**Modelling Colombian Economy: Stock-Flow Prototype Growth Model**

**Introduction**

We pretend to survey a middle's income economy front to global financial cycle, for which we’ll take to Colombian economy as a representative nation with a dependence on international trade and financial markets, and we’ll analyze its performance in front of distinct scenarios of changes in international dynamics. For this purpose, we’ll use a Stock-Flow model in continuous-time.

**Colombia Context**

* Structure of a small developing economy.
* Open capital account and flexible exchange rate.

At the beginning of the 20th century, Colombia was going out (getting out) from the deepest financial and economic crisis that had been faced until that moment. Trade and financial liberalization in the 1990s were some of the main reasons for why this happened. Nevertheless, the economic policies that were presented as solutions, and then as a way to get the development for most of the developing countries as Colombia, were for deepening even further the economic openness. So, came to Colombia the flexibilization of the exchange rate, the total open of capital account, the inflation targeting as monetary policy, etc.

The boom in the commodities prices in the first years that followed the crisis of 1999 (figure 1), was the real solution, and allowed Colombia to have economic growth (figure 2) and gradually become an upper-middle-income country (World Bank, 2019). However, this has meant a serious dependence on the international prices of commodities and international commercial and financial cycles (Botta, Godin & Missaglia, 2016).

[Figure 1: Insert commodities (oil) prices]

Source: U.S Energy Information Administration



Source: U.S Energy Information Administration

[Figure 2: Insert historical Colombia rate growth 1990-2019]

Source: World Bank



Given the process of financialization in the Colombian economy[[1]](#footnote-1), where financial logic dominates the production one, the ultimate goal of economic policy becomes to deal (and respond) with financial obligations both by the State as by the other economic agents. In this sense, “(Colombian) economic policy favors the achievement of macro-financial balances, through adjustment programs that seek to create a surplus in the trade balance that allows the generation of foreign exchange to make transfers to financial creditors” (Giraldo, 2005)

Financial capital, which is ultimately only interested in ensuring that those agents who contract financial obligations can accomplish with them in such a way as to achieve a valorization, will prevail in the ability (and possibilities) of payment of each economic agent to whom it confers a loan. Thus, financial capital goes only to those countries (or economic agents) that it considers having the capacity to meet its obligations. Therefore, it is important to indicate (analyze) what conditions have been in Colombia in recent years that have allowed a constant and significant inflow of financial capital in the country.

Colombia, as already mentioned above, had significant economic growth at the beginning of the century driven by the boom in commodities prices. This allowed him, in general terms, to build trust and confidence in macroeconomic prospects for other countries and international investors. In this way, Colombia presented a massive increase in Foreign Direct Investment (FDI) mainly in the mining sector (figure 3). These effects were presented simultaneously to produce a significant exchange rate appreciation (figure 4).

[Figure 3: Insert historical FDI by sectors 2000-2019 ]

Source: Banco de la República



[Figure 4: Insert historical Colombian Exchange rate 2000-2019 ]



Source: Banco de la República

Then, as mentioned by Botta, Godin and Missaglia (2016) “the exchange rate nominal appreciation attracted short-term portfolio investments, thus further appreciation”. Likewise, the interest rate difference between central countries (such as the US) and Colombia generated profits that were, once again, attractive for financial investments (figure 5). Finally, a passive monetary policy by the Central Bank enabled increasing financial yield via exchange rate appreciation.

[Figure 5: Insert historical interest rate U.S vs Colombia 2000-2018 ]



Source: Banco de la República and Macrotrend

In a nutshell, the expansion of the mining sector and the ensuing foreign revenue windfall, as a result of the boom in commodities price, has raised internal expenditures and led to a real exchange rate appreciation. This has made that domestic manufacture less profitable and less attractive for international markets and respectively investment in a classic "Dutch disease". But additionally, this situation has produced a significant inflow of capital portfolio investment (normally in short-term) driving for an even further exchange rate appreciation. So, some authors, given the importance of financial capital inflow, have begun to see this as a financial Dutch disease. These dynamics constitute a potential danger for the stability of the Colombian economy for the dependence on high commodities price, foreign capital inflow as an FDI or as a portfolio to support an increasing high current account deficit (figure 6).

[Figure 6: Insert historical Balance of payment (current a a account vs capital account) Colombia 2000-2018 ]



Source: Banco de la República and Macrotrend

Choosing an S-F model responds to an important tradition that it leaves us to develop a consistent representation of the economy, focusing on Financial’s Balance Sheet results that correspond to each institutional sector. In consequence, the survey can maintain financial and real variables in a system coherent technically and theoretically.

The SFC modeling is an approach with a long trajectory and wide reception; the first jobs appeared in the 80th-decade result of New’s Cambridge School work, with Winny Godley as head, and this method evolved until became to an important tool to several Economics School, and think tanks around of the world. Perhaps the main issue about this approach is the Godley and Lavoie(2007) work after that can be recognized as the enlargements realized by other authors as Genaro Zezza et al.( 2019), Antoine Godin et al.(2012), Yanis Dafermos et al(2017), etc.

A lot of jobs under this approximation have addressed the financialization and other research questions especially in the context of theoretical models, high’s income countries, and some emergent empirical models. Particularly, this kind of modeling has taken relevance in Latin America products to work of several authors, some jobs highlights correspond to effort Sebastían Valdecantos(2016), Alberto Botta et al.(2016), etc.

In other matters, the Colombian case hasn’t been stranger to this sort of analysis, it is possible to find a survey theoretically and empirically S-F that inquiry aspects both financialization and other economic issues. The research papers of Diego Guevara (2017), Andrés Escobar(2016), David Cano(2019), etc., are examples and reflect an experienced knowledge stock of management with this approach.

Otherwise, it has been added to the heritage of this kind of modeling the continuous-time formalization as an attempt to include the analyses on several variables in each moment, respond in part to some variables and decisions that determine that same occurs permanent, i.e. different to an account that shows the resulting quarterly or yearly, for example, Government's balance fiscal, other variables are modified all time and continuous way, as consumption and investment decisions. With a relationship, this methodology is far-reaching Godin & Yilmaz(2020), Gaël Giraud (2017), etc.

Continuous-time modeling has been a concern meaningful to various economic schools, fundamentally for this method has wide relevance to their purpose, as can explain adjust mechanism, real behavior, and surely the interaction between variables in continuous-time and others that only could build in discrete-time.

The interest for continuous-time modeling appeared in the jobs of Richard Goodwin(1948) and the realized by Koopman(1950) in middle of the last century, this as a consequence of that usually the economist theorize and formulate their abstractions through differential equations, that explicit and implicit form assumes continuous-time (see Mirowski(1984)).

On the other hand, Giancarlo Gandolfo has been crucial in this sort of modeling, particularly in econometry, since the 80th decade of the last century. He resumes the advantage of continuous-time modeling in eight groups: 1.) It’s a difficult thing for the agents to take your decisions the coordinate way, therefore, it is more plausible to expect that the aggregate decisions have a continuous-time shape. 2.) This modeling is more useful to reflect the adjust process. 3.) It is distinct to discrete-time modeling because the estimator of this model is an independent sort of interval, which is an advantage in S-F models to management flows. 4.)It’s invariant to period’s spread (the outcomes maintain when the period’s spread tends to zero). 5.) Its adjust’s velocity is more speed, thus It requires fewer lags. 6.)It leaves more adequate treatment of distributed-lag processes. 7.) The differential equation system is more workable than a difference system. 8.) The results of the system’s solve leave to realize improve forecasting (Gandolfo (1993))

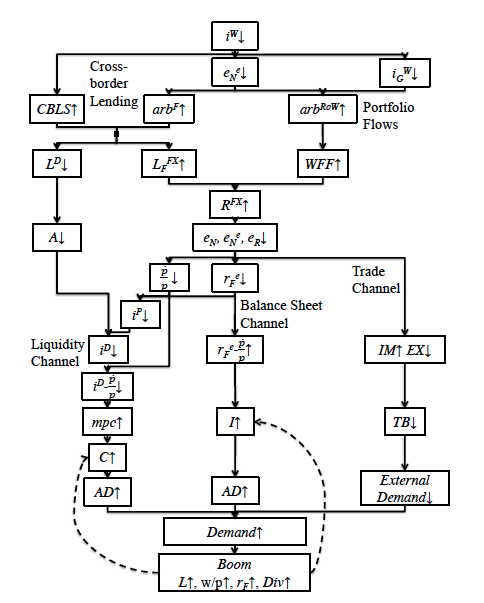
For the above, we choose to use continuous-time modeling to study the Colombian economy, because this approach is more convenient to the S-F model, and it leaves us to focus analyze on the process of principles of economic variables front changes in the international dynamics.

**The Benchmark model**

We take as a benchmark the model developed by Antoine et al. (2020), this job builds an SFC with continuous-time to analyze how the international financial market affects a small emergent economy. The extent and detail model represents an economy with an open capital account, flexible exchange rate; it exposes a balance-sheet approach that includes modeling of the financial and real spheres of the economy. The model’s contribution is that shows the changes in the international financial market, represented in movements of the rates, drives the behavior of the emergent economy, and the mechanisms that leave the external determination.

The external determination responds both demand conditions and supply characteristics, thus, the changes in international influence to funding needs therefore according to the direction of these movements the fundamentals variables of the emergent economy will be modified with contrary sign. The principle variables that adjust the behavior of the economy are portfolio flows and cross-border leading. And three transmission channels: Balance-sheet, trade, and liquidity.

[Insert Figure]: Causality graph showing how the foreign interest rate shock propagates in the economy.



**Main changes in benchmark model**

The document idea is to adapt the benchmark model presented by Devrim and Godin (2020) to the Colombian economy. So, this model keeps the main features of the benchmark in this sense: 1. continuous time; 2. small open developing economy; and 3. open capital account and a flexible exchange rate. Nevertheless, some changes are made to represent in a better way the dynamic in Colombian economy sectors.

**Firms:** Firms export two types of goods in contrast to the benchmark model in which exports just one. Likewise, the model enables Foreign direct investment which has been in the last decades an important component in Colombian investment, particularly in the commodities sector.

**Households:** In the new model, households take credits to expand their consumption even further of their incomes. Likewise, the propensity to consume of the government bonds in change to almost zero since in Colombia households hold these bonds as a pension portfolio, in this sense, they don't use part of these to consume.

**Banks (financial sector):** The main changes in the banking (financial) sector are three: 1. The sector will be able to provide loans and have deposits of households; 2. The sector will clean the market of government bonds; and 3. The sector will finance the FDI

**Central Bank:** The Central Bank only obtains profits from the interest paid by commercial banks of the advances.

**Rest of the world:** The rest of the world will be able to invest in the country, in this sense, expands the foreign exchange supply and changes the balance of payment.

| **Main changes in (on) Benchmark model** | | | |
| --- | --- | --- | --- |
| **Sector** | **Description** | **New Equation** | **Original Equation** |
| **Firms** | Exports | (. )  ( .)  (. ) | 1er ecuación Dem. Efectivo y en la segunda Ley de say…. Duplicar y cambiar parametron… la misma tactica, los mismo insumos, los mismos costos, lo único que cambia es la demanda….  Sería major como esta |
| Investment | ( .)  ( .)  ( .) | Esta Va |
| Total financing needs | ( ) |  |
| **Households** | Consumption | (.)  (.)  (.)  (.) |  |
| **Government** | Taxes | (.)  (.)  (.)  (.) |  |
| Government spending |  |  |
| **Banks**  **(financial sector)** | Bonds expenditure:  The financial sector absorbs the excess supply of governments bonds |  |  |
| Households loans |  |  |
| **Banks**  **(financial sector)** | Required reserves ratio |  |  |
| Total financing needs |  |  |
| Own funds needed according to regulation |  |  |
| Average funding costs |  |  |
| Households interest rate |  |  |
| **Central Bank** | Profits |  |  |
| **Rest of the word** | Foreign direct investment |  |  |
| Foreign exchange supply |  |  |
| Balance of payments constraint |  |  |

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1. Financialization in Colombia has its origins in the works and publications of the '70s and '80s that led to important both qualitative changes, with the new institutional regimes born of the 1991 constitution and the reforms in the '90s, and quantitative, with the increase in financial operations and transactions both nationally and internationally since the 1990s (Guevara, 2015). [↑](#footnote-ref-1)