ESSAYS IN INTEREST RATES, PENSION FUNDS AND MONETARY POLICY IN EMERGING ECONOMIES

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Abstract Of The Dissertation

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This dissertation focuses on the importance of pension funds investments in explaining the evolution of interest rates, and the interaction between monetary policy and the real economy. Even though there is an extensive literature on the behavior of interest rates, very few studies explain how and why a fully funded pension system contributes to the downward path of interest rates observed during the last decade. Also, there's very dynamic literature on non-linearities in monetary policy and the real economy, mostly as independent phenomena, but what if they can be explained simultaneously?

Chapter 2 studies how a pension fund system can put downward pressure on interest rates in economies with shallow capital markets. Using data from Dominican Republic, the chapter analyzes how the term structure of the lending and deposit interest rates of domestic banks, that serve as the main destination of pension fund investments, have been affected by this inflow of financial resources and compares this effect with traditional macroeconomic factors. Both lending and deposit rates respond throughout the term structure to the investment of pension funds.

The third chapter uses time series and panel data techniques to analyze the evolution of the key interest rates in Latin American countries in which the pension fund reform has been implemented. I focus my attention to the interest rate of the asset class that is weighted the most in the portfolio of pension fund institutions in Colombia, Dominican Republic, Mexico and Peru. Due to how the system creates incentives for the pension fund administrators to behave in similar fashion and the size of the funds under management, the pension fund system has been an important factor in the reduction of interest rates in the region.

Chapter 4 studies that interaction between Phillips Curve, fiscal and monetary policy nonlinearities. A simple model is derived to show how Phillips Curve and fiscal policy nonlinearities interact and generate different types of nonlinearities in monetary policy, even if a central bank has quadratic preferences on inflation and output gap. Using data from Dominican Republic and comparing three types of nonlinearities studied frequently in the literature, we show that nonlinearities are important to explain particular episodes, and that, whenever possible, they should be study as an interdependent, rather than as single issue.

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Dedication

To my family, for being an unconditional source of understanding and support.

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Chapter 1

Introduction

What happened to financial markets since 2007 have researchers and policymakers all over reconsider their understanding of the different pieces of the market, how the pieces interact with each other and the whole financial infrastructure. On the research agenda, aspects such as corporate gorvenance, incentives, herding behavior, liquidity, nonlinearities, and risk measures, dimensions and apetite and are being re-examined to help build a more stable system. On the side of policy makers, there's an open debate on how and what to regulate and supervise.

During the last decade of the XX century and first seven years of the first decade of the XXI, we experience a global environment characterized with a reduction in real-side and financial volatily. During these years, several central banks adopted inflation-targeting regimes, helping to anchor inflation expectations. On one side, deregulation, huge gross capital flows and positive expectations helped increased liquidity to reach many asset classes in many countries. On the other side, some elements of risk were not correctly being priced in the market value of some assets in the financial market.

As CEPR (2007) explains, pension funds and insurance companies are the two most important global investors. Their portfolios reach almost every asset class, country and maturity available in the market. Hence, due to their economic, financial and social significance, both pension funds and insurance companies have been in plenty of studies.

The public reform that created defined contribution pension systems started in Chile in 1981 and expanded throughout Latin America and Eastern Europe. The reform created a new system of fully funded pension funds in which workers pay for their own retirement, Pension Fund Administrators (PFA) manage and invest worker's contributions following principles of efficiency, risk management and seeking returns that are appropriate to for the system and subject to certain investment limits, and public authorities regulate and supervise the whole structure.

But so far, the literature on the effects of the reforms of pension systems on capital markets has focused on studies of quantities: analyzing the impact on trading volumes and the development of new institutions and regulations. However, the recent experience in global financial markets reminded us about the importance of studying prices. Interest rates, as any price, are key determinants for the allocation of resources; therefore, a decrease in the levels of interest rates could lead investors to underestimate the risk and not invest efficiently; long periods of sustained low interest rates can lead to episodes of financial stress, which could have higher costs if they trigger a crisis. Therefore it is important to motivate economic policy makers to incorporate new models that allow them to better explain the dynamics of interest rates and on which the pension fund industry could have significant impacts. In doing so, it would complement the analysis of the effects of pension funds in financial markets and could have wider macroeconomic implications, at least in monetary policy regimes where interest rates play an important role, such as inflation targeting.

Chapter 2 and 3 of this dissertation study how the reform of the pension fund system started playing an important role in determining the evolution of interest rates in Latin America. Chapter 2 shows how the creation of a fully funded pension system in Dominican Republic in 2003 put downward pressure on interest rates. This is due to several factors, including the shallowness of the country' capital markets and the system having a portfolio poorly diversified and heavily concentrated in banks' fixed income instruments. The chapter shows that pension fund investments have affected the whole term structure of the lending and deposit interest rates of domestic banks.

The third chapter continues with this study, focusing now not on the term structure of a single country but on analyzing key interest rates of four different countries in Latin America: Colombia, Dominican Republic, Mexico and Peru. By comparing the dynamics of these four countries with pension fund systems, but with different sizes of their economies and capital markets, we find that pension funds investments' still contribute importantly to reduce the interest rate of the asset class that is weighted the most in the portfolio of pension fund institutions.

The reasons discussed are related to the incentives to competition created within the pension fund system: Peer comparison competition contributes to the fact that different managers usually have very similar portfolios. If this is mixed with shallow domestic capital markets and restrictions to international allocation of the funds, pension fund investments take substantial positions in specific domestic markets, such as bonds of the treasury and other government offices and the banking sector, leading to upward pressure on asset prices and downward pressure on rates. Thus, my research suggest that researchers, financial market practitioners and policymakers should not neglect the effect of the reform on the pension fund system when explaining interest rates or asset prices using factor models in emerging economies.

Another relevant aspect in understanding the behavior of financial markets in emerging economies is the evolution of monetary policy, how to better understand it and characterize it with econometric models. Chapter 4 studies how different nonlinearities in the structure of the economy affect monetary policy.

Using data from Dominican Republic, a simple model is derived to show how Phillips Curve and fiscal policy nonlinearities interact and generate different types of nonlinearities in monetary policy, even if a central bank has quadratic preferences on inflation and output gap, conditions that generally lead to standard Taylor-type monetary policy rules.

We find that that nonlinearities are statistically significant and the magnitudes can become relevant in economic terms. Our results support our two main propositions: first that nonlinear components do play a relevenat role during some episodes, and second, that a joint, rather than single, estimation approach is a better tool to study nonlinearities. If authorities don't consider these phenomena, estimations used for economic policy, authorities accountability and forecasts can be significantly biased.

Chapter 2

Pension Funds and the Term Structure of Interest Rates in the Dominican Republic

2.1. Introduction and Purpose

Interest rates in the Dominican Republic have decreased gradually and steadily since the country's financial crisis of 2003, accelerated by the general worldwide fall in yields until the global financial crisis, beginning in 2007. One special, overlooked factor for the Dominican Republic is the reform to the Dominican Pension System in 2001. Beginning in June 2003, the Fund channeled large-scale flows of funds into deposits held in domestic financial institutions.

The defined contribution systems have been implemented in Latin America (LA) and Eastern Europe since 1981, when Chile started with the changes in Social Security. The reform created a new system of fully funded pension funds in which workers pay for their own retirement and Pension Fund Administrators (PFA) invest worker's contributions following principles of efficiency, risk management and seeking returns subject to some investment limits.

So far, the literature on the effects of the reforms of pension systems on capital markets focus on studies of quantities: analyzing the impact on trading volumes and the development of new institutions and regulations. However, recent experience in global financial markets helped to remind us that price effects are also important, particularly in financial assets.

Interest rates, like any price, are a key determinant for the allocation of resources; therefore, a decrease in the levels of interest rates could lead investors to underestimate the risk and not invest efficiently; long periods of sustained low interest rates can lead to episodes of financial stress, which could have higher costs if they trigger a crisis. Therefore it is important to motivate economic policy makers to incorporate new models that allow them to better explain the dynamics of interest rates and on which the pension fund industry could have significant impacts. In doing so, it would complement the analysis of the effects of pension funds in financial markets and could have wider macroeconomic implications, at least in monetary policy regimes where interest rates play an important role, such as inflation targeting.

This paper studies the term structure of the lending and deposit interest rates of the banks in the Dominican Republic and the influence of the new pension system and explains how the Pension Fund system affects it, an issue that has not received attention. This research will also compare the impact of the reform of the pension system with observable macroeconomic factors, frequently used in the literature.

We evaluate the performance of 13 different rates: 7 lending rates (3, 6, 12, 24, 60 and more than 60 months) and 5 deposit rates (1, 2, 3, 6 and 12 months). The main findings are that the lending rates respond throughout the term structure to: the investment of pension funds, the rate of inflation and the fiscal position of the period. They also responded significantly to the financial crisis of 2003. On the other hand, there is no significant relationship between the growth rate of real GDP or the LIBOR rate and the term structure of lending rates.

The regressions confirm that the dynamics of term structure of deposit rates are different than that of lending rates, possibly because on one hand the effect of pension funds' investments is a direct effect, unlike their effect on lending rates.

Deposit rates, along their term structure, respond to the investments of pension funds, the rate of inflation, real growth rate of GDP and the fiscal position of the period. The impact of the financial crisis of 2003 is only relevant for the rate of three months. No point of the term structure responds directly to changes in LIBOR rates, that is used as a proxy of international interest rates reflecting international conditions.

An increase in investments of pension funds of 1% of GDP reduces the entire term structure of deposit rates by an average of between 1.1% & 1.6%, significantly higher than in the case of lending rates in which could not be ruled out that the impact would reduce by 1%, at 95% confidence level. This result is in line with preliminary evidence that the author has found for Mexico, Colombia and Peru.

This result would be pointing out indirectly that the portfolios of the PFAs in Dominican Republic require new types of instruments and securities with longer maturities. Also, it is important to set proper incentives so these administrators invest in the new alternatives, once available. This is relevant, since international evidence indicates that having a type of instrument in the market whose characteristics are favorable for diversification of portfolios is not a sufficient condition for the PFA to buy the instrument.

In addition, to increase the levels of expected return on pension funds through market operations, the development of a more efficient public debt market is required, as well as openness to international markets, thereby also increasing the level of competition facing the financial sector to harness the resources of pension funds, assigning a higher price to the risk that the system takes implicitly.

The remainder of the study is divided as follows: section 2.2 discusses the different areas in economic and financial literature of term structure of interest rates and the relationship between investment of pension fund resources and capital markets. Section 2.3 summarizes the main findings on investment of reforms to pension systems in Latin America. Section 2.4 describes the basic econometric model, shows the evolution of the variables relevant to the study and presents the results of the regressions. Section 2.5 concludes and discusses some policy options with regard to this issue. The annexes provide further information of some points in the development of the study.

2.2. Literature Revision

The following study is related to three lines of research:

i. The term structure of interest rates and its determinants: Morales (2007); Vela (2006); Ang, Dong and Piazzesi (2004); Piazzessi (2005); Diebold, Rudebusch and Aruoba (2005); Reyna, Salazar and Salgado (2008), among others.

ii. The effects of defined contribution pension systems on financial markets, as they become the largest institutional investors in national and global financial markets:

CEPR (2007); Dayoub and Lasagabaster (2008); Palacios (2003). Also as they contribute to increase in the activity of domestic capital markets: Dayoub and Lasagabaster (2008); Impavido, Musalem and Tressel (2003); Impavido and Musalem (2000); Impavido, Musalem and Vittas (2002); Vittas (1999)

iii. The administration of pension funds by the Pension Fund Administrators (PFA), its empirical particularities and herding behavior by administrators: as Fontaine (1997); Reisen (1997); Srinivas (2000); Srinivas, Whitehouse J. Yermo (2000);

Interest rates and yield rates serve as a reflection of the allocation of resources between savers and borrowers of capital. In an economy there is no single interest or yield rate, but there is a range of different rates. Similarly, in the same market, assets of different terms are traded, each with their respective interest rate. These rates in turn are affected and have implications for other markets. For example, international evidence often points out that short-term rates reflect further changes in monetary policy rates, while longer-term variations tend to represent variations in expected inflation.

However, decisions to buy or not buy durable goods depend more on the medium and long term rates and not so much short-term rates. But still, changes in shorter-term rates can also affect longer-term rates. For all this, it is important to have a clear an understanding of the term structure of interest rates, specially under a scheme of of inflation targeting[1].

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[1] The Central Bank of the Dominican Republic is taking the first steps towards the implementation of this monetary policy regime under an IMF Stand-by Agreement . It is important to note that at this stage of the

In addition, long-term rates can be represented as a weighted average of short-term *spot*[2] rates and rates of the next periods, which is why, if monetary policy rates affect short term rates, the prediction of future policy rates and its expected effect also plays an important role. The current structure of interest rates depends on the current short term rate and the expectations that the market has of short-term rates in the coming periods.

The study of term structure has been a very dynamic area of research since the 70s. In 1977, Milton Friedman stated the need for parsimonious research on this topic. One of the most relevant studies in this field is Nelson and Siegel (1987), which allowed characterizing the term structure of returns on Treasury bonds through a single parameter. This parameter, depending on its value, allowed identifying three characteristics[3] of the term structure: the level, the slope of the yield curve and its curvature. Their approach allowed them to statistically represent some of the most common forms of the term structure of return rates:

i. Term structure of positive slope with respect to the terms or normal
ii. Term structure of negative slope with respect to the terms or inverted
iii. Term structure of high curvature or hump shaped.

Figure A. 1 Examples of Term Structures or Yield Curves

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process a period where inflation is not stationary and exhibits a downward trend is usually presented. Afterwards, the inflation rate becomes stationary. A better understanding of how the dynamics of inflation would affect market interest rates would then be relevant to the actions of monetary policy.

[2] Or available in the present time.

[3] Three common factors to all fixed income instruments, according to his study.

This study was quite influential in the sense that it achieved a parsimonious model that could explain the most familiar shapes of the yield curve. However, by using a single statistical variable to shape the three factors used as explanatory variables, it failed to give an economic explanation for the different shapes, or for the changes in levels over the entire term structure. For this reason, some studies have extended the model to include other factors of economic relevance, especially observable factors of easier interpretation, such as macroeconomic or statistical factors that largely replicate the behavior of macroeconomic variables.

In the literature, three variables are usually present in a large number of studies that explain the relationship between the term structure and macroeconomic variables: monetary policy rate, actual inflation or some measure of inflationary expectations and the real growth rate of the economy or some indicator of economic activity that is available in a larger frequency. The traditional approach is to consider that the impact goes from macroeconomic variables to the term structure – following for examples Morales (2007), Ang and Piazzesi (2003), among others –, but some studies consider the feedback of the term structure to macroeconomic variables, as in Diebold, Rudebusch and Aruoba (2005)[4].

The studies that extended the original approach of Nelson and Siegel (1987) maintain the essence of this first approach and seek to explain in different ways the level, slope and curvature of the term structure – include Diebold and Li (2005) and Diebold, Rudebusch and Aruoba (2005), among others.

[4] However, the authors also found that the most relevant direction goes from the macroeconomic variables to the term structure.

On the other hand, there was a line of research based on the **assumption of no arbitrage** in term structure using some statistical factors with other mathematical restrictions so as to ensure the non-existence of arbitration in the results. Here one can cite Piazzesi (2005), Ang and Piazzesi (2003), among others. The assumption of no arbitrage rests significantly in deep and very well organized financial markets, which is the case in developed countries and in some emerging economies but may be questionable in countries, such as the Dominican Republic with public offers of bonds starting in 2005, no public offers of stocks and very low financial education.

There are different trade-offs to consider when choosing which approach to use. Regarding the reliability of the results, the traditional regressions and models derived from Nelson and Siegel (1987) generate consistent results; however, the imposition of the no-arbitrage assumption allows the latter models to have less variance than the first approach. On the other hand, the efficiency of no-arbitrage models goes hand in hand with econometric procedures that are more complex to solve and interpret.

According to Diebold, Piazzesi and Rudebusch (2005), the first approach is widely used in the macroeconomic environment and in studies of central banks, given that the results are consistent and easier to interpret. On the other hand, the no arbitrage approach is used primarily in the area of finance. These models are also not better than the more traditional ones when the purpose is to forecast, possibly because of lower parsimony.

Although the literature that explains the term structure is abundant for the yield of zero coupon bonds in developed countries, mostly U.S., there are some interesting studies for Latin American countries like Mexico, Colombia, Brazil and Chile. Studies in emerging countries are not as abundant due mainly to two reasons: first, no quality data is available; second, the time interval comprising the data is usually quite small, making it difficult to reach robust conclusions.

Morales (2007) is based on the approach of Diebold and Li (2005) and estimates a dynamic model of the term structure of rates of inflation-indexed bonds and studies the effects of the monetary policy rate, the annual inflation and an index of economic activity on said rates. The author assumes that the data generating process of the latent variables (not observable) and the macro variables of the model are generated by an autoregressive vector (VAR) and estimated using the Kalman Filter. The results show a dynamic relationship between the yield curve and the macroeconomic variables considered in the study. In turn, inflation and monetary policy rate depend on the latent factors of the yield curve.

On the other hand, Larraín (2007) estimates the relationship between monetary policy surprises and the yield curve in Chile. The results show a strong relationship between nominal market rates and the monetary policy rate and between the actual market rates and surprise changes in monetary policy. As the theory points out, the effect of monetary policy weakens with interest rates of longer term.

Cajueiro et al. (2008) compare the effectiveness of different models with regard to forecasting different horizons of the yield curve in Brazil. They analyze a model developed by Bowsher and Meeks (2008) and compare it with that of Diebold and Li (2006). They conclude that the first model forecasts are better for short horizons, while the second model does a better job forecasting longer horizons. The authors use the interest rates of Brazilian swaps, because they are the main reference of bond markets in Brazil and since there is not a sufficiently long time series of government bonds[5]. The study was made taking into account that in June 1999, the Central Bank of Brazil adopted an inflation targeting regime.

On the other hand, Arango et al. (2006) study the Colombian case using the methodology of Nelson and Siegel (1987) and analyze data from Treasury bonds with annual coupons. Within Latin American countries, the Mexican case has the most studies on the subject, probably because it is the Latin American economy with deeper capital markets and more history. Cerecero et al. (2008) study how the long-term portion of the yield curve is important for predicting the growth of economic activity. They analyze annual data between 1993 and 2007 and take into account that the Bank of Mexico adopted in 2001 an inflation-targeting framework and the dynamics of the inflation rate go from not being stationary to being stationary. The authors continue the studies of Hamilton and Kim (2002) and Stock and Watson (2003) and link a probit model to explain whether the spread between the rates of 1 year and 3 months help explain economic activity. When breaking down the spread between a component of expectations and one of term structure, it is shown how the latter is the one that's relevant to forecast economic activity. Another relevant study of the Mexican case is Cortes and Ramos Francia (2008).

[5] These two reasons are present in the Dominican market and, in our case, draw us to model the interest rates of financial intermediation institutions.

A study to be distinguished from others in the Mexican case and other studies cited is Vela (2006). In this, the author uses data from 2001 to 2005 and when analyzing various fiscal indicators[6] it shows how these, usually absent in studies of the term structure, play an important role in explaining the prices of zero coupon bonds. The author focuses on the study of Dai and Phillipon (2004) and a procedure derived from the Generalized Method of Moments. Vela finds that the rates' reactions to the fiscal shocks are small in magnitude but bigger for shorter periods.

Finally, an interesting study is the one of Morita and Bueno (2008), which analyzes the yields at different times from a global perspective when using information on emerging market sovereign bonds from countries in investment-grade category[7]. The authors find that factors in emerging economies are linked qualitatively and quantitatively to those of developed economies.

Our point of view is that other sectors should be analyzed in depth when considering the term structure of interest rates and rates of return in domestic markets of emerging countries. This sector consists of institutional investors, especially after the reform of pension funds in Latin America. A relatively young literature is studying the defined contribution systems, and the regulatory practice is increasingly taking greater account of the impact of the investment policies of the system in the capital

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[6] In traditional models of macroeconomics, fiscal position is a very important variable in determining the interest rate of the economy, as a significant increase in public spending could lead to a crowding out of private spending and cause a pressure to the increase of interest rates. This argument becomes more important in economies where the public sector regularly goes to domestic financial markets to finance their spending, a reality that when used wisely, turns out quite healthy, and the Dominican case is not the exception to the rule.

[7] Credit risk rating between AAA + and BBB-for long-term international issuances.

markets. However, to date we do not know another study that has directly quantified the impact of pension fund investments on domestic interest rates.

By (i) explaining the term structure of interest rates of Financial Intermediation Institutions in the Dominican Republic and (ii) linking this literature with that about the impact of pension reform and capital market, we believe that we are contributing to a better understanding of the trajectory of Dominican interest rates and one of the medium and long term effects that pension funds may have in the financial market, the effect of reducing interest rates beyond what is prudent and contribute to the creation of new financial risks in the Dominican economy. The approach used by us is an approach that seeks to explain the various lending rates, deposit rates and some spreads through traditional macroeconomic factors in the literature. In turn, incorporates the fiscal position following roughly the position of Vela (2006) and includes a first measurement of the impact of investments of pension funds[8].

2.3. Key Features of the Investments of Defined Contribution Pension Fund Systems

2.3.1. Long-Term Goals of Pension Funds and Capital Market Development

Pension funds, along with insurance companies, have become the largest institutional investors in global markets– CEPR (2007) -. Although the volume of financial assets that are managed by the PFAs may be small in countries like the

[8] Although, in our opinion, this is the first study to explain the term structure in the Dominican Republic, it is not the first to deal with interest rates. The appendix provides a brief overview of the studies related to the subject in the country.

Dominican Republic when compared with the volumes traded in other markets, assets under their management have grown rapidly and can be significant for the sizes of the domestic markets. Similarly, because of the demographic characteristics of the country, as well as the space available to increase coverage by adding new companies, government agencies and independent workers nationwide, it is expected that this trend will continue and that the assets will grow significantly in coming decades.

According to Impavido, Musalem and Tressel (2003), PFA's participation in domestic financial markets can have a number of potential benefits, such as:

i. Increase demand for long-term assets.
ii. Encourage competition in primary markets.
iii. Be a source of financial innovation and modernization of trading systems.
iv. Contribute to greater transparency in financial markets.
v. Deepening the bond markets, and help build a yield curve.
vi. Reduce the cost of raising funds through stocks and bonds.

The development of the pension fund system, according to Vittas (1999) and Impavido, Musalem and Vittas (2002), depends on the conditions prevailing in the country before and during the first years the system, such as: prudent macroeconomic policies, an efficient and strong banking and insurance sector, a strong and long-term commitment from the reform of capital markets and from regulation and supervision of pension funds, as well as a sense of government's commitment to long- term sustainability of the system.

However, a study for Chile done by Raddatz and Schmuckler (2008) as well as other international studies have reassessed the effects of pension funds in capital markets and argue that:

i. PFA's investment strategies are often characterized by decisions of ***buy and hold***, having negligible effects on the activity and prices of financial assets in secondary markets.

ii. When PFAs need to rebalance the portfolios they tend to assign the income from periodic resources to those instruments where they want to increase their position instead of selling their holdings of instruments they do not want.

iii. Usually they invest in shares below the maximum value allowed and they tend to favor investments in debt instruments, even when this may not be optimal. E.g. according to figures from the International Association of Pension Funds Supervision, by June 2009 only 3 out of 9 Latin American countries invested more than 10% assets of their assets in equities: Peru (30%), Colombia (24.8%) & Chile (14.7%). The other cases are as follows: Mexico (5.3%), Costa Rica and Uruguay (<0.5%), while Bolivia, El Salvador and Rep. Dom (0%)

The evidence suggesting that the pension system contributes to institutional development within the capital market is more robust. Authors argue that they tend to modernize the institutions and methods of regulation, they encouraged the development of new institutions, such as trustees, rating agencies, brokers-dealers, mutual funds, etc., the same happens with the creation of more sophisticated instruments such as securitized assets, bonds of long-term infrastructure projects through Public-Private Partnerships, like in Mexico, Colombia and Chile.

2.3.2. Quantitative Limits of Investment and Portfolio Diversification

The pension fund reform is characterized by the accumulation of funds for long-term goals. Usually, on startup, pension funds are invested mainly in government debt and bank deposits. As the fund grows and new investment alternatives are allowed, an increasing portion of the portfolio is invested in the corporate sector, international markets and other more sophisticated instruments.

Regulators often impose a maximum quantitative limit for investments (as a percentage of the assets invested by the PFA). They have one or more of the following ways: Limits on concentration of ownership of a pension fund, issuer limits, limits by instrument, asset type limits and limits on credit risk (investment grade assets.) In much lesser circumstances, regulators put minimum investment limits, for example, Uruguay regarding how much to invest in government bonds, Costa Rica and El Salvador for some securities related to housing finance, and Mexico when it comes to the titles indexed to inflation for a type of funds, etc.

Generally, international investments are very low or not allowed at all. The justifications for this tend to follow: The authorities' interest in reducing the volatility of capital flows - Fontaine (1997) - , to reduce capital flight and deepen the domestic capital markets -Reisen (1997) -. Two countries invest more than 10% of its portfolio in securities issued abroad: Chile with 31% and Peru with 14.5%. On the other hand, Colombia spends 9.9%, Mexico 7.2%, Uruguay 3.2%, El Salvador 0.5%, while Bolivia and the Dominican Republic still do not allow this type of investment. The Figure A. 2

shows the degree of diversification by type of instrument in some countries in Latin America.

The literature tends to favor the idea that strict quantitative limits at can be an adequate starting point for the system, because it is easier to track and to be understood for the workers and the PFA, but as the system evolves authors thend to favor a model following the principles of a "prudent investor", as in the case of Europe. Dayoub, M and E. Lasagabaster, (2008) show that regulators in Chile and Mexico are moving to soften some of the investment restrictions and moving towards a risk-based framework (e.g. including Value at Risk measures like in Mexico).

Creating multi-funds as in Chile, Mexico and Peru is another source of investment flexibility. Multi-funds allow administrators to offer different combinations of assets and, therefore, more than one investment portfolio. These may be taken depending on the age cohort of subscribers to the system. These types of portfolios allow the workers to benefit from a life cycle type of investment, changing the asset composition of their portfolios as they grow old.

2.3.3. Herding behavior and Peer Comparison between managers

In the Dominican Republic, the PFAs invest the resources they managed maximizing their returns with an asset mix within the investment limits. In general, the regulators don’t ask the PFA’s to publicly show their exposures to different types of risks

Srinivas, Whitehouse and Yermo (2000), as well as Dayoub and Lasagabaster (2008), argue that strict asset allocation standards, as quantitative investment limits, along with the ***peer comparison*** regulators make in order to rank the performance of PFA, explain why pension funds are generally invested in a similar manner, and exhibit similar results.

In addition, regulators in countries as Dominican Republic, Peru and Colombia require the returns on pension funds not to fall below a minimum level, usually related to the industry average and therefore caused by the decisions of the PFAs[9]. This structure creates incentives for smaller PFAs act as "followers" in the Stackelberg-style, while choosing portfolios similar to those of the larger PFAs (and "leaders"). This would lead to concentration, greater than socially desirable, in the industry of PFA.

In connection with the latter explanation, Lasagabaster and Dayoub (2008) also explain that if in the PFA market, assets under management are concentrated in a few institutions; this worsens the effects of herding behavior. Given the importance of economies of scales in the asset management industry, it is natural that after some year of the reform there's a significant effort of PFA consolidation. In the Latin American countries that implemented the reform, with the exception of Mexico, the current number of PFA is less than or equal to the initial number of them. See Table A. 2

Herding decision-making can be the result of the PFA managing only one type of fund, combined with stringent international investment limits and shallow domestic financial markets. However, based on the literature reviewed to date, there is a lack of studies which empirically validate this observation. However, similar decisions not

[9] An alternative to this scheme is to use a benchmark that cannot be affected by herding behavior of PFA, sucha as a fixed return per year.

necessarily imply leader-follower relations or herding behavior; it can also be that administrators respond the same way to financial news, showing similar investment decisions. An investment of a PFA may have some relevant information to the other, that in turn will act in the same fashion..

Finally, it is important to note that pension funds have grown faster than Latin American capital markets, making it difficult for managers to improve the diversification of the assets under management following the investment limits imposed by the regulators.

2.3.4. What's the story so far?

i. The pension system reform in Latin America has created one of the largest institutional investors.
ii. The Pension Funds are heavily invested in domestic capital markets.
iii. The Pension Fund Administrators (PFA) of a country follow the same quantitative investment limits.
iv. The PFAs are compared based on peer performance and some regulators also ask for a minimum return. Both contribute to the various PFA investing similarly.
v. In the Dominican case, the flow of supply of financial instruments doesn't match the flow of demand for them from the PF, enabling the financial market to act as some sort of "residual market" that keeps the excess liquidity.
vi. Then, we would expect that the concentration of investments in certain types of assets, would pressure a decline in the rates of return in such types of assets. In the

Dominican Republic case we are studying, the instruments we focus on are those of Financial Intermediation Institutions.

2.4. Econometric Model

The Dominican market has two characteristics to highlight: i) the longest end of the term structure of interest rates of financial intermediation institutions reaches the rate of “more than 60 months” and has no more than six (6) different rates. ii) there is no significant variability of the shape of the term structure, usually following upward sloping or hump-shaped forms.

Market based interest rates started in the early 1990’s. The short interval and the small number of observations and variability in the shape of the term structure make it difficult to be able to estimate properly its variability across it cross section. In other words, there is not enough information to estimate in a reliable fashion an indicator of curvature of the term structure. Without curvature, estimating a model with only the level and slope factors of interest rates, would suffer from omitted variable bias. It is important to highlight that we did not want to impose the no-arbitrage assumption and derive from here the term structure. This shouldn’t affect the consistency of the estimates, but only their efficiency.

We proceeded to build an econometric model that would capture the impact of observable factors (different macroeconomic variables) in the term structure of lending and deposits interest rates, and the spreads of rates of financial intermediation institutions in the Dominican Republic.

Based on the review of relevant literature, we will consider the usual macroeconomic factors, such as reference rates of the Central Bank, the rate of inflation, real growth rate of GDP and the fiscal position. Also, the condition of international markets is approximated by including the LIBOR rate; finally the assets of pension funds invested nationally are also included as an observable factor. The study seeks to explain the relevance of pension fund investments in the banking sector rates and indirectly on the rates of other bonds issued domestically. In general, the regression model has the following functional form.

$$i_{kt}^{w} = f\left(i_{kt-p}^{w}, \pi_{t-1}, g_t, fis_t, libor_t, fp_{t-1}\right) + e_t$$

Where:

f is a linear function of macroeconomic factors.

w= indicates whether the rate is the lending rate, the deposit rate, the spread between active-passive or the spread between domestic-libor rate.

k= relevant term of w (1 month, 2 months,…)

t= quarter, starting at 1996-01 y ending in 2009-04

It will highlight the impact that different domestic macroeconomic factors and the LIBOR have through the different periods. In this way it will be possible to characterize the impacts according to how they move the whole term structure in approximately the same magnitude (level effects) or do so unevenly (slope effects).

Level Effect: $\frac{\partial i_{kt}^{w}}{\partial x_{t-1}} = \beta$, for all w. In other words, the impact is the same for the different time periods analyzed.

Slope Effect: $\frac{\partial i_{kt}^{w}}{\partial x_{t-1}} = \beta_w$. That is, the impact depends on the analyzed period and is not necessarily the same. This case serves to identify when the term structure slope increases or decreases, but also when it could take somewhat more general convex or concave shape, without having to directly model the curvature of the term structure.

For parsimony purposes, it is assumed that the transmission channel in the short term goes from macroeconomic factors to interest rates. However, we must take into account that in a more flexible model, it should start off considering any possible feedbacks from the variations in interest rates on macroeconomic factors.

For example, changes in market inflation rate should move quickly to nominal interest rates, but as these increase, everything else constant, economic activity should be reduced as well as the rate of inflation. Something similar would happen with the fiscal position, if there is no access to international capital markets.

On the other hand, the relationship between LIBOR and the domestic interest rate is unidirectional. Changes in the LIBOR reflect international market conditions. Since DR is a small open economy, domestic rates won't affect the LIBOR rate, but the latter could influence the domestic rates by modifying the cost of access to foreign capital.

With respect to pension funds, at an early stage of the system like in the Dominican Republic, the main source of increase in assets managed by the PFA is the accumulation of monthly contributions of workers; therefore, assuming that the impact goes from the volume of pension funds being managed to rates is not conceptually restrictive. In stages where the pension system has matured, the investments managed by the PFAs are such that changes in interest rates paid by financial assets would significantly change the monthly flows of the following months, thus creating an important channel of interest rates to the amount of pension funds under management. This could be the case in Chile, with more than two decades after the reform, but not the Dominican Republic.

In another sense, an additional assumption is made in the econometric regressions to facilitate us to estimate both lending and deposit rates. Some of the variables can have an effect both in passive and active interest rates (e.g., fiscal balance, as it may affect the deposit when the Government deposits the surpluses in local banks and it could affect lending rates when borrowing domestically), but strictly speaking the investments of pension funds could only directly affect deposit rates, as has been established that the investments of pension funds in the bank are a significant source of liquidity.

By assuming that financial intermediation institutions have as a main activity the placement of loans, excess liquidity would also lead to reductions in lending rates and increment in the debt of the representative agent. This could also be justified if the intermediation spreads have some level of rigidity, for example due to the existence of overlapping contracts, the relevance of customers with pre-existing relationship with the banks, menu costs, or if banks take decisions to change the spread when it falls below a mark-up. Finally, if the variables can affect differently the lending and deposit rates, they would also have an effect on the spreads.

Appendices 2 and 3 show preliminary results of a study done by the author to explain some interest and yield rates in the Dominican Republic, Mexico, Colombia and Peru, using the methodology proposed in this research but through panel data regressions. Although in these regressions, the yield curve is not directly studied, but rather we focus on the impact of macroeconomic factors and pension funds on the level of specific rates, qualitative results are quite similar.

2.4.1. Econometric Analysis

We study the performance of 13 different rates: 7 lending rates (3, 6, 12, 24, 60 and more than 60 months) and 5 deposit rates (1, 2, 3, 6 and 12 months). These were chosen because they are the only rates available on a significant portion of the sample.

A. Variables and Data 1996-2009 (Quarterly)

Path of Nominal Lending Interest Rates of Commercial Banks

As noted in Figure A. 3 and Table A. 3, in general, rates tend to move in the same direction, but there are episodes where there's an increase in the interval between the maximum and minimum rate. In no case is the correlation between lending rates below 0.94.

Table A. 4 shows that at other times, a rate can increase or decrease more significantly than others, thus altering their ordering. This may be due both to possible segmentation of markets or institutions that operate in specific sections of the term structure, as well as to the different impacts of various macroeconomic factors. This pattern is also noted for deposit rates and spreads.

Figure A. 4 shows that the term structure of lending rates has a unique shape in a general sense, in which the slope is neither completely positive nor completely negative. Interestingly, over 90% of cases, rates of more than 60 months are lower than that of 60 months, possibly related to the type of client operating in each market, since customers that are indebted in a medium-term, should comply with best credit history and performance than those who access shorter terms.

Path of Nominal Deposit Interest Rates of Commercial Banks

Figure A. 5 and Table A. 5 show that in general, all deposit rates also tend to move in the same direction, however it is noted that during 2001 and 2005 they had a greater dispersion than lending rates. The correlation of deposit rates reached values less than lending rates, even these being more concentrated in shorter terms than the first. The lower correlation between deposit rates is 0.87, still a reasonable high value but lower than in the case of lending rates. Table A. 6

Figure A. 6 shows that the term structure of deposit rates follows three characteristic shapes: one with positive slope across all maturities, one with negative slope and finally, one with humps. The first two shapes represent less than 10% of the sample. It is easy to realize that although deposit rates follow the pattern of moving in the same direction, their dynamic is different to lending rates, which makes it interesting to explain both rates. It is important to keep in mind that due to the short sample of the study, we are basically looking at one of a few number of business cylces, therefore we should be careful with making final judgments. The path of Pension Fund Assets and macroeconomic variables are in Figure A. 7,

Figure A. 8 and Table A. 7

B. Results[10].

Results for lending rates are in Table A.8. The term structure of lending rates respond in general to the investments of pension funds, the inflation rate, the fiscal position and a variable that controls for the financial crisis of 2003. On the other hand, there is no significant relationship between the real growth rate of GDP or the LIBOR rate and the term structure of lending rates.

An increase in the inflation rate almost has a level effect along the term structure, though surprisingly inflation is not significant to explain the 60-month lending rate. These results appear to contrast with other international studies in which longer-term rates are the most responsive to changes in expected inflation rates. This may reflect to some extent that inflationary variations are more predictable in these countries, as many of these countries with studies on the yield curve have adopted inflation targeting schemes. In addition, the term structure in the Dominican Republic still has a narrow range of maturities. It is expected that as they expand the range and the inflation rate becomes more predictable as under an inflation targeting retime, we will obtain results more consistent with the international experience.

Only 3-month lending rates respond significantly to changes in the fiscal position. Thus, we cannot reject at 95% confidence that an increase in government

[10] For lack of data and to not cut the sample, the presented regressions do not include the reference rate of Central Bank. The last annex provides an additional set of regressions which include this variable, proving to be significant only in 2 of 17 cases.

surplus of 1% relative to GDP translates into a reduction in the rate of 1%, generating an increase in the slope at the short end of the term structure. The relationship is not significant for longer periods. This can be explained by the fact that fiscal deficit positions are also funded with other alternatives, such as: explicitly through external financing, implicitly by delays in government payments, among others. Figure A. 9

Of the analyzed factors, the only one that has significant explanatory power over the different terms is that which corresponds to the investments of pension funds. As shown below, an increase in investments of pension funds of 1% of GDP, scrolls down the entire term structure with an average impact of 1% to 1.5%. Figure A. 10

Building the confidence interval at 95% of the impact of investments of pension funds on lending rates, we cannot exclude that there is an effect of a 1% along the term structure for every 1% increase on investments of pension funds relative to GDP. The impact is greater for rates of 6 months and more than 60 months. Figure A. 11

Results for deposit Rates are in Table A.9. The regressions confirm that the term structure of deposit interest rates have a different dynamic than the one corresponding to lending rates, because on one hand the effect of the fiscal position on deposit rates as well as the investments of pension funds are direct effects, unlike with the lending rates, which is through the assumption of relatively rigid intermediation margins in the short term.

Deposit rates respond in general to investments of pension funds, the rate of inflation, real growth rate of GDP and the fiscal position of the period. Only one-year deposit rate responds significantly to the variable that controls for the impact of financial crisis of 2003. No point of the term structure responds directly to changes in LIBOR rates.

The impact of the inflation rate on the term structure of deposit rates is similar in magnitude to the case of lending rates. For the term structure of deposit rates, the inflation rate is also not significant in one of the terms; in this case, the 6 month deposit rate.

The entire term structure responds significantly to changes in the fiscal position. We cannot reject that at 95% confidence an increase in government surplus of 1% relative to GDP translates into a reduction of 1% over the entire term structure, generating a level effect. This can be rationalized if the government at the times when it has cash surplus, deposits them over different terms.

Even when the government deposits its cash surpluses exclusively on one of the two biggest banks (based on capitalizatinon and assets), the Reserves Bank, the size of the bank and the conventional organizational structure of the banking sector of the country would push down rates across the market. Figure A. 12

The rate of real GDP growth negatively affects the term structure in its midsection. In this sense, increases of 1% of quarterly real GDP would reduce deposit rates of 2, 3 and 6 months at 0.15% approximately. This effect would stimulate the term structure to adopt a U shape[11].

This could indicate that as it boosts the economy, improvements in the flow of income / savings generated with the increased activity help to reduce the deposit rate in

[11] Similar to the representation that is usually done to the *volatility smile* in the financial literature.

the financial system. Another possible explanation is that during 1996-2009 a significant part of real GDP growth corresponds to increases in aggregate supply.

The other significant explanatory factor across the different terms is that which corresponds to the investments of pension funds. As shown in the regression, because of the direct effect that exists on deposit rates, the level of significance of the coefficient associated with this variable for each term is greater in the case of deposit rates.

As expected, an increase in pension funds investments of 1% of GDP, scrolls down the entire term structure with an average impact of between 1.1% -1.6%, significantly higher than in the case of lending rates. Figure A. 13

If we build the confidence interval at 95% of the impact of a 1% increase in investments of pension funds relative to GDP on lending rates, we find that for the 3-month term, we discard that the effect on the rate is -1%. However, we can not exclude that the effect is of -1.1% for all maturities.

Finally, it is important to note that the expected decline on rates can be up to 2% for intermediate points (maturities) of the curve. As in the case of GDP growth rate, it would generate a change of slope at the ends of the term structure and a smile shape. Figure A. 14

This result would point out that the PFA portfolios require of both longer term instruments to invest the managed resources taking into consideration the maturity risk, while on the same time generating the incentives for these managers to invest in securities of longer maturities, once the instruments are available. The latter is important, since international evidence indicates that having a diverse group of instruments in the capital market whose characteristics are favorable for diversification is not a sufficient condition for the PFA to purchase such instrument, even if it increase the diversification of the portfolios.

2.5. Concluding Remarks and Policy Recommendations

Interest rates in the Dominican Republic have decreased gradually and consistently since the left behind the financial crisis of 2003 and 2004. This downward path occurs in a period when many other countries worldwide experienced similar reductions in borrowing costs, one of the reasons that contributed to the accumulation of risks that triggered the financial crisis of 2007 and that continues until today. One of the reasons that helped allocating a small price to risk was the availability of easy money in the markets, influenced, among other factors, by resources supplied by of institutional investors. However, there are no enough studies addressing the effects on interest rates of the increased resources that the major institutional investors manage, particularly pension funds. This is the void in the literature in which this paper tries to contribute, focusing on the case of the Dominican Republic, itself as part of a larger study of some economies in Latin America.

Reforms to pension funds, in the form of defined contribution systems, have been implemented in Latin America (LA) and Eastern Europe, since the Chilean case in 1981. These reforms created new systems of fully funded pension funds in which workers pay for their own retirement. The system relies on the fact that Pension Fund Administrators (PFA) will:

i. have access to capital markets to invest workers' contributions with principles of efficiency, risk and profitability under certain investment restrictions.
ii. given this market, the PFA will make optimal decisions.

But as presented in the study, one cannot simply assume that i) and ii) are met at every moment.

At the international level the reforms of pension systems have contributed to the increase in activity of domestic capital markets, for example by increasing the volume of transactions - mainly in bonds and bank deposits-. By creating a significant institutional domestic demand they contribute to the emergence of modern institutions, such as centralized custodians, public-private partnerships, rating agencies, among others. However, in other areas, impact have been limited: For example, the PFAs have invested a small portion of their portfolio in domestic stocks and there are significant restrictions on international issuance. In these studies, it is often shown that ii) does not hold.

So far, the literature on the effects of defined contribution pension systems on capital markets has focused on studies of quantities: analyzing the impact on trading volumes and the development of new institutions and regulations. However, recent experience in global financial markets has served to remind the importance of monitoring the prices of financial assets. The impact on interest rates occurs more easily when the availability of a deep financial market, as assumed in "i)", is not met.

Interest rates are essential to an adequate resource allocation because they reflect the level of risk of the capital transaction to both parties. A decrease in interest rates could lead investors to underestimate risk and not invest efficiently; if this extends for long periods, it could contribute to episodes of financial stress and crisis as its most expensive manifestation.

We studied the term structure of interest rates in the financial system (as these are taken as reference in determining the rates of bonds issued domestically) through observable macroeconomic factors, emphasizing the reasons to include pension fund investments as an additional factor.

The econometric study is based on two important assumptions. Of these, the one which assumes that the relationship in short-term goes from macroeconomic factors to interest rates could be removed easily in future studies.

The econometric regressions show that interest rates respond to the domestic macroeconomic factors used, but within these, investments by pension funds play an important role. On the other hand, no part of the term structure responds directly to changes in LIBOR rates.

The fact that none of the Dominican rates studied is significantly influenced by the LIBOR is evidence that the transmission of international shocks should rest more on channels of the real sector (reduced foreign investment) or balance of services (reduction in tourism and remittances) than on financial variables (in the form of changes in liquidity conditions, the risk appetite of investors and changes in credit risk).

The other significant explanatory factor across the different terms for borrowing and lending rates is the one related to the investments of pension funds, however it impacts at different levels. An increase in investments of pension funds of 1% of GDP scrolls down the entire term structure of deposit rates by an average of between 1.1% - 1.6%, significantly higher than in the case of lending rates in which could not rule out that the impact was to reduce by 1%, at a 95% confidence level.

These results are indirectly saying that in order not to affect the returns of pension fund investments, the portfolios of the PFAs require both new financial instruments, as well as instruments with longer maturities and to be able to match better the term risk of their investments and their liabilities. The recent development of a treasury debt market led by the area of Public Credit of the Ministry of Finance is a very significant step in this direction.

Also, the PFA managers should have the incentives to invest the resources on different instruments. This is important, since international evidence indicates that having a type of instrument in the market whose characteristics are favorable for diversification of portfolios is not a sufficient condition for the PFA to buy the instrument.

To contribute to increasing levels of market-based expected returns on pension funds, it is also very important to begin a process of gradual opening to international markets, thus also increasing the level of competition that the financial sector face in order to attract the resources of pension funds (and rising the price of the risks being taken implicitly by the pension fund system). The opening to the international market should go hand in hand with a more active risk management to the PFAs and preferably authorizing at the same time the purchase of financial derivatives with the purpose of limiting these risks.

In short, unlike some of the other macroeconomic variables that affect the level and shape of the term structure of interest rates, investments by pension funds should continue to grow exponentially in subsequent years. The growth of financial markets must not rest in the cheap liquidity that pension funds provide, but in sustainably exploiting opportunities that come from the system. A better understanding of the relationship between pension funds and financial markets must take into account the impact this market has on interest rates. To the extent that this is significant, it should be included in the models used by the Central Bank regarding the transmission channels of monetary policy and models of risk of the financial system. Also, a deeper government bond market and with longer-term securities, as well as investments of pension funds that can be placed on the international market, are steps that should be given towards both the development of domestic capital market, future benefits of the pension system and reducing the accumulation of latent risks in the Dominican economy.

Chapter 3

Pension Fund Reforms in Latin America: Have PF Contributed to the Decrease in Interest Rates Levels in the Last Two Decades?

3.1. Introduction

During the last two decades, Latin American countries have been shifting their pension programs from defined benefits to defined contribution systems. To invest contributed fund they have established investment plans that are heavily invested in government securities. These systems have begun to take substantial positions in specific markets, such as bonds of the treasury and other government offices and the banking sector, leading to the potential for effects on interest rates. For several political and economic reasons, international investments are very low or not allowed at all for these pension funds, allowing for pension funds portfolios to own large shares of the markets in which they are allowed to invest.

Continuing with the study of the previous chapter, I attempt to address the effect of pension funds investments on selected interest rates for 4 different countries that have adopted the defined contribution framework following Chile, these are: Colombia, Dominican Republic, Mexico and Peru. For this purpose, I start providing a detailed explanation of the structure of the pension fund system and how it creates incentives for the pension fund administrators to behave in similar fashion.

The main hypothesis is that the coincidence of pension fund administrator behavior and the size of the funds under management have contributed to the reduction in interest rates in these Latin-American countries. We run different time series and panel data regressions and we find, after controlling for different macroeconomic factors, that we cannot reject that the amount of pension fund assets contribute to the reduction of interest rates in these countries. This finding suggests that in order to address the behavior of interest rates, particularly in Latin-American countries with pension fund regimes based on defined contribution, authorities and researchers should not undermine the importance of the system.

The body of this study relies heavily on the previous chapter, because it is intended to complement its findings. However it is important to distinguish the main differences in both chapters. First, in the previous chapter we focus our attention in explaining the relationship between whole term structures of lending and savings rates and pension funds investments in Dominican Republic using only time series techniques. Second, in this chapter, we pay attention to the rates of 4 countries using both panel data analysis and time series techniques. Third, for the Dominican Republic case, in this chapter we use the weighted average savings rate as oppose to the whole term structure as in the previous chapter.

The remaining part of the chapter is structured as follows: section 3.2 summarizes the literature review on interest rates and the key financial aspects of the pension fund reform that started in Chile; section 3.3 addresses the empirical strategy, the econometric specification and empirical results, while section 3.4 presents the main conclusions.

3.2. Literature Review

3.2.1. The determinants of interest rates

Interest rates and yield rates serve as a reflection of the allocation of resources between savers and borrowers of capital. In an economy there is no single interest or yield rate, but there is a range of different rates. In addition, within a specific market, assets of different terms are traded, each with their respective rate. These rates in turn may be affected and/or may have implications for other markets.

The study of the drivers of interest rates and its term structure has been a very dynamic area of research since the 70s. The line of research that I follow both in this and the previous chapter, explains interest rates using factor models with observable economic variables as the factors. In the literature, three variables are usually present in a large number of studies that explain the relationship between the term structure and macroeconomic variables: the monetary policy rate, actual inflation rate or some measure of inflationary expectations and the real growth rate of the economy or some indicator of economic activity that is available monthly or quarterly.

The traditional approach is to consider that the impact goes from macroeconomic variables to the term structure – following for examples Morales (2007), Ang and Piazzesi (2003), among others –, but some studies consider the feedback of the term structure to macroeconomic variables, as in Diebold, Rudebusch and Aruoba (2005)[12].

[12] However, the authors also found that the most relevant direction goes from the macroeconomic variables to the term structure.

According to Diebold, Piazzesi and Rudebusch (2005), researchs that follows Nelson & Siegel (1987) and include different macroeconomic variables as factors are very important for the central banks, given that the results are statistically consistent and easier to interpret than very complex models.

For Latin-American countries there are some interesting studies with respect to the evolution of interest, although these are not abundant. The reasons could be twofold: first, no quality data is available, albeit the quality of economic data have been improving substantially in the last decade; second, the time interval comprising the data is usually quite small, making it difficult to reach robust conclusions.

Among the literature in the field, an interesting study to highlight is Morales (2007), which shows a dynamic relationship between the yield curve and macroeconomic variables. In turn, he also shows how inflation and monetary policy rate depend on the latent factors of the yield curve. Larraín (2007) estimates the relationship between monetary policy surprises and the nominal interest rates in Chile. The results show a strong relationship between nominal market rates and the monetary policy rate and between the actual market rates and surprise changes in monetary policy. As the theory points out, the effect of monetary policy weakens with interest rates of longer maturities.

Within Latin-American countries, the Mexican case has the most studies on the subject, probably because it is one of the economies in the region with the deepest capital markets and longer financial history. A study that is important to distinguish from others is Vela (2006). In his paper, the author uses mexican data from 2001 to 2005 and analyses how several fiscal indicators[13] play an important role in explaining the prices of zero coupon bonds. The author builds on the study of Dai and Phillipon (2004) and a procedure derived from the Generalized Method of Moments. His main finding is that fiscal shocks are small in magnitude but relevant. This may be even intuitive, but is often neglected in this literature.

Our point of view is that, along with Vela (2006) findings, other sectors should be analyzed in depth when considering the evolution of interest rates in emerging economies, in particular the defined contribution pension fund system. Pension systems should not be analyzed as separate from the rest of the economy, since by affecting the interest rates and asset prices they could have macroeconomic and financial impacts on the rest of the economy, beyond what has been traditionally documented.

A relatively young literature studying the defined contribution systems is emerging, and the regulators all over are increasingly taking greater account of the impact of that pension fund investments and policies have in the capital markets. However, to date we do not know another study that has attempted to quantify the impact of pension fund investments on domestic rates.

However, there are still plenty of questions to be made with respect to the defined contribution pension system. For example, how does a defined contribution system affect

[13] In traditional models of macroeconomics, fiscal position is a very important variable in determining the interest rate of the economy, as a significant increase in public spending could lead to a crowding out of private spending and cause a pressure to the increase of interest rates. This argument becomes more important in economies where the public sector regularly goes to domestic financial markets to finance their spending, a reality that when used wisely, turns out quite healthy, and the Dominican case is not the exception to the rule.

economic growth –Davis and Hu (2007) have established empirical evidence between the system and higher levels of GDP growth-. If the accumulation of pension funds was to increase the prospects and actual growth rates of the economy, we could have at least transitory effects on monetary policy decisions as the growth rate may go above the central bank's explicit or implicit GDP growth objective[14].

On the other hand, if the pension system has a measurable impact on market interest rates, it could affect the effectiveness and the lag of monetary policy transmission mechanism, the allocation of capital and the perception of financial risks, particularly in countries with shallow capital markets and without strong evidence of desirable portfolio diversification and returns maximization for the investments of pension funds.

Also, if pension funds investments affect the rates that are taken as benchmarks for the bond issuances, the effect can be translated to the supply-demand of funds equilibrium, and translate into real side effects. A better understanding of the channel that relates investments of pension funds and market interest rates, if it exists, could significantly complement current monetary policy models and beyond.

By (i) explaining how the defined contribution pension fund system works in Latin-American countries, and (ii) linking this literature with the one that explains the evolution of interest rates, we believe that we are contributing to a better understanding of both markets, particularly by showing that pension funds can have durable effects on market rates.

[14] A central bank that makes monetary policy that can be represented by a Taylor rule or some similar rule, changes its monetary policy rate according to variations in the current rate of growth that does not shift the economic growth rate in the long term at the same proportion.

3.2.2. PF reform in Chile & Spread to Latin America

During the past two decades, Latin American countries have been reforming their pension programs leaving behind defined benefit schemes and starting defined contribution systems. To invest the funds accumulated by workers, the regulators created Pension Fund Administrators (PFA), which can buy a variety of securities in financial markets, secutiries that are usually approved within a positive list.

Chile was the first country to replace its defined benefit system by a defined contribution system in 1981. Since then, nine Latin American countries and eleven from Eastern Europe have adopted a defined contribution pension system with some adjustments. One of the main advantages of defined contribution system, compared to the previous one of defined benefit, is that the former is self-sustainable[15]. Another advantage is that the system generates an integrated work between the Government (in regulation) and the private sector (management, investment of resources and related services). Although governmental PFAs can compete with private ones, the vast majority belong to the private sector.

In the defined contribution system, the value of pensions to be granted depends on the accumulation of contributions during working life and the returns on investments. In some cases the Government establish is a minimum pension[16]. When workers are affiliated to the defined contribution system, he has a private account administered by a

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[15] If the system has a social pillar, this pillar may have to be financed partly by government budget contributions.

[16] Yaryura (2008) presents simulations that show that the resources allocated to meet the minimum pension in the Dominican Republic would be insufficient under plausible assumptions.

PFA selected by the worker/owner of the account or established by law. The fate of these resources is solely to fund the pension of its owner, or his relatives, depending on the case.

Contributions to the system are mandatory (although workers can also make voluntary contributions) and are credited monthly to the worker's account. The PFAs have to invest the assets they manage within a time period established by law[17]. In Latin America, the regulations of the PFAs follow quantitative investment limits, unlike Europe and the U.S., where it follows a more flexible approach known as "prudent investor".

The regulation and supervision of the system tends to be the responsibility of a new and specialized institution (Superintendence). In some cases it can become part of bigger regulatory body that supervises financial, pension and insurance institutions, as is the case of El Salvador and Peru. The regulation by the government tends to be justified by the existence of asymmetric information in the market of the investors and the workers that own the resources, the required fiscal incentives in the early stages of the system characterized by a low asset based and high infrastructure and operational costs, among others. The new system is usually regulated on three aspects: the structure of the industry, asset allocation and investment performance.

[17] Which is not necessarily recommended. For example, in the face of a systemic shock in which all kinds of assets suffer from falling prices and it is expected that these are maintained in the future, the optimal strategy would be to not invest until the minimum expected value is achieved, otherwise resources will be lost.

The PFA's industry is usually limited to do business within the reformed system, such as collecting contributions, investments, reporting income to participants and provide benefit payments where appropriate. Activities such as safeguarding the computational infrastructure, the custody of financial assets and providing the market with the necessary insurance are made by institutions other than the PFA.

In practice, in the early stages of the system, investments of the PFA usually go to government securities and/or instruments of financial institutions. Over time, as resources are accumulated, these systems acquire a enormous outstanding positions of financial securities in domestic financial markets. If investments in new types of domestic or foreign instruments are not allowed at a significant scale and in a timely fashion, they can keep being pumped into the same assets affecting their prices and rates. This could in turn have significant effects in capital allocations and in the accumulation of financial risks that have not been studied and may prove to be significant in the future.

The investment scheme that follows the defined contribution system was conceived as the best way to achieve an appropriate risk/return relationship of portfolios created with the savings of the workers. If an investor can choose between different investment alternatives in the same period, he will allocate resources in those instruments with the best risk-return ratio. If this ratio is exogenous it will diversify its portfolio according to his preferences and risk diversification established by law.

Theoretical models such as those based on the efficiency frontier and portfolio life cycle[18], establish that, generally, properly diversified portfolios should include a non-negligible proportion of assets traded abroad and denominated in international currency. However, the evidence indicates that for the Latin American pension funds, these "international" investments are below optimal levels, and sometimes are not allowed at all.

The justification for the investments of pension funds to be concentrated domestically are several, among which stand out regulatory explanations, such as: authorities have the interest of reducing the volatility of capital flows - Fontaine (1997) -, as well as avoiding capital flight and deepen the domestic market, as provided Reisen (1997). As explained by Srinivas (2000), the fact that the portfolios of pension funds are heavily tilted towards domestic markets, makes them the main investors of several public offerings[19]. However, evidence shows that even when some of the regulatory barriers are lifted, PFAs still engage in practices that deviate from optimality.

[18] The life cycle models have an optimal portfolio structure oriented to deal with a specific payment to the initial investment and income (such as pension payments at the end of the working age of a person). In these models, the optimal portfolio depends not only on the characteristics of investment alternatives, as in the case of the results based on the efficiency frontier, but also depend on population characteristics such as informal work and age. Ceteris paribus, a younger population and with a more stable source of jobs can take more risks in their investments than older people or people with more volatile sources of labor income.

[19] Although in an ex ante perspective, the little international diversification of investments of pension funds in some countries can be considered as inefficient, countries with a higher proportion of these international investment were the ones that suffered the most the depreciation of stock markets that started in 2007. On the other hand, a strong concentration of investment in domestic instruments, may distort the level of interest rates, capital allocation, and could stimulate the accumulation of risks and bubbles; a situation that can have significant impacts as well. Although this study excludes the determination of an optimal portfolio for pension funds, surely this would entail an investment volume abroad different from zero.

As Dayoub and Lasagabaster (2008) show, in recent years, the assets of pension funds have increased significantly in Latin America. Since 2005, the authors suggest that they have reached 18% of GDP. In contrast, only 18 of the 30 OECD countries had higher PF assets as a percentage of GDP, showing that by creating a growing demand for financial assets, the reform has been crucial in stimulating financial asset supply in the region. But the authors point out that, in general, reforms often coincide with periods of macroeconomic stability, which could overstate the actual impact of pension fund systems in the economy.

The International Association of Pension Funds Supervision states that pension fund assets in Latin America reached US$ 244 billion (averaging 15.6% of GDP), by June 2009, after peaking in June 2008 with US$ 283 billion, before the current crisis which initially began in the United States, became a global phenomenon. See Table A. 1

In general, the growth in assets of pension funds comes from four sources:

i. The increase of **coverage** (number of workers contributing to the system),
ii. The increase in **contribution** rates (share of the wages of workers that is intended to buy shares at market value and to increasing their accounts) and voluntary contributions.
iii. **Wage increases**, which due to contribution rates being set as a proportion of these nominal wages, increase what is intended to build assets for the pension.
iv. The **rates of return on current investments**, which might not be exogenous to the system if the pension funds investments have a direct impact on interest rates of the

markets in which they invest significantly, as well as if the market is used as a reference for the calculation of other interest rates and economic performance.

So, does the story of the previous chapter hold for countries different than the Dominican Republic?

We believe it does, particularly because the system generally reflects a similar macro structure, even though it has characteristics idiosyncratic to each country social purpose, fiscal balances, labor and financial market.

- The pension system reform in Latin America has created one of the largest institutional investors.
- The Pension Funds are heavily invested in domestic capital markets.
- The Pension Fund Administrators (PFA) of a country follow the same quantitative investment limits.
- The PFAs are compared based on peer performance and some regulators also ask for a minimum return. Both contribute to the various PFA investing similarly.
- In the Dominican case, the flow of supply of financial instruments doesn’t match the flow of demand for them from the PF, enabling the financial market to act as some sort of "residual market" that keeps the excess liquidity.
- Then, we would expect that the concentration of investments in certain types of assets, would pressure a decline in the rates of return in such types of assets. In the Dominican Republic case we are studying, the instruments we focus on are those of Financial Intermediation Institutions.

3.3. Empirical Strategy & Econometric Model Specification

Attempts to explain interest rates levels or yields in Latin America don't address formally the effect of pension funds investments. Macroeconomic studies of the interest rates tend to motivate the inclusion of specific macroeconomic factors, such as the monetary policy rate, the inflation rate or a measure of inflation expectations and real GDP growth rate; for example see Arango et al. (2001), Morales (2007), Larrain (2007), Cortes y Ramos-Francia (2008) & Cercero et al. (2008), and so on. Vela (2006) shows and motivates how the public sector stance could affect interest rate dynamics.

In this study, I will consider the standard macroeconomic factors found in the literature, but I also include additional factors: the fiscal position and the size of pension funds assets. The study will address results based on different estimation procedures and functional forms to show the relevance of pension funds investments in small domestic capital markets.

3.3.1. Functional Forms

Both panel data and time series regressions have the following form:

$$i_{kt}^{w} = f(\pi_{t-1}, g_t, fis_t, libor_t, pf_{t-1}) + v\phi_t$$

Where:

f is a linear function

π is the inflation rate

g is the fiscal position

libor is the London interbank offered rate

pf is the pension funds assets, and

v is the residual term

3.3.2. Definition of Variables & Data

3.3.2.1. Definition of variables & Sources

Macroeconomic variables are from the Global Financial Database, the data for the fiscal positions is from the webpages of the central banks and ministries of finance. Finally, data on the assets held by the pension fund administrators are from the pension fund regulators in each country.

Data is from 1988 to 2009 to include relatively enough information from the years before the pension reform. The panel is unbalanced comprising 336 observations.

3.3.2.2. Empirical Results & Robustness

i. Panel Data Estimations

I run 2 different functional forms and 4 different estimation procedures to analyze if there's a "general" negative impact of pension funds investments in the interest rate of selected markets for Dominican Republic (1 rate), Mexico (4 rates), Peru (2 rates), Colombia (1 rate).

The first functional form includes the PF assets as % of GDP, while the second functional form includes it as logarithm, facilitating the direct calculation of the semi elasticity of interest rates to PF assets. The 4 different estimation procedures are: pooled OLS, fixed effects, GLS using cross section weights and GLS using Seemingly Unrelated Regressions technique. To control for heteroskedasticity, we use White Heteroskedasticity technique to compute the standard errors of the regressions.

In 16 of the 21 cases, PF investments are statistically significant and with the expected negative sign (8 at the 1% sig level, 6 at the 5% and 2 at the 10%). In 12 of the 21 cases, a global negative trend is also significant (2 at the 1% sig level, 8 at the 5% and 2 at the 10%). In 3 of the 21 cases, the global negative trend is significant and the PF investments are not. On the other hand, in 7 of the 21 cases the relationship is inverted. Results seem to be robust to 3 different functional forms and to 4 different estimation procedures. Results for the PF variable are summarized in Table B. 4

ii. Time Series Estimations

For the 4 countries studied, we run a total of 18 regressions and our findings can be summarized as follows:

Results In sum, results suggest that PF contribute to the downward trend in interest rates as its investments accumulate in domestic assets. For 15 of the 18 regressions, the PF assets as a % of GDP had a negative coefficient statistically significant.

Interestingly, in the case of Colombia, results change based on controlling for the financial crisis in 1998 and early 1999. If we don't control for the financial crisis, PF investment results exhibit a positive sign, although a dummy variable controlling for the time of the PF reform exhibit a negative sign with a higher number (in absolute vale).

After controlling for the financial crisis, in 3 of the 4 for cases, the financial crisis dummy that interacts with the PF investments shows the negative expected coefficient. If I use a shorter sample, the direct PF effect is not statistically significant, but the interacting term has negative sign and is statistically significant.

For the Dominican Republic, there's evidence in the line of the results of the previous chapter. We observe a reduction of the average interest rates of the banking sector as PF investments accumulate as share of GDP. Results are significant at 1% level.

For Peru, there's evidence of a reduction in the banking sector interest rates as PF investments accumulate as share of GDP. Results are significant at 1% level. However, there's no statistically significant relationship between the rates of the central bank certificates of deposit and PF investments. Surprisingly, there's evidence of an increase in the level of the rates in the quarter in which the PF reform started. Results are significant at 1% level.

For Mexico, there's evidence of an effect when the PF system started for the 1 month & 3 months Treasury bills, but not for later maturities. There's evidence of a reduction in the 1 month T-bills rates as PF investments grow as share of GDP. Results are significant at 10% level. There's evidence of a reduction in the T-bill rates in the quarter of the PF reform. Results are also significant at 1% level.

For the 3 months T-bills rates, there's also a reduction in these as PF investments accumulate as share of GDP (significant at 10% level). There's evidence of a level decrease in the rates in the quarter of the PF reform. Results significant at 1% level. For the 6 months T-bills rates, as PF investments accumulate as share of GDP, rates are reduced with a significant at 1% level. Finally, there's evidence of a reduction in the 12 months T-bills rates as PF investments as share of GDP, with results significant at 10% level. Results are summarized in the Table B.5. and Table B.6.

3.4. Concluding Remarks

During the last two decades, Latin American countries have been shifting their pension programs from defined benefits to defined contribution systems. These systems have begun to take substantial positions in specific markets, such as bonds of the treasury and other government offices and the banking sector, leading to the potential for effects on interest rates. For several political and economic reasons, international investments are very low or not allowed at all for these pension funds, allowing for pension funds portfolios to own large shares of the markets in which they are allowed to invest.

Although this paper relies heavily on the previous chapter, it is important to distinguish the main differences of both chapters. In the previous one, we focus our attention in explaining the relationship between whole term structures of lending and savings rates and pension funds investments in Dominican Republic using only time series techniques, while in this chapter we also study the effect on Mexico, Colombia and Peru using both panel data analysis and time series techniques.

This chapter explains how the coincidence of pension fund administrator behavior and the size of the funds under management have contribute to the reduction in interest rates in these Latin-American countries. Running different time series and panel data regressions we find that we cannot reject that the amount of pension fund assets contribute to the reduction of interest rates in these countries.

This finding suggests that in order to address the behavior of interest rates, particularly in Latin-American countries with pension fund regimes based on defined contribution, authorities and researchers should not undermine the importance of the system. Additional lines of research based on this one include the relationship between the volatility of interest rates and pension fund investments using GARCH models, the construction of theoretical models relating monetary policy, or GDP growth and pension fund investments.

Chapter 4

Fiscal Policy, Phillips Curve and Nonlinearities in Monetary Policy: Theories and Evidence for the Dominican Republic

4.1. Introduction

Theoretical models are frequently developed with some type of nonlinearity in its structure; also, empirical studies usually have different types of nonlinearities in some of the equations and regressions involved. However, the traditional macroeconomic approach generally neglects them and it is focused on linear approximations. In addition, in the topic of our study, the empirical literature treats the nonlinearities of the Phillips Curve and the nonlinearities of the monetary policy rules as non related, and when it rarely relates them, it is focused on a single possible type of nonlinearity. Also, studies of fiscal policy and monetary policy interaction focusing on nonlinearities are not abundant.

Based on all this, our objective with this paper is twofolds; first, to formally show the relationship between nonlinearities in the economy's structure (approached by the Phillips Curve and aggregate demand interaction) and monetary policy (approached by a central bank's reaction function) and to show its relevance, and second, to show that nonlinearities are better studied as affecting more than a single equation. For this study, we use a simple model with a central bank with quadratic preferences and we estimate it using data from the Dominican Republic.

This research contributes to economic literature in that it integrates monetary policy to the type of nonlinearity in the Phillips Curve or Aggregate Demand (as that one that fiscal policy may induce), and demonstrates that nonlinearities (as they are usually proposed in empirical studies) in the former may be generated by the nonlinearities of the latter. In addition of developing this integral approach, we can hereby mention three additional contributions: i) it studies the most recent versions of the Phillips Curve for an emerging economy, and it's the first time it's done for the Dominican Republic, ii) it brings to discussion the economic relevance that nonlinearities may have, and concludes which of those analyzed fits better the regressions for real sector and monetary policy data, and iii) it shows that nonlinearities generate relevant differences in the point estimates or the marginal effects and sacrifice ratios, although differences in point estimates of sacrifice ratio calculations are of economic relevance but not statistically significant. We consider that detailed knowledge on the relevance of nonlinearities is important, given the widespread used of linear monetary policy rules, both in academia and economic policy circles, to address central bank behaviour and it's transmition on the economy.

On the basis of different types of nonlinearities, and without assuming a central bank with asymmetric preferences over inflation and economic cycle, we find that nonlinearities are statistically significant and of economic relevance. When comparing three types of nonlinearities studied internationally (the one originated from possible overheating of the economy, one that depends upon the interaction of inflation with the economic cycle and lastly the one that depends on the relation between inflation and its volatility) we find evidence suggesting that the Phillips Curve that relates inflation with its volatility is the one that fits the country data better, while the central bank's reaction function appears to be characterized better as the one responding to a convex Phillips Curve structure. To get consistent results between both regressions, we follow a joint estimation approach and find that the nonlinearity that relates inflation with its volatility is consistent with both Phillips Curve and Monetary Policy rules, cross equation restrictions and theoretical restrictions on the signs of the coefficients, hence we propose studying nonlinearities using joint instead of single regression estimation techniques. We show that nonlinearity's relevance is not sensitive to the definition of economic cycle used, but results are less conclusive for the fiscal driven nonlinearities, which appear to be nonsignificant.

In sum, our findings can be summarized as follows: i) nonlinearities explain a relevant and variable proportion of inflation and liquidity dynamics, ii) nonlinear models' forecasts are better than equivalent forecasts for linear models, iii) Davidson and Mackinnon (1981) methodology chooses a nonlinear characterization instead of a linear one, iv) differences in calculations of marginal effects between linear and nonlinear models can be of economic relevance and statistically significant, v) studying Phillips Curve and Monetary Policy rules nonlinearities using a joint estimation approach allow us to reach more consistent conclusions, and finally, v) differences in calculations of sacrifice ratios between linear and nonlinear models can be of economic relevance but are not statistically significant. Our research is divided into six sections. In section 2 we summarize the linear Phillips Curve, linear aggregate demand and their relevance to monetary policy. In section 3 we present nonlinear extensions of both the Phillips Curve and aggregate demand and their effect on monetary policy. In section 4 we present international evidence in relation to the Phillips Curve, fiscal and monetary policy. In section 5 we develop an intensive empirical and econometric analysis. Finally in section 6 we conclude.

4.2. Linear Phillips Curves and Monetary Policy

The negative relation between wage inflation and unemployment was originally presented for the United Kingdom by Alban Phillips in 1958. During the 70's, Lucas critique questioned the level of confidence that economists should give to econometric results, whilst Friedman and Phelps suggested (and was later accepted as part of macreoconomic theory) that in the long run there should be no systematic relation between these variables, and that the negative relationship found should be relevant only in the short run. In their view, wages (and prices) are completely flexible in the long run, thus only one possible level of unemployment would be consistent with any level of inflation in the economy, the natural or long run rate of unemployment and it is usually addressed as the Non-Accelerating Inflation Rate of Unemployment (NAIRU).

Initially, although many theories and empirical studies still give place to different types of Phillips Curves, the recent ones differ from the original version. Some of these differences are: the substitution of wage inflation for price inflation [20], an extension of its functional form to include other relevant channels (i.e.: exchange rate, the price of final

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[20]As Whelan (1997, 1999) show, when changes in real wages depend on the unemployment rate, assuming adaptive expectations and prices that respect a mark-up over unitary labor costs, we can go from wage inflation and the original Phillips Curve to one that relates price inflation with unemployment, as commonly on theoretical and empirical studies. This result is robust to the microeconomic dynamics of wages.

goods produced abroad and the price of importable intermediate goods [21], lending interest rates, and others), the fact that some authors use estimations of the economic cycle instead of the unemployment rate [22] and more robust theoretical microfoundations.

In the following subsection we provide a summary of the bibliography of some of the most recent literature about the Phillips Curve, its nonlinearities and monetary policy, but because of the extensive literature available we limit the details exposed to those strictly relevant for out study [23].

4.2.1. Backward and Forward Looking Inflation

Rational expectations models visualize inflation as a completely forward looking phenomenon in which, in the absence of any other type of restriction, there is no space for backward looking inflation. Models like Lucas (1972, 1973), Taylor (1981), Calvo (1983), and others, derive a short run Phillips Curve as a consequence of a different friction in the economy.

In the case of Lucas (1972), there's a component of backward looking inflation in the sense that producers evaluate the stance of average inflation to decide wether they observe sector specific or aggregate shocks and decide wether they change their production or their prices. Shocks considered as aggregate shocks have no real effect over production, while shocks ti relative prices do.

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[21] As in the case of petroleum.

[22] Following Arthur Okun's Law, which according to Prachowny (1993), was first used in 1962.

[23] The interested reader is invited to review the theoretical revision of Agénor and Bayraktar (2008), the most important source for this subsection.

In the case of Taylor (1981), what relates inflation and unemployment is the existence of overlapping labor contracts; these are not constantly renegotiated nor in a fully synchronized way, but instead they last for a specific time length (that allow non anticipated shocks to have real effects).

In Calvo's (1983) model, a proportion of the firms bring to period t the prices of period t-1 while the rest have the opportunity to change their prices today (period t), and rationally choose what price to assign between today and the expected moment at which they can once again make this decision according to their objective of profit maximization.

Although the assumption of forward looking inflation assumption seems theoretically attractive, several theoretical models and international evidence suggest that inflation exhibits a relevant backward looking component. In theory, inertia may arise from real rigidities -i.e.: wages, like the cases of Blanchard and Galí (2007) or Fuhrer and Moore (1995)-, from utility functions that include real money holdings[24], from the assumption of firms that fix prices by rules of thumb -as in Galí-Gertler (1999)-. Also, models with adjustment costs suggest that the transition from effective inflation in period t to the desired level in period t+1 is donde gradually and takes place when the benefits that arise from the change overweigh their costs, suggesting also the presence of inertia in inflation.

[24]Inflationary inertia can arise if real holding demand enters in a nonseparable form with consumption and depends on lagged inflation.

4.2.2. Models for Open Economies

Although traditional Phillips Curves models focused on closed economies, most countries nowadays are open to trade and capital flows. Several decades ago, and particularly the 90's, international competition increased rapidly. Even though it used to be primarily based on rapid increase of exports and imports of goods, today it covers both goods and services. As Agénor and Montiel (2006) explain, there at least three channels by which openness affects domestic prices: first, due to changes in marginal costs of production as a result of international competition; second, due to the effect that arise from changes in the price of final importable goods over nominal wages (this is an indirect effect over changes in the consumer prices index); and third, due to changes in the relative price of commodities (importable) over costs of production [25].

If we consider these three channels as determinants of the marginal cost of production within an open economy, it results that the latter is a function of the economic cycle (because it relates directly with real wages), the relative price of imports with respect to in relation with the CPI and of the relationship between imports and nominal wages [26]. In addition to these three, real exchange rate depreciation would be the other

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[25] In their study, the authors also include directly domestic petroleum prices as a determinant of domestic inflation, as it represents a very important importable commodity in the production function.

[26] Note that although similar, these three different variables: one is a real variable and the others are relative prices with different open economy transmission channels.

relevant component for an open economy Phillips Curve [27]. The Phillips Curve equation that consolidates the recently explained theories is presented as follows:

$$\pi_t = \chi_1 \widehat{y_t} + \chi_2 E_t \pi_t + \chi_3 \widehat{z_t} + \chi_4 (\widehat{p_t}^J - \widehat{w_t}) + \chi_5 (\widehat{p_t}^J - \pi_t) + \chi_6 \pi_{t-1} + \chi_7 \widehat{R_t} \quad ,(1)$$

Where: Variables in small caps represent logarithms, $\widehat{x_t}$ represents the logarithmic deviation of x_t with respect to its steady state value, except for the real exchange rate (z), which si considered in percentage change, E denotes the expectations operator, p^J the price in domestic currency of the imported commodity (i.e.: petroleum), w is the nominal wage, R is the lending interest rate, the subindex t denotes time and y the economic cycle.

Equation (1) is the one studied in in Agénor and Bayraktar (2008), but ours have some additional algebraic manipulations; first, grouping inflation on the left hand side and dividing by its new coefficient we have:

$$\pi_t = \frac{\chi_1}{1+\chi_5} \widehat{y_t} + \frac{\chi_2}{1+\chi_5} E_t \pi_t + \frac{\chi_3}{1+\chi_5} \widehat{z_t} + \frac{\chi_4}{1+\chi_5} (\widehat{p_t}^J - \widehat{w_t}) + \frac{\chi_5}{1+\chi_5} (\widehat{p_t}^J) + \frac{\chi_6}{1+\chi_5} \pi_{t-1} + \frac{\chi_7}{1+\chi_5} \widehat{R_t} \quad , \qquad (2)$$

Finally, in order to work with the nominal, and not real exchange rate (because data corresponding to the former are less questionable than the latter), we consider that real exchange rate deviations obeys:

$$\widehat{z_t} = \widehat{e_t} + \widehat{\pi_t}^* - \widehat{\pi_t} \quad , \qquad (3)$$

[27]Note that studies so far have not payed too much attention to capital flows interaction with the Phillips Curve, a future extension of this study coul focus this issue.

Where: e corresponds to the nominal exchange rate and π^* to international inflation.

Substituting (3) in (2) and regrouping once again domestic inflation, we have the Phillips Curve that we study in the empirical section:

$$\pi_t = \psi_1 \widehat{y_t} + \psi_2 E_t \pi_t + \psi_3 (\widehat{e_t} + \widehat{\pi_t}^*) + \psi_4 (\widehat{p_t}^J - \widehat{w_t}) + \psi_5 (\widehat{p_t}^J) + \psi_6 \pi_{t-1} + \psi_7 \widehat{R_t} \quad ,(4)$$

Where:

$$\psi_i = \frac{\chi_i}{1+\chi_3+\chi_5} \quad (5)$$

4.2.3. Fiscal Policy and Aggregate Demand

In the abscense of fiscal policy, a simple characterization of aggregate demand is

$$y_t = \phi j_t + \varepsilon_t \ , \quad (6)$$

where j is the central bank's policy instrument, $\phi > 0$ if the authorities use a monetary aggregate as an instrument and opposite if the interest rate is used. If we would like to include the fiscal position in the model, we should consider that fiscal policy may affect private consumption in varios ways depending on the economic model. An increase in fiscal expenditure keeping taxes constante can increase, decrease or leave unaltered private consumption and aggregate demand [28]. If aggregate demand is

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[28]See for example Giavazzi, Jappelli and Pagano (2000) for a summary of the different theories and a global panel data application or Schalck (2007) for a study of the european evidence using non-linear structural VAR.

augmented to consider the direct effect of fiscal spending, a plausible form it would take is:

$$y_t = \phi_1 j_t + \phi_2 D_t + \varepsilon_t \ , \tag{7}$$

where the only difference from the previous equation is the second term. Note that ϕ_2 *a priori* can take any value (including zero) depending on the private sector's reaction to an increase in public sector's deficit. As we will later see, the independent effect of a fiscal stimulus on aggregate demand won't affect the monetary rule; in this framework, its effect depends only on the significance of a complementary effect between the monetary and fiscal policy instruments.

The reader should note that because in the empirical section we do not model aggregate demand, our approach is not completely structural, but allows us to identify all the variables that are of our interest and the significance and relevance of the nonlinearities.

4.2.4. Monetary Policy with a Linear Phillips Curve

In the case of an economy characterized by a linear structure, the central bank reaction function[29] (under the assumptions of quadratic preferences with respect to an inflation target and economic cycle) would have exact solutions, be parametrically linear, be symmetric in its arguments, and resemble the response of a central bank that follows a

[29]The reader should be aware that we use the term monetary policy rule and central bank reaction function indistinctively.

flexible inflation targeting regime [30]. If the policy instrument is an overnight interest rate, monetary policy would have the form of a Taylor Rule[31]. According to this rule, the institution adjust the level of a short run interest rate [32] when changes in inflation rate, growth or any other intermediate target represent a menace to the institutions final objectives.

According to traditional models, changes in the level of interest rate affect aggregate demand through various channels. If the economy is a net debtor (creditor), increases (decreases) in the bank's interest rate [33] generates, *ceteris paribus*, a negative (positive) income effect which pushes for a contraction in private consumption (consumption of durable goods being the most sensitive) of domestically produced and imported goods. Additionally, this interest rate increase makes saving in financial assets more attractive than investing in physical capital, which would result in a reduction of both domestic private investment and capital goods imports. The final policy effect would be a reduction in aggregate demand that would translate into smaller inflationary pressures.

A simple representation of the model is as follows:

A central banks' loss function would be represented as

$$L_t = \sum_{t=1}^{\infty} \beta^{t-1} U^{CB}[\pi_t, y_t, j_t] \ , \tag{8}$$

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[30]Equivalent to the one derived in Agénor (2002).

[31]Because of John taylor 1993 empirical characterization of the Federal Reserve's monetary policy.

[32]The Federal Funds Rate in the case of USA.

[33]An implicit assumption here is that the financial sector doesn't have enough market power to offset central bank's interest rate changes, but that the changes affect the relevant spots along the yield curve.

where β represents the discount factor.

Specifically, we assume the quadratic loss function:

$$U^{CB} = \frac{\gamma_1}{2}\pi_t^2 + \frac{\gamma_2}{2}y_t^2 + \frac{\gamma_3}{2}j_t^2 \ , \tag{9}$$

where:

$$\gamma_1, \gamma_2, \gamma_3 \geq 0.$$

Let us assume, to maintain this representation simple, that the Phillips Curve follows:

$$\pi_t = \lambda_1 y_t + \Phi_t + \xi_t \tag{10}$$

Where: Φ_t summarizes all other relevant variables for the Phillips Curve, and that for our purposes are considered to be exogenous [34].

The central banks' objective is to minimize its loss function -(8)- subject to the economy structure -(7) and (10)-. The first order condition is:

$$\frac{\partial U^{CB}}{\partial j_t} = \gamma_1 \pi_t \left(\frac{\partial \pi_t}{\partial y_t}\frac{\partial y_t}{\partial j_t}\right) + \gamma_2 y_t \left(\frac{\partial y_t}{\partial j_t}\right) + \gamma_3 j_t \ . \tag{11}$$

And the reaction function would be:

$$j_t = \frac{-\gamma_2 \phi}{\gamma_3} y_t + \frac{-\gamma_1 \phi \lambda}{\gamma_3} \pi_t \ . \tag{12}$$

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[34]If we assuming a Phillips Curve as (4), we should be aware of dynamic effects that arise from inflation inertia. In our empirical model, this effect takes the form of an additional constant term (relating actual monetary policy instrument with its previous value) but doesn't alter the results nor the functional form of the equations. Something similar would happen if we endogenize other variables on the Phillips Curve such as the nominal exchange rate.

On the empirical section of this paper we study the different forms of (4) and (11).

Note that if we introduce fiscal policy in aggregate demand, in the way we do in equation (7), the central bank maintains the functional form of its first order condition (12) and fiscal policy doesn't generate any type of nonlinearity.

If we augment aggregate demand to consider the direct effect of fiscal spending and the possibility of a complementary effect when interacting with monetary policy, a plausible form it would take is:

$$y_t = \phi_1 j_t + \phi_2 D_t + \phi_3 D_t j_t + \varepsilon_t \ , \qquad (13)$$

where ϕ_1, and ϕ_2, are as before and ϕ_3 would be positive or negative and could depend on the nature of ϕ_2. As we remarked earlier, the independent effect of a fiscal stimulus on aggregate demand don't induce any nonlinearity on the monetary rule, given that $\frac{\partial y_t}{\partial j_t} = \phi_1$; however if the complementary effect between the policy instruments is significant, optimal monetary policy would exhibit a different source of nonlinearity.

Note also that if we introduce fiscal policy and we model aggregate demand with the complementary effect, the central bank maintains the general form of its first order condition, but now $\frac{\partial y_t}{\partial j_t} = \phi_1 + \phi_3 D_t$, which generates the nonlinearity on the monetary policy rule through interaction of the fiscal deficit with the inflation rate and the output gap. In this case, optimal monetary policy rule has two adicional terms and takes the form:

$$j_t = \frac{-\gamma_2\phi}{\gamma_3} y_t + \frac{-\gamma_1\phi\lambda_1}{\gamma_3}\pi_t + \frac{-\gamma_1\lambda_1\phi}{\gamma_3} D_t\pi_t + \frac{-\gamma_2\phi}{\gamma_3} D_t y_t \ . \qquad (14)$$

4.3. Phillips Curve and Monetary Policy' NonLinearities

Although the linearity hypothesis tends to fit the data relatively well, theoretically speaking much of these models may have nonlinear structures. The usual procedure suggests linearizing the models following approximations around their steady state values. However, by definition this last procedure is an approximation to a more exact solution. These will be valid as long as the economy faces slightly reduced deviations or does not experiment structural changes on the steady state that was used for the approximation[35]. Due to the fact that one (or both) factors can be observed in practice, analyzing the relevance that nonlinearities can attain is an interesting exercise, most importantly in cases and countries with extreme episodes (like financial and balance of payments crisis, etc); not infrequent in emerging market economies. Plenty of international studies show evidence of nonlinearities in the Phillips Curve and Monetary Policy both in theory and practice [36].

We study three types of nonlinearities in the Phillips Curve [37]: a convex Phillips Curve due to production limitations in the short run, nonlinearities due to price adjustments frequency or due to the inflations' volatility.

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[35]See for example, Aguiar and Gopinath (2005).

[36] Kim, Osborn and Sensier (2002) and Dolado, María-Dolores and Naveira (2003) study the USA evidence, while Kesriyeli, Osborn and Sensier (2004) study USA, UK and Germany cases.

[37]When we mention nonlinearity we specificaly mean the relationship between inflation and economic cycle in the Phillips Curve and the relationship between fiscal deficit and aggregate demand and their effect on monetary policy. It won't come as a surprise if the influence of the other variables of the Phillips Curve is also nonlinear, but to handle every possible nonlinearity would be impractical. For this reason, we focus our attention to the nonlinearity that have been studied the most in this literature .

4.3.1. Convex Phillips Curve

As Agénor (2002) explain and Dolado, María-Dolores and Naveira (2003) show, among others, the Phillips Curve can be convex at a determined period of time if the economy's production function has a maximum capacity. In this case, this limit would serve as an asymptote from which any additional demand pressure would translate into inflation and not additional production, at least in the short run. Maintaining the Phillips Curve compact structure from equation (10), let us consider now the general form:

$$\pi_t = f(y_t) + \Phi_t + \xi_t \tag{15}$$

One way of representing such nonlinearity is including a quadratic term:

$$\pi_t = \lambda_1 y_t + \lambda_2 y_t^2 + \Phi_t + \xi_t \tag{16}$$

For the convexity with respect to the output gap to hold we require $\lambda_1 \geq 0$ and $\lambda_2 \geq 0$.

4.3.2. Ball, Mankiw and Romer Phillips Curve

The second nonlinear form is derived from the frequency of the price adjustments as in Ball, Mankiw and Romer (1998). These authors show that firm owners would make price adjustments more frequently if inflation's trend is high (and therefore a lower proportion of demand shocks would translate into growth). In the case of lower trend inflation, demand shocks would translate in a greater proportion into production changes and therefore causing the appearance of price rigidity. Assuming that effective inflation is positively related to its trend, one way of representing this nonlinearity is including an interaction term between inflation and economic cycle:

$$\pi_t = \lambda_1 y_t + \lambda_2 y_t \pi_t + \Phi_t + \xi_t \tag{17}$$

Where we sould also expect $\lambda_{21 \geq 0}$ and $\lambda_2 \geq 0$.

4.3.3. Lucas Phillips Curve

Finally, the third form of nonlinearity to study is based on Lucas (1972,1973); in his model producers adjust prices in response to changes in relative prices. The relative price information is taken from aggregate price variations. Periods of high aggregate price volatility are considered to be periods of reduced relative price changes and more inclined to be periods of systematic price changes. In this same manner, periods of reduced aggregate price volatility are considered to be more informative periods for each sector and after a shock there's a greater response from production. One way of representing this nonlinearity is including a term that relates economic cycle to inflation volatility:

$$\pi_t = \lambda_1 y_t + \lambda_2 y_t \sigma_{\pi t}^2 + \Phi_t + \xi_t \tag{18}$$

Also here, $\lambda_2 \geq 0$.

So, following these studies, domestic inflation can have at least three nonlinear components: one related to the economy's maximum capacity, another related to inflation's trend, and the other related to inflation volatility [38]. Also notice that in order to make equation (4) nonlinear one would only need to substitute y_t for $f(y_t)$, where these take the forms:

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[38]See De Veirman (2007) for an application of the three cases to Japan data.

$$f(y_t) = \lambda_1 y_t + \lambda_2 y_t^2 \tag{19}$$

for the convex Phillips Curve,

$$f(y_t) = \lambda_1 y_t + \lambda_2 y_t \pi_t \tag{20}$$

For Ball, Mankiw and Romer(1998) and

$$f(y_t) = \lambda_1 y_t + \lambda_2 y_t \sigma_{\pi t}^2 \tag{21}$$

for Lucas.

The theory suggests we would also expect $\lambda_1 \geq 0$ and $\lambda_2 \geq 0$.

4.3.4. Monetary Policy with Nonlinear Phillips Curve

Under the assumption of a central bank that minimizes a loss function, monetary policy may appear as nonlinear at least for three reasons: first, if the institution, even with quadratic and symmetric preferences (as suggested by equation (21), for example), reacts to an economy with a nonlinear structure. Second, assuming quadratic and symmetric prefferences for the central bank may seem too restrictive; for example, the institution could assign different weights to positive (overheating) output gaps relative to the negative ones. In the same sense, the central bank could also react to inflation volatility, and others. If inflation presents inertia, the central bank would react more aggressively because inflation deviations relative to its target would be long-lasting and more difficult to correct in the case of a forward looking behavior, finally, both types of nonlinearities can co-exist [39].

Our study is based on the case of a central bank (under the assumption of quadratic preferences) that can exhibit nonlinearities in its reaction functions due to the existence of nonlinearities In the Phillips Curve (of which we are going to present evidence in the empirical section) or because of interactions with fiscal policy. This allows us to reach conclusions about nonlinearities without deriving them in the central banks' loss function, which cannot cannot be measured directly and to focus on what we find most interesting, the interaction between different sources of nonlinearities.

If we consider a central bank that minimizes its loss function (8), without interaction with the fiscal policy, the generic reaction function (11) acquires three forms depending on the nonlinearity exhibited by the Phillips Curve. For the corresponding convex Phillips Curve would be:

$$j_t = \frac{-\gamma_2\phi}{\gamma_3} y_t + \frac{-\gamma_1\phi\lambda_1}{\gamma_3}\pi_t + \frac{-2\lambda_2\gamma_1\phi}{\gamma_3} y_t\pi_t \ . \tag{22}$$

Ball, Mankiw and Romer (1998) would be:

$$j_t = \frac{-\gamma_2\phi}{\gamma_3} y_t + \frac{-\gamma_1\phi\lambda_1}{\gamma_3}\pi_t + \frac{-\gamma_1\lambda_2\phi}{\gamma_3}\pi_t^2 \ . \tag{23}$$

Finally, Lucas (1973) type is:

$$j_t = \frac{-\gamma_2\phi}{\gamma_3} y_t + \frac{-\gamma_1\phi\lambda_1}{\gamma_3}\pi_t + \frac{-\gamma_1\phi\lambda_2}{\gamma_3}\sigma_{\pi_t}\pi_t \ . \tag{24}$$

[39]Dolado, María-Dolores and Ruge-Murcia (2003) develop a methodology to study this third group.

If we now allow for the central bank to minimize its loss function (8) interacting also with the fiscal policy -as in equation (13)-, the generic reaction function (11) acquires three extended forms depending on both sources of nonlinearities. The corresponding convex Phillips Curve would be:

$$j_t = \frac{-\gamma_2\phi_1}{\gamma_3} y_t - \frac{-\gamma_1\phi_1\lambda_1}{\gamma_3} \pi_t - \frac{-2\lambda_2\gamma_1\phi_1}{\gamma_3} y_t\pi_t - \frac{\gamma_1\lambda_1\phi_3}{\gamma_3} D_t\pi_t - \frac{\gamma_2\phi_3}{\gamma_3} D_t y_t - \frac{2\gamma_1\lambda_2\phi_3}{\gamma_3} D_t\pi_t y_t \ . \tag{25}$$

Ball, Mankiw and Romer (1998) would be:

$$j_t = \frac{-\gamma_2\phi_1}{\gamma_3} y_t - \frac{-\gamma_1\phi_1\lambda_1}{\gamma_3} \pi_t - \frac{\lambda_2\gamma_1\phi_1}{\gamma_3} \pi_t^2 - \frac{\gamma_1\lambda_1\phi_3}{\gamma_3} D_t\pi_t - \frac{\gamma_2\phi_3}{\gamma_3} D_t y_t - \frac{\lambda_2\phi_3\gamma_1}{\gamma_3} D_t\pi_t^2 \ . \tag{26}$$

Finally, Lucas (1973) type is:

$$j_t = \frac{-\gamma_2\phi_1}{\gamma_3} y_t - \frac{-\gamma_1\phi_1\lambda_1}{\gamma_3} \pi_t - \frac{\lambda_2\gamma_1\phi_1}{\gamma_3} \sigma_{\pi_t}\pi_t - \frac{\gamma_1\lambda_1\phi_3}{\gamma_3} D_t\pi_t - \frac{\gamma_2\phi_3}{\gamma_3} D_t y_t - \frac{\lambda_2\phi_3\gamma_1}{\gamma_3} D_t\sigma_{\pi_t}\pi_t \ . \tag{27}$$

Notice that if we allow only for Phillips Curves nonlinearities, monetary policy exhibits nonlinearities through one additional term. In the case that we also allow for the fiscal deficit to play a role, there could be up to four additional nonlinear terms characterizing optimal monetary policy, even in the face of a central bank with quadratic preferences: the nonlinearity induced by the Phillips Curve, the two nonlinearities induced by the fiscal deficit and an addittional term in which Phillips Curve and fiscal deficit interact. Also notice that although real side nonlinearities takes part on the Phillips Curve through the economic cycle-inflation relationship, and fiscal side nonlinearities takes part on the monetary policy-economic cycle relationship, in the central bank reaction function both types enter through the monetary policy instrument-inflation relation.

With respect to the signs that we would expect when we estimate the monetary policy rules, notice that if we assume that $\gamma_1 \geq 0$ and $\gamma_2 \geq 0$, the signs of the coefficients of these regressions depend on the signs of the coefficients of the Phillips Curve. This cross-equation restriction would suggest that studying solely monetary policy rules nonlinearities may not be appropiate. Later in the study we show that if we estimate the monetary policy rule by a single regression we find evidence that suggests a convex nonlinearity for the Phillips Curve, but if we study also the Phillips Curve, we show that the Lucas type nonlinearity is a better characterization.

4.4. International and Dominican Republic Evidence

Much of the international literature characterizes monetary policy by linear Taylor Rules, which in our framework would arise from the instituion's quadratic loss function functions and a linear economic structure. However, contemporary literature shows the relevance of Phillips Curve and monetary policy; although we haven't found until now an approach that relates them in a non *ad-hoc* fashion. Most of the studies focus on USA, EU economies and other industrial countries.

Ospina (2003) presents empirical evidence about Phillips Curve nonlinearities in Colombia, this is done by applying a Kalman Filter technique to a convex Phillips Curve in which the limit of firms production capacity is measured by an installation capacity index.

Gonzalez and Tejada (2006), using a forward-looking Taylor Rule, study nonlinearities in the chilean monetary policy using a flexible approach proposed by Hamilton (2001) and they don't reject linearity for the institution response to the inflation target deviations but they do for the response to the output gap. The central bank reacts immediately to positive gaps wile there's an inaction period when it is negative [40].

Dolado, María-Dolores and Naveira (2003) show that if nominal wages are to increase but exhibit rigidity to decrease, inflation would be a negative and convex function of the unemployment rate. By Okun's Law we can go to a convex relationship between inflation and the output gap. They find evidence of a convex Phillips Curve for the European Union but not for USA and relate this to greater real wage rigidities in the Euro zone than in the United States. Latxon et al. (1995,1999), Alvarez-Lois (2000), Gerlach (2000), also present evidence of a convex Phillips Curve for several countries of the European Union and the United States.

Kesriyeli, Osborn and Sensier (2004) find evidence of nonlinearities for the United States, the United Kingdom and Germany. They study changes in monetary policy behavior using smoothed transition (STR) models. They outline that the observed nonlinearity is associated with time and with interest rate dynamics and not with the output gap, inflation gap and international inflation.

[40] The opposite behavior is given to Alan Greenspans' monetary policy. In the current financial distress, he is now criticized an apparent accomodative responses both to periods of elevated growth (raising interest rates slowly) and in periods of slow or negative growth (in the form of fast interest rate reductions).

Tambakis (1998) analyzes the time consistency problem outlined by Barro and Gordon (1983) based on optimal monetary policy under asymmetric loss functions and convex Phillips Curve. Using with data from the United States they find an inactivity region when the institution defends inflationary shocks and show that the size of the region increases with the NAIRU.

Kim, Osborn and Sensier (2002) follow Hamilton (2001) and find evidence of nonlinearity using data from the United States. They find that the nonlinearity changes with the time period studied. Between 1960-1979, the Fed seems to react stronger to positive inflationary shocks and negative output gaps,in the same line of Dolado, María-Dolores y Naveira (2006), but the difference becomes almost negligible for the Volcker-Greenspan era.

When it comes to the subject of nonlinearities because of the mix of monetary and fiscal policy research is less abundant. The interaction of both policies is mostly studied in the form of strategic games whose results affect the economy's outcomes -for example see Bennett and Loayza (2000), Benigno and Woodford (2004) and Nordhaus (1994)-. Possible nonlinearities may arise in the sense of Davig and Leeper (2007), that find evidence of exogenous regime switching in both fiscal and monetary linear policies for the United States. We proposed here another viepoint of the same phenomena.

In sum, the literature shows that monetary policy and Phillips Curve can exhibit nolinearities, but most of them are focused on convex Phillips Curve. De Veirman (2007) studies the three types of Phillips Curve nonlinearities for Japan, but not its effect on monetary policy, and finds that the model based on Ball, Mankiw and Romer explains more adequately inflation dynamics than the others. In the next section we study linear specifications and nonlinear specifications of the Phillips Curve and monetary policy using different definitions of output gap. These are equations (2) and (14) for the linear,equations (16) and (25) for the convex,equations (17) and (26) for the Ball, Mankiw and Romer and finally, equations (18) and (27) for the Lucas cases.

4.5. Empirical Analysis

The main objective of this section is to study the different models of nonlinearity in the Phillips Curve and monetary policy proposed in earlier sections using data from the Dominican Republic. When relevant, we incorporate findings from other studies and reference other studies and particularities of the data. We show that nonlinearities are statistically significant and of economic relevance in the past 20 years, but that these, as the usual macroeconomic procedures assume, are negligible in periods of relative macroeconomic stability. Additionally, we approximate the costs of desinflationary policies calculating the sacrifice ratios for the different Phillips Curves and show that point estimates differ, although the difference is not statistically significant. Finally, we show that open economy variables and instituional structural breaks (in the form of macroeconomic and financial turmoils) are relevant to address more appropiately the significance of such nonlinearities.

While theoretically important for a small and open economy as Dominican Republic, two variables are excluded from the study: domestic oil prices and the financial system lending interest rate. The reason is that, as Francos (2006) highlights, dometic prices of oil derivatives during the 90's show almost no changes, until a law in the year

2000 changed the calculation methodology for the domestic prices of oil [41], and most important for us, we couldn't find data prior to 1997. In the case of the interest rate, the Monetary Board of the Central Bank of the Dominican Republic had direct control on its value until 1991, when they were allowed to fluctuate with the market [42].

To consider possible effects of open economy variables, we include in the models the rate of depreciacion on the nominal exchange rate, given the evidence of an important passthrough effect to domestic inflation [43], and international inflation, using as proxy the wholesale price index inflation from the United States, as in Sánchez-Fung (1999) and Williams and Adedeji (2004), given that the country is the main trading partner of Dominican Republic.

Give the evidence showing inflationary inertia (as Prazmowski (1997) and Reyes (2005), for example) and because the country lacks a series of inflationary expectations or data from the yield curve before 1991[44], we don't include the effective inflation in t+1

[41]We could have used and articially created series or using international prices as proxy, but given the potential difference between the two variables time paths due to institutional factors we decided not to include this channel in the Phillips Curve estimations, although we recognize its potential importance in driving inflation during the late 80's and after 2005.

[42] To include a time series of this variable we tried to estimate a cointegrating money demand equation to using data posterior to 1991 and then capture an ``equilibrium'' interest rate for the years missing using the time path of the other variables, but the results weren't significant. Another alternative was to estimate the regressions from 1991 onwards, which we chose not to because we would have excluded times of potential relevance after the mid 80's such as going from a fixed exchange rate regime to a flexible one and the stress episodes in the late 80's and early 90's.

[43]See Grateraux and Ruiz (2006) and Hernández (2005b).

[44]An alternative was to follow a procedure similar to Mishkin (1981), which is to estimate an inflation regression and to take the forecast in in t +1 as its expected value. Although it is an intuitively appealing, it would involve using estimated regressors in our main regressions. We are not aware of studies that address the case of more than one estimated regressor and we use already an output gap estimated regressor. Because are focused on the nonlinearities from this component we decided to keep the estimated output gap

as the forecast because this would implicitely stated perfect forecast, but instead use the lagged value of inflation.

Our monetary policy reaction function follows a hybrid McCallum-Taylor rule as equation (11), following the model presented in Hernández (2005a) and evidence from a publication from the Central Bank of the Dominican Republic -BCRD (2008)- in which they mention monetary issuance as their policy instrument. We address the monetary policy instrument as liquidity ratio (the ratio M1 over GDP). All variables are obtained from the Central Bank of the Dominican Republic webpage, except for Wholesale Price Index for the USA, which is obtained from the IMF International Financial Statistics Database. Finally, we assume that the central bank responds to any inflationary value (an implicit zero inflation target) because there's no explicit or implicit inflationary objective.

It is worth noting two caveats to our approach, the first elaborated in detail by Pérez and Medina (2004), which is that the historical M1 series reported to the Central Bank of the Dominican Republic differs from the effective M1 because of some private banks misreports before the financial distress of early 2003. However, we use the reported original series provided by the monetary institution. The second caveat is that every change in M1 may not be due to changes in monetary policy, but for example changes money demand; however, our indicator of liquidity ratio may not exhibit completely this caveat because we control by GDP (and given the evidence of constant

as regressor but not the expected inflation. See Pagan (1984) and Newey and McFadden (1994) for the theory of estimated regressors and Kim, Osborn and Sensier (2002) for an empirical study.

returns to scale in money holdings we would expect that any change in GDP would be rapidly offset by an equivalent change in M1).

4.5.1. Structural Changes and Spurious Nonlinearities

In principle, econometric methods can show evidence of (spurious) nonlinearity in the data if there's significan effect from outliers, structural changes and regime switching. For the sample studied in this section (1980-2006), Dominican Republic experienced several economic and institutional changes that if we don't account for, could invalidate our results. In this sense we control for: the existence of a *de jure* fixed exchange rate regime until 1984 (and a brief reincorporation during 1989-1990), a period of macroeconomic distress in 1990 and a financial stress during 2003-2004. For simplicity, and to keep the number of variables from increasing considerably, we include these in the form of intercept dummy variables [45].

We motivate the ideas of nonlinearities with figures C. 1 and C. 2. Figure C. 1 Linear and Nonlinear Correlation: Inflation and Output Gap while Figure C. 2 Linear and Nonlinear Correlation: Liquidity Ratio and Inflation. Both figures show a distinguishable difference when correlations are computed in a linear (the left column) or in a nonlinear fashion (right column) [46].

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[45] Although we recognize that these events may have also changed the slopes of the regressions.

[46] Figure 1 and 2 show graphically what we captured later with regression analysis, for the Phillips curve and monetary policy, respectively. Note that in figure 2 we present the results with and without some outliers from 1986. Nonlinear correlations are computed using nearest neighbor fit.

Sánchez Fung (1999) shows that pressures against the fixed exchange rate regime before its collaps in 1984 contributed to the surge of a black market in which the US Dollar was traded more expensively than the official rate. Based on this evidence, we include these four years of the fixed exchange rate in the monetary policy regressions and do not assume that monetary aggregates are completely exogenous, as in credible fixed exchange rate regimes [47]. On the other hand, Prazmowski (2004) and IMF (1999) highlight a considerable impact of the 1990's crisis in the country's macroceonomic performance. Finally, Grateraux and Ruiz (2006) and Hernández (2005b) show that the crisis of 2003-2004 had a significant effect on the inflation rate.

4.5.2. Phillips Curves Results

To run the regressions we first came with two different estimations of output gap, given that there is no formal estimation of the variable for the Dominican Republic. We estimate output gap using the Hodrick and Prescott (HP) filter and a quadratic trend (QT) [48].

For each definition of output gap, we consider eight (8) independent regressions for the Phillips Curve and also for the monetary policy rule (linear, convex, BMR -by Ball, Mankiw and Romer- and Lucas). The results for regressions estimated independently are summarized in the appendix in the tables C.7 and C.8. Additionaly, we

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[47] Also, the econometric results do not reject, as expected, that the collapse of the regime to a flexible exchange rate is not statistically significant for the Phillips Curve nor the monetary policy rule.

[48] Taking as trend the fitted value of a regression of GDP growth on a constant, a deterministic trend and its squared. In a previous study, an autoregressive approach was used to compute output gap, but for space and because results don't differ significantly we don't include them.

estimate system of equations using GMM (but results with similar results). A key finding is that the results seem to be are robust to both output gap definitions.

Every Phillips Curve regression show that there is evidence of inflationary inertia in the sense that approximately 0.8 % for every 1 % of inflation is carried from one quarter to another[49] are ; on the other hand, the effect of a 1% increase in the output gap on inflation is around 0.5%. Every BMR regression, as well as every Lucas regression shows that the nonlinear component is significant, while for the convex regressions this is not the case [50]. In addition to these components, the percentage depreciation of the nominal exchange rate is statistically significant for every regression, showing a pass-through in the range of 9.4 % to 13.7 % with a quarter lag [51]. The dummy variable related to the fixed exchange rate regime is not statistically significant for any of the regressions, the dummy related to the 1990 episode is significant in 7 of the 8 regressions and the 2003-2004 episode in 6 of them . In 1990, the quarterly inflationary effect is in the range of 11.3 % to 16.9 % and 2003-2004 in the range of 7.4 % to 15.1 %.

Surprisingly, we don't find evidence of convexity, nor concavity, in the Phillips Curve with the models used; Further studies can be done in order to see the robustness of this finding with different models for convexity. A different, but still not implausible

[49]We show Phillips Curve marginal effects on figure 6 and 7. These go from 0.79% to 0.82% for the inflation inertia and from 0.49% to 0.53% for the output gap.

[50]What may be suggesting that on average the Dominican Republic GDP hasn't reached levels of overheating.

[51]Corresponding to the annual range between 30.9 % to 60.8 %, in line with results of previous studies.

explanation is that, the Phillips Curve may have a shape known as convex-concave as in Filardo (1998)[52]

4.5.3. Statistical Significance and Economic Relevance of Nonlinearities

As mentioned above, there's no evidence of a convex Phillips Curve of the form studied in this paper, but BMR and Lucas nonlinearities are statistically significant. In the attempt to distinguish between statistical significance and economic relevance in order to give a sense of magnitude to the relationships found in the regressions, we compute in this section the share of the inflation rate that we can attribute to the nonliner component and the dates in which these calculations are the highest [53]. The results confirm that nonlinearities become important in specific episodes, and their contribution can be fairly large. See Table C. 1 Share of Inflation Explained by Nonlinearities

As shown in Table C.1, the nonlinear BMR component represented, on average, no less than 5 basis points of every 1 % of inflation explained by the model [54] , while the Lucas component explains no less than 2 bp [55]. However, the nonlinear component climbed up to almost one-fifth of the inflation rate explained by the model (approximately 17 bp for the BMR case and 18 bp for the Lucas case, respectively). This would mean that if the expected annual inflation rate (explained by the model) reaches 10

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[52]A feature that has not been explored for the Phillips Curve in this study and have also empirical support, but to a lower extent, is that it may be concave along the whole output gap axis, or within some intervals. See for example Eisner (1997) and Stiglitz (1997).

[53]See Appendix 8.2.1 for a detailed explanation of the calculations.

[54]Excluding the value of the residuals.

[55]The median representation is no less than 3 bp and 1 bp respectively, indicating that the distribution concentrates more values below the average.

%, up to 1.7 % could be explained independently by the nonlinear component; a share that is non negligible in a country with a history of medium level inflation.

However, as Figure C. 3 Share of Inflation Explained by Nonlinearitiesshows, the relevance of nonlinearities varies over time. The BMR regressions show that nonlinearities have explained at least 9 bp of inflation during the three years between 1985.4 and 1988.4, during the four quarters of 1991 (while dominican authorities implemented several economic reforms after the 1990 crisis) and in 1993.1. They have also been relevant in the years 2000, 2001, during the episode of financial stress (2003.3 and 2004.1), and finally in 2006.1. On the other hand, Lucas regression shows nonlinearities became important during 1988.4 and during 1991.-1991.3.

Another way to address if using a nonlinear model is justified is by analyzing the marginal effects of these models and compare them with the constant marginal effects of the linear ones. Notice that in the Phillips Curve regressions we have estimated, the reason for any difference between the would be evidence of real side driven nonlinearities. As shown in section 8.4 of the appendix, marginal effects exhibit rich dynamics not captured by the linear components; which in turn are of economic relevance and are statistically significant.

4.5.4. Monetary Policy Results

Regression results for the monetary policy rules are summarized in Table C.8. Every monetary policy regression show that the central bank has followed an anti-inflationary policy and show evidence of nonlinearities [56].

Every regression show that the institution doesn't react countercyclically to output gap (i.e. the liquidity ratio increases between 0.11%-0.15% after a 1% increase in the output gap). For the dummies, every regression shows that the one associated to the transition from fixed to flexible exchange rate regime is not significant, probably indicating that the regime did not bind the monetary policy rule; the dummy related to the 1990 turmoil is significant only for the monetary rules associated to a convex Phillips Curve and the 2003 turmoil is significant in every regression.

Table C. 2 Shares of Liquitidy Explainde by Nonlinearitiesallows us to distinguish the economic relevance from the nonlinearities. In the monetary policy rule, noninearities represent on average almost 3 % of the liquidity explained by the model, but the share have reached to up to 22 %. However, as figure 4 shows, although nonlinearities peak around turmoil episodes, their effect is less pronounced for the monetary policy rule than for the Phillips Curve. The data show that the nonlinearities of the monetary rule associated to the convex curve Phillips, explained at least 6 % of the liquidity ratio from 1985.4 to 1986.2, during 1988.4, from 1990.4 to 1991.1 and finally from 2003.4 to 2004.1. The nonlinearities of the monterary policy rule associated to the

[56] For the monetary policy regressions, we show the marginal effects of inflation on figure 8 and the marginal effect of output gap on figure 9.

BMR Phillips Curve were significant during 1985.2-1986.1, 1988.2-1989.3, 1990.4-1991.1 and finally in the whole year of 2004; finally, the nonlinearities of the monetary policy rule associated to the Lucas Phillips Curve were relevant during the first three quarters of 1991.

As we can also observe from Figure C. 4 Share of Liquitidy Explained by Nonlinearities, the fiscal and monetary policy interaction is only relevant for the monetary policy rule associated to the convex Phillips Curve[57].The marginal effects for the monetary policy rules have three potential sources of dynamics, one driven by the direct effect of nonlinearity in the Phillips Curve, and two others related to the intereaction of the fiscal policy with the linear and nonlinear compoment of the Phillips Cuve, respectively. As shown in section 8.4 of the appendix, marginal effects also exhibit rich dynamics not captured by the linear models and with differences that can become of economic relevance and statistically significant.

As we can see from Tables C.8 and C.11, the coefficients obtained from estimating different monetary policy rules are consistent with the coefficients of the ``underlying'' Phillips Curves of the economy (see Tables C.7 and C.10), satisfying the cross equation restrictions shown in equations (22) - (27); this also means that the monetary policy rule associated with a Convex Phillips Curve have coefficients of opposite signs than the ones of the theoretical models.

[57]When the regressions are estimated simultaneously, the fiscal policy coefficients related to the (linear and nonlinear components of the) Phillips Curve are statistically significant.

4.5.5. Forecast and Choosing Among Non-Nested Models

The preceding sections show that different types of nonlinearity are statistically significant and of economic relevance for both the Phillips Curve and the monetary policy rule. In this section we apply Davidson and Mackinnon (1981) methodology to choose between not nested models, as the ones developed earlier. This methodology would allow us to show which nonlinear theory characterizes better the evidence for Dominican Republic. We follow the methodology explained in Gourieroux and Monfort (1994) and Greene (2003) [58]. In our view, the most important caveat of this methodology is that it doesn't always lead to conclusions.

Table C. 3 and Table C. 4 show the results of applying the methodology to the Phillips Curve and monetary policy models. The rows show the model that is taken as the null hypothesis and the columns present the different alternative hypothesis. We use NH in a cell to report that when testing the specific null against the alternative, we couldn't reject the null that the better model is the one in the row; AH means that we can reject the null hypothesis and that the better model is the one in the column.

For example, as shown in the Phillips Curve case using HP output gaps (left table of table 3), Lucas nonlinearity cannot be rejected as null hypothesis, and when it was used as alternative hypothesis, every other possible nonlinearity was not statistically significant. We consider this evidence supporting that, among the theories and functional forms studied, Lucas nonlinearity is the most relevant model for characterizing the

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[58]The methodology is explained in the Appendix.

economy. On the other hand, the methodology doesn't conclude for the Phillips curve with QT ouput gaps, because none of the nonlinearities considered as null hypothesis is rejected when tested against the others as alternative hypothesis. Also note that in every case, the linear model assumption is always rejected in favor of nonlinear models.

In the case of the monetary policy regressions reported in Table C. 4 Davidson and Mackinnon (1981) Test: Monetary Policyresults are more robusts for both HP and QT estimations: monetary policy rule derived from a convex Phillips Curve outperform the others. Also note that in every case, as it happened with the Phillips Curves, the linear model assumption is always rejected in favor of the nonlinear cases.

Furthermore, we perform two additional comparisons for the models: one based on their descriptive statistics and the other with the (within sample) forecast of financial turmoil of 2003-2005 [59]. For the Phillips Curve regressions, results with the HP trend show that Lucas type outperform the others, followed by the linear case; for the QT case, descriptive statistics show Lucas type Phillips Curve outperform the others, while the linear forecast outperform every nonlinear model (but Lucas type come in second place). For the monetary policy rules, the forecast associated to a Lucas type Phillips Curve outperforms the other models, while the descriptive statistics show that, in general, every nonlinear model explains the data better than the linear model[60].In broad terms, these comparisons suggest that nonlinear models of the Phillips Curve and Monetary Policy Rules are more appropiate than linear models.

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[59]We present the details on the forecasts statistics in section 8.2.4 of the appendix.

[60]But for the Schwartz Information Criteria, which ranks models in the following order: Convex, linear, BMR and Lucas.

4.5.6. Phillips Curve and Monetary Policy Interaction

Regression results for the system of Phillips Curves and monetary policy rules are summarized in tables C.10 and C.11. The previous subsection shows the results of our comparison of single regression estimations. We find that on the Phillips Curve section, the nonlinearity derived from Lucas (1972) ouperforms the others. On the other hand, studying solely the monetary policy reaction suggests that the Central Bank reacts to a convex Phillips Curve. As this suggests, we need some form of joint estimation approach to allow for a more consistent explanation of nonlinearities, and also that satisfies the signs of the coefficients of the theoretical models.

The theoretical and cross equation restrictions can be motivated from section 3.3 and 3.4. If we model the Phillips Curve as either a convex type, as shown in equation (19), the BMR, as shown in equations (20), or the Lucas type, as shown in equation (21), we would expect $\lambda_1 \geq 0$ and $\lambda_2 \geq 0$; which are are what we call theoretical restrictions. If we model the Phillips Curve - monetary policy rules as a system, we find that the coefficients of the latter are consistent with the coefficients of the former; hence, every pair of Phillips Curve - monetary policy rule is consistent in a cross equation way; but when we compared the coefficients of the Phillips Curve with the coefficients of the monetary policy rule, the systems that are theoretically consistent are BMR and Lucas.

Given that the Lucas regression outperforms the BMR, we pick the Lucas model as the one that characterizes better the data [61].

This finding would suggest that, in order to better characterize and model different types of nonlinearities, it is recommended to use a joint estimation approach instead of a single equation estimation approach. Based on the results of estimating the monetary policy rules as single regressions, we would choose the one derived from a Convex Phillips Curve even though the convex Phillips Curve doesn't outperform the others and that we get a coefficient of different sign as the theory would suggest. The finding also suggest that, although the joint estimation procedure is prefered to the single estimation procedure, we may need additional criteria to choose among nonlinearities, given that in this case we had to decide between the BMR and Lucas case.

4.5.7. Sacrifice Ratio

In this subsection we attempt to calculate different sacrifice ratios and explore any potential disparity between the linear model and the nonlinear extensions. The Phillips Curve regressions allow us to approximate the reduction required in terms of economic cycle to reduce inflation in 1%. Sacrifice ratios are not negligible and point estimates vary according to the model (although not in statistical significance).

[61] The convex system is not theoretically consistent because the coefficient of the term associated to the convex part of the Phillips Curve is not statistically different from zero, but it is for the monetary policy rule.

Table C. 5 Sacrifice Ratiospresents different calculations of the sacrifice ratio: average and median for an overall result and the computation corresponding to the last observation in the data (first quarter of 2006), the most recent data for the country at the time of this study [62]. Even though sacrifice ratio point estimates statistically do not differ from the point estimate of the linear Phillips Curve, the interval of possible values may be of economic relevance. The last row of table 5 shows that the cost of reducing inflation in 1% in 2006 was to reduce the output gap between 0.6% and 3%, depending on the model considered.

4.6. Concluding Remarks

Our goal with this paper is to show the interaction, relevance and effects of nonlinearities in the real sector and the ones driven by fiscal policy on two variables: inflation and liquidity ratio (as a proxy for the instrument of monetary policy). We think that this study contributes to the literature by integrating the form of the monetary policy nonlinearity to the form of the other ones mentioned, instead of assuming it directly, as it is sometimes assumed in the literature. It also tries to distinguish between the economic relevance and statistical significance of nonlinearities with computations of the shares of inflation and the ratio of M1 over GDP explained by nonlinearities and by comparing the results of sacrifice ratios estimates.

Studying three types of nonlinearity in the Phillips Curve and considering nonlinearities thay could arise by the interaction of monetary and fiscal policy, we find

[62]For example, acoording to the linear model with HP trend, average sacrifice ratio is 0.62%, equivalent to a sacrifice of 62 bp of economic cycle to reduce inflation in 1%.

that these are of economic relevance and statistically significant. By comparing three types of nonlinearity used internationally (convex, Ball Mankiw and Romer style and Lucas style) we find evidence that the Phillips curve that relates inflation rate with its volatility (Lucas type) characterizes better real sector data for the country. On the other hand, the monetary policy rule that responds to a convex Phillips curve is the one that characterizes monetary policy nonlinearities better. To get consistent results between both regressions, we follow a joint estimation approach and find that the nonlinearity that relates inflation with its volatility is consistent with both Phillips Curve and Monetary Policy rules, cross equation restrictions and theoretical restrictions on the signs of the coefficients, hence we propose studying nonlinearities using joint instead of single regression estimation techniques, but paying attention also to the results of the single equation regressions.

We also show that the economic relevance and the statistical significance of nonlinearities are not sensitive to the two different definitions of output gap. Results are less conclusive for the nonlinearities generated by the interaction of monetary and fiscal policy; the nonlinearity that arises on the monetary policy rule from the interaction of fiscal policy and linear Phillips curve is statistically significant only for the monetary policy based on a convex Phillips Curve.

This paper, as any empirical study, can be criticized in different ways. For example, lags were limited to one and four quarters because these tend to reduce the existence of the autocorrelation shown in the quarterly data and are commonly used to address inertia; a more general lag structure could have been considered or other proxies for inflationary volatility could have been constructed. Also, some variables were not available and this may generate the typical ommitted variables consequences. Moreover, the methodology of generated regressors limits the number of regressors of this type that can appear in a single equation, constraining the functional forms that these regressions can take. At the same line, we use only one source of fiscal driven nonlinearities, the one that depends on monetary and fiscal policy complementarity effects, but others can be studied too in future versions of this paper. Finally, it's important to recall that the Phillips Curve may be characterized better using the GDP deflator instead of the CPI; however, Dominican Republic institutions don't provide public calculations of the GDP deflator.

The results of this study support the proposition that linear models can be relatively good approximations of the economy during relative calm periods, but nonlinear components do play a relevenat role from time to time. Nonlinearities can explain a relevant and variable proportion of inflation and the liquidity ratio; also nonlinear models are better than linear models in terms of forecasts according to our results based on Davidson and Mackinnon (1981) methodology. Differences in calculations of marginal effects between linear and nonlinear models can be of economic relevance and statistically significant, while sacrifice ratios calculations show point estimates differences that, although of economic relevance, are not significant in statistical terms. Depending on the model, the average trade-off between output gap and inflation is between a floor 0.6% and a ceiling of 1.5% for any 1% reduction in inflation. Not to consider these phenomena can significantly bias estimations for economic policy and forecasts.

Taken together, these results indicate that authorities should pay more attention to real side and policy induced nonlinearities, specially around times of distress or during transitions near these periods. If authorities don't consider these phenomena, estimations used for economic policy, authorities accountability and forecasts could be significantly biased. Also, authorities should focus on the estimation of the system of regressions, even if their interest is only related to monetary policy.

Appendix Chapter 2

A.1. Other Studies of Interest Rates in the Dominican Republic

Studies on interest rates in the Dominican Republic are rare, probably because they were not market-based, but were determined by resolutions of the Monetary Board until 1991, making it difficult to economically explain interest rates behavior. Interest rates started responding to market fundamentals in 1991, so it's relative a recent phenomenon.

The studies found are listed below: Reyes (1998) presents a series of macro-financial regressions to determine if the interest parity holds in the country *vis a vis* the U.S. dollar. This is of interest because in 1994, by resolution of the Monetary Board, banks were allowed to have portfolios of investments denominated in local currency and US$. In this study, the author shows that the interest rate differential is statistically significant in explaining the dynamics of nominal exchange rate.

Prazmowski and Sanchez-Fung (2004) show a similar result, finding that the interest parity is statistically significant in explaining the behavior of nominal exchange rate and that a 1% variation in the spread of rates roughly corresponds to a similar variation in the exchange rate.

Prazmowski (2001) developed a version of the theory of life cycle consumption in a stochastic model which allows partial mobility of capital. In the model, the domestic interest rate changes the relative interest rate between Dominican Republic and United States of America. This relative rate is important in determining the sensitivity of local consumption and the accumulation of assets in US$ for dominicans. The author found a sensitivity of -0.5 between local consumption and the relative interest rate.

Most of the attention to interest rates is done indirectly through studies of money demand. Díaz (1999), IMF (1999) and Williams and Adedeji (2004) estimate money demand regressions in which they use as an explanatory variable i) some of the banks' interest rates, or ii) the interest rate differential between the USA and Dominican Republic. The authors often find that different definitions of these variables are statistically significant for determining money demand.

Finally, Andujar (2009), makes an interesting study trying to break the effects of good domestic policies versus good luck in determining the economic performance of the country. The author makes various estimates of the effects of interest rate differential (foreign-domestic) on GDP growth and find that this is statistically relevant, although its impact on economic growth changed from positive to negative in the decade of 1991-2000.

A.2. Tables

Table A. 1 Managed Funds Relative to GDP

Managed Funds Relative to GDP
(In %)

Countries	30/06/04	30/06/05	30/06/06	30/06/07	30/06/08	30/06/09
Argentina	11,3	12,3	12,3	13,2	11,8	
Bolivia	19,5	20,1	21,0	22,0	25,2	22,6
Chile	62,6	63,9	63,2	68,5	65,1	59,9
Colombia	9,7	11,7	12,9	13,4	15,0	14,1
Costa Rica	2,1	3,0	3,9	4,9	5,0	5,9
El Salvador	12,7	16,4	19,5	19,6	22,8	25,5
México	5,8	6,3	7,1	8,4	7,1	8,5
Perú	11,2	12,3	14,2	20,5	17,5	15,3
R. Dominicana	0,4	1,7	1,7	2,2	2,9	3,7
Uruguay	14,4	14,8	13,1	14,5	14,2	12,0
Total	11,4	12,5	13,7	15,9	14,0	15,6

Source: Quarterly Bulletin, June 2009, International Administration of Pension Funds Supervision

Table A. 2 Amount of PFA in the System

Amount of PFA in the System

Country	Amount of PFA					
	Jun '04	Jun '05	Jun '06	Jun '07	Jun '08	Jun '09
Argentina	12	12	11	11	11	
Bolivia	2	2	2	2	2	2
Chile	6	6	6	6	5	5
Colombia	6	6	6	6	6	6
Costa Rica	8	8	8	8	8	8
El Salvador	2	2	2	2	2	2
México	13	15	17	21	18	18
Perú	4	4	5	4	4	4
R. Dominican	9	7	7	5	5	5
Uruguay	4	4	4	4	4	4
Average	7.3	6.6	6.8	6.9	6.5	6.0

Source: Quarterly Bulletin june 2009, International Administration of Pension Funds Supervision

Table A. 3 Definition of Variables

DEFINITION OF VARIABLES	
NOMENCLATURE	**DESCRIPTION**
ia03RD	Nominal lending interest rate to 3 months (from 0 to 90 days)
ia06RD	Nominal lending interest rate to 6 months (from 91 to 180 days)
ia12RD	Nominal lending interest rate to 12 months (from 181 to 360 days)
iamas12RD	Nominal lending interest rate to more than 12 months (more than 1 year)
ia24RD	Nominal lending interest rate to 24 months (from 361 days to 2 years)
ia60RD	Nominal lending interest rate to 60 months (from 2 to 5 years)
iamas60RD	Nominal lending interest rate to more than 60 months (more than 5 years)
iaAVRD	Weighted average of nominal lending interest rates

Table A. 4 Correlation Matrix of Lending Rates

Correlation Matrix of Lending Rates

	IA03RD	IA06RD	IA12RD	IA24RD	IA60RD	IAMAS60RD
IA03RD	1.000	0.936	0.975	0.969	0.972	0.962
IA06RD	0.936	1.000	0.950	0.954	0.955	0.941
IA12RD	0.975	0.950	1.000	0.983	0.988	0.973
IA24RD	0.969	0.954	0.983	1.000	0.987	0.974
IA60RD	0.972	0.955	0.988	0.987	1.000	0.977
IAMAS60RD	0.962	0.941	0.973	0.974	0.977	1.000

Table A. 5 Definition of Variables

DEFINITION OF VARIABLES	
NOMENCLATURE	**DESCRIPTION**
ip01RD	Nominal deposit interest rate to 1 month (30 days)
ip02RD	Nominal deposit interest rate to 2 months (60 days)
ip03RD	Nominal deposit interest rate to 3 months (90 days)
ip06RD	Nominal deposit interest rate to 6 months (180 days)
ip12RD	Nominal deposit interest rate to 12 months (360 days)
ipmas12RD	Nominal deposit interest rate to more than 12 months
ipAVRD	Weighted average of nominal deposit interest rates

Table A. 6 Correlation Matrix of Deposit Rates

Correlation Matrix of Deposit Rates

	IP01RD	IP02RD	IP03RD	IP06RD	IP12RD
IP01RD	1.000	0.981	0.973	0.880	0.930
IP02RD	0.981	1.000	0.990	0.908	0.933
IP03RD	0.973	0.990	1.000	0.912	0.936
IP06RD	0.880	0.908	0.912	1.000	0.866
IP12RD	0.930	0.933	0.936	0.866	1.000

Table A. 7 Definition of Variables: Macroeconomic Variables

DEFINITION OF VARIALBES: Macroeconomic Variables	
NOMENCLATURE	**DESCRIPTION**
ICBD	Lombard rate of the Central Bank of the Dominican Republic
INF	12 month inflation rate
G	GDP growth rate for quarter t with respect to quarter t-4.
FIS	Fiscal Surplus in Millions of RD$
FISY	Fiscal Surplus in Millions of RD$ over Nominal GDP
LIBOR	London Interbank Reference Rate expressed in dollars
PFN	Current Pension Funds capital relative to the initial pension fund
PFY	Pension Fund Capital over Nominal GDP
LPFN	Logarithm of Pension Funds

Table A. 8 Lending Rates' Regressions

LENDING RATES' REGRESSIONS						
MACROECONOMIC VARIABLES						
Estimation Method	MICO-NW	MICO-NW	MICO-NW	MICO-NW	MICO	MICO-NW
Explained Variable	IA03RD	IA06RD	IA12RD	IA24RD	IA60RD	IAmas60RD
	Y	Y	Y	Y	Y	Y
INF(-1)	0.062	0.065	0.051	0.054	0.054	0.082
	0.003	*0.090*	*0.061*	*0.061*	*0.166*	*0.009*
G	-0.131	-0.125	-0.138	-0.037	-0.080	-0.170
	0.166	*0.243*	*0.187*	*0.712*	*0.441*	*0.191*
LIBOR	-0.062	-0.145	0.026	-0.108	-0.034	-0.204
	0.770	*0.650*	*0.929*	*0.710*	*0.900*	*0.563*
FISY	-0.859	-0.098	-0.540	-0.816	-0.528	0.192
	0.009	0.901	*0.282*	*0.064*	*0.311*	*0.535*
DUMMIES						
FINDUM	0.007	0.018	0.019	0.024	0.022	0.008
	0.505	*0.088*	*0.112*	*0.041*	*0.084*	*0.623*
PENSION FUNDS						
PFY(-1)	-1.132	-1.421	-1.009	-1.098	-1.039	-1.516
	0.000	*0.004*	*0.005*	*0.016*	*0.007*	*0.004*
CONSTANTS AND AUTOREGRESSIVE VARIABLES						
C	0.120	0.162	0.118	0.115	0.138	0.172
	0.000	*0.010*	*0.001*	*0.002*	*0.006*	*0.000*
AR(-1)	0.876	0.394	0.538	0.563	0.808	0.407
	0.000	*0.039*	*0.000*	*0.000*	*0.000*	*0.000*
AR(-2)	-0.344	-	-	-	-0.294	-
	0.008	-	-	-	*0.054*	-
AR(-3)	-	-	-	-	-	-
	-	-	-	-	-	-
AR(-4)	-	-	-	-	-	-
	-	-	-	-	-	-
DESCRIPTIVE STATISTICS						
Adjusted R-squared	0.857	0.761	0.792	0.852	0.893	0.863
S.E. of regression	0.022	0.027	0.025	0.024	0.020	0.024
Log likelihood	135.209	125.608	129.683	93.919	99.830	94.507
Akaike info criterion	-4.674	-4.277	-4.425	-4.406	-4.781	-4.436
Schwarz criterion	-4.343	-3.985	-4.133	-4.065	-4.393	-4.095
Breusch Godfrey	0.010	0.020	0.055	0.046	0.162	0.003
ARCH	0.046	0.284	0.660	0.831	0.964	0.473
White	0.301	0.088	0.762	0.313	0.464	0.081
Ramsey	0.636	0.545	0.077	0.006	0.038	0.016

Table A. 9 Deposit Rates' Regressions

DEPOSIT RATES' REGRESSIONS					
MACROECONOMIC VARIABLES					
Estimation Method	MICO-NW	MICO-NW	MICO	MICO-NW	MICO-NW
Explained Variable	IP01RD	IP02RD	IP03RD	IP06RD	IP12RD
	Y	Y	Y	Y	Y
INF(-1)	0.051	0.062	0.063	-0.016	0.051
	0.007	*0.008*	*0.031*	*0.466*	*0.105*
G	-0.048	-0.142	-0.169	-0.151	-0.103
	0.393	*0.053*	*0.047*	*0.061*	*0.289*
LIBOR	-0.116	-0.238	-0.225	-0.017	-0.046
	0.510	*0.262*	*0.246*	*0.947*	*0.856*
FISY	-0.838	-0.950	-1.246	-0.863	-0.857
	0.007	*0.005*	*0.008*	*0.036*	*0.002*
DUMMIES					
FINDUM	0.007	0.006	0.006	0.020	0.023
	0.364	*0.482*	*0.548*	*0.240*	*0.007*
PENSION FUNDS					
PFY(-1)	-1.200	-1.490	-1.621	-1.257	-1.086
	0.000	*0.000*	*0.000*	*0.010*	*0.003*
CONSTANTS AND AUTOREGRESSIVE VARIABLES					
C	0.077	0.115	0.128	0.105	0.077
	0.000	*0.000*	*0.000*	*0.013*	*0.008*
AR(-1)	0.860	0.720	0.651	0.396	0.551
	0.000	*0.000*	0.000	*0.046*	*0.000*
AR(-2)	-0.306	-0.328	-0.095	-	-
	0.020	*0.015*	*0.556*	-	-
AR(-3)	-	-	-0.240	-	-
	-	-	*0.044*	-	-
AR(-4)	-	-	-	-	-
	-	-	-	-	-
DESCRIPTIVE STATISTICS					
Adjusted R-squared	0.895	0.863	0.883	0.664	0.827
S.E. of regression	0.017	0.019	0.017	0.026	0.024
Log likelihood	149.665	143.121	145.772	126.928	131.922
Akaike info criterion	-5.210	-4.967	-5.123	-4.325	-4.506
Schwarz criterion	-4.878	-4.636	-4.752	-4.033	-4.214
Breusch Godfrey	0.033	0.012	0.088	0.010	0.007
ARCH	0.593	0.720	0.446	0.105	0.179
White	0.800	0.678	0.143	0.023	0.850
Ramsey	0.264	0.123	0.933	0.004	0.775

Descriptive Statistics of Variables for the Dominican Republic

Table A. 10 Descriptive Statistics of Variables for the Dominican Republic: Lending Rates

	IA03	IA06	IA12	IAMAS12	IA24	IA60	IAMAS60	IAAV
Mean	0.2263	0.2334	0.2352	0.2411	0.2392	0.2621	0.2364	0.2365
Median	0.2247	0.2452	0.2371	0.2403	0.2406	0.2598	0.2319	0.2358
Max	0.3190	0.3394	0.3406	0.2669	0.3589	0.3717	0.3380	0.3427
Min	0.1131	0.1099	0.1321	0.2151	0.1430	0.1645	0.1339	0.1382
Est. Dev.	0.0563	0.0541	0.0538	0.0165	0.0626	0.0599	0.0644	0.0531
Asymmetry	-0.1466	-0.2625	0.0112	0.1161	0.0677	0.1378	0.0402	0.0554
Kurtosis	1.9922	2.3161	2.2085	1.9418	1.9201	1.8456	1.6582	2.2043
Var. Coef.	0.2488	0.2317	0.2288	0.0683	0.2618	0.2284	0.2727	0.2245
Sample	1996.1-2009.4	1996.1-2009.4	1996.1-2009.4	1996.1-1999.4	2000.1-2009.4	2000.1-2009.4	2000.1-2009.4	1996.1-2009.4

Table A. 11 Descriptive Statistics for the Dominican Republic:Deposit Rates

	IP01RD	IP02RD	IP03RD	IP06RD	IP12RD	IPMAS12RD	IPAVRD
Mean	0.1406	0.1420	0.1422	0.1368	0.1486	0.1182	0.1425
Median	0.1403	0.1399	0.1404	0.1395	0.1412	0.1122	0.1385
Max.	0.2251	0.2291	0.2256	0.2754	0.2654	0.2265	0.2259
Min.	0.0361	0.0449	0.0460	0.0489	0.0550	0.0541	0.0457
Est. Dev.	0.0503	0.0496	0.0488	0.0445	0.0567	0.0434	0.0482
Asymmetry	-0.3418	-0.2346	-0.2086	0.3063	0.3975	0.5640	-0.2497
Kurtosis	2.1235	2.0516	2.0101	3.3619	2.3423	2.6822	2.0680
Var. Coef.	0.3577	0.3493	0.3431	0.3254	0.3816	0.3672	0.3382
Sample	1996.1-2009.4	1996.1-2009.4	1996.1-2009.4	1996.1-2009.4	1996.1-2009.4	2000.1-2009.4	1996.1-2009.4

Table A. 12 Descriptive Statistics for Dominican Republic: Macro Variables

	INF	G	FIS	FISY	ICBD	LIBOR
Mean	0.1127	0.0589	-2779.1160	-0.0021	0.2683	0.0477
Median	0.0658	0.0641	-278.1000	-0.0008	0.1800	0.0494
Max.	0.6232	0.1278	3651.7000	0.0040	0.6000	0.0788
Min.	-0.0157	-0.0218	-34286.3000	-0.0236	0.0950	0.0051
Est. Dev.	0.1345	0.0389	7502.8630	0.0062	0.1674	0.0168
Asymmetry	2.5594	-0.3157	-2.6630	-2.2413	0.9023	-0.8760
Kurtosis	8.9579	2.3140	9.4527	7.5369	2.4848	3.7875
Var. Coef.	1.1928	0.6607	-2.6997	-2.9971	0.6240	0.3525
Sample	1996.1-2009.4	1996.1-2009.4	1996.1-2009.4	1996.1-2009.4	2004.1-2009.4	1996.1-2009.4

Table A. 13 Descriptive Statistics of Variables for the Dominican Republic: Accumulation of Pension Funds:

	PFN	PFY	LPFN
Mean	3.8945	0.0130	1.8572
Median	0.0000	0.0000	1.9429
Max.	20.4800	0.0547	3.0194
Min.	0.0000	0.0000	0.2070
Est. Dev.	5.7233	0.0174	0.8041
Asymmetry	1.4272	0.9765	-0.4139
Kurtosis	3.9357	2.6342	2.2318
Var. Coef.	1.4696	1.3335	0.4330
Sample	1996.1-2009.4	1996.1-2009.4	2003.3-2009.4

Table A. 14 Regression Model Discarded in the Study

LENDING RATES' REGRESSIONS						
MACROECONOMIC VARIABLES						
Estimation Method	MICO	MICO-NW	MICO-NW	MICO	MICO	MICO
Explained Variable	IA03RD	IA06RD	IA12RD	IA24RD	IA60RD	IAmas60RD
	NOMINAL	NOMINAL	NOMINAL	NOMINAL	NOMINAL	NOMINAL
ICBD	0.162	0.208	0.178	0.108	0.177	0.242
	0.149	*0.100*	*0.141*	*0.422*	*0.133*	*0.058*
INF(-1)	0.076	0.108	0.084	0.020	0.047	0.047
	0.141	*0.023*	*0.136*	*0.751*	*0.372*	*0.404*
G	-0.179	-0.226	-0.156	-0.222	-0.250	-0.247
	0.173	*0.147*	*0.399*	*0.153*	*0.064*	*0.091*
FIS	-8.84E-07	-3.14E-07	-5.07E-07	-9.72E-07	-4.07E-07	-9.95E-09
	0.032	*0.690*	*0.295*	*0.048*	*0.298*	*0.981*
LIBOR	0.417	-0.334	0.290	-0.248	0.411	0.431
	0.159	*0.237*	*0.565*	*0.524*	*0.163*	*0.183*
DUMMIES						
FINDUM	-	-	-	-	-	-
	-	-	-	-	-	-
PENSION FUNDS						
LOG(PFN(-1))	0.018	-0.001	0.019	-0.021	0.015	0.030
	0.420	*0.977*	*0.596*	*0.464*	*0.511*	*0.232*
CONSTANTS AND AUTOREGRESSIVE VARIABLES						
C	-0.010	0.158	0.019	0.157	0.040	-0.021
	0.902	*0.145*	*0.883*	*0.145*	*0.624*	*0.810*
AR(-1)	0.516	-	-	0.858	0.454	0.458
	0.001	-	-	*0.002*	*0.012*	*0.008*
AR(-2)	-	-	-	-0.460	-	-
	-	-	-	*0.047*	-	-
AR(-3)	-	-	-	-	-	-
	-	-	-	-	-	-
AR(-4)	-	-	-	-	-	-
	-	-	-	-	-	-
DESCRIPTIVE STATISTICS						
Adjusted R-squared	0.929	0.801	0.853	0.907	0.920	0.912
S.E. of regression	0.017	0.027	0.024	0.020	0.017	0.019
Log likelihood	68.163	56.525	60.589	65.375	67.947	65.855
Akaike info criterion	-5.014	-4.127	-4.382	-4.698	-4.996	-4.821
Schwarz criterion	-4.621	-3.783	-3.990	-4.256	-4.603	-4.429
Breusch Godfrey	0.150	0.023	0.526	0.302	0.220	0.240
ARCH	0.258	0.018	0.597	0.732	0.184	0.794
White	0.571	0.039	0.606	0.328	0.156	0.416
Ramsey	0.004	0.033	0.000	0.055	0.002	0.000

DEPOSIT RATES' REGRESSIONS

MACROECONOMIC VARIABLES					
Estimation Method	MICO-NW	MICO-NW	MICO	MICO-NW	MICO-NW
Explained Variable	IP01RD	IP02RD	IP03RD	IP06RD	IP12RD
	NOMINAL	NOMINAL	NOMINAL	NOMINAL	NOMINAL
ICBD	0.104	0.094	0.087	0.104	0.158
	0.227	*0.457*	*0.397*	*0.284*	*0.116*
INF(-1)	0.092	0.055	0.050	-0.009	0.051
	0.003	*0.234*	*0.327*	*0.721*	*0.165*
G	-0.026	-0.183	-0.251	-0.099	-0.245
	0.738	*0.097*	*0.050*	*0.296*	*0.010*
FIS	-6.53E-07	-8.20E-07	-8.54E-07	-7.78E-07	-6.24E-07
	0.001	*0.038*	*0.033*	*0.004*	*0.023*
LIBOR	0.264	-0.018	-0.027	0.734	0.133
	0.207	*0.948*	*0.928*	*0.013*	*0.627*
DUMMIES					
FINDUM	-	-	-	-	-
	-	-	-	-	-
PENSION FUNDS					
LOG(PFN(-1))	0.011	-0.012	-0.018	0.022	-0.007
	0.606	*0.686*	*0.432*	*0.427*	*0.758*
CONSTANTS AND AUTOREGRESSIVE VARIABLES					
C	-0.029	0.071	0.098	-0.081	0.057
	0.668	*0.441*	*0.224*	*0.394*	*0.442*
AR(-1)	0.541	0.679	0.596	0.800	0.600
	0.000	*0.007*	*0.006*	*0.000*	*0.002*
AR(-2)	-	-0.354	-0.341	-	-0.308
	-	*0.025*	*0.060*	-	*0.005*
AR(-3)	-	-	-	-	-
	-	-	-	-	-
AR(-4)	-	-	-	-	-
	-	-	-	-	-
DESCRIPTIVE STATISTICS					
Adjusted R-squared	0.941	0.907	0.909	0.821	0.955
S.E. of regression	0.014	0.017	0.016	0.015	0.014
Log likelihood	73.658	69.660	70.350	71.278	74.816
Akaike info criterion	-5.472	-5.055	-5.113	-5.273	-5.485
Schwarz criterion	-5.079	-4.613	-4.671	-4.881	-5.043
Breusch Godfrey	0.074	0.045	0.192	0.089	0.090
ARCH	0.223	0.789	0.818	0.762	0.696
White	0.174	0.528	0.403	0.292	0.443
Ramsey	0.000	0.000	0.007	0.658	0.002

A.3. Figures

Figure A. 1 Examples of Term Structures or Yield Curves

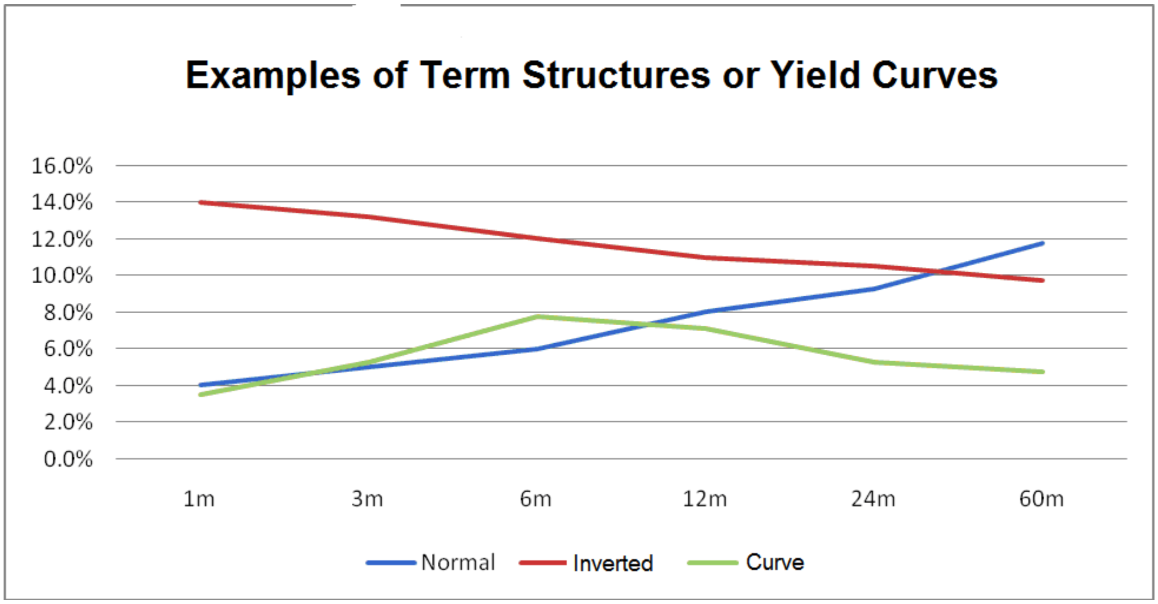


Figure A. 2 Portfolio Diversification

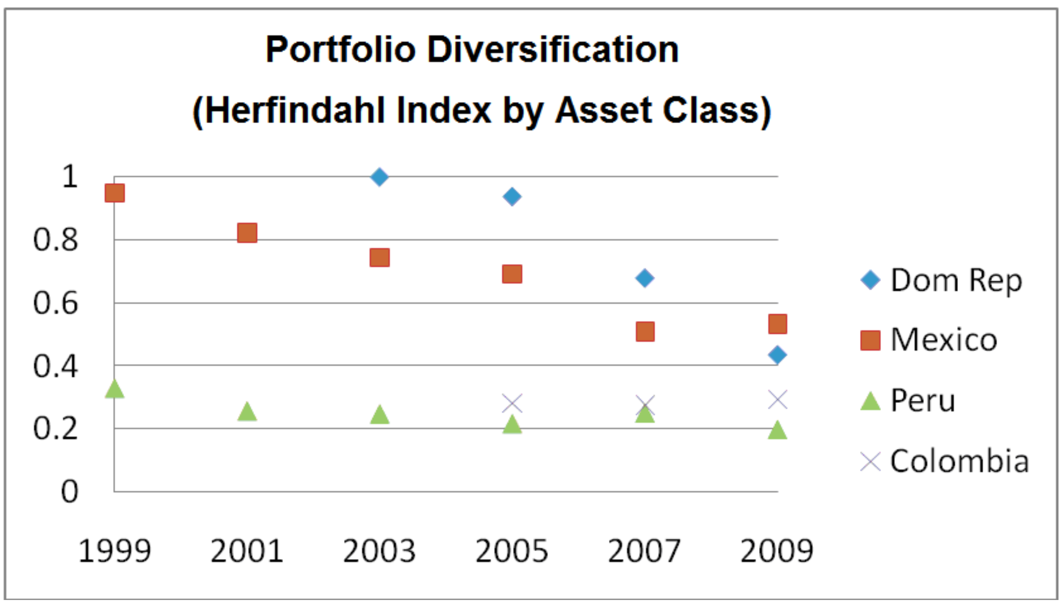


Figure A. 3 Path of Nominal Lending Interest Rates of Commercial Banks

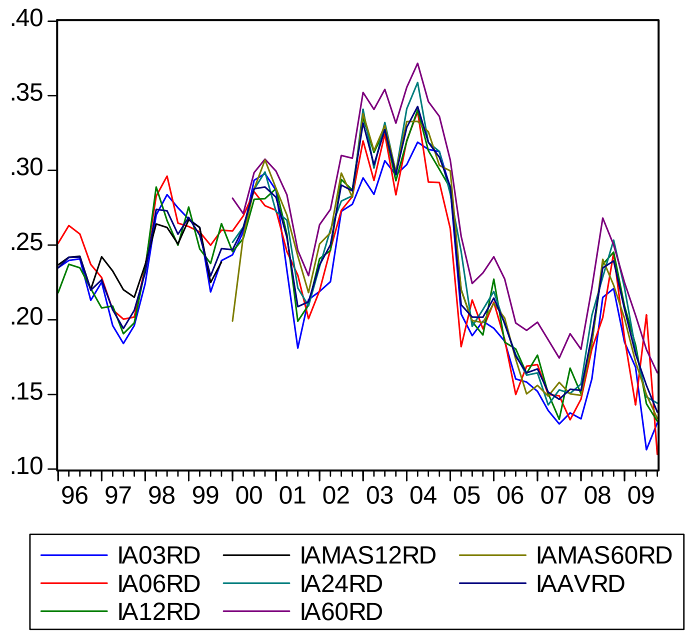


Figure A. 4 Term Structure of Selected Lending Interest Rates

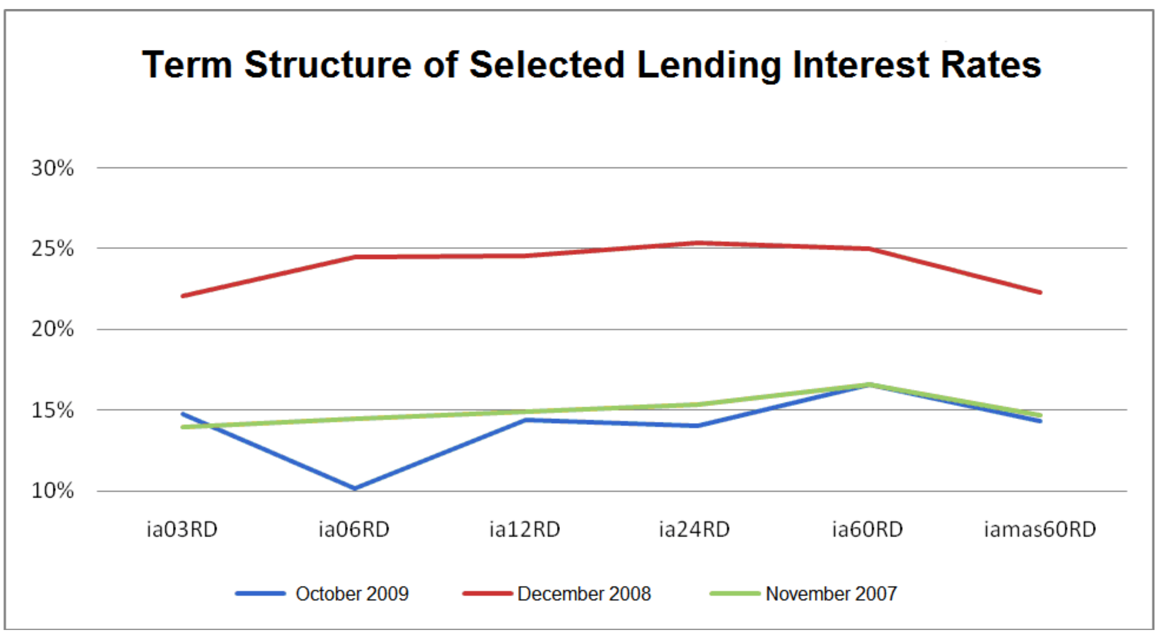


Figure A. 5 Path of Nominal Deposit Interest Rates of Commercial Banks

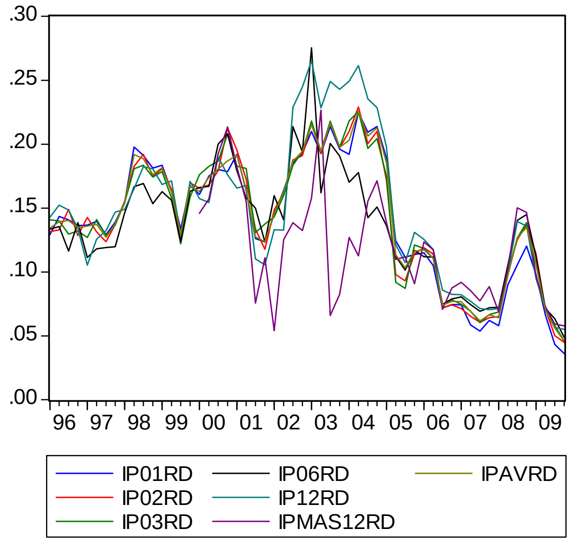


Figure A. 6 Term Structure of Selected Deposit Interest Rates

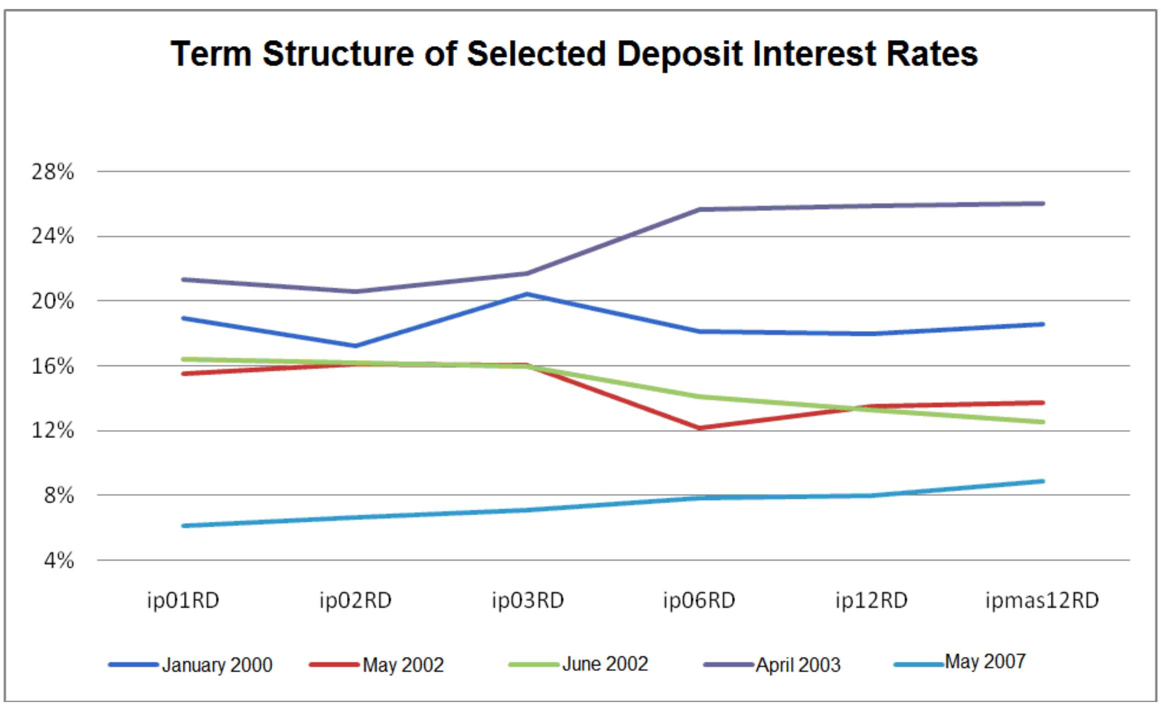


Figure A. 7 Path of Pension Fund Assets: Logarithm of Nominal Assets and Assests as a % of GDP

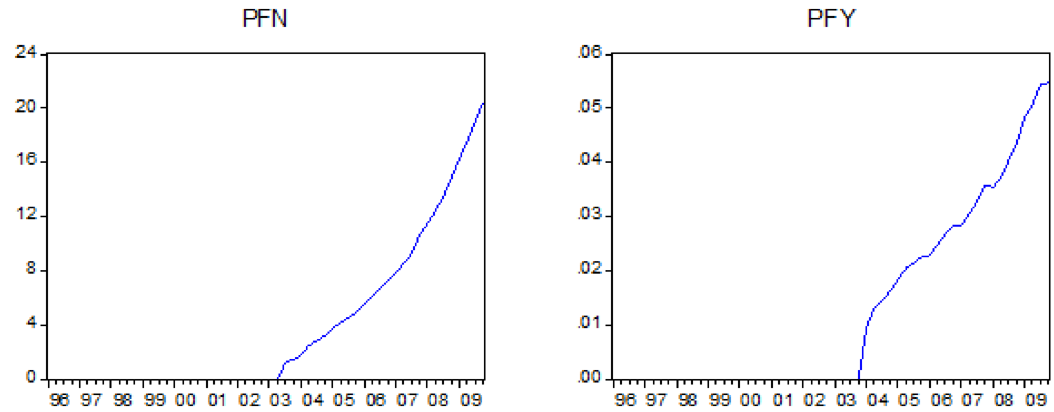


Figure A. 8 Path of Macroeconomic Variables

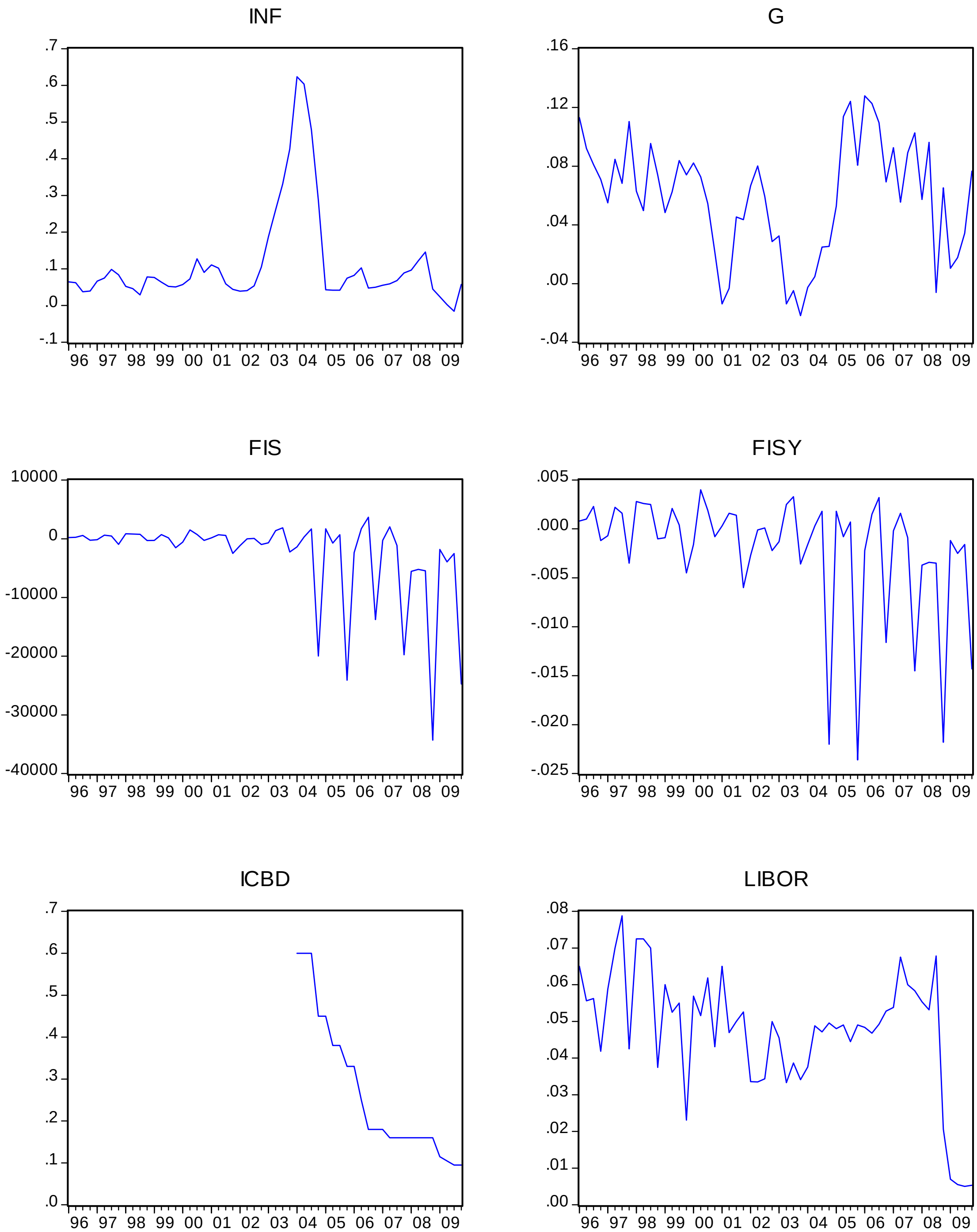


Figure A. 9 Term Impact of Macroeconomic Variables on Lending Rates

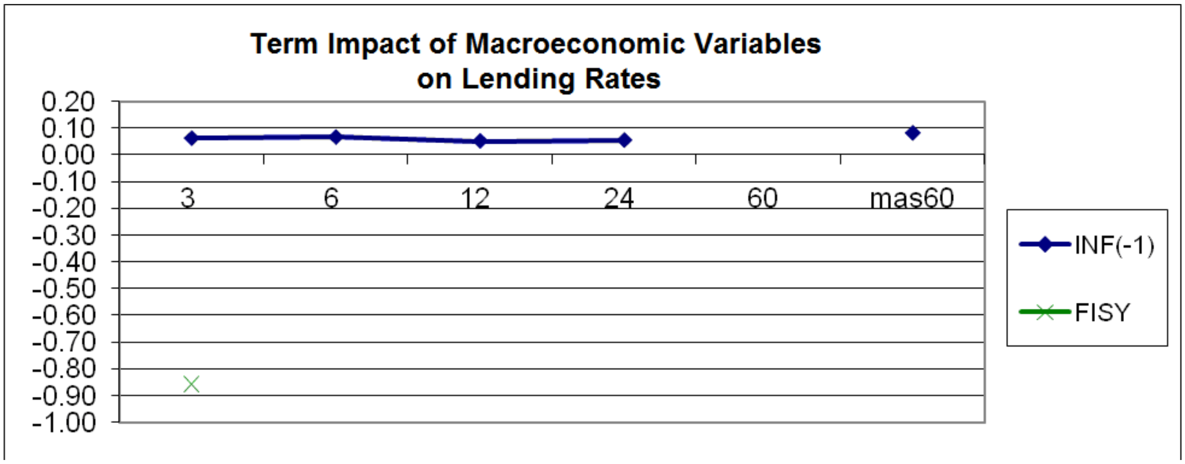


Figure A. 10 Term Impact of the Patrimony of Pension Funds divided by Nominal GDP in the Lending Rates

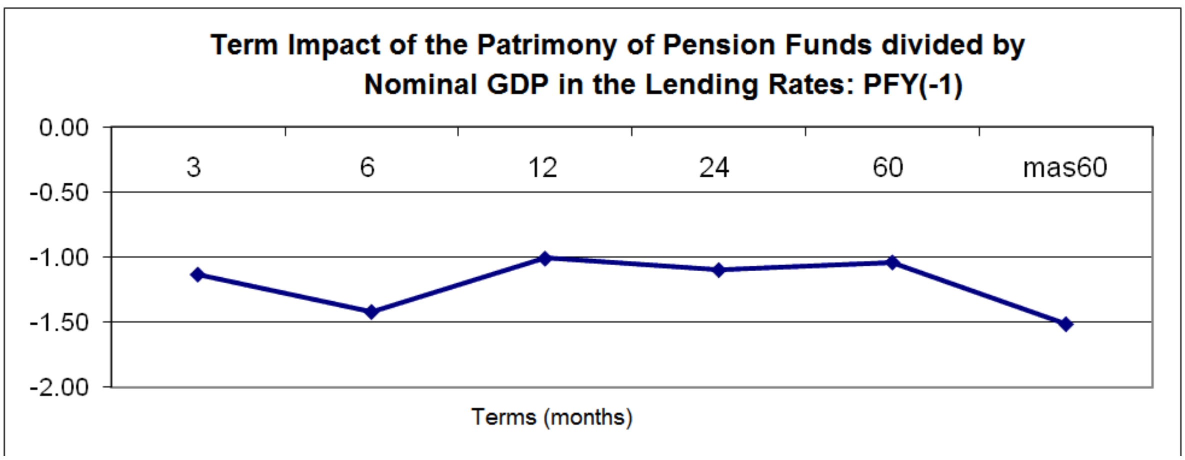


Figure A. 11 Confidence Intervals Impact of Pension Fund Investments on Lending Rates

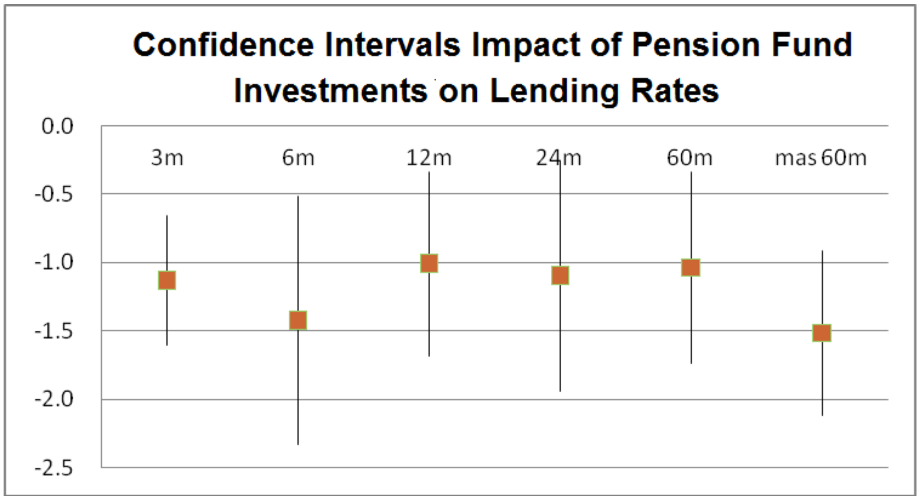


Figure A. 12 Term Impact of Macroeconomic Variables on Deposit Rates

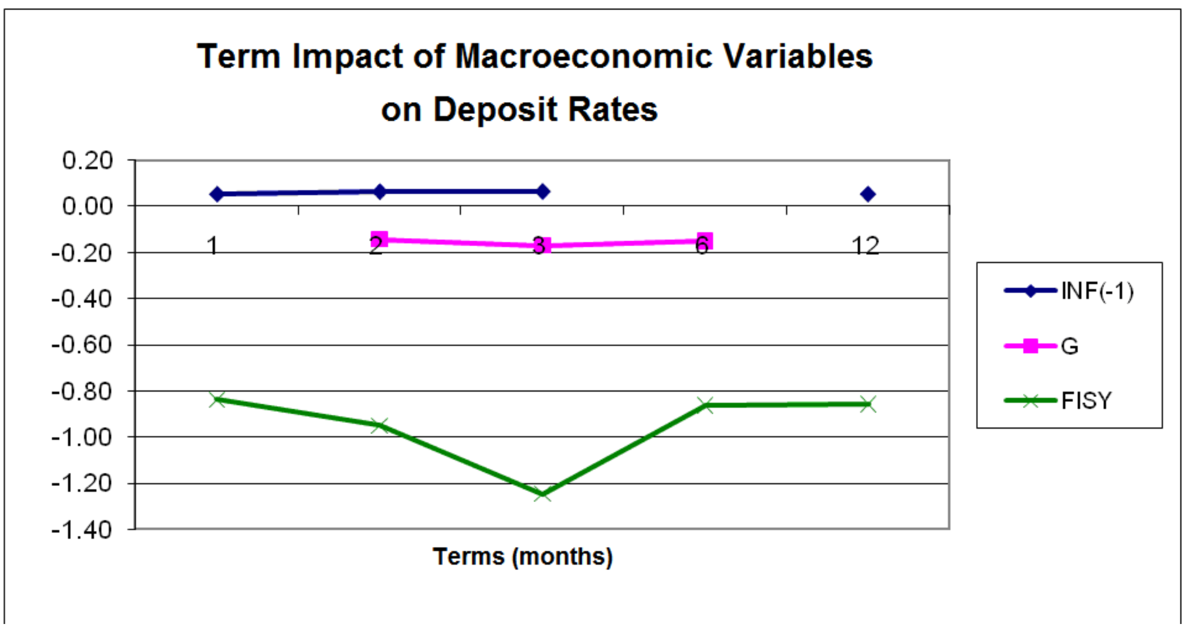


Figure A. 13 Term Impact of the Patrimony of Pension Funds divided by Nominal GDP in Deposit Rates

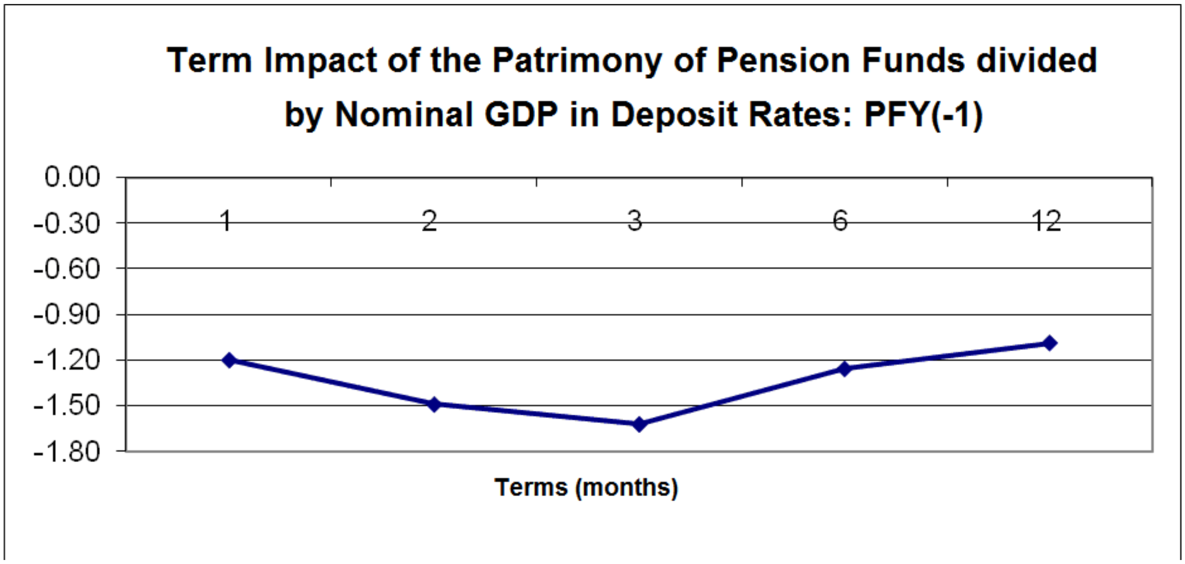
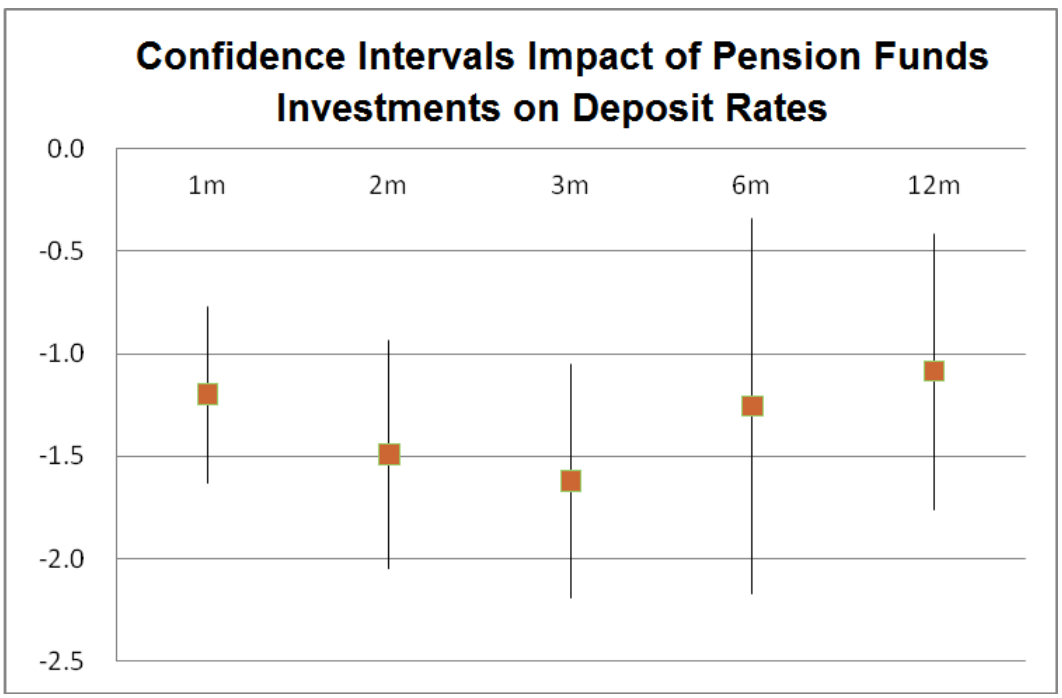


Figure A. 14 Confidence Intervals Impact of Pension Funds Investments on Deposit Rates



Path of Nominal Interest Rates of Commercial Banks in the Dominican Republic

Figure A. 15 Lending Rates

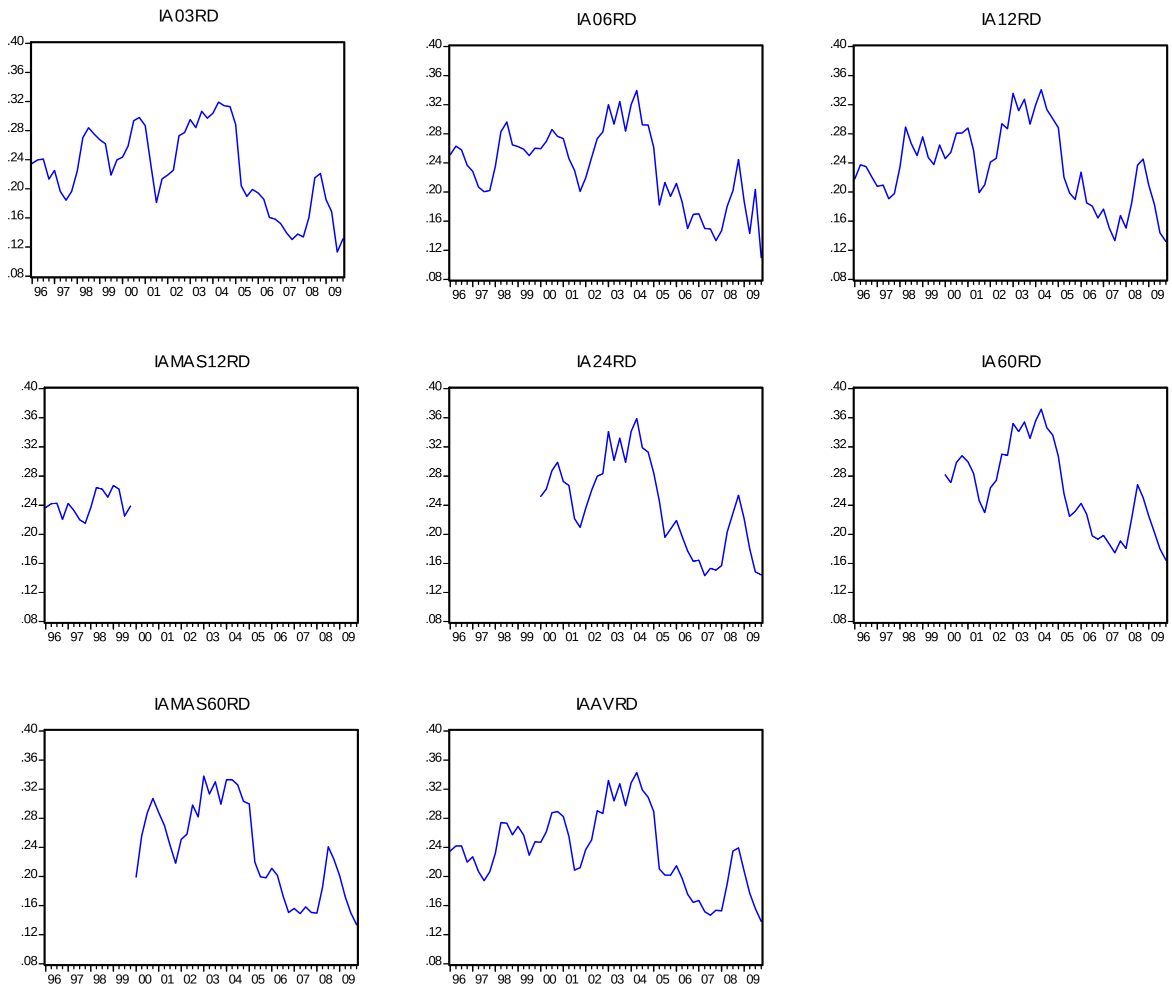
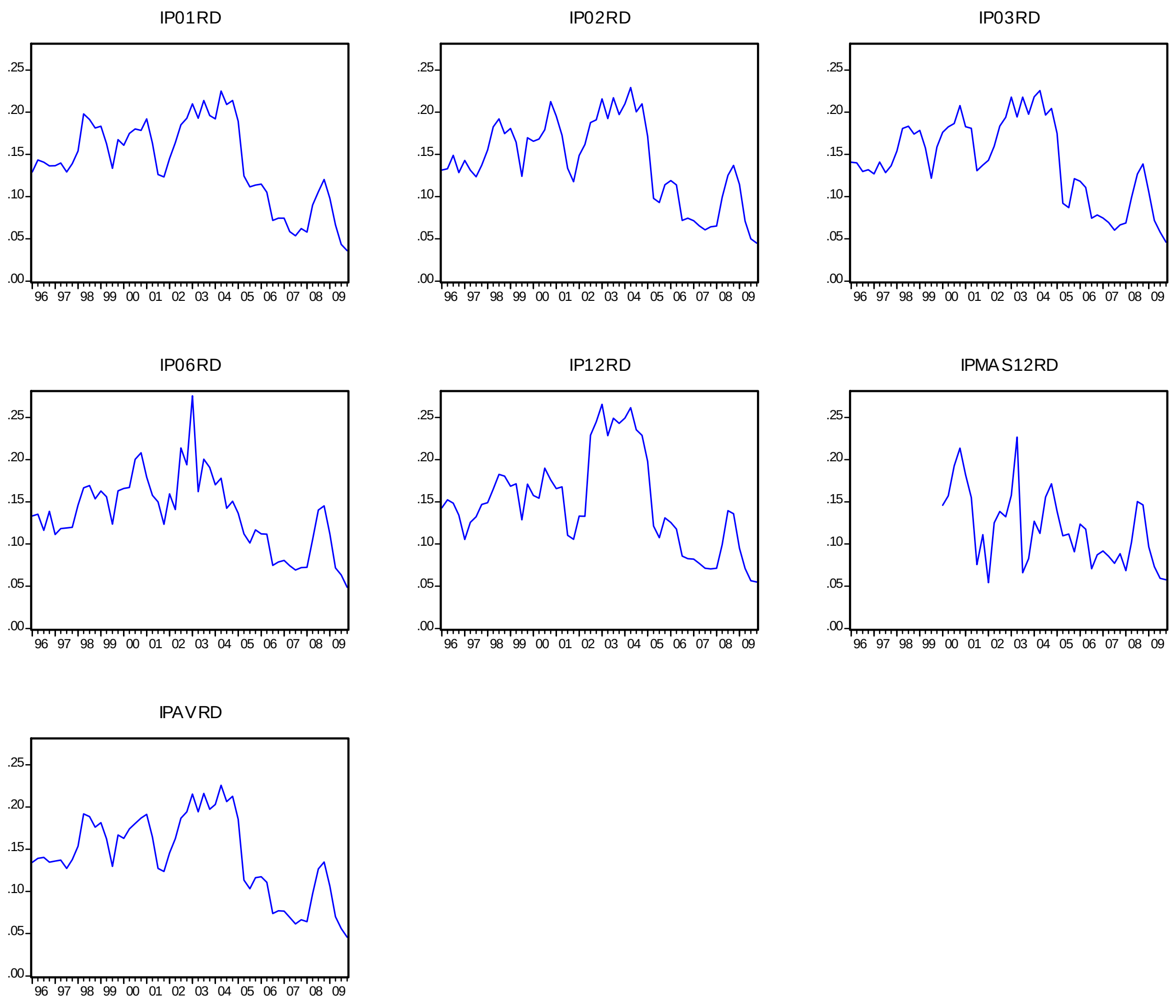


Figure A. 16 Deposits Rates



Correlations between explained and explanatory variables of the Dominican Republic

As an example we show the correlations between the explanatory variables and lending rates of 3 months. Remains the same with the rates on deposits and then the spread[63].

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[63] Note that there is a set of these correlations for each of the rates. These are available upon request and were excluded from the attachments because of the volume of pages that would be added if they were included.

Figure A. 17 3-month Lending Rate

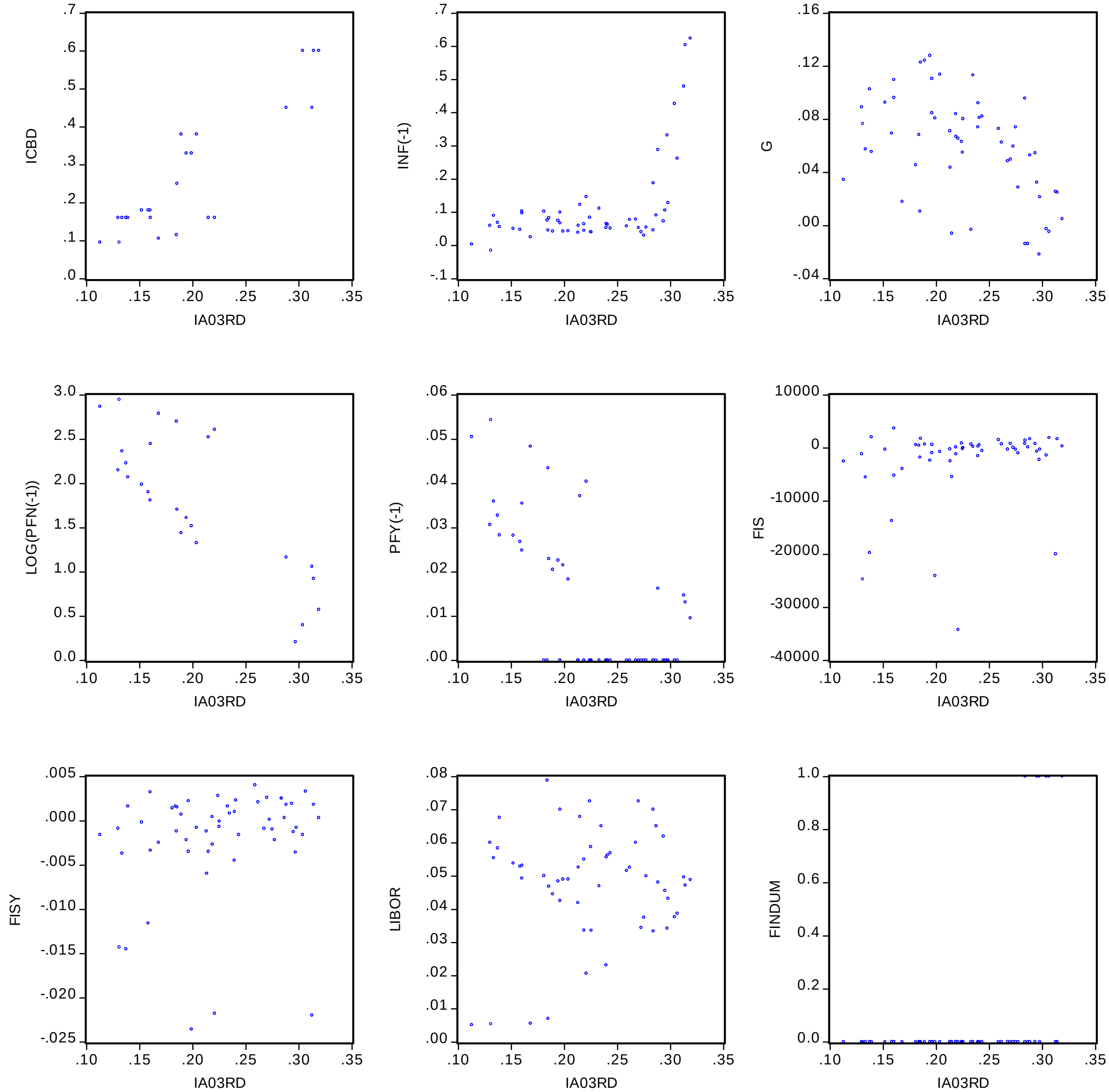
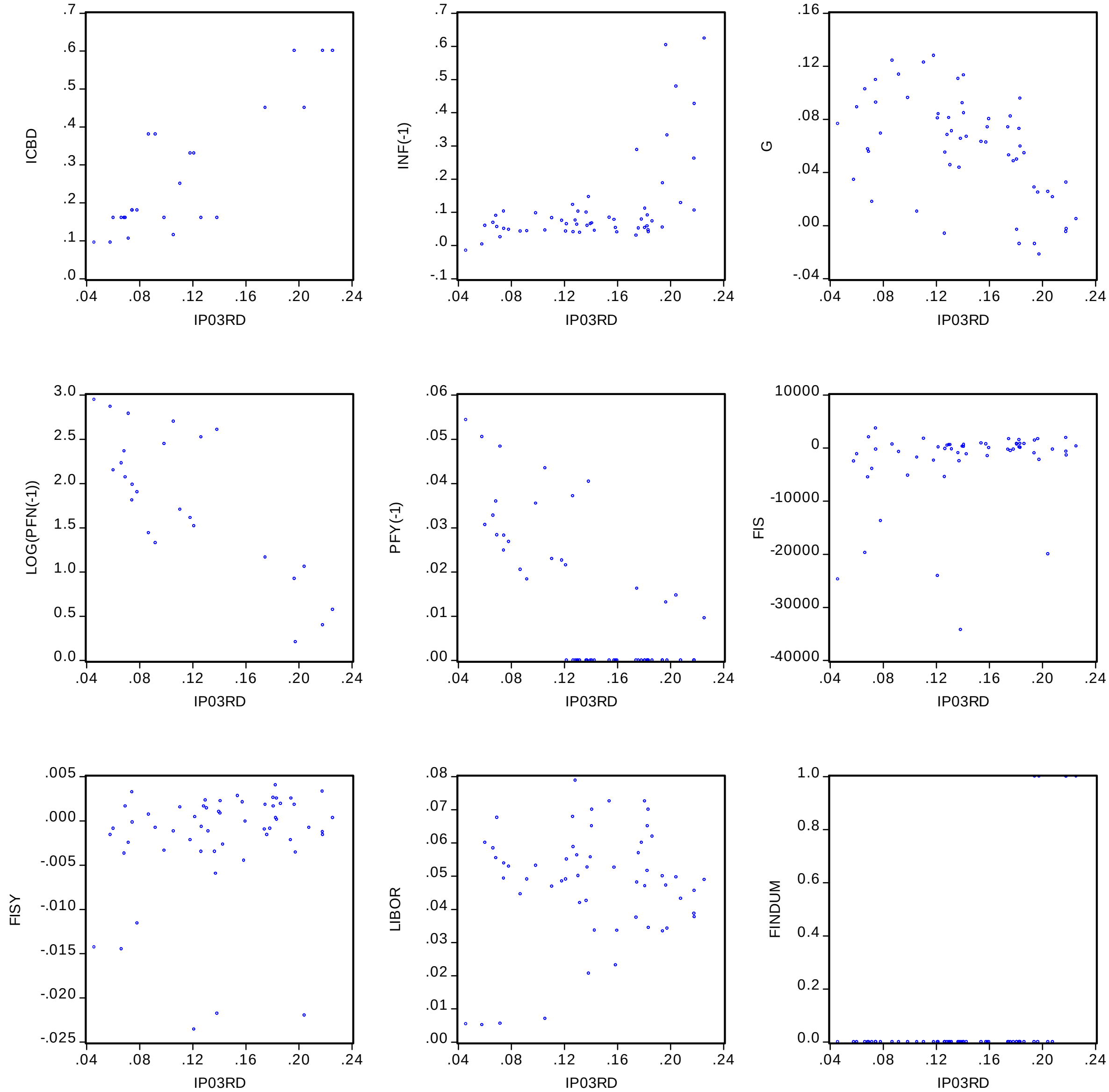


Figure A. 18 3-month Deposit Rate



Appendix Chapter 3

B.1. Tables

Table B. 1 Managed Funds Relative to GDP

Managed Funds Relative to GDP
(In %)

Countries	30/06/04	30/06/05	30/06/06	30/06/07	30/06/08	30/06/09
Argentina	11,3	12,3	12,3	13,2	11,8	
Bolivia	19,5	20,1	21,0	22,0	25,2	22,6
Chile	62,6	63,9	63,2	68,5	65,1	59,9
Colombia	9,7	11,7	12,9	13,4	15,0	14,1
Costa Rica	2,1	3,0	3,9	4,9	5,0	5,9
El Salvador	12,7	16,4	19,5	19,6	22,8	25,5
México	5,8	6,3	7,1	8,4	7,1	8,5
Perú	11,2	12,3	14,2	20,5	17,5	15,3
R. Dominicana	0,4	1,7	1,7	2,2	2,9	3,7
Uruguay	14,4	14,8	13,1	14,5	14,2	12,0
Total	11,4	12,5	13,7	15,9	14,0	15,6

Source: Quarterly Bulletin, June 2009, International Administration of Pension Funds Supervision

Table B. 2 Amount of PFA in te System

Amount of PFA in the System

Country	Amount of PFA					
	Jun '04	Jun '05	Jun '06	Jun '07	Jun '08	Jun '09
Argentina	12	12	11	11	11	
Bolivia	2	2	2	2	2	2
Chile	6	6	6	6	5	5
Colombia	6	6	6	6	6	6
Costa Rica	8	8	8	8	8	8
El Salvador	2	2	2	2	2	2
México	13	15	17	21	18	18
Perú	4	4	5	4	4	4
R. Dominican	9	7	7	5	5	5
Uruguay	4	4	4	4	4	4
Average	7.3	6.6	6.8	6.9	6.5	6.0

Source: Quarterly Bulletin June 2009, International Administration of Pension Funds Supervision

Table B. 3 Capital market development in Latin America, G-7, and East Asia, 1990 and 2004 (percent)

Market development indicator	Latin American countries[a]		G-7 countries[b]		East Asian countries[c]	
	1990	2004	1990	2004	1990	2004
Domestic stock market						
Market capitalization/GDP	12.4	42.3	48.2	93.6	53.5	147.1
Value traded domestically/GDP	2.0	6.1	23.9	92.2	82.7	104.5
Capital raised domestically/GDP	0.4	0.5	0.9	1.4	3.4	5.9
Domestic bond market						
Amount outstanding of domestic public sector bonds/GDP	12.3	20.7	50.5	67.9	13.9	25.6
Amount outstanding of domestic private sector bonds/GDP	4.4	10.7	38.6	47.7	15.9	36.3

Notes: [a]Averages for Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela. [b]Averages for Canada, France, Germany, Italy, Japan, UK, and US. [c]Averages for Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Taiwan, and Thailand.
Source: Bank for International Settlements, S&P Emerging Markets Database, World Bank and World Federation of Exchanges in de la Torre et al. (2006).

From Dayoub & Lasagabaster (2008)

Table B. 4 Results for the PF variable

	Pooled OLS	**Pooled OLS'w**	**Fixed Effects**	**Fixed Effects's**	**GLS-Cross**	**GLS-Cross**	**GLS-SUR**
PF (% GDP)	-0.094*	-0.0939**	-0.2243**	-0.2243***	-0.0672	-0.0672***	-0.0268
Trend	-0.0004**	-0.0004**	-0.0003	-0.0003	-0.0002	-0.0002**	-0.0004*
Log(PFn)	-0.0015**	-0.0015**	-0.0106***	-0.0106***	-0.0009***	-0.0009***	-0.0092***
Trend	-0.0005**	-0.0005***	3.89E-5	3.89E-5	0.0001	0.0001	-0.0002

Note: W refers to White Heteroskedasticity Consistent Standard Errors
*10%, **5% & ***1% sig level.

Table B. 5 Regressions: Pension Fund Summary of Results

Regressions: Pension Fund Summary of Results						
Country	**Rate**	**PF variable**	**PF Reform Dummy**	**SL**	**PF variable**	**SL**
Dominican Republic	Banks	As % GDP	-0.02		-1.59	***
Peru	Banks	As % GDP	0.01		-0.07	***
Peru	CD of CB	As % GDP	0.18	***	-0.71	
Mexico	Treasury 1m	As % GDP	-0.05	***	-1.2	*
Mexico	Treasury 3m	As % GDP	-0.03	**	-1.3	*
Mexico	Treasury 6m	As % GDP	-0.006		-1.25	***
Mexico	Treasury 12m	As % GDP	-0.005		-0.87	*
Colombia	Banks	As % GDP	-0.01	***	0.52	***
Colombia (post 95)	Banks	As % GDP	-		-0.2	

Table B. 6 Regressions: Pension Fund (With dummy in 1995 due to Crisis in Colombia)

Country	**Rate**	**PF variable**	**PF Reform Dummy**	**SL**	**PF variable**	**SL**	**Interacting Term PF & Financial Crisis**	**SL**
Colombia	Banks	As % GDP	-0.001		0.04		-2.3	
Colombia (post 95)	Banks	As % GDP	-		0.12		-2.92	**

*10% significance Level
**5% significance level
***1% significance level

PF Dummy Average	0.0087
PF Nominal Average	-0.0027
PF as % GDP Avg.	-0.7589

Table B. 7 Economic Relevance of the pension funds effects on interest rates

Economic Relevance of the pension funds effects on interest rates		
Country	PF/GDP Effect (Share of PfT)	Peak to Trough (PtT)
Dominican Republic	-8.69% (51/100)	-17%
Peru	-0.98% (3/100)	-35%
Mexico	-10.5% (62/100)	-17%
Colombia	Not significant effect	-17%

Table B. 8 Interest Rate Dynamics in Latin America in the last two Decades

Dominican Republic

Banks Deposit Rate (Weighted Average)			
Descriptive Statistics		Descriptive Statistics	
Before Reform		After Reform	
Median	16.25%	Median	11.3%
Mean	16.13%	Mean	12.3%
SD	2.58%	SD	5.8%
Var Coef	16.02%	Var Coef	47.0%

Where: Var Coef= Standard Deviation/Mean

Pension Funds Investments		
	In MM Pesos	As % GDP
Min	4,606.47	0.95%
Max	94,318.75	5.43%
Average	37,532.43	2.79%
Median	31,275.12	2.68%

Mexico

Treasury Yields 1m			
Descriptive Statistics		Descriptive Statistics	
Before Reform		After Reform	
Median	38.2%	Median	7.9%
Mean	44.1%	Mean	11.0%
SD	29.6%	SD	6.7%
Var Coef	67.15%	Var Coef	60.8%

Treasury Yields 3m			
Descriptive Statistics		Descriptive Statistics	
Before Reform		After Reform	
Median	32.6%	Median	8.2%
Mean	39.9%	Mean	11.6%
SD	27.6%	SD	7.1%
Var Coef	69.13%	Var Coef	61.4%

Treasury Yields 6m			
Descriptive Statistics		Descriptive Statistics	
Before Reform		After Reform	
Median	24.2%	Median	8.4%
Mean	34.5%	Mean	11.3%
SD	27.4%	SD	6.1%
Var Coef	79.43%	Var Coef	54.3%

Treasury Yields 12m			
Descriptive Statistics		Descriptive Statistics	
Before Reform		After Reform	
Median	18.5%	Median	8.6%
Mean	22.0%	Mean	11.6%
SD	9.5%	SD	6.3%
Var Coef	43.04%	Var Coef	54.1%

Pension Funds Investments		
	In MM Pesos	As % GDP
Min	27,449.28	1.90%
Max	1,151,184.76	8.50%
Average	465,198.27	5.63%
Median	418,042.29	5.75%

Table B. 9 Interest Rate Dynamics in Colombia in the last two Decades

3M T-bills Yield			
Descriptive Statistics Before Reform		Descriptive Statistics After Reform	
Mean	N.A.	Mean	13.62%
Median	N.A.	Median	9.72%
SD	N.A.	SD	9.33%
Var Coef	N.A.	Var Coef	68.5%

Banks Deposit Rate			
Descriptive Statistics Before Reform		Descriptive Statistics After Reform	
Mean	31.68%	Mean	20.53%
Median	31.84%	Median	19.15%
SD	4.27%	SD	10.29%
Var Coef	13.48%	Var Coef	50.1%

Table B. 10 Interest Rate Dynamics in Peru in the last two Decades

Savings Deposit Yield			
Descriptive Statistics Before Reform		Descriptive Statistics After Reform	
Mean	43.62%	Mean	6.6%
Median	43.10%	Median	4.7%
SD	5.24%	SD	6.6%
Var Coef	12.01%	Var Coef	100.1%

CD Rates BCRP			
Descriptive Statistics Before Reform		Descriptive Statistics After Reform	
Mean	330.48%	Mean	10.3%
Median	54.47%	Median	10.4%
SD	963.79%	SD	8.6%
Var Coef	291.63%	Var Coef	83.1%

Pension Funds Investments	
	In MM New Soles
Min	8,389.45
Max	69,287.47
Average	31,923.66
Median	25,907.63

Table B. 11 Descriptive Statistics

	I_DR	I_1MX	I_3MX	I_6MX	I_12MX	I_1PE	I_2PE	I_CO
Mean	0.143	0.167	0.172	0.157	0.147	0.099	1.848	0.205
Median	0.139	0.141	0.147	0.125	0.120	0.075	0.146	0.229
Maximum	0.226	0.750	0.780	0.600	0.500	0.494	50.130	0.393
Minimum	0.046	0.045	0.046	0.049	0.051	0.012	0.024	0.041
Std. Dev.	0.048	0.124	0.126	0.104	0.089	0.120	6.301	0.118
Skewness	(0.250)	1.915	1.937	1.756	1.523	1.931	5.812	0.096
Kurtosis	2.063	8.023	8.479	6.823	5.867	6.005	42.384	1.361
Jarque-Bera	2.629	134.685	152.000	85.352	53.210	68.838	5,972.024	9.981
Probability	0.269	-	-	-	-	-	-	0.007
Observations	56	81	81	76	73	69	85	88

	ICB_DR	ICB_MX	ICB_PE	ICB_CO	LIBOR
Mean	0.268	0.083	1.980	0.252	0.056
Median	0.180	0.075	0.161	0.298	0.053
Maximum	0.600	0.313	63.428	0.473	0.151
Minimum	0.095	-	0.030	0.055	0.005
Std. Dev.	0.167	0.060	7.553	0.132	0.032
Skewness	0.902	1.551	6.723	0.018	1.153
Kurtosis	2.485	6.783	53.340	1.408	4.799
Jarque-Bera	3.522	44.878	9,615.443	9.300	30.296
Probability	0.172	-	-	0.010	-
Observations	24	45	85	88	85

	INF_DR	INF_MX	INF_PE	INF_CO	Y_DR	Y_MX	Y_PE	Y_CO
Mean	0.116	0.129	2.846	0.153	0.059	0.027	0.031	0.021
Median	0.067	0.080	0.048	0.151	0.064	0.036	0.042	0.017
Maximum	0.623	0.536	58.346	0.324	0.128	0.084	0.128	0.084
Minimum	0.003	0.031	(1.000)	0.020	(0.022)	(0.094)	(0.189)	(0.068)
Std. Dev.	0.135	0.108	10.303	0.094	0.039	0.039	0.064	0.030
Skewness	2.536	1.504	3.868	0.233	(0.316)	(1.447)	(1.418)	(0.046)
Kurtosis	8.737	5.095	17.525	1.497	2.314	5.111	5.372	3.174
Jarque-Bera	131.951	45.353	913.949	9.083	2.029	42.772	46.136	0.141
Probability	-	-	-	0.011	0.363	-	-	0.932
Observations	54	81	81	88	56	80	81	87

	FIS_DR	FIS_MX	FIS_PE	FIS_CO	FISY_DR	FISY_MX	FISY_PE	FISY_CO
Mean	(2,779)	11,189	462	(549)	(0.002)	0.001	0.522	(0.012)
Median	(278)	8,243	41	-	(0.001)	0.002	0.300	-
Maximum	3,652	139,853	7,143	4,672	0.004	0.023	7.300	0.048
Minimum	(34,286)	(274,511)	(2,782)	(10,220)	(0.024)	(0.045)	(5.400)	(0.150)
Std. Dev.	7,503	56,896	1,578	2,595	0.006	0.010	2.560	0.038
Skewness	(2.663)	(1.226)	1.988	(1.573)	(2.241)	(1.580)	0.274	(1.417)
Kurtosis	9.453	10.199	7.983	7.177	7.537	7.929	3.287	5.404
Jarque-Bera	163.341	195.219	143.932	99.121	94.913	115.669	1.359	50.077
Probability	-	-	-	-	-	-	0.507	-
Observations	56	81	85	87	56	81	85	87
	PFY_DR	PFY_MX	PFY_PE	PFY_CO	PFN_DR	PFN_MX	PFN_PE	PFN_CO
Mean	0.029	0.052	0.109	0.067	38,639	479,937	29,528,065	20,829,692
Median	0.028	0.057	0.107	0.061	32,167	427,279	23,992,738	12,193,154
Maximum	0.055	0.092	0.193	0.180	94,319	1,151,528	63,152,119	79,897,623
Minimum	0.010	0.012	0.048	-	5,668	45,577	8,389,449	732
Std. Dev.	0.014	0.022	0.044	0.052	26,406	315,159	18,509,068	21,982,720
Skewness	0.402	(0.209)	0.334	0.296	0.632	0.398	0.603	0.970
Kurtosis	2.158	2.208	2.036	1.784	2.255	2.017	1.952	2.859
Jarque-Bera	1.468	1.538	2.181	4.729	2.333	3.063	4.039	9.935
Probability	0.480	0.464	0.336	0.094	0.311	0.216	0.133	0.007
Observations	26	46	38	62	26	46	38	63

Table B. 12 Time Series Results Dominican Republic

Dependent Variable: IBDR
Method: Least Squares
Date: 04/13/10 Time: 14:29
Sample(adjusted): 1997:1 2009:3
Included observations: 50
Excluded observations: 1 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.121236	0.030863	3.928194	0.0003
IBDR(-1)	0.612233	0.107072	5.717946	0.0000
IBDR(-4)	-0.261335	0.097881	-2.669916	0.0110
ICBD	0.028692	0.035243	0.814129	0.4205
INF(-1)	0.044493	0.041656	1.068103	0.2920
G	-0.156760	0.101143	-1.549885	0.1292
REF	-0.024291	0.018441	-1.317226	0.1955
PFY*PFID	-1.594236	0.382594	-4.166910	0.0002
FISY	-0.991388	0.444573	-2.229975	0.0316
LIBOR	-0.176250	0.198003	-0.890134	0.3789
FINDUM	0.009081	0.010235	0.887267	0.3804

R-squared	0.901096	Mean dependent var	0.145680
Adjusted R-squared	0.875736	S.D. dependent var	0.048736
S.E. of regression	0.017180	Akaike info criterion	-5.098620
Sum squared resid	0.011511	Schwarz criterion	-4.677975
Log likelihood	138.4655	F-statistic	35.53212
Durbin-Watson stat	1.791490	Prob(F-statistic)	0.000000

Table B. 13 Time Series Results Peru

Banking sector:

Dependent Variable: IBPE
Method: Least Squares
Date: 04/06/10 Time: 02:22
Sample(adjusted): 1993:1 2009:1
Included observations: 65 after adjusting endpoints
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.007192	0.003355	2.143581	0.0365
IBPE(-1)	1.098965	0.073240	15.00491	0.0000
IBPE(-4)	-0.188191	0.045783	-4.110511	0.0001
ICB	0.022344	0.011472	1.947778	0.0566
INF(-1)	-0.016782	0.017055	-0.983981	0.3294
Y	0.082228	0.038379	2.142494	0.0366
REF	0.012100	0.006700	1.805893	0.0764
PFY*PFID	-0.068693	0.020431	-3.362224	0.0014
FISCY	0.000620	0.000331	1.873034	0.0664
LIBOR	-0.083520	0.071897	-1.161658	0.2504

R-squared	0.993764	Mean dependent var	0.076795
Adjusted R-squared	0.992743	S.D. dependent var	0.082287
S.E. of regression	0.007010	Akaike info criterion	-6.942377
Sum squared resid	0.002703	Schwarz criterion	-6.607856
Log likelihood	235.6273	F-statistic	973.8074
Durbin-Watson stat	1.634726	Prob(F-statistic)	0.000000

Table B. 13 Time Series Results Peru (cont.)

Certificate of Deposit from the Central Bank:

Dependent Variable: IPPE
Method: Least Squares
Date: 04/06/10 Time: 02:23
Sample(adjusted): 1989:2 2009:1
Included observations: 80 after adjusting endpoints
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.219193	0.247110	0.887025	0.3781
IPPE(-1)	0.168709	0.011454	14.72868	0.0000
IPPE(-4)	-0.079824	0.007086	-11.26545	0.0000
ICB	0.766286	0.006533	117.2859	0.0000
INF(-1)	0.028621	0.009771	2.929138	0.0046
Y	-1.460144	1.548058	-0.943211	0.3488
REF	0.181163	0.076466	2.369215	0.0206
PFY*PFID	-0.709671	0.501302	-1.415655	0.1613
FISCY	0.025896	0.014932	1.734275	0.0873
LIBOR	-1.947090	4.846034	-0.401790	0.6891

R-squared	0.996579	Mean dependent var	1.641580
Adjusted R-squared	0.996140	S.D. dependent var	6.319707
S.E. of regression	0.392653	Akaike info criterion	1.084686
Sum squared resid	10.79232	Schwarz criterion	1.382439
Log likelihood	-33.38742	F-statistic	2266.071
Durbin-Watson stat	3.009344	Prob(F-statistic)	0.000000

Table B. 14 Time Series Results Mexico:

Treasury Bills:

1month:

Dependent Variable: IP01MX
Method: Least Squares
Date: 04/06/10 Time: 02:25
Sample(adjusted): 1990:4 2009:4
Included observations: 77 after adjusting endpoints
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.135974	0.060909	2.232421	0.0289
IP01MX(-1)	0.594086	0.187482	3.168757	0.0023
IP01MX(-4)	-0.159197	0.096758	-1.645309	0.1046
INF(-1)	0.121391	0.299251	0.405651	0.6863
Y	0.026744	0.249242	0.107301	0.9149
REF	-0.047941	0.012681	-3.780530	0.0003
PFY*PFID	-1.242550	0.672824	-1.846768	0.0692
FISFY	-0.761330	0.519989	-1.464128	0.1478
ICB	-0.073004	0.105081	-0.694743	0.4896
LIBOR	-0.325959	0.219366	-1.485916	0.1420

R-squared	0.651937	Mean dependent var	0.156565
Adjusted R-squared	0.605182	S.D. dependent var	0.116290
S.E. of regression	0.073070	Akaike info criterion	-2.274164
Sum squared resid	0.357730	Schwarz criterion	-1.969774
Log likelihood	97.55531	F-statistic	13.94375
Durbin-Watson stat	2.008902	Prob(F-statistic)	0.000000

Table B. 14 Time Series Results Mexico (cont.) :

Treasury Bills:

3 months:

Dependent Variable: IP03MX
Method: Least Squares
Date: 04/11/10 Time: 01:34
Sample(adjusted): 1990:4 2009:4
Included observations: 77 after adjusting endpoints
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.139859	0.066284	2.109999	0.0386
IP03MX(-1)	0.587848	0.188238	3.122902	0.0026
IP03MX(-4)	-0.114443	0.085479	-1.338846	0.1851
INF(-1)	0.082833	0.290841	0.284805	0.7767
Y	-0.002584	0.247795	-0.010428	0.9917
REF	-0.028724	0.012853	-2.234779	0.0288
PFY*PFID	-1.286991	0.729997	-1.763007	0.0825
FISFY	-0.368378	0.505778	-0.728339	0.4689
ICB	-0.064415	0.105036	-0.613265	0.5418
LIBOR	-0.374573	0.232073	-1.614029	0.1112

R-squared	0.648050	Mean dependent var	0.161961
Adjusted R-squared	0.600773	S.D. dependent var	0.119262
S.E. of regression	0.075355	Akaike info criterion	-2.212579
Sum squared resid	0.380454	Schwarz criterion	-1.908189
Log likelihood	95.18429	F-statistic	13.70754
Durbin-Watson stat	1.981854	Prob(F-statistic)	0.000000

Table B. 14 Time Series Results Mexico (cont.) :

Treasury Bills:

6 months:

Dependent Variable: IP06MX
Method: Least Squares
Date: 04/06/10 Time: 02:26
Sample(adjusted): 1991:3 2009:4
Included observations: 69
Excluded observations: 5 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.124050	0.041553	2.985326	0.0041
IP06MX(-1)	0.497393	0.158274	3.142604	0.0026
IP06MX(-4)	-0.192994	0.147077	-1.312198	0.1945
INF(-1)	0.243492	0.172429	1.412126	0.1632
Y	-0.180615	0.254119	-0.710751	0.4800
REF	-0.005846	0.061162	-0.095582	0.9242
PFY*PFID	-1.247904	0.435895	-2.862853	0.0058
FISFY	-0.091298	1.215461	-0.075114	0.9404
ICB	0.078614	0.203574	0.386171	0.7008
LIBOR	-0.060673	0.496906	-0.122102	0.9032

R-squared	0.728712	Mean dependent var	0.149514
Adjusted R-squared	0.687329	S.D. dependent var	0.105961
S.E. of regression	0.059250	Akaike info criterion	-2.680810
Sum squared resid	0.207124	Schwarz criterion	-2.357027
Log likelihood	102.4879	F-statistic	17.60903
Durbin-Watson stat	2.049890	Prob(F-statistic)	0.000000

Table B. 14 Time Series Results Mexico (cont.) :

Treasury Bills:

12 months:

Dependent Variable: IP12MX
Method: Least Squares
Date: 04/06/10 Time: 02:27
Sample(adjusted): 1991:4 2009:4
Included observations: 62
Excluded observations: 11 after adjusting endpoints
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.070659	0.028727	2.459634	0.0173
IP12MX(-1)	1.085299	0.403334	2.690817	0.0096
IP12MX(-4)	-0.316287	0.226105	-1.398845	0.1678
INF(-1)	-0.092519	0.304010	-0.304330	0.7621
Y	-0.248465	0.400056	-0.621074	0.5373
REF	-0.004780	0.011138	-0.429148	0.6696
PFY*PFID	-0.871166	0.447070	-1.948611	0.0567
FISFY	-0.116633	0.607294	-0.192054	0.8484
ICB	0.020089	0.072504	0.277066	0.7828
LIBOR	0.273498	0.384955	0.710468	0.4806

R-squared	0.662510	Mean dependent var	0.127282
Adjusted R-squared	0.604099	S.D. dependent var	0.074760
S.E. of regression	0.047040	Akaike info criterion	-3.128961
Sum squared resid	0.115062	Schwarz criterion	-2.785875
Log likelihood	106.9978	F-statistic	11.34209
Durbin-Watson stat	1.143378	Prob(F-statistic)	0.000000

Table B. 15 Time Series Results Colombia:

3 months CD

Dependent Variable: IBCO
Method: Least Squares
Date: 04/13/10 Time: 13:33
Sample(adjusted): 1989:1 2009:3
Included observations: 83 after adjusting endpoints
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.028204	0.016910	-1.667889	0.0997
IBCO(-1)	0.174174	0.115863	1.503267	0.1372
IBCO(-4)	-0.076347	0.035399	-2.156784	0.0344
ICB	0.768798	0.122683	6.266558	0.0000
INF(-1)	-0.010639	0.071486	-0.148826	0.8821
Y*YD	-0.103673	0.080817	-1.282814	0.2037
REF	-0.001554	0.004409	-0.352475	0.7255
PFY*PFD	0.044420	0.115456	0.384735	0.7016
FISY*FISD	0.017373	0.011873	1.463269	0.1478
LIBOR	0.321158	0.106192	3.024328	0.0035
FINDUM	0.040596	0.033095	1.226647	0.2240
FINDUM*PFY*PFD	-2.323333	1.563690	-1.485802	0.1418

R-squared	0.989658	Mean dependent var	0.200904
Adjusted R-squared	0.988056	S.D. dependent var	0.117137
S.E. of regression	0.012802	Akaike info criterion	-5.745450
Sum squared resid	0.011636	Schwarz criterion	-5.395739
Log likelihood	250.4362	F-statistic	617.6495
Durbin-Watson stat	1.063212	Prob(F-statistic)	0.000000

Table B. 15 Time Series Results Colombia (cont.):

3 months CD

Dependent Variable: IBCO
Method: Least Squares
Date: 04/13/10 Time: 13:34
Sample(adjusted): 1995:1 2009:3
Included observations: 59 after adjusting endpoints
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.021986	0.017071	-1.287928	0.2039
IBCO(-1)	0.223397	0.116771	1.913123	0.0617
IBCO(-4)	-0.066954	0.031075	-2.154625	0.0362
ICB	0.725344	0.124683	5.817506	0.0000
INF(-1)	0.055335	0.096601	0.572819	0.5694
Y*YD	-0.041541	0.080359	-0.516945	0.6076
PFY*PFD	0.121539	0.102430	1.186554	0.2412
FISY*FISD	-0.001638	0.010106	-0.162069	0.8719
LIBOR	-0.109628	0.098575	-1.112128	0.2716
FINDUM	0.059186	0.033778	1.752209	0.0861
PFY*PFD*FINDUM	-2.925634	1.573180	-1.859694	0.0691

R-squared	0.993899	Mean dependent var	0.153102
Adjusted R-squared	0.992628	S.D. dependent var	0.101492
S.E. of regression	0.008714	Akaike info criterion	-6.481264
Sum squared resid	0.003645	Schwarz criterion	-6.093926
Log likelihood	202.1973	F-statistic	782.0112
Durbin-Watson stat	1.000048	Prob(F-statistic)	0.000000

Set of Tables B. 16 Panel Data Regressions

Panel Data Results (As of 04/20/2010)

Estimations by Pooled OLS, Fixed Effects, GLS-Cross Section & GLS-SUR:

a. PF Investments as % GDP
b. PF Investments in Logs of MM Pesos

Tables B. 17i Panel Data Regressions: Pooled OLS

Dependent Variable: I?
Method: Pooled Least Squares
Date: 04/20/10 Time: 00:52
Sample(adjusted): 1994:2 2009:4
Included observations: 63 after adjusting endpoints
Number of cross-sections used: 8
Total panel (unbalanced) observations: 336

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.063253	0.017637	3.586303	0.0004
I?(-1)	0.827807	0.039417	21.00131	0.0000
I?(-4)	-0.033261	0.034871	-0.953830	0.3409
ICB?	0.011894	0.020204	0.588710	0.5565
INF?(-1)	0.072714	0.026344	2.760207	0.0061
Y?	0.083407	0.040264	2.071503	0.0391
LOG(PFN?)	-0.001502	0.000658	-2.283781	0.0230
FIS?	8.85E-09	2.75E-08	0.322079	0.7476
LIBOR	0.002798	0.007791	0.359126	0.7197
@TREND	-0.000521	0.000164	-3.179938	0.0016

R-squared	0.913043	Mean dependent var	0.099648
Adjusted R-squared	0.910642	S.D. dependent var	0.076214
S.E. of regression	0.022783	Sum squared resid	0.169208
Log likelihood	798.9842	F-statistic	380.3314
Durbin-Watson stat	1.526170	Prob(F-statistic)	0.000000

Tables B. 16i Panel Data Regressions: Pooled OLS (cont.)

Dependent Variable: I?
Method: Pooled Least Squares
Date: 04/20/10 Time: 00:51
Sample(adjusted): 1994:2 2009:4
Included observations: 63 after adjusting endpoints
Number of cross-sections used: 8
Total panel (unbalanced) observations: 336
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.063253	0.020539	3.079710	0.0022
I?(-1)	0.827807	0.067054	12.34544	0.0000
I?(-4)	-0.033261	0.047307	-0.703098	0.4825
ICB?	0.011894	0.046952	0.253325	0.8002
INF?(-1)	0.072714	0.039802	1.826920	0.0686
Y?	0.083407	0.052823	1.578999	0.1153
LOG(PFN?)	-0.001502	0.000673	-2.231801	0.0263
FIS?	8.85E-09	1.66E-08	0.533764	0.5939
LIBOR	0.002798	0.006876	0.406869	0.6844
@TREND	-0.000521	0.000197	-2.644971	0.0086

R-squared	0.913043	Mean dependent var	0.099648
Adjusted R-squared	0.910642	S.D. dependent var	0.076214
S.E. of regression	0.022783	Sum squared resid	0.169208
Log likelihood	798.9842	F-statistic	380.3314
Durbin-Watson stat	1.526170	Prob(F-statistic)	0.000000

Tables B. 16i Panel Data Regressions: Pooled OLS (cont.)

Dependent Variable: I?
Method: Pooled Least Squares
Date: 04/20/10 Time: 00:53
Sample(adjusted): 1994:2 2009:4
Included observations: 63 after adjusting endpoints
Number of cross-sections used: 8
Total panel (unbalanced) observations: 336

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.038632	0.012400	3.115439	0.0020
I?(-1)	0.835755	0.038937	21.46453	0.0000
I?(-4)	-0.035105	0.035268	-0.995374	0.3203
ICB?	0.003886	0.019885	0.195441	0.8452
INF?(-1)	0.082588	0.026051	3.170230	0.0017
Y?	0.096064	0.042119	2.280754	0.0232
PFY?	-0.093999	0.052734	-1.782512	0.0756
FISY?	-0.000219	0.001099	-0.199475	0.8420
LIBOR	0.002024	0.006925	0.292240	0.7703
@TREND	-0.000379	0.000157	-2.409387	0.0165

R-squared	0.912722	Mean dependent var	0.099648
Adjusted R-squared	0.910313	S.D. dependent var	0.076214
S.E. of regression	0.022824	Sum squared resid	0.169832
Log likelihood	798.3660	F-statistic	378.8013
Durbin-Watson stat	1.534346	Prob(F-statistic)	0.000000

Tables B. 16i Panel Data Regressions: Pooled OLS (cont.)

Dependent Variable: I?
Method: Pooled Least Squares
Date: 04/20/10 Time: 00:53
Sample(adjusted): 1994:2 2009:4
Included observations: 63 after adjusting endpoints
Number of cross-sections used: 8
Total panel (unbalanced) observations: 336
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.038632	0.013383	2.886582	0.0042
I?(-1)	0.835755	0.066487	12.57017	0.0000
I?(-4)	-0.035105	0.047045	-0.746196	0.4561
ICB?	0.003886	0.048039	0.080899	0.9356
INF?(-1)	0.082588	0.041138	2.007590	0.0455
Y?	0.096064	0.057000	1.685339	0.0929
PFY?	-0.093999	0.040619	-2.314181	0.0213
FISY?	-0.000219	0.000457	-0.479408	0.6320
LIBOR	0.002024	0.006334	0.319535	0.7495
@TREND	-0.000379	0.000173	-2.187770	0.0294

R-squared	0.912722	Mean dependent var	0.099648
Adjusted R-squared	0.910313	S.D. dependent var	0.076214
S.E. of regression	0.022824	Sum squared resid	0.169832
Log likelihood	798.3660	F-statistic	378.8013
Durbin-Watson stat	1.534346	Prob(F-statistic)	0.000000

Tables B. 18ii Panel Data Regressions: Fixed Effects

Dependent Variable: I?
Method: Pooled Least Squares
Date: 04/20/10 Time: 00:56
Sample(adjusted): 1994:2 2009:4
Included observations: 63 after adjusting endpoints
Number of cross-sections used: 8
Total panel (unbalanced) observations: 336

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I?(-1)	0.753888	0.040284	18.71454	0.0000
I?(-4)	-0.041212	0.035206	-1.170616	0.2426
ICB?	0.007539	0.022855	0.329843	0.7417
INF?(-1)	0.082600	0.025644	3.221059	0.0014
Y?	0.114437	0.041029	2.789164	0.0056
LOG(PFN?)	-0.010640	0.002278	-4.671670	0.0000
FIS?	-1.17E-08	2.72E-08	-0.429815	0.6676
LIBOR	-0.002079	0.007701	-0.269974	0.7874
@TREND	3.89E-05	0.000248	0.157253	0.8751
Fixed Effects				
_DR--C	0.116311			
_1MX--C	0.153112			
_3MX--C	0.153975			
_6MX--C	0.153139			
_12MX--C	0.153330			
_1PE--C	0.175855			
_2PE--C	0.184209			
_CO--C	0.194215			

R-squared	0.921592	Mean dependent var	0.099648
Adjusted R-squared	0.917659	S.D. dependent var	0.076214
S.E. of regression	0.021870	Sum squared resid	0.152574
Log likelihood	816.3696	F-statistic	234.3408
Durbin-Watson stat	1.529895	Prob(F-statistic)	0.000000

Tables B. 16ii Panel Data Regressions: Fixed Effects (cont.)

Dependent Variable: I?
Method: Pooled Least Squares
Date: 04/20/10 Time: 00:56
Sample(adjusted): 1994:2 2009:4
Included observations: 63 after adjusting endpoints
Number of cross-sections used: 8
Total panel (unbalanced) observations: 336
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I?(-1)	0.753888	0.066103	11.40471	0.0000
I?(-4)	-0.041212	0.043147	-0.955157	0.3402
ICB?	0.007539	0.052317	0.144095	0.8855
INF?(-1)	0.082600	0.035375	2.334991	0.0202
Y?	0.114437	0.050569	2.262985	0.0243
LOG(PFN?)	-0.010640	0.003929	-2.707771	0.0071
FIS?	-1.17E-08	1.35E-08	-0.862538	0.3890
LIBOR	-0.002079	0.006153	-0.337909	0.7357
@TREND	3.89E-05	0.000266	0.146587	0.8836
Fixed Effects				
_DR—C	0.116311			
_1MX—C	0.153112			
_3MX—C	0.153975			
_6MX—C	0.153139			
_12MX--C	0.153330			
_1PE—C	0.175855			
_2PE—C	0.184209			
_CO—C	0.194215			

R-squared	0.921592	Mean dependent var	0.099648
Adjusted R-squared	0.917659	S.D. dependent var	0.076214
S.E. of regression	0.021870	Sum squared resid	0.152574
Log likelihood	816.3696	F-statistic	234.3408
Durbin-Watson stat	1.529895	Prob(F-statistic)	0.000000

Tables B. 16ii Panel Data Regressions: Fixed Effects (cont.)

Dependent Variable: I?
Method: Pooled Least Squares
Date: 04/20/10 Time: 00:55
Sample(adjusted): 1994:2 2009:4
Included observations: 63 after adjusting endpoints
Number of cross-sections used: 8
Total panel (unbalanced) observations: 336

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I?(-1)	0.782308	0.040769	19.18864	0.0000
I?(-4)	-0.061532	0.035945	-1.711857	0.0879
ICB?	0.013203	0.023652	0.558229	0.5771
INF?(-1)	0.106021	0.026796	3.956537	0.0001
Y?	0.145575	0.044237	3.290810	0.0011
PFY?	-0.224288	0.103927	-2.158138	0.0317
FISY?	0.000820	0.001130	0.725364	0.4688
LIBOR	0.005938	0.006936	0.856043	0.3926
@TREND	-0.000271	0.000283	-0.956746	0.3394
Fixed Effects				
_DR—C	0.027179			
_1MX—C	0.044134			
_3MX—C	0.044974			
_6MX—C	0.044258			
_12MX--C	0.044452			
_1PE—C	0.035284			
_2PE—C	0.043500			
_CO—C	0.053915			

R-squared	0.917434	Mean dependent var	0.099648
Adjusted R-squared	0.913293	S.D. dependent var	0.076214
S.E. of regression	0.022442	Sum squared resid	0.160664
Log likelihood	807.6897	F-statistic	221.5369
Durbin-Watson stat	1.526766	Prob(F-statistic)	0.000000

Tables B. 16ii Panel Data Regressions: Fixed Effects (cont.)

Dependent Variable: I?
Method: Pooled Least Squares
Date: 04/20/10 Time: 00:55
Sample(adjusted): 1994:2 2009:4
Included observations: 63 after adjusting endpoints
Number of cross-sections used: 8
Total panel (unbalanced) observations: 336
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I?(-1)	0.782308	0.065786	11.89176	0.0000
I?(-4)	-0.061532	0.044873	-1.371255	0.1713
ICB?	0.013203	0.052732	0.250385	0.8025
INF?(-1)	0.106021	0.040970	2.587737	0.0101
Y?	0.145575	0.056971	2.555234	0.0111
PFY?	-0.224288	0.074020	-3.030118	0.0026
FISY?	0.000820	0.000531	1.544600	0.1234
LIBOR	0.005938	0.006638	0.894420	0.3718
@TREND	-0.000271	0.000234	-1.161119	0.2465
Fixed Effects				
_DR--C	0.027179			
_1MX--C	0.044134			
_3MX--C	0.044974			
_6MX--C	0.044258			
_12MX--C	0.044452			
_1PE--C	0.035284			
_2PE--C	0.043500			
_CO--C	0.053915			

R-squared	0.917434	Mean dependent var	0.099648
Adjusted R-squared	0.913293	S.D. dependent var	0.076214
S.E. of regression	0.022442	Sum squared resid	0.160664
Log likelihood	807.6897	F-statistic	221.5369
Durbin-Watson stat	1.526766	Prob(F-statistic)	0.000000

Tables B. 19iii Panel Data Regressions: Feasible GLS-Cross Section

Dependent Variable: I?
Method: GLS (Cross Section Weights)
Date: 04/20/10 Time: 01:00
Sample: 1994:2 2009:4
Included observations: 63
Number of cross-sections used: 8
Total panel (unbalanced) observations: 336
One-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I?(-1)	0.828955	0.037494	22.10911	0.0000
I?(-4)	-0.049172	0.032032	-1.535088	0.1258
ICB?	0.057757	0.017605	3.280666	0.0012
INF?(-1)	0.046389	0.019345	2.397979	0.0171
Y?	0.100137	0.029776	3.363002	0.0009
(PFY?)	-0.067183	0.056906	-1.180592	0.2386
FISY?	0.000344	0.000524	0.657519	0.5113
LIBOR	0.001302	0.004941	0.263561	0.7923
@TREND	-0.000254	0.000183	-1.389561	0.1656
Fixed Effects				
_DR--C	0.016221			
_1MX--C	0.030419			
_3MX--C	0.030966			
_6MX--C	0.030233			
_12MX--C	0.030340			
_1PE--C	0.017392			
_2PE--C	0.023819			
_CO--C	0.031785			

Weighted Statistics			
R-squared	0.938527	Mean dependent var	0.118381
Adjusted R-squared	0.935443	S.D. dependent var	0.084460
S.E. of regression	0.021460	Sum squared resid	0.146903
Log likelihood	902.5669	F-statistic	304.3904
Durbin-Watson stat	1.661967	Prob(F-statistic)	0.000000

Unweighted Statistics			
R-squared	0.914513	Mean dependent var	0.099648
Adjusted R-squared	0.910226	S.D. dependent var	0.076214
S.E. of regression	0.022836	Sum squared resid	0.166348
Durbin-Watson stat	1.571910		

Tables B. 16iii Panel Data Regressions: Feasible GLS-Cross Section (cont.)

Dependent Variable: I?
Method: GLS (Cross Section Weights)
Date: 04/20/10 Time: 01:03
Sample: 1994:2 2009:4
Included observations: 63
Number of cross-sections used: 8
Total panel (unbalanced) observations: 336
One-step weighting matrix
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I?(-1)	0.828955	0.055621	14.90371	0.0000
I?(-4)	-0.049172	0.038167	-1.288334	0.1986
ICB?	0.057757	0.027995	2.063101	0.0399
INF?(-1)	0.046389	0.019599	2.366909	0.0185
Y?	0.100137	0.027717	3.612856	0.0004
PFY?	-0.067183	0.023108	-2.907372	0.0039
FISY?	0.000344	0.000146	2.353016	0.0192
LIBOR	0.001302	0.003849	0.338315	0.7353
@TREND	-0.000254	0.000119	-2.129477	0.0340
Fixed Effects				
_DR--C	0.016221			
_1MX--C	0.030419			
_3MX--C	0.030966			
_6MX--C	0.030233			
_12MX--C	0.030340			
_1PE--C	0.017392			
_2PE--C	0.023819			
_CO--C	0.031785			

Weighted Statistics

R-squared	0.938527	Mean dependent var	0.118381
Adjusted R-squared	0.935443	S.D. dependent var	0.084460
S.E. of regression	0.021460	Sum squared resid	0.146903
Log likelihood	902.5669	F-statistic	304.3904
Durbin-Watson stat	1.661967	Prob(F-statistic)	0.000000

Unweighted Statistics

R-squared	0.914513	Mean dependent var	0.099648
Adjusted R-squared	0.910226	S.D. dependent var	0.076214
S.E. of regression	0.022836	Sum squared resid	0.166348
Durbin-Watson stat	1.571910		

Tables B. 16iii Panel Data Regressions: Feasible GLS-Cross Section (cont.)

Dependent Variable: I?
Method: GLS (Cross Section Weights)
Date: 04/20/10 Time: 01:00
Sample: 1994:2 2009:4
Included observations: 63
Number of cross-sections used: 8
Total panel (unbalanced) observations: 336
One-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I?(-1)	0.805093	0.036929	21.80121	0.0000
I?(-4)	-0.048302	0.030975	-1.559413	0.1199
ICB?	0.055483	0.016010	3.465571	0.0006
INF?(-1)	0.032731	0.017181	1.905070	0.0577
Y?	0.092016	0.025860	3.558296	0.0004
LOG(PFN?)	-0.008658	0.002133	-4.059229	0.0001
FIS?	-2.40E-08	1.80E-08	-1.330883	0.1842
LIBOR	-0.004336	0.005017	-0.864117	0.3882
@TREND	0.000127	0.000167	0.763713	0.4456
Fixed Effects				
_DR--C	0.082023			
_1MX--C	0.117904			
_3MX--C	0.118561			
_6MX--C	0.117867			
_12MX--C	0.118004			
_1PE--C	0.134788			
_2PE--C	0.141885			
_CO--C	0.147657			

Weighted Statistics			
R-squared	0.941691	Mean dependent var	0.120703
Adjusted R-squared	0.938766	S.D. dependent var	0.085162
S.E. of regression	0.021074	Sum squared resid	0.141669
Log likelihood	912.6530	F-statistic	321.9885
Durbin-Watson stat	1.661718	Prob(F-statistic)	0.000000

Unweighted Statistics			
R-squared	0.919156	Mean dependent var	0.099648
Adjusted R-squared	0.915102	S.D. dependent var	0.076214
S.E. of regression	0.022207	Sum squared resid	0.157312
Durbin-Watson stat	1.603360		

Tables B. 16iii Panel Data Regressions: Feasible GLS-Cross Section (cont.)

Dependent Variable: I?
Method: GLS (Cross Section Weights)
Date: 04/20/10 Time: 01:03
Sample: 1994:2 2009:4
Included observations: 63
Number of cross-sections used: 8
Total panel (unbalanced) observations: 336
One-step weighting matrix
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I?(-1)	0.805093	0.054561	14.75594	0.0000
I?(-4)	-0.048302	0.035726	-1.352035	0.1773
ICB?	0.055483	0.024068	2.305261	0.0218
INF?(-1)	0.032731	0.014705	2.225806	0.0267
Y?	0.092016	0.023333	3.943563	0.0001
LOG(PFN?)	-0.008658	0.002823	-3.066592	0.0024
FIS?	-2.40E-08	7.34E-09	-3.266780	0.0012
LIBOR	-0.004336	0.003093	-1.401829	0.1619
@TREND	0.000127	0.000150	0.846518	0.3979
Fixed Effects				
_DR--C	0.082023			
_1MX--C	0.117904			
_3MX--C	0.118561			
_6MX--C	0.117867			
_12MX--C	0.118004			
_1PE--C	0.134788			
_2PE--C	0.141885			
_CO--C	0.147657			

Weighted Statistics			
R-squared	0.941691	Mean dependent var	0.120703
Adjusted R-squared	0.938766	S.D. dependent var	0.085162
S.E. of regression	0.021074	Sum squared resid	0.141669
Log likelihood	912.6530	F-statistic	321.9885
Durbin-Watson stat	1.661718	Prob(F-statistic)	0.000000

Unweighted Statistics			
R-squared	0.919156	Mean dependent var	0.099648
Adjusted R-squared	0.915102	S.D. dependent var	0.076214
S.E. of regression	0.022207	Sum squared resid	0.157312
Durbin-Watson stat	1.603360		

Tables B. 20iii Panel Data Regressions: Feasible GLS- SUR

Dependent Variable: I?
Method: Seemingly Unrelated Regression
Date: 04/20/10 Time: 00:59
Sample: 1994:2 2009:4
Included observations: 63
Number of cross-sections used: 8
Total panel (unbalanced) observations: 336
One-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I?(-1)	0.769596	0.039676	19.39709	0.0000
I?(-4)	-0.010959	0.033843	-0.323814	0.7463
ICB?	0.046364	0.019851	2.335592	0.0201
INF?(-1)	0.064883	0.021027	3.085760	0.0022
Y?	0.081654	0.035915	2.273501	0.0237
(PFY?)	-0.026842	0.066225	-0.405311	0.6855
FISY?	0.000350	0.000592	0.591576	0.5546
LIBOR	-0.001588	0.006111	-0.259842	0.7952
@TREND	-0.000394	0.000225	-1.750992	0.0809
Fixed Effects				
_DR--C	0.029054			
_1MX--C	0.039750			
_3MX--C	0.040369			
_6MX--C	0.039405			
_12MX--C	0.039516			
_1PE--C	0.023898			
_2PE--C	0.030759			
_CO--C	0.041162			
Weighted Statistics				
Unweighted Statistics				
R-squared	0.914936	Mean dependent var	0.099648	
Adjusted R-squared	0.910670	S.D. dependent var	0.076214	
S.E. of regression	0.022779	Sum squared resid	0.165524	
Durbin-Watson stat	1.468531			

Tables B. 16iii Panel Data Regressions: Feasible GLS- SUR (cont.)

Dependent Variable: I?
Method: Seemingly Unrelated Regression
Date: 04/20/10 Time: 00:58
Sample: 1994:2 2009:4
Included observations: 63
Number of cross-sections used: 8
Total panel (unbalanced) observations: 336
One-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I?(-1)	0.749470	0.038235	19.60150	0.0000
I?(-4)	-0.015661	0.032055	-0.488572	0.6255
ICB?	0.041071	0.016836	2.439516	0.0153
INF?(-1)	0.049252	0.017851	2.759042	0.0061
Y?	0.091647	0.028922	3.168798	0.0017
LOG(PFN?)	-0.009193	0.002143	-4.290318	0.0000
FIS?	-3.35E-08	2.29E-08	-1.459660	0.1454
LIBOR	-0.009117	0.005423	-1.681216	0.0937
@TREND	0.000182	0.000175	1.041173	0.2986
Fixed Effects				
_DR--C	0.087646			
_1MX--C	0.124209			
_3MX--C	0.124950			
_6MX--C	0.123853			
_12MX--C	0.124000			
_1PE--C	0.141555			
_2PE--C	0.149166			
_CO--C	0.158078			
Weighted Statistics				
Unweighted Statistics				
R-squared	0.920079	Mean dependent var		0.099648
Adjusted R-squared	0.916070	S.D. dependent var		0.076214
S.E. of regression	0.022080	Sum squared resid		0.155517
Durbin-Watson stat	1.513349			

B.2. Figures

Figure B. 1 Portfolio Diversification

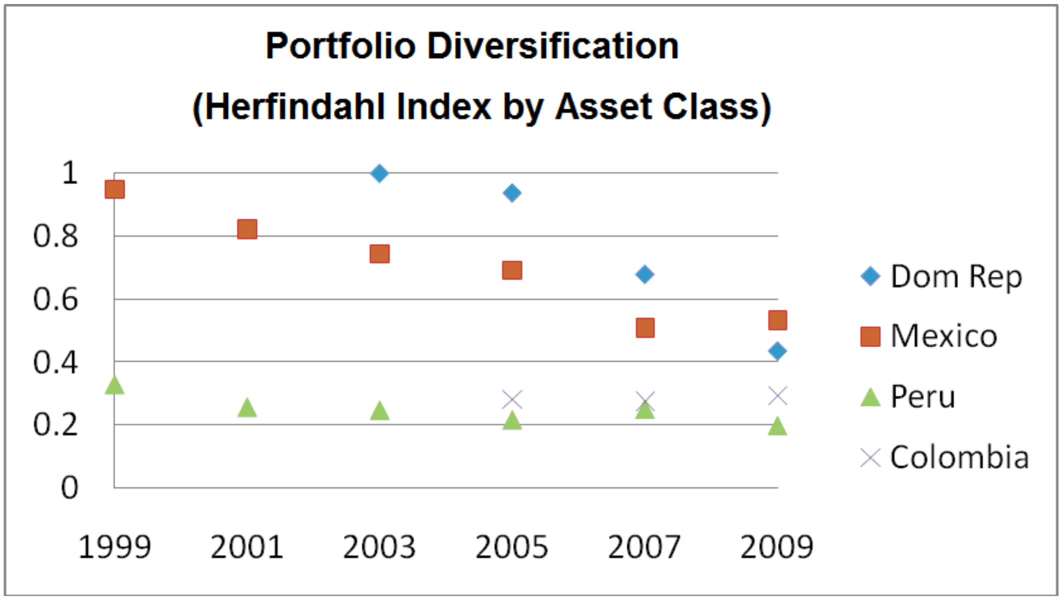


Figure B. 2 Diversification of Portfolio

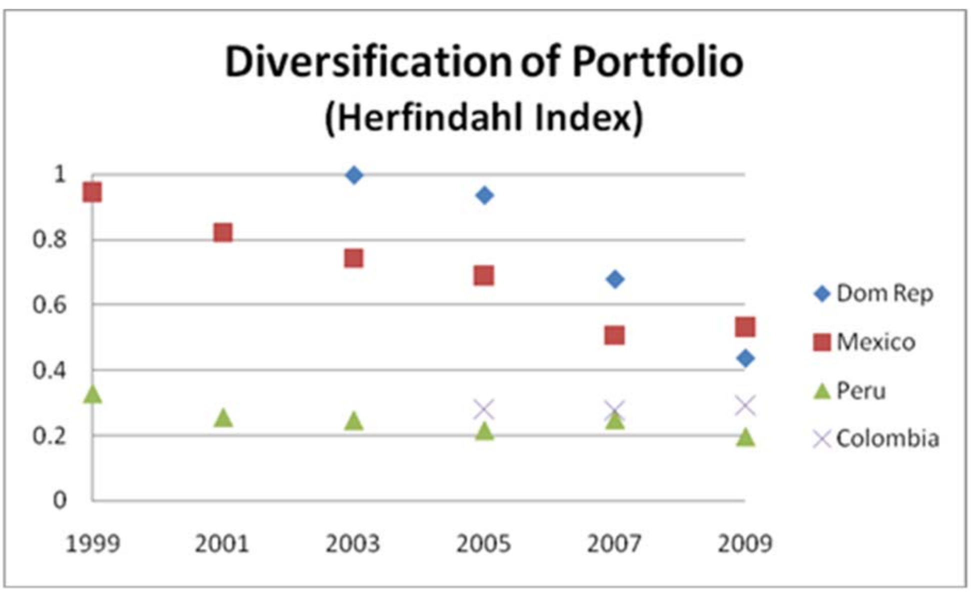
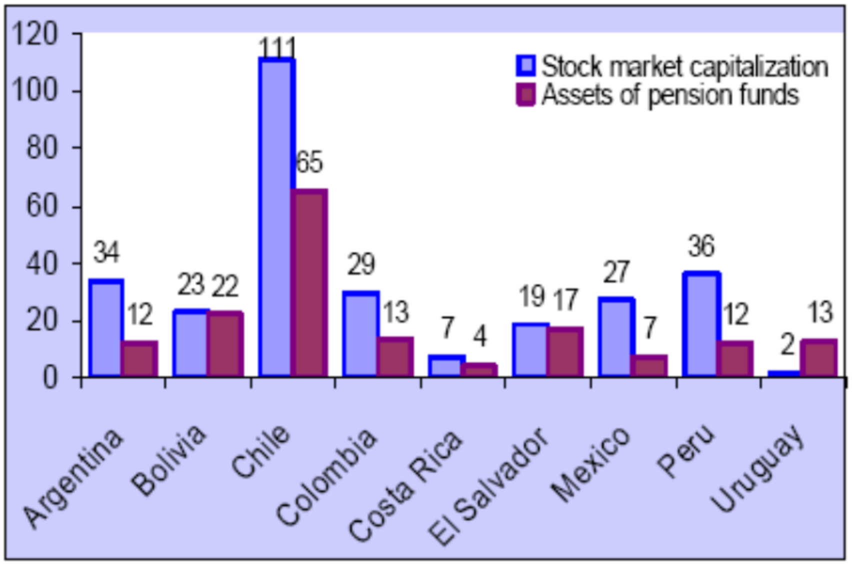


Figure B. 3 Selected LAC countries Pension fund assets and stock market capitalization as shares of GDP (percent)



Sources: AIOS and the World Bank Financial Development Database.

From Dayoub & Lasagabaster (2008)

Figure B. 4 Interest Rate and Pension Fund Investments Dynamics in Dominican Republic

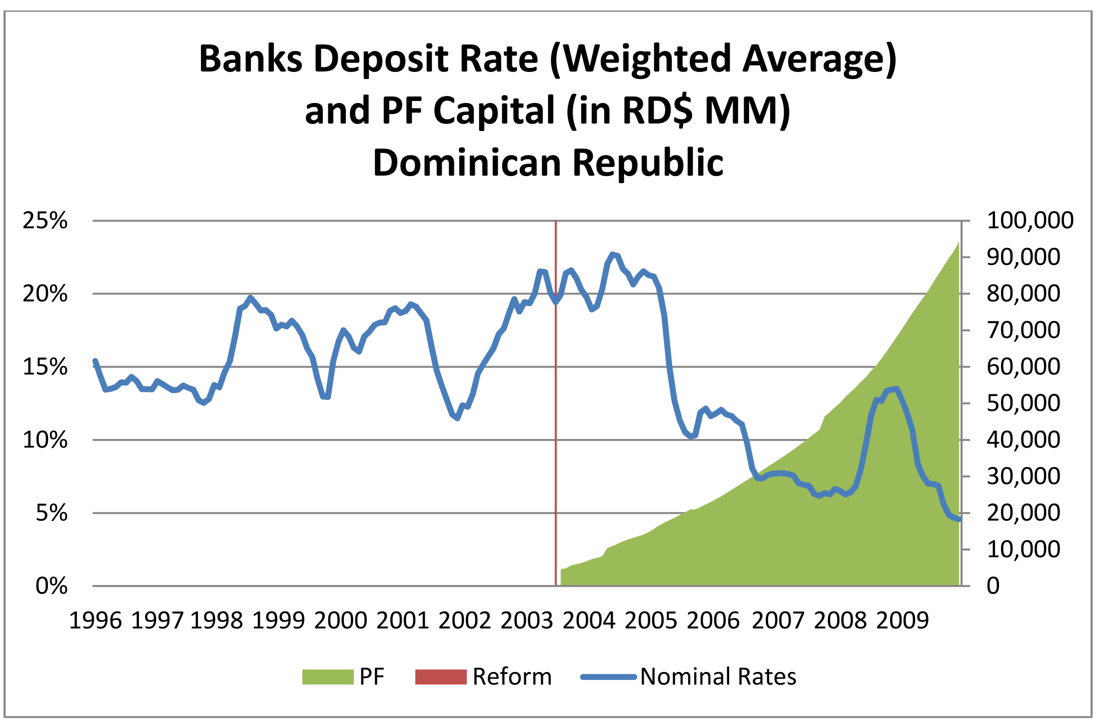


Figure B. 5 Treasury Real Yields (CETES) & and Pension Fund Investments in Mexico

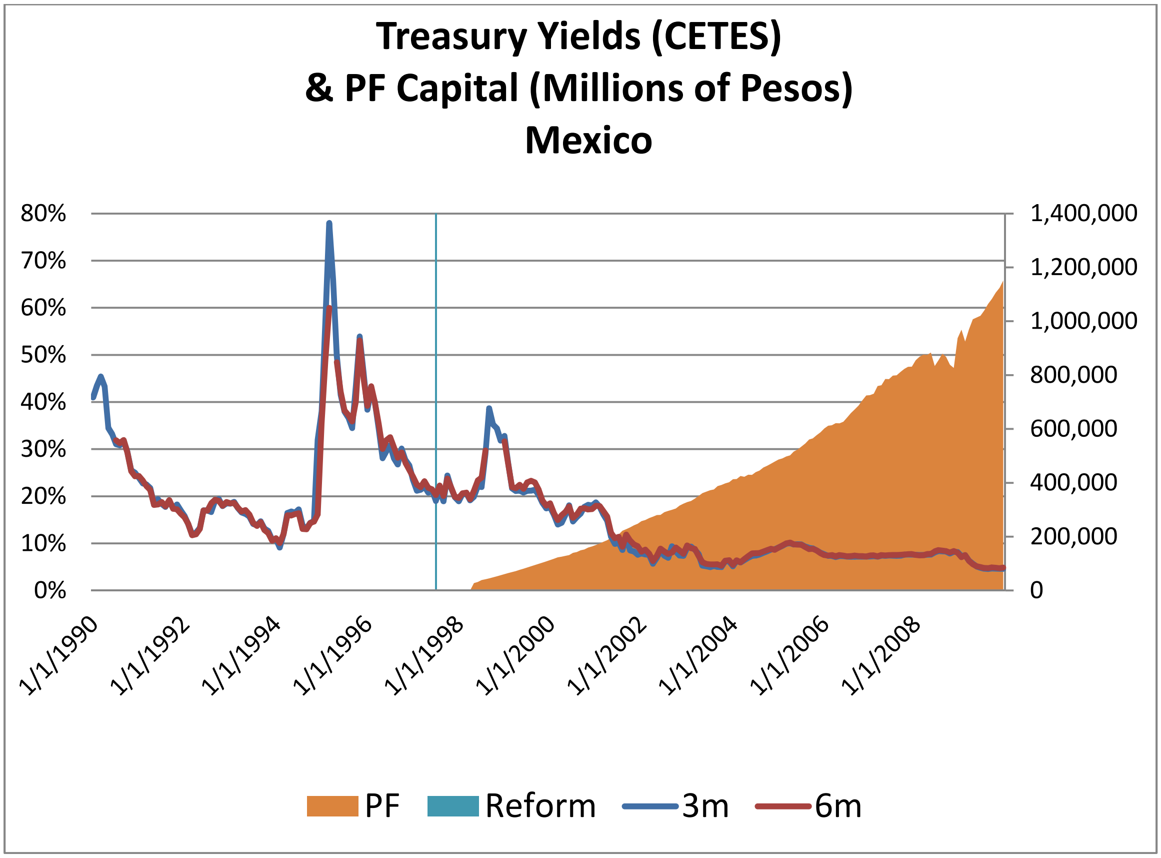


Figure B. 6 Interest Rate and Pension Fund Investments Dynamics in Colombia

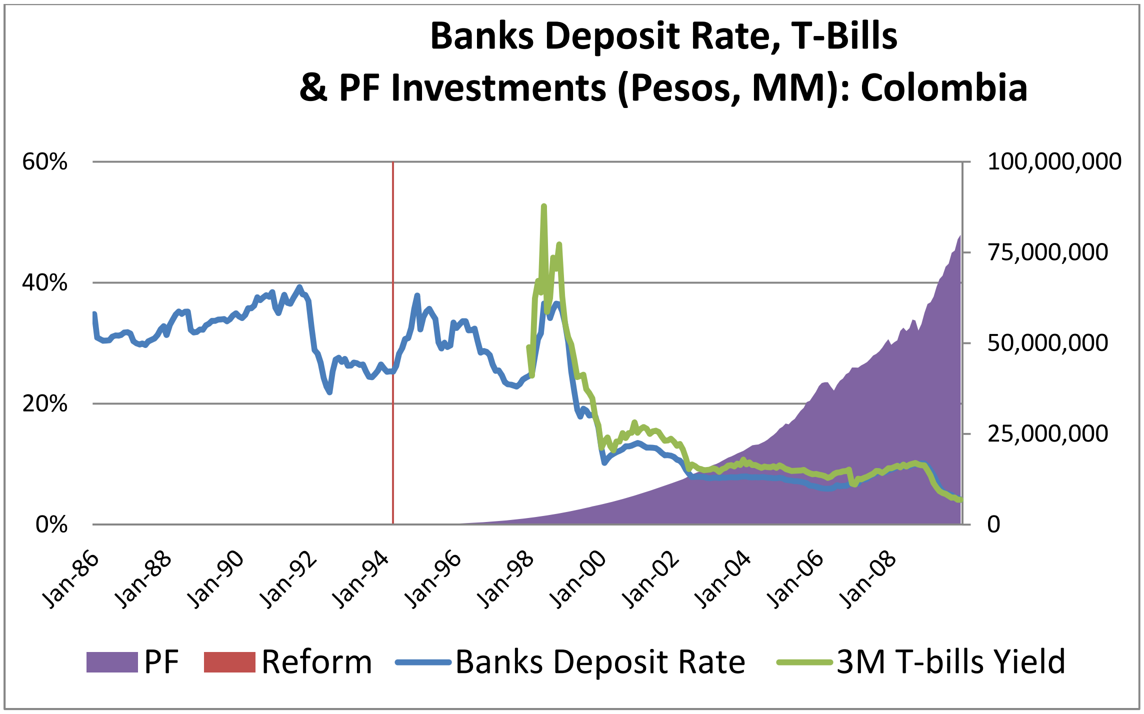


Figure B. 7 Interest Rate and Pension Fund Investments Dynamics in Peru

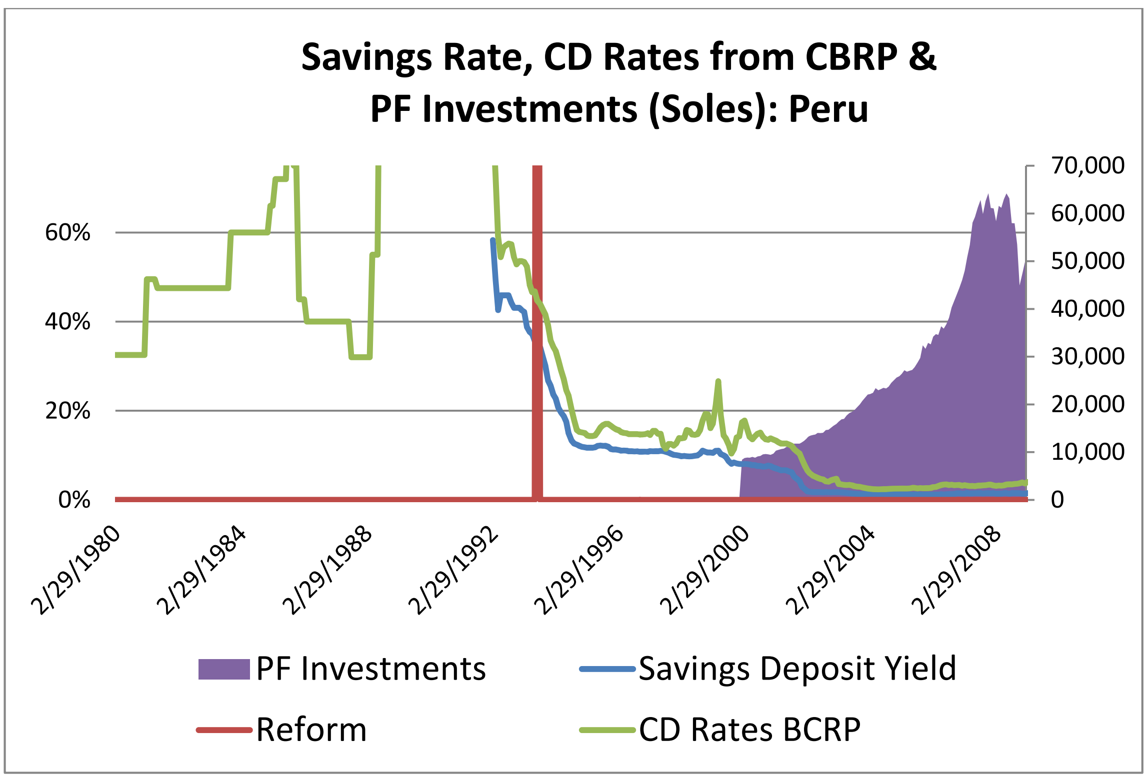
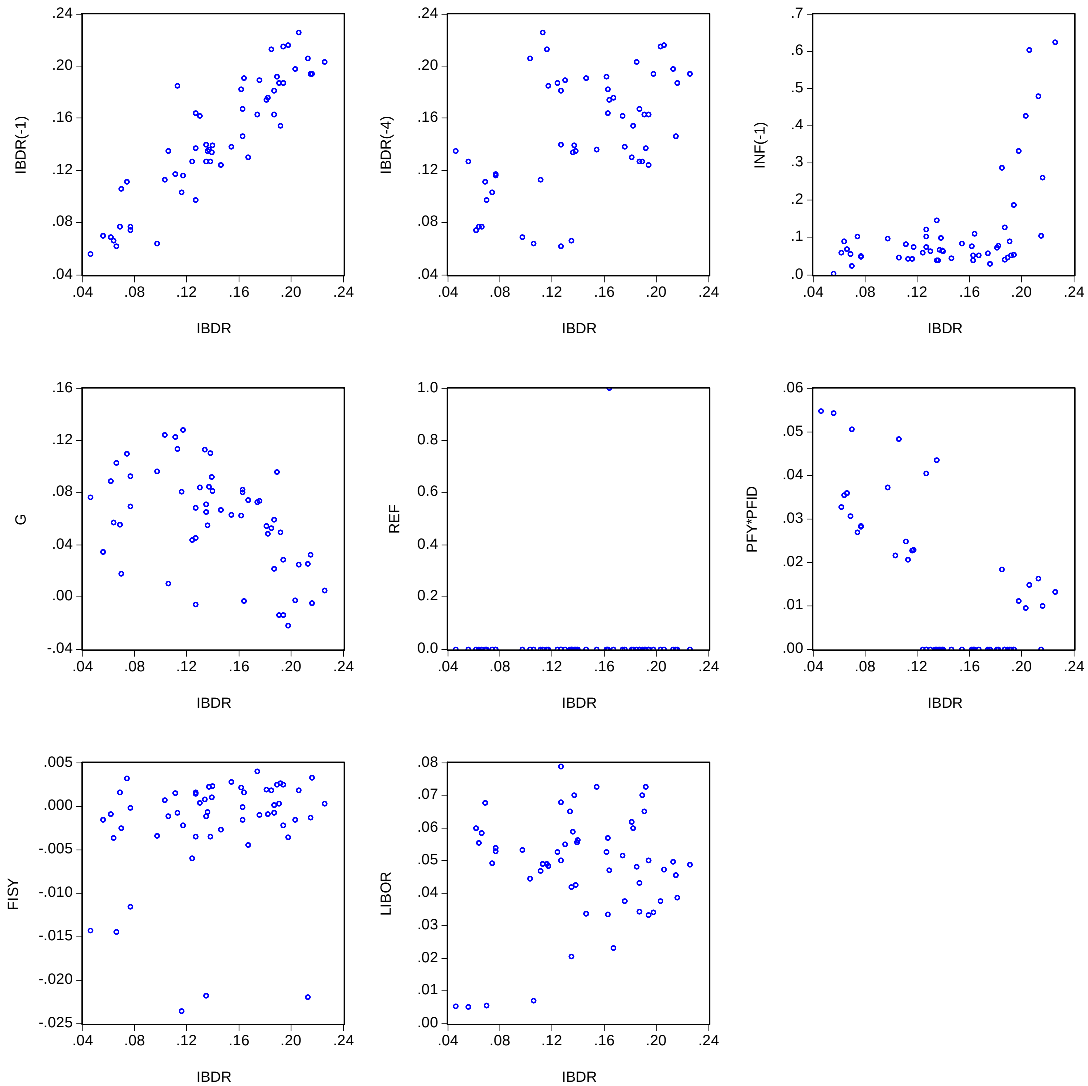


Figure B. 8 Interest Rate Dynamics in Dominican Republic Scatter Plot:



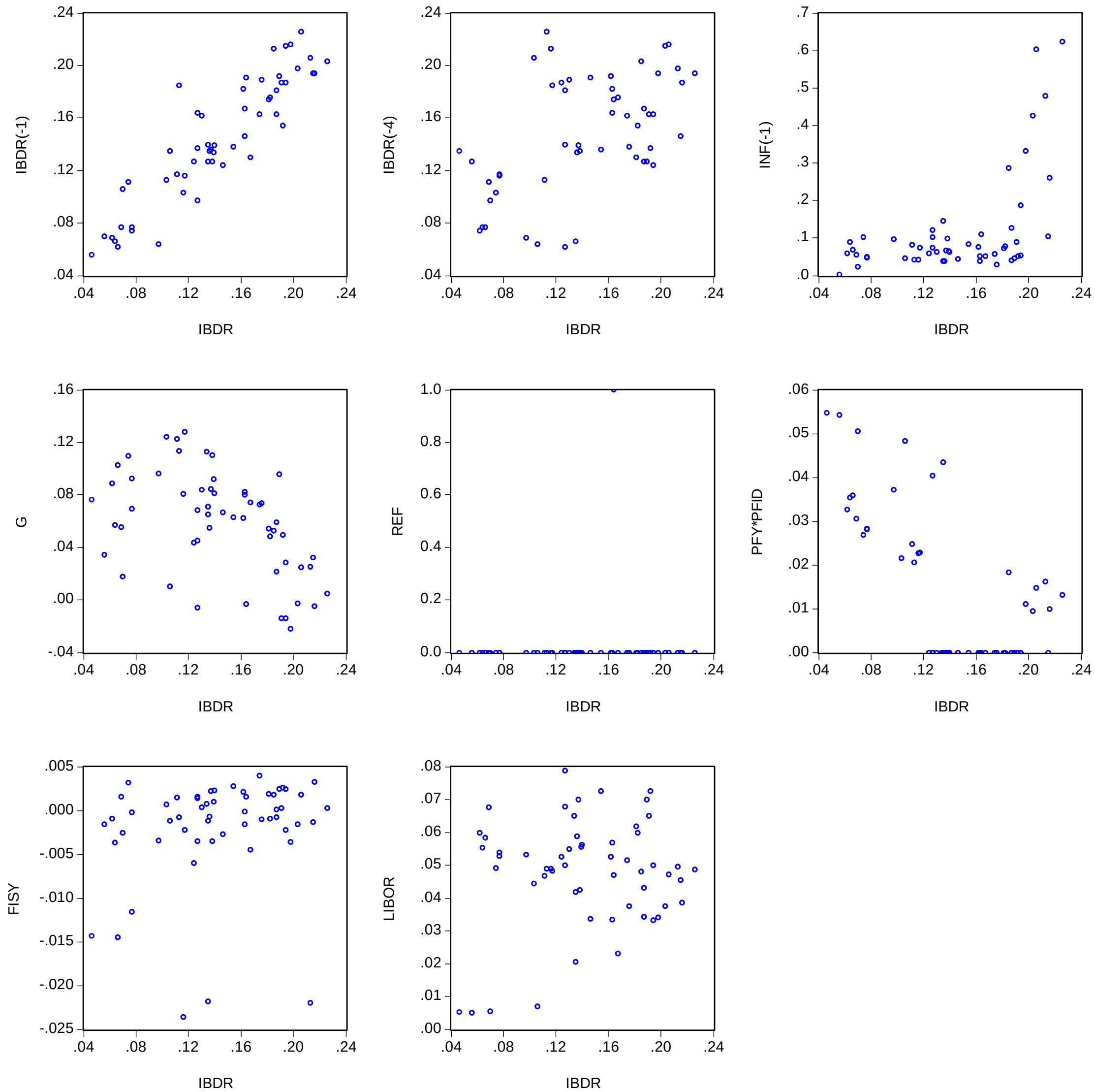
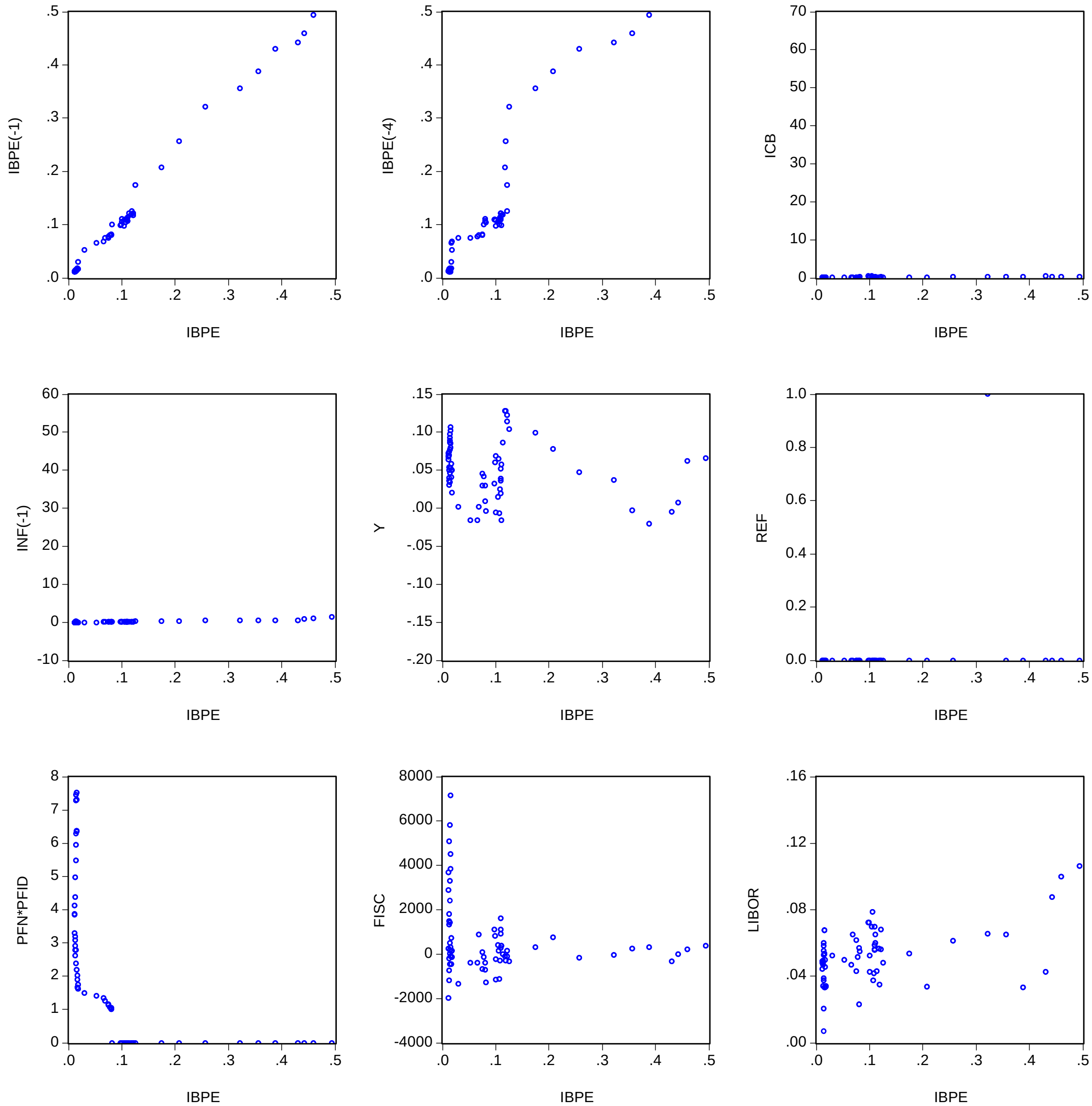
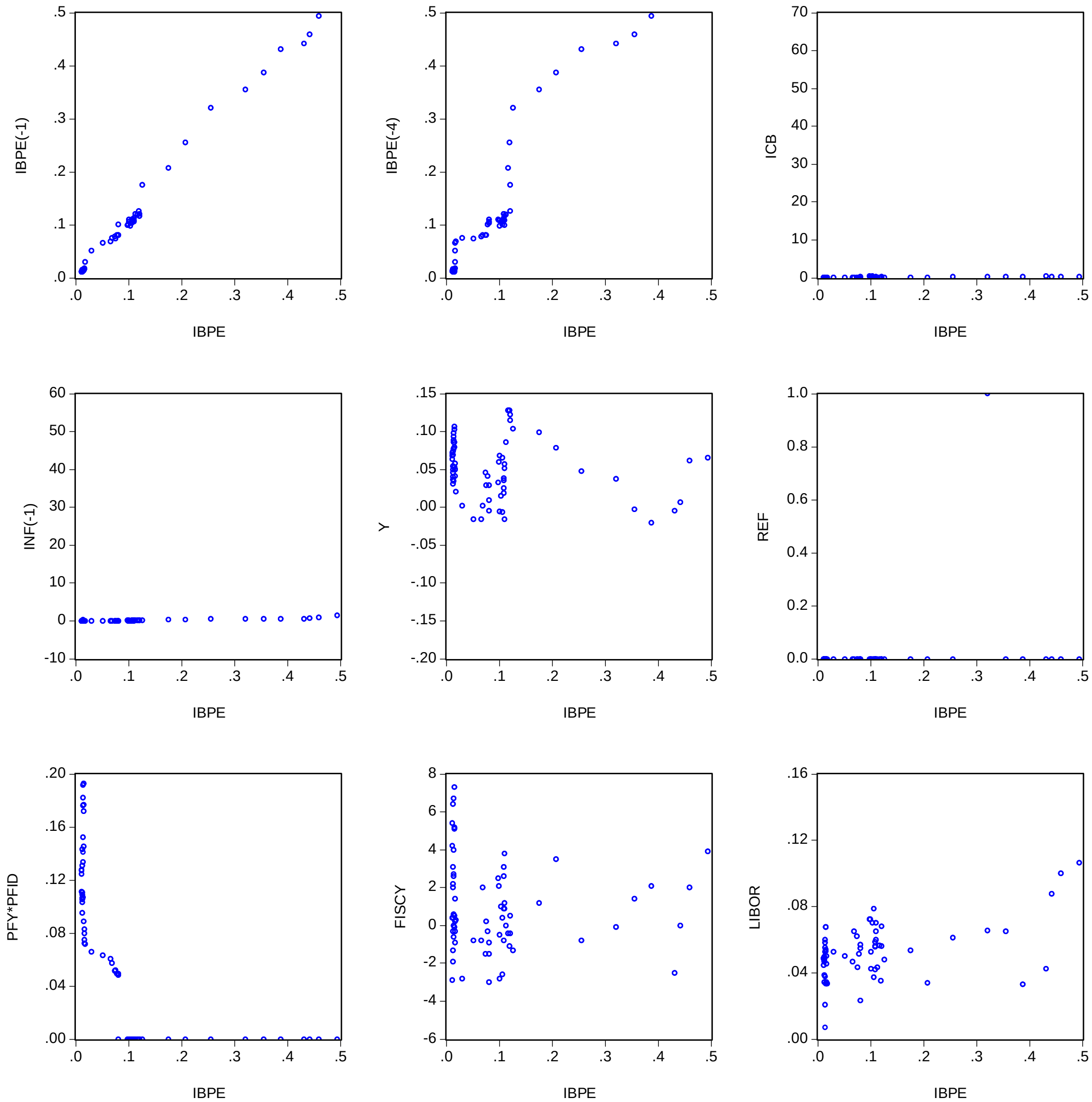
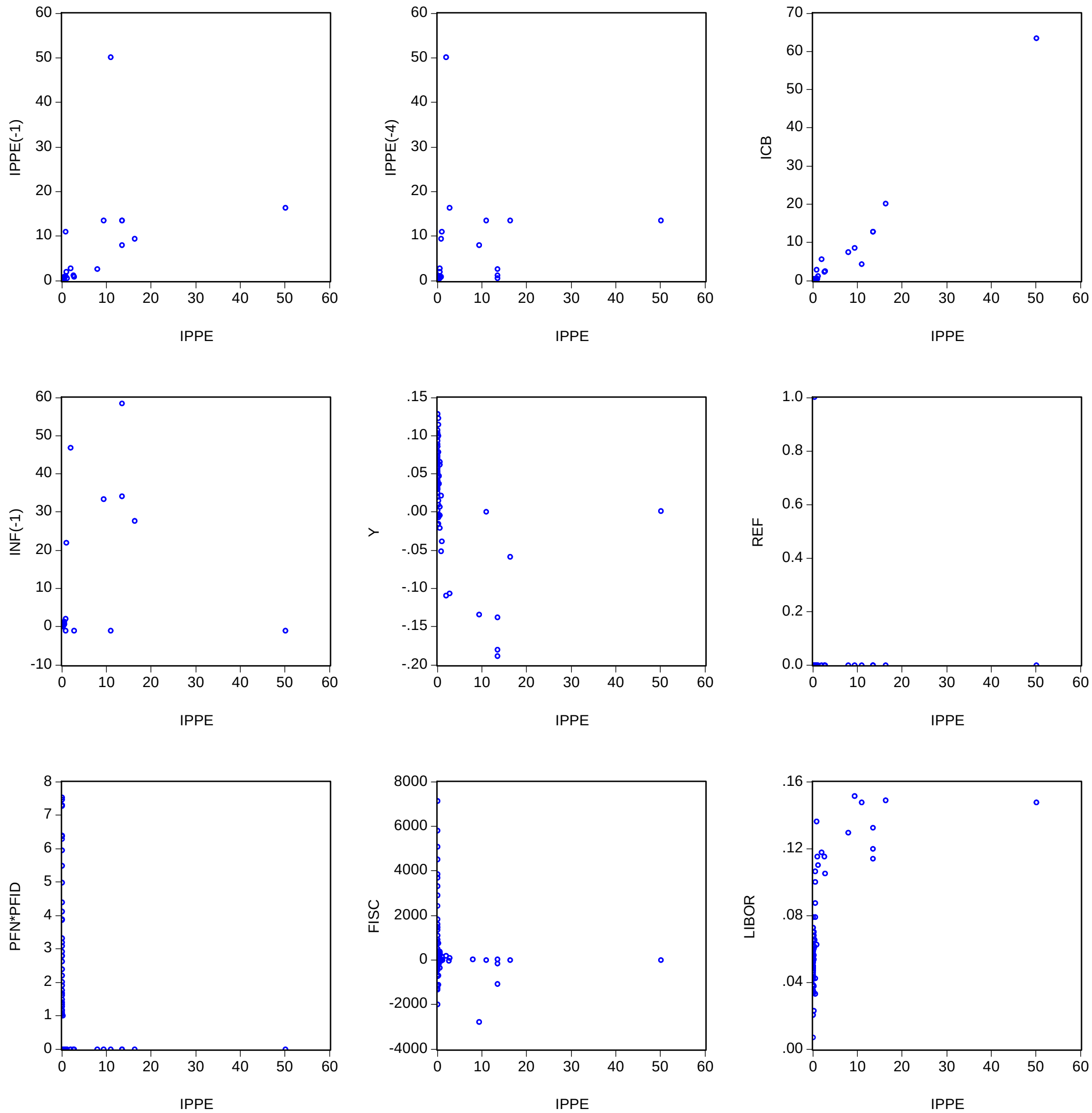

IBDR(-1)
IBDR(-4)
INF(-1)
G
REF
PFY*PFID
FISY
LIBOR
IBDR
.04 .08 .12 .16 .20 .24

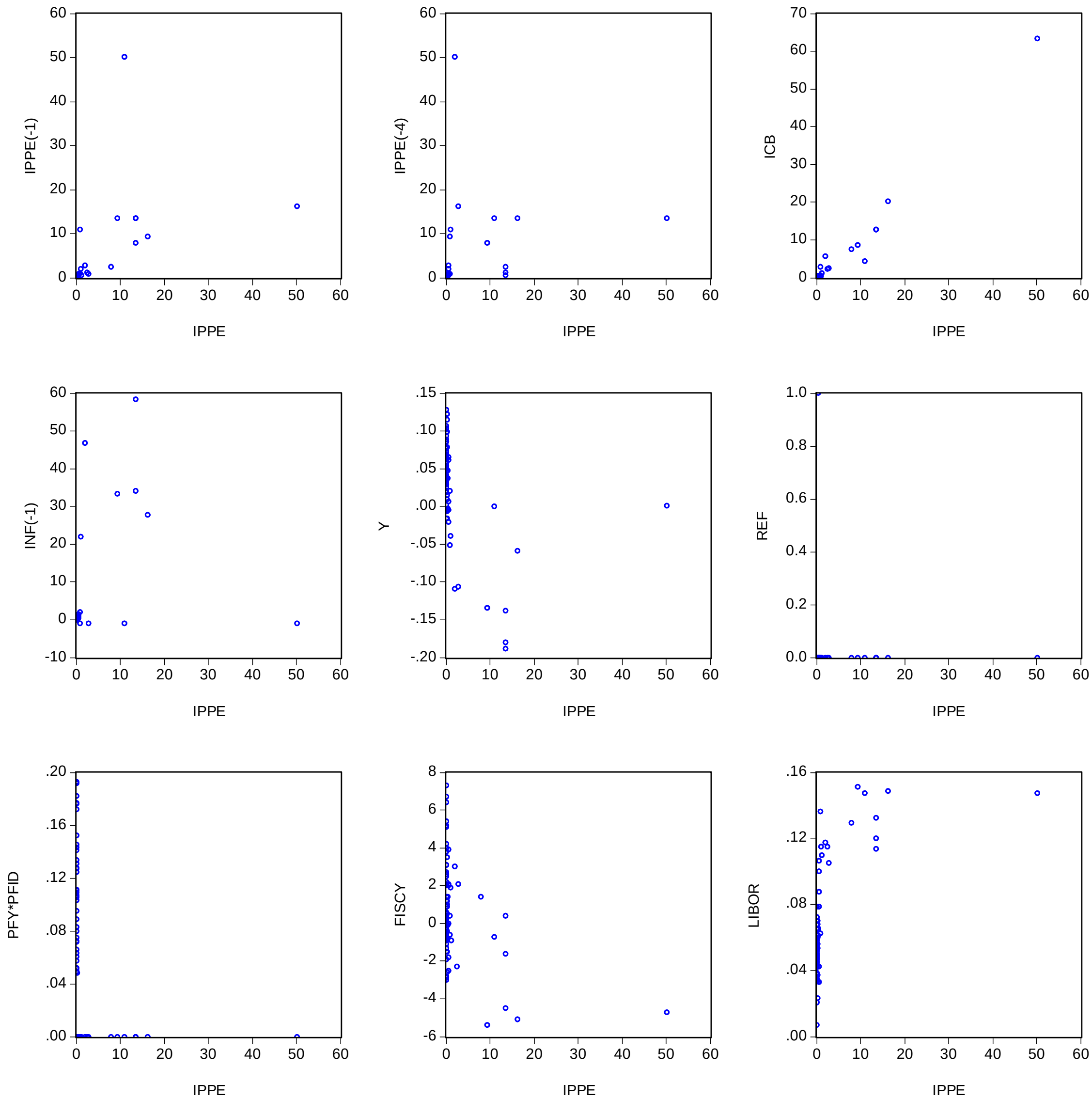
Figure B. 9 Interest Rate Dynamics Peru Scatter Plot




IBPE(-1)
IBPE
IBPE(-4)
IBPE
ICB
IBPE
INF(-1)
IBPE
Y
IBPE
REF
IBPE
PFY*PFID
IBPE
FISCY
IBPE
LIBOR
IBPE



IPPE(-1)
IPPE(-4)
ICB
INF(-1)
Y
REF
PFN*PFID
FISC
LIBOR
IPPE


IPPE(-1)
IPPE
IPPE(-4)
IPPE
ICB
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INF(-1)
IPPE
Y
IPPE
REF
IPPE
PFY*PFID
IPPE
FISCY
IPPE
LIBOR
IPPE

Appendix Chapter 4

C.1. Data and Descriptive Statistics

Variables

Variable	Description
DU03	Financial distress period: From 2003.1 to 2004.2.
DU90	Macroeconomic distress period and reforms: 1990.1 to 1991.3.
DUFER	Nominal exchange rate regime periods: 1980.1 to 1984.4 and 1989.1 to 1990.2.
ERGR	Annual percentage rate of nominal exchange rate (For the years under fixed exchange rate regime, data on black market exchange rate is used.) .
GR	Annual real GDP growth rate
GRHP	Real GDP trend computed using Hodrich-Prescott filter.
GRQT	Real GDP trend computed using quadratic trend estimation.
INFI	USA Wholesale Price Index annual Inflation.
INFRD	Dominican Republic Consumer Price Index annual inflation.
M	Ration M1/Nominal GDP: Liquidity Ratio
VINFRD	Inflation Volatility Proxy: (Inflation - Sample Average)^2

We usa quarterly data from 1980:1 to 2006:1. Whenever we use growth rates, these are annual rates. Using ADF tests, we cannot reject at the 5% significance level that every variable in the sample is stationary.

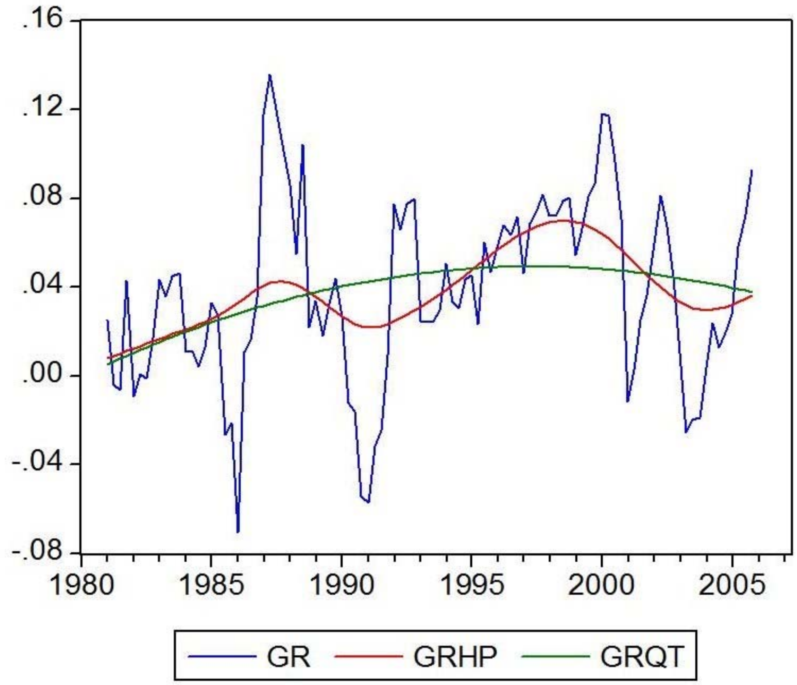
ADF Integration Test

	ADF (P-value)		ADF (P-value)
INFRD	0.0001	INFRD*(GR-GRHP)	0.0029
INFRD^2	0.0040	INFRD*(GR-GRQT)	0.0022
VINFRD	0.0017	ERGR	0.0000
INFRD*VINFRD	0.0030	INFI	0.0009
GR-GRHP	0.0000	M	0.0274
GR-GRQT	0.0077	(GR-GRHP)^2	0.0000
		(GR-GRQT)^2	0.0001

We reduce the potential simultaneity bias including as explanatory variables lagged values of the variables.

Output gap estimations follow two different approaches: one following the Hodrick-Prescott filter and the other estimating a quadratic trend regression. Given that in this second case we estimate output gap with a regression (first stage), Phillips Curve and monetary policy rule (second stage)estimations follow the generated regressor econometric literature. Pagan (1984) shows that using OLS without taking proper consideration of the generated regressors could yield inefficient and inconsisten estimators, which arise due to the potential correlation from the second stage residuals with the dependent variable of the first stage. With the purpose of obtaining consistency, we include only one lagged value of the generated variable, although we could have expected annual lagged values to be significant too.

Growth Rate and Trend



The difference between the convex Phillips curve and the other Phillip curves estimations is that the former include the residual of the first stage (the output gap) in two different forms: with exponential 1 and in quadratic form. This is the reason why we estimate the convez Phillips Curve in a system with the auxiliary regression (the first stage) using GMM as explained by Newey and McFadden (1994). Lucas and Ball, Mankiw and Romer cases and their related monetary policy rules can be estimated using a two steps approach and OLS. Results should be consistent and efficient.

Regressions follow an ADL(4,4,3) format. In the cases we find evidence of autocorrelation (using the LM-Breusch Godfrey with 4 lags) and heteroskedasticity (using White test without crossed terms and Engle's ARCH test with 4 lags) we use

Newey-West HAC variance estimator. If we only find evidence of heteroskedasticity we use White variance estimator.

C.2. Methods Used

C.2.1 Shares Explained by Nonlinearities

To calculate the shares corresponding to the nonlinearities we use the folling indicator. If:

$$y_t = \alpha f(x_t) + \beta z_t \ . \tag{28}$$

The share of y_t that we attribute to z_t is $\frac{|\beta z_t|}{|\beta z_t|+|\alpha f(x_t)|}$, where each term is in absolute values. In the same fashion, the share associated to the nonlinear component is $\frac{|\alpha f(x_t)|}{|\beta z_t|+|\alpha f(x_t)|}$.

The reason we use absolute values is because we can capture the relevance of each term, with an indicator that is always between 0 and 1 disregarding if the dependent variable has a value of zero or negative. For example, if $y = 0$ because $\alpha f(x) = 2$ and $\beta z = -2$ and we analyze $\frac{|\beta z_t|}{|y_t|}$ it won't be informative, while our indicator reveals that in this case, 50% of the zero observed in y is associated to z_t, or $\frac{|\beta z_t|}{|\beta z_t|+|\alpha f(x_t)|} = \frac{|2|}{|2|+|-2|} = \frac{2}{4} = 0.5$. This is how we calculate the results summarized in tables 1 and 2 and in figures 3 and 4. Note that the extension to a case with more than two explanatory variables is trivial.

C.2.2 Sacrifice Ratio

Recall that the generic Phillips curve takes the form of:

$$\pi_t = f(y_{t-1}) + \alpha_1 \pi_{t-1} + \alpha_2 \pi_{t-4} + ov + \xi_t \quad (29)$$

Where ov means other variables. In this regression we capture long and short run effects. For the short run sacrifice ratio we just need to find $\frac{\partial \pi_t}{\partial y_t} \equiv f'(y_{t-1})_{lr}$. By definition, in our case, the sacrifice ratio is $\frac{1\%}{f'(y_{t-1})_{lr}}$.

The sacrifice ratio that we calculate and report is the long run sacrifice ratio, taking into account the effects of inflation inertia. Based on $\pi_t = \pi_{t-j}$, for every j, the regression takes the long run form:

$$[1 - \alpha_1 - \alpha_2]\pi_t = f(y_{t-1})_{cp} + ov + \xi_t \quad (30)$$

We can calculate $f'(y_{t-1})_{lr} \equiv \frac{\partial \pi_t}{\partial y_{t-1}} \equiv \frac{f'(y_{t-1})_{sr}}{1-\alpha_1-\alpha_2}$. Finally, the sacrifice ratio is $\frac{1\%}{f'(y_{t-1})_{lr}} = \frac{1-\alpha_1-\alpha_2}{f'(y_{t-1})_{sr}}$. Note that the denominator of this expression refers to the marginal effect.

C.2.3 Forecasts

To compare the forecasts precision we use the root mean squared error, the mean absolute percentage error and the theil inequality coefficient.

- Root Mean Squared Error (RMSE): The squared root of the residuals divided over the total number of observations.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n} (\hat{y}_t - y_t)^2}{n}}$$

- Mean Absolute Percentage Error (MAPE): Thee average of the division of the absolute value of the residual and the dependent variable.

$$MAPE = \frac{\sum_{i=1}^{n} |y_t - \hat{y}_t|}{n}$$

- Theil Inequality: An indicator of goodness of fit. It takes values between zero and one, where zero means perfect adjustment.

$$TheilInequalityCoef = \frac{RMSE}{\sqrt{\frac{\sum_{i=1}^{n} (y_t)^2}{n}} + \sqrt{\frac{\sum_{i=1}^{n} (\hat{y}_t)^2}{n}}}$$

The next table shows these values for the regressions we studied.

Forecasts Summary

Modelos HP	Linear	Convex	BMR	Lucas
RMSE*	3.07	3.16	2.92	2.88
MAPE	6.30	6.89	6.54	6.52
Theil Inequality*	4.30	4.42	4.08	4.03

*Multiplied by 100. The lower the value, the more acurate the forecast

Modelos QT	Linear	Convex	BMR	Lucas
RMSE*	3.16	3.17	3.00	2.97
MAPE	6.37	6.83	6.60	6.64
Theil Inequality*	4.42	4.43	4.21	4.16

C.3. Tables

Table C. 1 Share of Inflation Explaind by Nonlinearities

HP Models	Convex	BMR	Lucas
Mean	0.01	0.05	0.02
Median	0.00	0.03	0.01
Max	0.09	0.17	0.18
Min	0.00	0.00	0.00
Variation Coef	1.53	0.92	1.42

QT Models	Convex	BMR	Lucas
Mean	0.12	0.06	0.02
Median	0.10	0.04	0.01
Max	0.35	0.19	0.19
Min	0.00	0.00	0.00
Variation Coef	0.75	0.81	1.36

Table C. 2 Shares of Liquitidy Explainde by Nonlinearities

HP Models	Convex	BMR	Lucas
Mean	0.02	0.03	0.01
Median	0.01	0.00	0.00
Max	0.18	0.22	0.14
Min	0.00	0.00	0.00
Variation Coef	1.60	1.67	2.69

QT Models	Convex	BMR	Lucas
Mean	0.02	0.03	0.01
Median	0.01	0.00	0.00
Max	0.19	0.21	0.13
Min	0.00	0.00	0.00
Variation Coef	1.58	1.67	2.69

Table C. 3 Davidson and Mackinnon (1981) Test: Phillips Curve

HP				
	BMR	CON	LU	LI
BMR	x	NH*	AH	NH*
CON	NH*	x	AH	NH*
LU	NH*	NH*	x	NH*
LI	AH	AH	AH	x

* significant at 1%,** significant at 10%

QT				
	BMR	CON	LU	LI
BMR	x	NH*	NH*	NH*
CON	NH*	x	NH*	NH*
LU	NH*	NH**	x	NH*
LI	AH	AH	AH	x

* significant at 1%,** significant at 10%

Table C. 4 Davidson and Mackinnon (1981) Test: Monetary Policy

HP				
	BMR	CON	LU	LI
BMR	x	AH	NH*	NH*
CON	NH*	x	NH*	NH*
LU	NH*	AH	x	NH*
LI	AH	AH	AH	x

* significant at 1%,** significant at 10%

QT				
	BMR	CON	LU	LI
BMR	x	AH	NH*	NH*
CON	NH*	x	NH*	NH*
LU	NH*	AH	x	NH*
LI	AH	AH	AH	x

* significant at 1%,** significant at 10%

Table C. 5 Sacrifice Ratios

HP Models	Lineal	BMR	Lucas
Mean	0.62	0.60	1.21
Median	0.62	1.25	3.20
Last observation	0.62	1.88	3.03

QT Models	Lineal	BMR	Lucas
Mean	0.64	0.56	1.47
Median	0.64	1.16	3.59
Last observation	0.64	1.74	2.93

Table C. 6 Instrument Variables List

MODEL	INSTRUMENTS
PhC and Monetary Policy: Linear	INFRD(-1), INFRD(-4), GR(-1)-GRHP(-1), ERGR(-1), INFI(-1), DUFER, DU90, DU03, M(-1), M(-4), INFRD(-1)*(GR(-1)-GRHP(-1)), C, SF(-1)*INFRD(-1), SF(-1)*(GR(-1)-GRHP(-1))
PhC and Monetary Policy: Convex	INFRD(-1), INFRD(-4), GR(-1)-GRHP(-1), ERGR(-1), INFI(-1), DUFER, DU90, DU03, M(-1), M(-4), INFRD(-1)*(GR(-1)-GRHP(-1)), C, SF(-1)*INFRD(-1), SF(-1)*(GR(-1)-GRHP(-1)), SF(-1)*INFRD^2(-1)
PhC and Monetary Policy: Ball, Mankiw y Romer	INFRD(-1), INFRD(-4), INFRD(-1)^2, GR(-1)-GRHP(-1), ERGR(-1), INFI(-1), DUFER, DU90, DU03, M(-1,) M(-4), C, SF(-1)*INFRD(-1), SF(-1)*(GR(-1)-GRHP(-1)), SF(-1)*INFRD(-1)*(GR(-1)-GRHP(-1))
PhC and Monetary Policy: Lucas	INFRD(-1), INFRD(-4), VINFRD(-1), GR(-1)-GRHP(-1), ERGR(-1), INFI(-1), DUFER, DU90, DU03, M(-1), M(-4), C, SF(-1)*INFRD(-1), SF(-1)*(GR(-1)-GRHP(-1)), SF(-1)*INFRD(-1)*VINFRD(-1)
Quadratic Trend and Convex PhC	GR(-1), @TREND, @TREND^2, INFRD(-1), INFRD(-4), ERGR(-1), INFI(-1), INFI, DUFER, DU90, DU03, C

The moment condition for the GMM estimation takes the form $\frac{1}{t}\sum \upsilon_t inst_t$; where t is the sample size, υ is the residual of the Phillips Curve or Monetary Policy rule regression and inst is an instrument from the instrument list.

Table C. 7 Individual Regressions: Phillips Curve

Explained Variable: INFRD	Convex	Linear		Ball, Mankiw y Romer		Lucas	
OLS (Newey West HAC Correct	HP	HP	QT	HP	QT	HP	QT
Linear Variables							
C	0.0260	0.0243	0.0209	0.0238	0.0215	0.0212	0.0187
	0.016	*0.021*	*0.052*	*0.022*	*0.041*	*0.024*	*0.040*
INFRD(-1)	0.7847	0.7850	0.7816	0.8080	0.8163	0.8222	0.8238
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
INFRD(-4)	-0.1060	-0.1093	-0.0956	-0.1039	-0.0970	-0.1213	-0.1130
	0.013	*0.009*	*0.014*	*0.011*	*0.016*	*0.009*	*0.016*
GR(-1)-GRHP(-1)	0.5317	0.5199		-0.0298		0.2441	
	0.005	*0.004*		*0.909*		*0.113*	
GR(-1)-GRQT(-1)			0.4938		-0.1090		0.2152
			0.009		*0.652*		*0.184*
Nonlinear Variables Related to Economic Cycle							
(GR(-1)-GRHP(-1))^2	-2.2886						
	0.494						
INFRD(-1)*(GR(-1)-GRHP(-1))				2.8483			
				0.002			
INFRD(-1)*(GR(-1)-GRQT(-1))					2.9135		
					0.000		
VINFRD(-1)*(GR(-1)-GRHP(-1))						7.1000	
						0.000	
VINFRD(-1)*(GR(-1)-GRQT(-1))							6.1308
							0.000
Open Economy Variables							
ERGR(-1)	0.1196	0.1161	0.1183	0.1259	0.1298	0.1335	0.1371
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
INFI(-1)	0.1042	0.0922	0.1110	0.0900	0.1068	0.1196	0.1406
	0.556	*0.570*	*0.496*	*0.630*	*0.558*	*0.484*	*0.407*
Dummy Variables							
DUFER	0.0006	0.0033	0.0036	-0.0025	-0.0036	-0.0033	-0.0040
	0.967	*0.814*	*0.794*	*0.872*	*0.811*	*0.790*	*0.743*
DU90	0.1152	0.1134	0.1187	0.1499	0.1682	0.1601	0.1686
	0.024	*0.027*	*0.018*	*0.000*	*0.000*	*0.000*	*0.000*
DU03	0.0741	0.0744	0.0798	0.0746	0.0779	0.0520	0.0528
	0.021	*0.021*	*0.016*	*0.019*	*0.014*	*0.124*	*0.135*
Descriptive Statistics							
Adjusted R-squared	0.9003	0.9009	0.9007	0.9098	0.9135	0.9127	0.9142
S.E. of regression	0.0589	0.0587	0.0588	0.0560	0.0549	0.0551	0.0546
Log likelihood	146.5775	146.3177	146.2150	151.5909	153.6748	153.2341	154.1073
Akaike info criterion	-2.7316	-2.7464	-2.7443	-2.8318	-2.8735	-2.8647	-2.8821
Schwarz criterion	-2.4710	-2.5119	-2.5098	-2.5713	-2.6130	-2.6042	-2.6216

Table C. 8 Individual Regressions: Monetary Policy

Explained Variable: M	Convex		Linear		Ball, Mankiw y Romer		Lucas	
OLS (Newey West HAC Correction)	HP	QT	HP	QT	HP	QT	HP	QT
Linear Variables								
CONST	0.0833	0.0783	0.0537	0.0546	0.0629	0.0624	0.0681	0.0674
	0.180	*0.217*	*0.330*	*0.329*	*0.282*	*0.292*	*0.253*	*0.263*
INFRD(-1)	-0.1010	-0.0936	-0.0998	-0.1047	0.0418	0.0343	-0.0569	-0.0626
	0.038	*0.060*	*0.033*	*0.017*	*0.617*	*0.662*	*0.305*	*0.230*
INFRD(-4)	0.0843	0.0804	0.0749	0.0801	0.0641	0.0690	0.0652	0.0695
	0.015	*0.019*	*0.036*	*0.018*	*0.084*	*0.049*	*0.084*	*0.052*
GR(-1)-TREND(-1)	-0.0800	-0.1053	0.1626	0.1460	0.1802	0.1534	0.1595	0.1365
	0.705	*0.607*	*0.392*	*0.430*	*0.335*	*0.403*	*0.397*	*0.460*
M(-1)	-0.0100	0.0011	0.0617	0.0612	0.0305	0.0328	0.0295	0.0319
	0.835	*0.982*	*0.325*	*0.310*	*0.635*	*0.597*	*0.640*	*0.602*
M(-4)	0.8045	0.8065	0.8170	0.8124	0.8003	0.7976	0.8027	0.8004
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
Nonlinear Variables Related to Economic Cycle								
VINFRD(-1)*INFRD(-1)							-0.2396	-0.2320
							0.102	*0.126*
(INFRD(-1))^(2)					-0.2208	-0.2177		
					0.045	*0.048*		
INFRD(-1)*(GR(-1)-TREND(-1))	1.2968	1.2409						
	0.055	*0.046*						
Open Economy Variables								
ERGR(-1)	0.0009	0.0004	-0.0096	-0.0075	-0.0120	-0.0101	-0.0079	-0.0063
	0.964	*0.983*	*0.648*	*0.706*	*0.564*	*0.609*	*0.698*	*0.747*
INFI(-1)	-0.2955	-0.3002	-0.3243	-0.3238	-0.3367	-0.3351	-0.3183	-0.3185
	0.079	*0.080*	*0.080*	*0.088*	*0.059*	*0.067*	*0.082*	*0.090*
Non Linear Variables Related to Fiscal Policy								
FS(-1)*(GR(-1)-TREND(-1))	-39.2868	-31.1251	-6.0782	2.5962	-10.2930	-1.4207	-11.3258	-2.3543
	0.000	*0.002*	*0.724*	*0.876*	*0.566*	*0.933*	*0.505*	*0.886*
FS(-1)*INFRD(-1)	2.3649	2.3971	0.1909	0.7674	3.2370	3.2809	1.8040	2.1287
	0.297	*0.374*	*0.937*	*0.774*	*0.324*	*0.320*	*0.468*	*0.433*
FS(-1)*(GR(-1)-TREND(-1))*INFRD(-1)	124.0003	91.0454						
	0.051	*0.078*						
FS(-1)*(INFRD(-1))^(2)					-4.8536	-3.9603		
					0.564	*0.635*		
FS(-1)*INFRD(-1)*VINFRD(-1)							-8.2832	-7.4719
							0.442	*0.482*
Dummy Variables								
DUFER	-0.0048	-0.0041	0.0026	0.0026	-0.0016	-0.0013	-0.0016	-0.0013
	0.662	*0.708*	*0.797*	*0.801*	*0.886*	*0.907*	*0.882*	*0.906*
DU90	0.0327	0.0372	0.0021	0.0057	0.0154	0.0180	0.0169	0.0193
	0.004	*0.002*	*0.898*	*0.729*	*0.166*	*0.130*	*0.117*	*0.099*
DU03	0.0611	0.0607	0.0691	0.0728	0.0575	0.0615	0.0569	0.0606
	0.001	*0.002*	*0.005*	*0.007*	*0.009*	*0.013*	*0.011*	*0.015*
Descriptive Statistics								
Adjusted R-squared	0.6473	0.6448	0.5995	0.6001	0.6089	0.6079	0.6071	0.6060
S.E. of regression	0.0362	0.0363	0.0385	0.0385	0.0381	0.0381	0.0382	0.0382
Log likelihood	196.2922	195.9451	188.8373	188.9057	191.1756	191.0457	190.9535	190.8057
Akaike info criterion	-3.6625	-3.6555	-3.5523	-3.5537	-3.5591	-3.5565	-3.5546	-3.5516
Schwarz criterion	-3.2693	-3.2623	-3.2115	-3.2129	-3.1659	-3.1633	-3.1614	-3.1584

Table C. 9 System: Quadratic Trend and Convex Phillips Curve

Explained Variable: GRQT and INFRD

GMM-SYSTEM

Explained Variable: GRQT

Linear Variables	
C	0.0006
	0.934
TREND	0.0013
	0.000
Nonlinear Variable	
TREND^2	0.0000
	0.012
Descriptive Statistics	
Adjusted R-squared	0.060653
No. de Obs.	199
S.E. of regression	0.040189
J-Statistic	0.343433
Durbin-Watson stat	0.482667

Notice: GRQT=0.0006+0.0013*TREND+0.0000*TREND^2

Explained Variable: INFRD

Linear Variables	
C	-0.0267
	0.408
INFRD(-1)	0.8018
	0.000
INFRD(-4)	-0.0830
	0.034
GR(-1)-GRQT(-1)	0.9584
	0.209
Nonlinear Variables Related to Economic Cycle	
(GR(-1)-GRQT(-1))^2	-3.5084
	0.391
Open Economy Variables	
ERGR(-1)	0.0947
	0.000
INFI(-1)	0.2219
	0.194
Dummy Variables	
DUFER	-0.0169
	0.159
DU90	0.0622
	0.129
DU03	0.1514
	0.007
Descriptive Statistics	
Adjusted R-squared	0.892396
No. de Obs.	199
S.E. of regression	0.061181
J-Statistic	0.343433
Durbin-Watson stat	1.153037

Table C. 10 Systems: Phillips Curve and Monetary Policy

Explained Variable: INFRD and M				
GMM-SYSTEM				
Explained Variable: INFRD	**Convex**	**Linear**	**Ball, Mankiw y Romer**	**Lucas**
Linear Variables				
CONST	0.0256	0.0218	0.0198	0.0170
	0.000	*0.001*	*0.003*	*0.015*
INFRD(-1)	0.7941	0.8041	0.8495	0.8614
	0.000	*0.000*	*0.000*	*0.000*
INFRD(-4)	-0.0722	-0.1024	-0.0912	-0.1200
	0.007	*0.000*	*0.002*	*0.000*
GR(-1)-GRHP(-1)	0.4134	0.3911	-0.2974	0.1881
	0.025	*0.003*	*0.195*	*0.152*
Nonlinear Variables Related to Economic Cycle				
GR(-1)-GRHP(-1)^2	-6.5301			
	0.337			
INFRD(-1)*(GR(-1)-GRHP(-1))			4.2598	
			0.000	
VINFRD(-1)*(GR(-1)-GRHP(-1))				8.3900
				0.000
Open Economy Variables				
ERGR(-1)	0.1295	0.1280	0.1298	0.1325
	0.000	*0.000*	*0.000*	*0.000*
INFI(-1)	0.0692	-0.0213	-0.0773	-0.0106
	0.602	*0.848*	*0.535*	*0.925*
Dummy Variables				
DUFER	-0.0107	-0.0015	-0.0028	-0.0050
	0.479	*0.907*	*0.793*	*0.621*
DU90	0.0935	0.0856	0.1613	0.1619
	0.010	*0.030*	*0.000*	*0.000*
DU03	0.0563	0.0568	0.0755	0.0468
	0.019	*0.017*	*0.021*	*0.092*
Descriptive Statistics				
Adjusted R-squared	0.8958	0.8982	0.9058	0.9110
No. de Obs.	100	100	100	100
S.E. of regression	0.0602	0.060	0.0573	0.0556
J-Statistic	0.1631	0.1701	0.1370	0.1500
Durbin-Watson stat	1.1422	1.0667	1.3960	1.3679

Table C. 11 Systems: Phillips Curve and Monetary Policy (cont...)

Explained Variable: M	Convex	Lineal	Ball, Mankiw y Romer	Lucas
Linear Variables				
CONST	0.0257	0.0152	0.0299	0.0268
	0.470	*0.623*	*0.411*	*0.494*
INFRD(-1)	-0.1498	-0.1348	0.0050	-0.0794
	0.000	*0.000*	*0.935*	*0.042*
INFRD(-4)	0.1191	0.1052	0.0879	0.0851
	0.000	*0.000*	*0.001*	*0.003*
GR(-1)-GRHP(-1)	-0.1348	0.0116	0.1832	0.1405
	0.302	*0.922*	*0.198*	*0.329*
M(-1)	0.0051	0.0476	0.0333	0.0340
	0.887	*0.314*	*0.497*	*0.490*
M(-4)	0.9490	0.9382	0.8893	0.9071
	0.000	*0.000*	*0.000*	*0.000*
Nonlinear Variables Related to Economic Cycle				
INFRD(-1)^2			-0.1987	
			0.019	
VINFRD(-1)*INFRD(-1)				-0.2991
				0.011
INFRD(-1)*(GR(-1)-GRHP(-1))	0.9638			
	0.053			
Open Economy Variables				
ERGR(-1)	0.0152	0.0060	-0.0034	0.0027
	0.251	*0.667*	*0.804*	*0.840*
INFI(-1)	-0.3608	-0.3748	-0.3493	-0.2931
	0.005	*0.008*	*0.035*	*0.082*
Non Linear Variables Related to Fiscal Policy				
FS(-1)*(GR(-1)-TREND(-1))	-41.5936	-15.0609	-19.4030	-21.9524
	0.000	*0.137*	*0.120*	*0.071*
FS(-1)*INFRD(-1)	3.0881	0.2807	4.5849	1.9572
	0.060	*0.853*	*0.062*	*0.273*
FS(-1)*(GR(-1)-TREND(-1))*INFRD(-1)			-7.4687	
			0.235	
FS(-1)*(INFRD(-1))^(2)	165.6579			
	0.001			
FS(-1)*INFRD(-1)*VINFRD(-1)				-7.3867
				0.345
Dummy Variables				
DUFER	0.0058	0.0098	0.0036	0.0046
	0.505	*0.149*	*0.666*	*0.598*
DU90	0.0255	-0.0131	0.0097	0.0133
	0.018	*0.253*	*0.257*	*0.100*
DU03	0.0709	0.0656	0.0550	0.0556
	0.000	*0.000*	*0.001*	*0.001*
Descriptive Statistics				
Adjusted R-squared	0.6191	0.5679	0.5943	0.5881
No. de Obs.	99	99	99	99
S.E. of regression	0.0376	0.0400	0.0388	0.0391
J-Statistic	0.1631	0.1701	0.1370	0.1500
Durbin-Watson stat	1.8769	1.9853	1.7991	1.9446

C.4. Figures

Figure C. 1 Linear and Nonlinear Correlation: Inflation and Output Gap

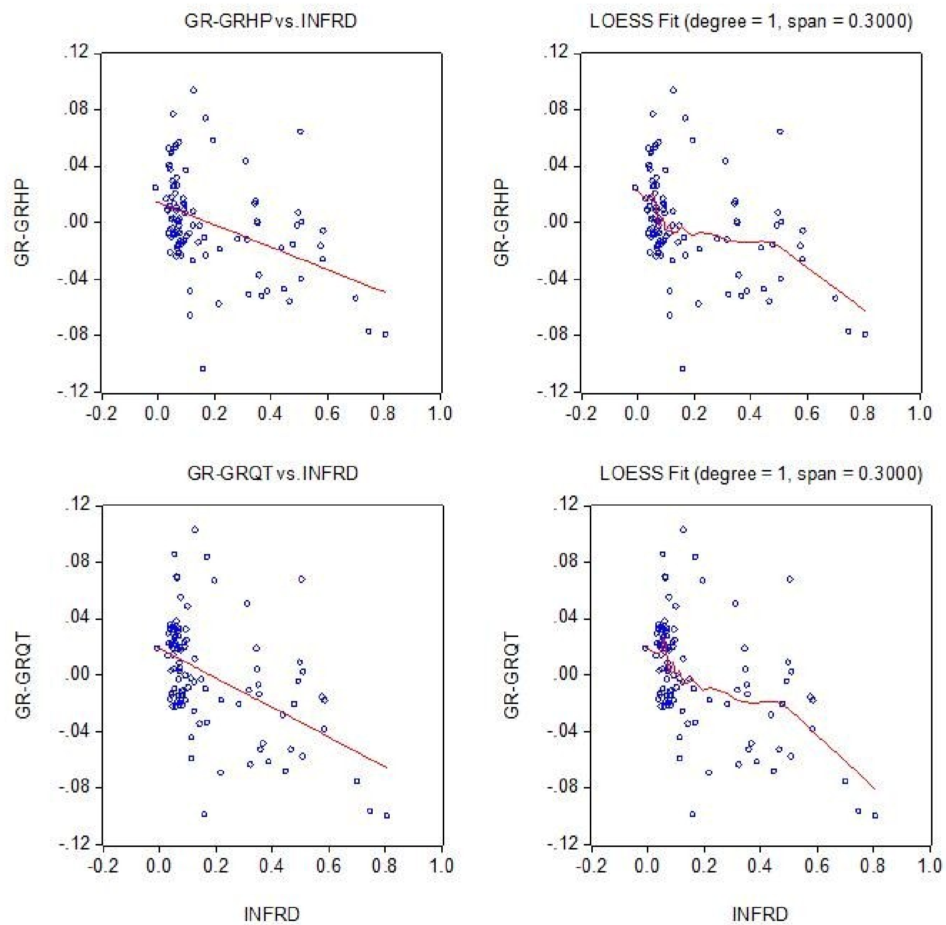


Figure C. 2 Linear and Nonlinear Correlation: Liquidity Ratio and Inflation

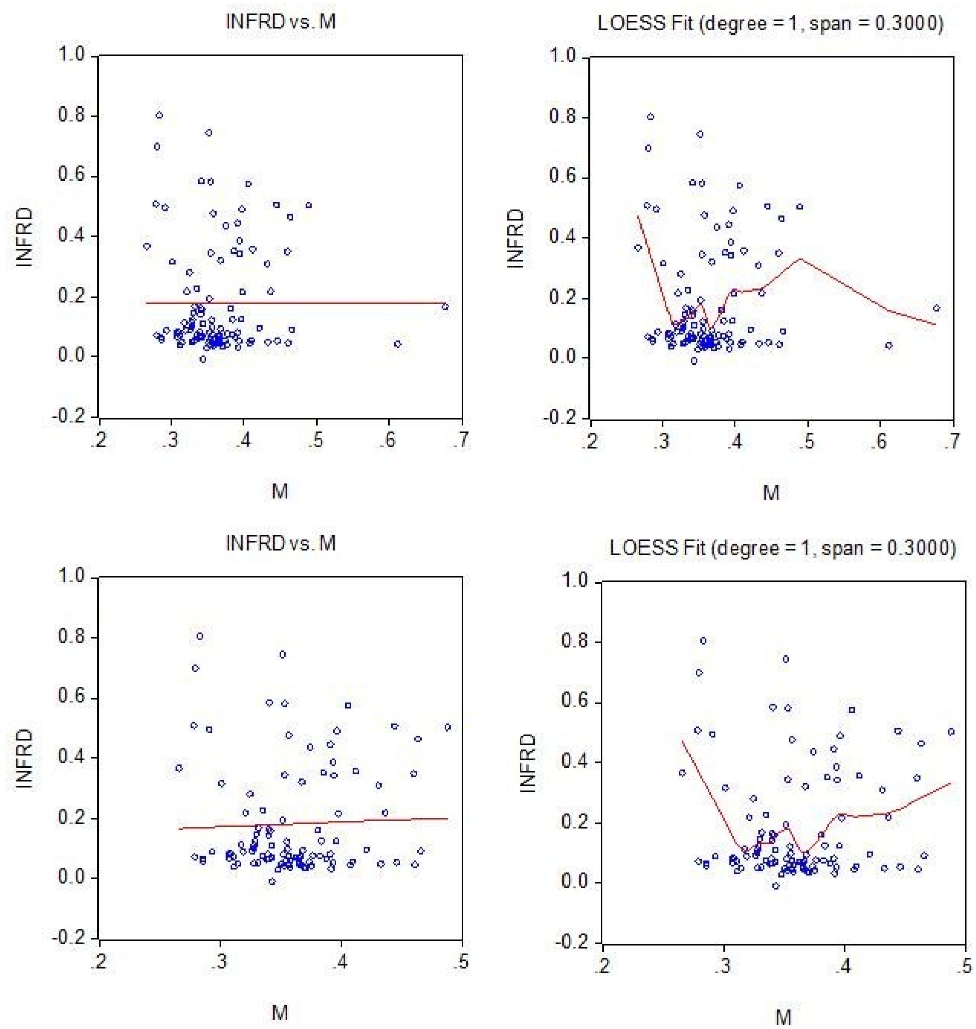


Figure C. 3 Share of Inflation Explained by Nonlinearities

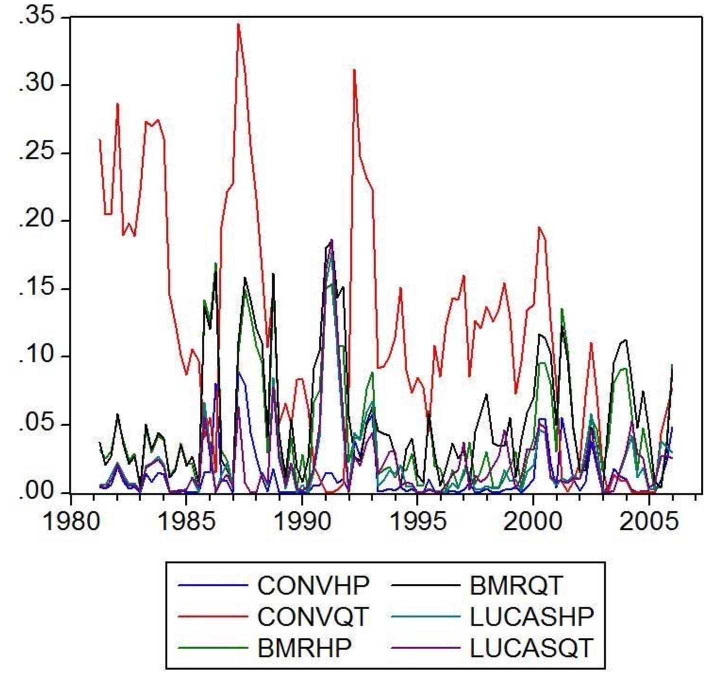
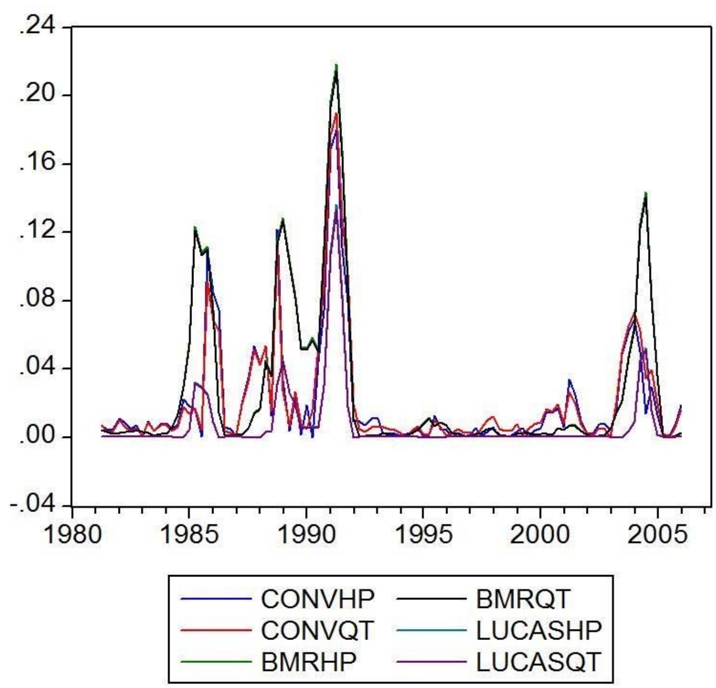


Figure C. 4 Share of Liquitidy Explained by Nonlinearities



Marginal Effects and Regressions

Figure C. 5 Phillips Curve: Marginal Effect of lagged Inflation

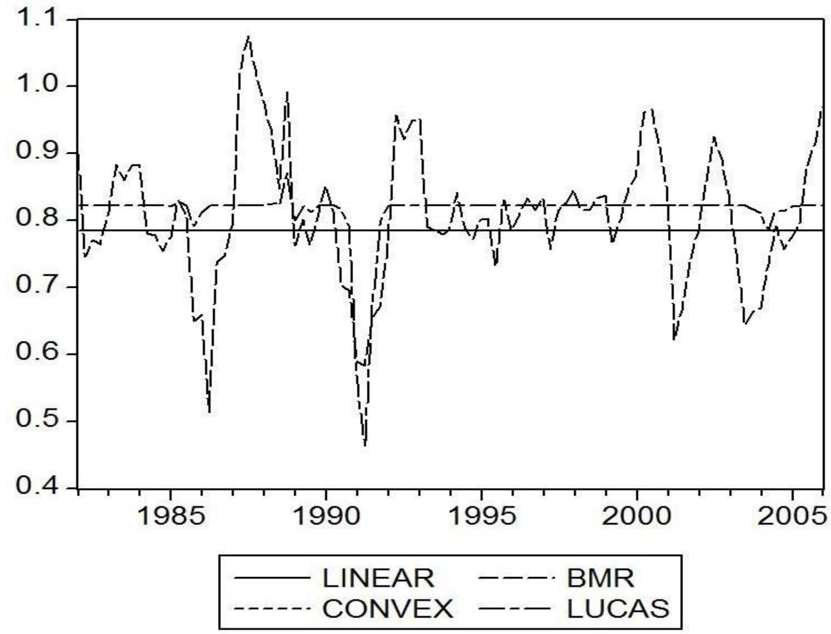


Figure C. 6 Phillips Curve: Marginal Effect of lagged Output Gap

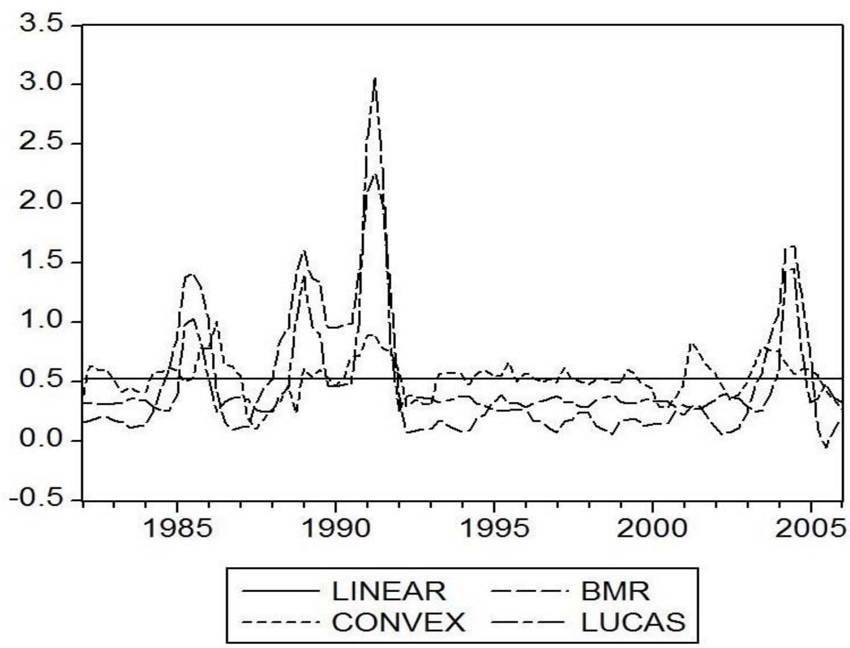


Figure C. 7 Monetary Policy: Marginal Effect of lagged Inflation

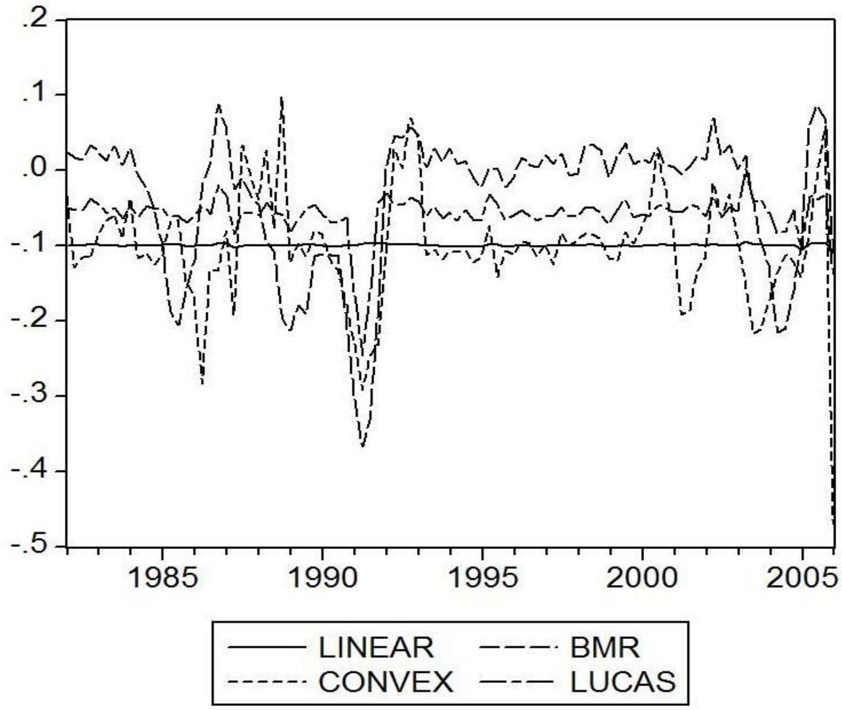
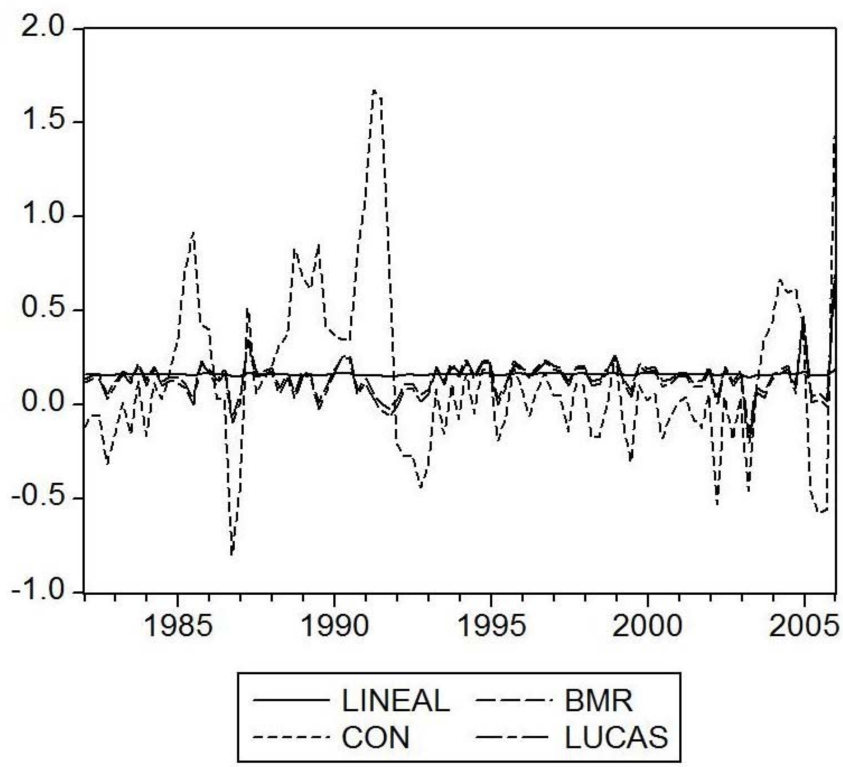


Figure C. 8 Monetary Policy: Marginal Effect of lagged Output Gap



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