ffrench Davis et al (2019)

Even more complex was the fact that, as the Chilean economy was so heavily focused on growth as the first step to solving social unbalances, its overestimation by the Solow – Model misled the timing of public policy correction, creating a policy lag which reduced its effectiveness with essential consequences to reduce inequality by effective social policies which depend upon stable resources.

c. It dismisses short-run shocks, such as there is no room for economic policy to influence the growth path. So, every financial crisis (1975, 1982.1997,2008) was an unexpected event without a policy tool kit available other than what was supposed to work better as emergency response. So, in 1982 the "available option" was either to get wages down or devaluation. In 1997, to increase the interest rate well above its equilibrium, or inflation and in 2008, to get rid of the fiscal policy rule or to have a deep recession.

d. Besides, the Solow Model, does not consider quality but only quantity, splitting long-run output growth component between inputs changes and total productivity factors, leaving aside human capital quality. Wulf (2020).

Thus, the initial reforms were supposed to increase saving, capital stock and investment, following the conditions suggested for the Solow Model in equations (3), (4), (5),(8) and (10), such as to focus on economic growth based on inputs and productivity increases as the key driver, except that it lead to an overestimated, output which implied a miscalculation about what it was necessary to do in terms of both social and public policies, as the economy went into its new setting. Fuentes (2021)

Besides, in a less developed economy, productivity gains would hardly come up without efficient government intervention. However, the Government was supposed to be a source of inefficiency, but it would be hard to expect technical change without a proper institutional framework concerning property rights, taxes incentives, regulations and the like. Therefore, leaving Government aside

(G=0) set a bias as the model depends on its self-correction capabilities and the trickle-down to solve the distribution issues.

Despite its weakness, this model proved to work well in the nineties. At the same time, there was a huge amount of capital inflow due to new investment opportunities for private investors, higher saving rates as well as a better institutional framework. Central Bank became independent, and the Free Trade Agreement boosted full integration into international markets (NX>0). The average growth was 7%, 2/3 of which resulted from productivity gains. But, this dynamic slowed down in the next decade (2000-2010) with a GDP growth half the one in the previous decade, making evident the consequences of overinvestment and output overestimation, which overtime moved downward the expectations about the output trend.

4. Results and discussion: the microeconomic weakness

The over-estimation of the Solow Model performance led to a delay in key necessary microeconomic reforms to complement the growth path of GDP with a more comprehensive approach aimed at a balance between economic and social progress. The budget government equation (B) makes it quite clear.

$$B=T(y)-(G+D(i))=0 \quad (12)$$

T(y): Taxes depend on real output (y). Given equation (8), taxes must stay low
G: Government expenditures. And D (i) interest payments due to external debt

As "y" increases, it is the taxes available for financing G and D(i). If "y" is overestimated, so it will be the taxes projections such that some time along the budget period, a downward correction has to be done in taxes revenues. Keeping debt payment stable, as equation (8) suggest, government expenditures must also be downward adjusted, once real output data is available.

Thus, given equation (8), the Solow model assumes to keep the budget government balanced, both tax and external debt should stay at a low level. In

the case of Taxes, it means that the primary tool for income distribution is restricted to trickle-down, and a low debt mean an additional limitation to the scope of social policies. It looks like the Solow Model is not designed to solve income distribution.

Since the mid-2000s, it became more evident that the narrow microeconomic fundamentals of the Solow Model were a severe constraint to cope with the delay in the improvement of social policies.

As income restriction set a limit to public resources available, which becomes a serious problem in the case of public or half-public goods. In these cases, the Pareto optimum requires the support of efficient public policies. Whether this policy either fails or is inefficient because of lag effects, as equation (12) suggest, the system creates a gap between the ones on the top and those who are at the bottom of welfare. In fact, in Chile and, for this matter, in any place, soccer fans, icon singers fans, and auctiongoers; can pay the highest prices for these optional events, and each one chooses voluntarily to do so given their real and expected incomes. However, this is not the case for those non-optional consumer goods, such as health, retirement, housing, and education, whose prices are well above that which can be sustained by the income restriction. It is, therefore, inherent in the price system that differences may arise between the consumption of public goods (with lower prices) and private ones (with higher prices). The former has less value contempt than the latter, so it requires public policy support, more so in the case of Chile, which it concentrates 90% of its citizens, while the latter, the remaining 10%. Public goods are a matter of public policies, while private goods are a matter of each individual decision.

So, whether public policies are not efficient enough, equation (12) suggests that the perception of inequality increases, no matter how well the economic growth is doing. The free market solution in the Chilean economy, based upon the Solow formulation, with inefficient public policies, created a gap between those at the top and those behind in the bottom. So, it required a reformulation in its general form to get a better State with a higher quality standard for public policies to work as it should. Otherwise, a disequilibrium arises with nonneutral consequences.

Let's test the argument with two examples. Chilean public health covers 80% of the population, forced to wait in lines, either real or virtual, because

there are no sufficient resources to keep up with the demand. Instead, private health covers the remaining 20% who may pay for their treatments coupled with a private insurance system. It follows that not all consumers may pay the private cost of their treatment because income did not grow as high and wide as expected. They depend upon a good public system at more affordable prices. But, if the public system cannot make it? The outcome is waiting in lines in Hospitals for different kinds of services. In 2016, any individual requiring medical surgery had to wait 381 days, actually in 2023, down to 331 days. However, the worst is the situation of those who died (9274 persons), while waiting for health care in 2016.

The pension fund for retirement, based on individual capitalization accounts, is a similar case. No matter the requirement of a minimum amount accumulated in the saving account, it is obvious that those who can save a higher monthly amount may retire earlier. Actually, the monthly contribution leaves no option to the majority other than to delay retirement. Private pension funds have a key weakness, with the replacement rate close to 40% of average income (USD 700,00), which is not enough to cover the cost of medicament, a major item in elderly people. Wulf (2021).

Increasing the replacement rate means delaying retirement age from current 65 to at least 68 and to save 15%-17% of monthly gross income. Thus, the issue at stake deals with the best way individual capitalization works to make it both socially and financially stronger. This means to consider a proper policy to support those with lower incomes, women, and independent workers, besides wider options to invest the accumulated savings, in alternative assets, and more flexibility to adjust the retirement age.

The dynamic of competition lead to an oligopolistic structure in the Chilean economy, with market power concentrated in a few companies, mostly those within key sectors of economic activity with high demand for innovation, competitiveness, efficiency and value-added (Banks, insurance, basic consumer products, pension fund companies, pharmacies, telecommunications companies, transport, etc.).Thus three pharmacy stores have 95% share of its markets, Two mega supermarket Stores get almost 2/3 share of its market, and three main private companies manage the pension funds.UNDP (2017)

Without effective regulation, there is no way to neutralize the ability of just a few firms to obtain economic rent at the cost of consumer welfare and its surplus. Therefore, it is needed a better state. At the same time, public policies focused on specific target should have higher standards of effectiveness and efficiency. This has been achieved in the case of poverty reduction, but this has not been sufficient to reduce inequality fast enough. The outcome of this public policy omission has been the demand for essential corrections in favour of greater social investment, which is essentially the task of public policy.

The macroeconomic side of an economy has its microeconomic foundations. This means that they reinforce one another, but when these foundations are weak, it is like driving a car with its tires almost flat. Sooner or later, the trip will stop either when the passenger or the driver realizes that something has gone wrong.

Low inflation means a benefit for consumers who may keep their purchasing power over time. But whether regulations are not efficient enough to control market power arising from oligopoly, firms use their market power to get an economic rent through prices collusion, price discrimination or quantity restriction, at the cost of the consumer surplus of those who may pay higher prices, but those who cannot there is no other option left than to constraint consumption

4.1. Inequality in a free market economy

Lacking a proper set of public policies was the seed of inequality that remains over time. Just a few may pay the price of good education, health and retirement, while the remaining ones depend upon public funds. In other words, without an efficient public policy, any differentiation in the ability to pay creates a bias towards inequality that markets and economic growth cannot correct on its own. More so when the outcome is overestimated, the inequality due to income constraint is not fully solved and may eventually increase over time. (Equation (2),(3),(4) and (8), (12)).-

The indicator that measures income inequality is the Gini Coefficient (GC), which focuses only on income, leaving aside other parameters of inequality (price segmentation, housing access). Chile had a GC of 0,47 (2017), even

with some improvement over time since 2004 (0,55) (Figure N° 2). However, it is still the highest among the OECD countries (2016) (Figure N°3), but not different to that of most Latin American countries.

Figure N° 2

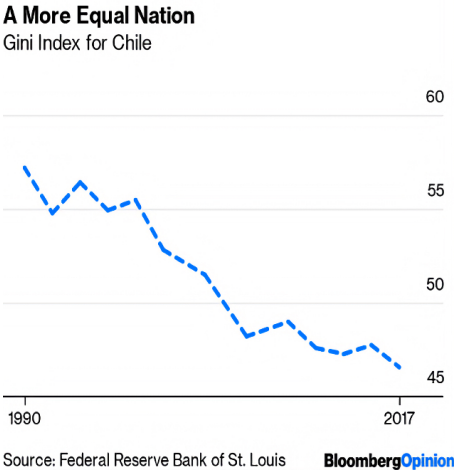
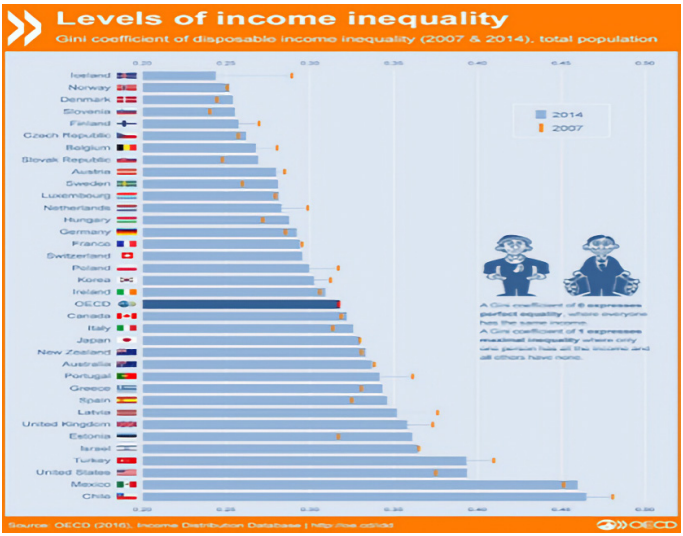


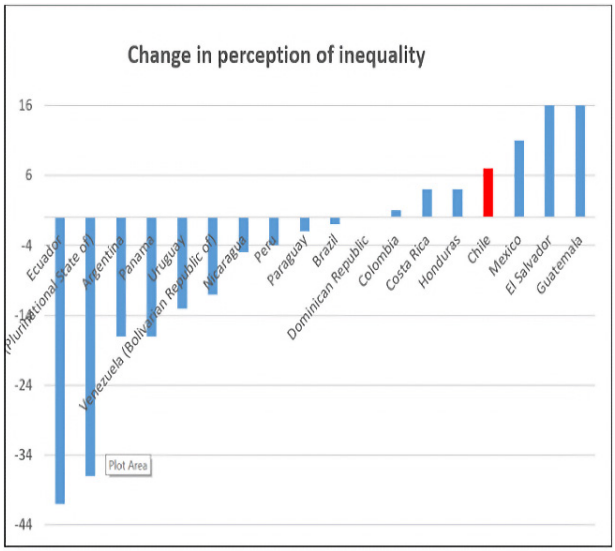
Figure N°3



Source: Income inequality OECD (2016)

Given the correlation between taxes (higher) and inequality (lower), the focus on reducing the Gini Coefficient in Chile leads to higher taxes, but without solving the perception about the increasing inequality, (Figure N°4, below): as "y" in equation (12) is overestimated.

Figure N°4



Source: The reality of Inequality and its perception Chile's paradox explained: Edwards, S. (2019, www.promarket.org

To cope with Horizontal inequality, the OECD has implemented an index with 11 items (Housing, Jobs, Environment, Civil engagement, Community, Income, Life satisfaction, Safety, Work-Life allocation, education. health) for its member countries. Doing the same index for selected Latin American countries (Brazil, Mexico, Colombia, and Chile), Chile is on top only in 4/11, housing, Education, Income and safety, leaving key areas apart. Edwards (2019).

5. Conclusions

The macroeconomic side of an economy has its microeconomic foundations. This means that they reinforce one another, but when these foundations are weak, sooner or later, the macroeconomic policies will be weaker than the expected outcome. In particular, the Chilean economy set its free markets foundation within the field of neoclassical production function, like the one proposed by the Solow Model, with overall positive macro empirical evidence in advanced economies (USA). But, based on the unrealistic assumption of homogeneous capital, despite the fact that capital goods are highly heterogeneous. Durlauf, Kourtellos, Minkin (2001), Nkalu, Edeme, Chukuruma (2018).

Furthermore, the Solow model has additional important limitations dealing with Lack of human capital; Mankiw, Romer, Weil (1992), Constant return of scale; Solow(1994), Lack of endogenous variables; Caselli ,et al (1996),Production function specifications; Duffy and Papageorgiou (2000), Durlauf ,et al (2001),Wulf (2020),the share of income share does not match national accounting data Barossi-Filho et al, (2004),Full employment assumption, and investment independent from firms Magnani, (2015), and capital homogeneity Nkalu, et al (2018).

Concerning the full employment assumption, the level of labour force skills in Chile, turned out to be below average in key abilities such as understanding and reading skills, foreign languages communications and effective decisions, which set a restriction to get a steady productivity increase, therefore a natural trend to unemployment. In Chile, a mining worker, produce 65% of his counterpart in USA, while in the industry sector produces 28%, and in banking activities 61%.

Very much of the evaluation of the Chilean economy outcome up to 2019 was based on the advantages and disadvantages of the neo-liberal model principles, without taking into consideration the ill-designed microeconomic setting provided by the Solow model to sustain the path of key variables (Economic growth), as input for public policies design and its right timing. In particular, the role of the Government did not keep pace with high-quality standards of public policies, other than those one to reduce poverty, but leaving aside inequality given it overestimated the output increase, creating

a crucial lag in policy adjustment with important consequences in terms of welfare and equality.

The overestimation of output growth generated an upward bias in business expectations about investment becoming higher than needed, particularly in the nineties, which led to expanding business to the regional market (Argentina, Brazil, Paraguay and Peru), in some cases without a clear strategy to consolidate its business positions in those new markets. So, emerging economies need to have an economic framework suited to their own realities and limitations, such that any adjustment follow the effective fundamentals of both internal and external equilibrium.

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