Economic Costs of Compliance with Basel III: The Case of Puerto Rico

By

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Abstract

Financial Regulations arising from the Basel III Regulatory Framework, in response to the Global Financial Crisis, will impose important transition costs upon the economies of the countries who implement them. In this project, we assessed and contrasted the transition costs to the economies of Puerto Rico (PR) and United States (US) by simulating the main capital requirement provisions under two scenarios (i.e., Base and Regulatory), over the period 2010-2020. We built stress-test models of the respective Financial Industries and linked their outputs to multivariate models that provided macroeconomic outputs.

Our findings suggest:

1. Average effects on Real Lending Rates would be slightly higher in PR by mid-simulation (161bps for PR vs. 142bps for US) and indifferent from one economy to the other by the end of the simulation period (125bps for PR vs. 124bps for US)
2. Impact on Lending Volumes would be higher in PR by mid-simulation (-10.4% for PR vs. -9.8% for US) and lower by the end (-7.8% for PR vs. -10.1% for US)
3. Impact on GDP would be lower in PR throughout the entire simulation period (-2.6% for PR vs. -4.0% for US, midway; -1.7% for PR vs. -4.2% for US, final)

Resumen

Las Regulaciones Financieras, al marco de los estándares de Basilea III, en respuesta a la Crisis Financiera Mundial, impondrán costos de transición significativos en las economías de los países a su alcance. En este estudio se evalúan y contrastan dichos costos para las economías de Puerto Rico (PR) y Estados Unidos (EEUU), simulando las nuevas disposiciones sobre requisitos de capital bajo dos escenarios (Base y Regulatorio), durante el período 2010-2020. Para ellos, construimos modelos de "stress-test" para las Industrias Financieras de cada país, cuyos resultados fueron insumo de modelos multi-variables que proporcionaron los resultados macroeconómicos.

Nuestros hallazgos sugieren:

1. Efecto promedio en las Tasas de Interés Real sería mayor en PR hacia la mitad de la simulación (161pbs en PR vs. 142pbs en EEUU) e indiferente de una economía a la otra hacia el final (125pbs en PR vs. 124pbs en EEUU)
2. Impacto en los Volúmenes de Préstamos sería mayor en PR hacia la mitad de la simulación (-10.4% en PR vs. -9.8% en EEUU) y mayor hacia el final (-7.8% en PR vs. -10.1% en EEUU)
3. Impacto en el crecimiento de PIB sería menor en PR a lo largo de toda la simulación (-2.6% en PR vs. -4.0% en EEUU a mediados; -1.7% en PR vs. -4.2% en EEUU al final)

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List of Definitions[1]

Contagion: The likelihood that significant economic changes in one country will spread to other countries. Contagion can refer to the spread of either economic booms or economic crises throughout a geographic region.

Latin American Debt Crisis: The default on government debt, and subsequent rescheduling, by more than two dozen less developed countries including many in Latin America, in the early 1980s starting with Mexico on August 12, 1982.

Basel Accords: A set of agreements set by the Basel Committee on Bank Supervision (BCBS), which provides recommendations on banking regulations in regards to capital risk, market risk and operational risk. The purpose of the accords is to ensure that financial institutions have enough capital on account to meet obligations and absorb unexpected losses.

Basel III Framework: A comprehensive set of reform measures designed to improve the regulation, supervision and risk management within the banking sector. The Basel Committee on Banking Supervision published the first version of Basel III in late 2009, giving banks approximately three years to satisfy all requirements. Largely in response to the credit crisis, banks are required to maintain proper leverage ratios and meet certain capital requirements.

Commercial Banks: A financial institution that provides services, such as accepting deposits, giving business loans and auto loans, mortgage lending, and basic investment products like savings accounts and certificates of deposit. The traditional commercial bank is a brick and mortar institution with tellers, safe deposit boxes, vaults and ATMs. However, some commercial banks do not have any physical branches and require consumers to complete all transactions by phone or Internet. In exchange, they generally pay higher interest rates on investments and deposits, and charge lower fees.

Credit Intermediation: Activities that include (1) lending funds raised from depositors; (2) lending funds raised from credit market borrowing; or (3) facilitating the lending of funds or issuance of credit by engaging in such activities as mortgage and loan brokerage, clearinghouse and reserve services, and check cashing services.

Stress-Testing: A simulation technique used on asset and liability portfolios to determine their reactions to different financial situations. Stress tests are also used to gauge how certain stressors will affect a company or industry. They are usually computer-generated simulation models that test hypothetical scenarios.

Capital Structure: A mix of a company's long-term debt, specific short-term debt, common equity and preferred equity. The capital structure is how a firm finances its overall operations and growth by using different sources of funds.

[1] The majority of the definitions in this list were accessed through Investopedia.com; the rest were accessed (in alphabetical order) via BLS.gov, businessdictionary.com, eba.europa.eu, Economics.com, ehow.com, FDIC.gov, Investorwords.com, Larapedia.com, moneycafe.com and transtutors.com. These words appear underlined in the body of the study.

Risky Assets: Any asset that carries a degree of risk. Risk asset generally refers to assets that have a significant degree of price volatility, such as equities, commodities, high-yield bonds, real estate and currencies. Specifically in the banking context, risk asset refers to an asset owned by a bank or financial institution whose value may fluctuate due to changes in interest rates, credit quality, repayment risk and so on. The term may also refer to equity capital in a financially stretched or near-bankrupt company, as its shareholders' claims would rank below those of the firm's bondholders' and other lenders.

Deleverage: A company's attempt to decrease its financial leverage. The best way for a company to delever is to immediately pay off any existing debt on its balance sheet. If it is unable to do this, the company will be in significant risk of defaulting.

Regulatory Capital Minima: The standardized requirements in place for banks and other depository institutions, which determines how much liquidity is required to be held for a certain level of assets through regulatory agencies such as the Bank for International Settlements, Federal Deposit Insurance Corporation or Federal Reserve Board. These requirements are put into place to ensure that these institutions are not participating or holding investments that increase the risk of default and that they have enough capital to sustain operating losses while still honoring withdrawals.

Bretton Woods System of Managed Exchange Rates: A landmark system for monetary and exchange rate management established in 1944. The Bretton Woods Agreement was developed at the United Nations Monetary and Financial Conference held in Bretton Woods, New Hampshire, from July 1 to July 22, 1944.

Capital Adequacy: A measure of a bank's capital. It is expressed as a percentage of a bank's risk weighted credit exposures.

Risk-Weighted Assets: In terms of the minimum amount of capital that is required within banks and other institutions, based on a percentage of the assets, weighted by risk.

Credit Risk: The risk of loss of principal or loss of a financial reward stemming from a borrower's failure to repay a loan or otherwise meet a contractual obligation. Credit risk arises whenever a borrower is expecting to use future cash flows to pay a current debt. Investors are compensated for assuming credit risk by way of interest payments from the borrower or issuer of a debt obligation.

Market Risk: The possibility for an investor to experience losses due to factors that affect the overall performance of the financial markets. Market risk, also called "systematic risk," cannot be eliminated through diversification, though it can be hedged against. The risk that a major natural disaster will cause a decline in the market as a whole is an example of market risk. Other sources of market risk include recessions, political turmoil, changes in interest rates and terrorist attacks.

Regulatory Arbitrage: A practice whereby firms capitalize on loopholes in regulatory systems in order to circumvent unfavorable regulation. Arbitrage opportunities may be accomplished by a variety of tactics, including restructuring transactions, financial engineering and geographic relocation. Regulatory arbitrage is difficult to prevent entirely, but its prevalence can be limited by closing the most obvious loopholes and thus increasing the costs associated of circumventing the regulation.

Operational Risk: A form of risk that summarizes the risks a company or firm undertakes when it attempts to operate within a given field or industry. Operational risk is the risk that is not inherent in financial, systematic or market-wide risk. It is the risk remaining after determining financing and systematic risk, and includes risks resulting from breakdowns in internal procedures, people and systems.

Reputation Risk: A threat or danger to the good name or standing of a business or entity. Reputational risk can occur through a number of ways: directly as the result of the actions of the company itself; indirectly due to the actions of an employee or employees; or tangentially through other peripheral parties, such as joint venture partners or suppliers. In addition to having good governance practices and transparency, companies also need to be socially responsible and environmentally conscious to avoid reputational risk.

Systemic Risk: The risk inherent to the entire market or an entire market segment. Systematic risk, also known as "undiversifiable risk," "volatility" or "market risk," affects the overall market, not just a particular stock or industry. This type of risk is both unpredictable and impossible to completely avoid. It cannot be mitigated through diversification, only through hedging or by using the right asset allocation strategy.

Internal or Economic Capital: The amount of capital that a firm, usually in financial services, needs to ensure that the company stays solvent. Economic capital is calculated internally and is the amount of capital the firm should have to support any risks it takes on.

Procyclicality: A condition of positive correlation between the value of a good, a service or an economic indicator and the overall state of the economy. In other words, the value of the good, service or indicator tends to move in the same direction as the economy, growing when the economy grows and declining when the economy declines.

Subprime Mortgage: A classification of borrowers with a tarnished or limited credit history. Lenders will use a credit scoring system to determine which loans a borrower may qualify for. Subprime loans carry more credit risk, and as such, will carry higher interest rates as well. Approximately 25% of mortgage originations are classified as subprime.

Credit Default Swap: A credit default swap is a particular type of swap designed to transfer the credit exposure of fixed income products between two or more parties. In a credit default swap, the buyer of the swap makes payments to the swap's seller up until the maturity date of a contract. In return, the seller agrees that, in the event that the debt issuer defaults or experiences another credit event, the seller will pay the buyer the security's premium as well all interest payments that would have been paid between that time and the security's maturity date.

Manufacturing Index: Index that monitors conditions in national manufacturing such as employment, production inventories, new orders and supplier deliveries.

Productive Factor: Resources required for generation of goods or services

Required Return: The minimum annual percentage earned by an investment that will induce individuals or companies to put money into a particular security or project. The required rate of return (RRR) is used in both equity valuation and in corporate finance.

Time Value of Money: The idea that money available at the present time is worth more than the same amount in the future due to its potential earning capacity. This core principle of finance holds that, provided money can earn interest, any amount of money is worth more the sooner it is received.

Real Risk-Free Rate of Return: The risk-free rate of return after taking inflation into account.

Nominal or Monetary Risk-Free Rate of Return: The interest rate that an investor expects to yield after adding Inflation Rate to the Real Risk Free Rate of Return

Risk Premium: The return in excess of the risk-free rate of return that an investment is expected to yield. An asset's risk premium is a form of compensation for investors who tolerate the extra risk - compared to that of a risk-free asset - in a given investment.

Target Federal Funds Rate: Commonly known as the Fed Funds Rate, the Federal Funds Rate is a short-term rate objective or Target Rate of the Federal Reserve Board. The actual Fed Funds Rate is the interest rate at which depository institutions lend balances at the Federal Reserve to other depository institutions overnight. The real rate changes daily but is usually close to the target rate desired by the Federal Reserve. Adjustments to the Federal Funds Target Rate are made by the Federal Open Market Committee (FOMC) usually at regularly scheduled meetings; but can also be adjusted at any time with an emergency meeting.

Liquidity Adjustment Facility: A tool used in monetary policy that allows banks to borrow money through repurchase agreements. This arrangement allows banks to respond to liquidity pressures and is used by governments to assure basic stability in the financial markets.

Inflation-Indexed Treasury Security: A treasury security that is indexed to inflation in order to protect investors from the negative effects of inflation. TIPS are considered an extremely low-risk investment since they are backed by the U.S. government and since their par value rises with inflation, as measured by the Consumer Price Index, while their interest rate remains fixed. Interest on TIPS is paid semiannually. TIPS can be purchased directly from the government through the TreasuryDirect system in $100 increments with a minimum investment of $100 and are available with 5-, 10-, and 30-year maturities.

Structural Imbalance: Structural balance refers to the matching of ongoing expenditures with ongoing revenues. If revenues equal or exceed expenditures, structural balance is achieved. If expenditures exceed revenues, structural imbalance occurs.

Network Model: A model conceived as a flexible way of representing objects and their relationships. Its distinguishing feature is that the schema, viewed as a graph in which object types are nodes and relationship types are arcs, is not restricted to being a hierarchy or lattice.

Securitization: The process through which an issuer creates a financial instrument by combining other financial assets and then marketing different tiers of the repackaged instruments to investors. The process can encompass any type of financial asset and promotes liquidity in the marketplace.

Trading Assets: A collection of securities held by a firm that are held for the purpose of reselling for a profit. Trading assets are recorded as a separate account from the investment portfolio. Trading assets may include U.S. Treasury securities, mortgage-backed securities, foreign exchange rate contracts and interest rate contracts. Trading assets include those positions acquired by the firm with the purpose of reselling in the near term in order to profit from short-term price movements.

Counterparty Exposure: The other party that participates in a financial transaction. Every transaction must have a counterparty in order for the transaction to go through. More specifically, every buyer of an asset must be paired up with a seller that is willing to sell and vice versa.

Leverage Ratio: Companies rely on a mixture of owners' equity and debt to finance their operations. A leverage ratio is any one of several financial measurements that look at how much capital comes in the form of debt (loans), or assesses the ability of a company to meet financial obligations.

Supervisory College: Colleges are permanent, although flexible, coordination structures that bring together regulatory authorities involved in the supervision of a banking group. In practice, colleges are a mechanism for the exchange of information between home and host authorities, for the planning and performance of key supervisory tasks in a coordinated manner or jointly, including all aspects of ongoing supervision, and also for the preparation for and the handling of emergency situations. One of the fundamental tasks for supervisory authorities as members of colleges is reaching joint decisions on the risk-based capital adequacy of cross-border groups and their EEA subsidiaries.

Debt Structure: A debt structure provides a historical window into a company's liabilities, indicating to investors the maturity dates of corporate debts. The idea is to tell investors how soon the business must settle debts and whether it has the money to do so.

Systemic Shock: A shock to any system that perturbs a system enough to drive it out of equilibrium.

CDO (Collateralized Debt Obligation): A structured financial product that pools together cash flow-generating assets and repackages this asset pool into discrete tranches that can be sold to investors. A collateralized debt obligation (CDO) is so-called because the pooled assets – such as mortgages, bonds and loans – are essentially debt obligations that serve as collateral for the CDO. The tranches in a CDO vary substantially in their risk profile. The senior tranches are relatively safer because they have first priority on the collateral in the event of default. As a result, the senior tranches of a CDO generally have a higher credit rating and offer lower coupon rates than the junior tranches, which offer higher coupon rates to compensate for their higher default risk.

Cost-benefit Analysis: A process by which business decisions are analyzed. The benefits of a given situation or business-related action are summed and then the costs associated with taking that action are subtracted. Some consultants or analysts also build the model to put a dollar value on intangible

items, such as the benefits and costs associated with living in a certain town. Most analysts will also factor opportunity cost into such equations.

Bottom-Up Analysis: A method of analysis that de-emphasizes the significance of economic and market cycles. This approach focuses on the analysis of individual companies.

Top-Down Analysis: A method of analysis that involves looking at the "big picture" first, and then analyzing the details of smaller components. By first analyzing the overall picture, such as a macroeconomic trend, an investor can start narrowing potential companies to analyze. A trader that uses technical analysis may use top-down analysis as part of their trading system.

DSGE Model: Dynamic stochastic general equilibrium modeling (abbreviated DSGE or sometimes SDGE or DGE) is a branch of applied general equilibrium theory that is influential in contemporary macroeconomics. The DSGE methodology attempts to explain aggregate economic phenomena, such as economic growth, business cycles, and the effects of monetary and fiscal policy, on the basis of macroeconomic models derived from microeconomic principles.

Semi-Structural Model: A description of how the economy operates, using a combination of equations that describe the behavior of firms and consumers in many sectors of the economy and exogenously calculated data.

Reduced-Form Model: The reduced form of an econometric model is one that has been rearranged algebraically so that each endogenous variable is on the left side of one equation and only predetermined variables (like exogenous variables and lagged endogenous variables) are on the right side.

Marginal Cost of Funding: The incremental cost of borrowing more money to fund additional asset purchases or investments. In its simplest calculation, the marginal cost of funds is simply the interest rate on the new loan balance. Marginal cost of funds is often confused with the average cost of funds, which would be calculated by computing a weighted-average of all the combined loans' interest rates.

Iterative Model: The act of repeating a process with the aim of approaching a desired goal, target or result. Each repetition of the process is also called an "iteration", and the results of one iteration are used as the starting point for the next iteration.

Accounting Identities: An equality that must be true regardless of the value of its variables, or a statement that by definition (or construction) must be true. Where an accounting identity applies, any deviation from numerical equality signifies an error in formulation, calculation or measurement.

Structural Model: A description of how the economy operates, using a combination of equations that describe the behavior of firms and consumers in many sectors of the economy.

Macroeconomic Model: An analytical tool designed to describe the operation of the economy of a country or a region. These models are usually designed to examine the dynamics of aggregate quantities

such as the total amount of goods and services produced, total income earned, the level of employment of productive resources, and the level of prices.

Trading Book: The portfolio of financial instruments held by a brokerage or bank that are purchased or sold to facilitate trading for the institution's customers, to profit from trading spreads between the bid and ask prices, or to hedge against various types of risk. Trading books can range in size from hundreds of thousands of dollars at the smallest institutions to tens of billions at the largest financial institutions. Most institutions employ sophisticated risk metrics to manage and mitigate risk in their trading books.

Banking Book: The portfolio of financial instruments held by a borkerage or bank that are not actively traded by the institution, that are meant to be held until they mature. These financial assets are accounted for in a different way than those in the trading book, which are traded on the market and valued by the performance of the market

Non-core Deposits: The deposits made in a bank's natural demographic market. Banks count on core deposits as a stable source of funds for their lending base. Core deposits offer many advantages to banks, such as predictable costs and a measurement of the degree of customer loyalty.

Non-Performing Loans: A sum of borrowed money upon which the debtor has not made his or her scheduled payments for at least 90 days. A nonperforming loan is either in default or close to being in default. Once a loan is nonperforming, the odds that it will be repaid in full are considered to be substantially lower. If the debtor starts making payments again on a nonperforming loan, it becomes a reperforming loan, even if the debtor has not caught up on all the missed payments.

Noncurrent Loans to Loans Ratio: Total noncurrent loans and leases, Loans and leases 90 days or more past due plus loans in nonaccrual status, as a percent of gross loans and leases.

Credit Crunch: An economic condition in which investment capital is difficult to obtain. Banks and investors become wary of lending funds to corporations, which drives up the price of debt products for borrowers.

Credit Rationing: A measure employed by lending institutions to limit the availability of capital based on determinations they make about the credit-worthiness of borrowers as well as the lending environment in general. Raising interest rates above current market rates, regardless of the supply and demand equilibrium, is seen as a form of credit rationing.

Wholesale Deposits: Funding instruments that banks use in addition to core demand deposits to finance operations and manage risk. Wholesale funding sources include, but are not limited to, Federal funds, public funds (such as state and local municipalities), U.S. Federal Home Loan Bank advances, the U.S. Federal Reserve's primary credit program, foreign deposits, brokered deposits, and deposits obtained through the Internet or CD listing services.

Discount Window Lending: Credit facilities in which financial institutions go to borrow funds from the Federal Reserve. These loans, which are priced at the discount rate, are often structured as secured

loans to alleviate pressure in reserve markets. It helps to reduce liquidity problems for banks and assists in assuring the basic stability of financial markets.

GDP Price Deflator: An economic metric that accounts for inflation by converting output measured at current prices into constant-dollar GDP. The GDP deflator shows how much a change in the base year's GDP relies upon changes in the price level. Also known as the "GDP implicit price deflator."

Output Gap: An economic measure of the difference between the actual output of an economy and the output it could achieve when it is most efficient, or at full capacity. There are two types of output gaps: positive and negative. A positive output gap occurs when actual output is more than the full-capacity output. Negative output gap occurs when actual output is less than full-capacity output.

Net Unilateral Transfer Payment: In the United States, a payment made to individuals by the federal government through various social benefit programs.

Personal Consumption: A measure of price changes in consumer goods and services. Personal consumption expenditures consist of the actual and imputed expenditures of households; the measure includes data pertaining to durables, non-durables and services. It is essentially a measure of goods and services targeted toward individuals and consumed by individuals.

Noise Factor: A factor that varies naturally and uncontrollably in a process, which can be controlled for purposes of an experiment.

Statistical Significance: A result that is not likely to occur randomly, but rather is likely to be attributable to a specific cause. Statistical significance can be strong or weak, and is important to research in many math- and science-related fields, including medicine, sociology, psychology and biology. Statistical significance does not always indicate practical significance. In addition, it can be misinterpreted when researchers do not use language carefully in reporting their results.

Goodness-Of-Fit: Used in statistics and statistical modelling to compare an anticipated frequency to an actual frequency. Goodness-of-fit tests are often used in business decision making. In order to calculate a chi-square goodness-of-fit, it is necessary to first state the null hypothesis and the alternative hypothesis, choose a significance level (such as $\alpha = 0.5$) and determine the critical value.

Shadow Banking: The financial intermediaries involved in facilitating the creation of credit across the global financial system, but whose members are not subject to regulatory oversight. The shadow banking system also refers to unregulated activities by regulated institutions.

Maturity Transformation: The practice by financial institutions of borrowing money on shorter timeframes than they lend money out. Financial markets also have the effect of maturity transformation whereby investors such as shareholders and bondholders can sell their shares and bonds in the secondary market (i.e. the larger part of the stock market) at any time without affecting the company that issued the shares or bonds.

Market-Based Lending: Some authorities and market participants prefer to use this term instead of "shadow banking"

Perpetual Preferred Stock: A type of preferred stock that has no maturity date. The issuers of perpetual preferred stock will always have redemption privileges on such shares. Issued perpetual preferred stock will continue paying dividends indefinitely.

Idiosyncratic Buffer: A discretionary buffer set above regulatory minima for prudential purposes.

Financial Deepness: Measure of the financial assets as a percentage of GDP.

Backtesting: The process of testing a trading strategy on prior time periods. Instead of applying a strategy for the time period forward, which could take years, a trader can do a simulation of his or her trading strategy on relevant past data in order to gauge the its effectiveness.

List of Abbreviations

Abbreviation	Description
PR	Puerto Rico
US	United States of America
GDP	Gross Domestic Product
IIF	Institute of International Finance
Bps	Basis Points
BCBS	Basel Committee on Banking Supervision
RWA	Risk-Weighted Assets
SA	Standardized Approach
IRBFA	Internal Risk Based Foundation Approach
IRBAA	Internal Risk Based Advanced Approach
BIA	Basic Indicator Approach
SA	Standardized Approach
AMA	Advanced Measurement Approach
IRB	Internal Risk Based
TIPS	Treasury Inflation-Protected Securities
CET1	Common Equity Tier 1 Capital-to-RWA
G-SIFI	Global Systemically Important Financial Institution
SIB	Systemically Important Bank
D-SIFI	Domestic Systemically Important Financial Institution
LCR	Liquidity Coverage Ratio
NSFR	Net Stable Funding Ratio
CDO	Credit Default Obligations
NPR	Notice of Proposed Rulemaking
DSGE	Dynamic Stochastic General Equilibrium Model
RORWA	Return on Risk-Weighted Assets
MAG	Macro Assessment Group
BIS	Bank for International Settlements
IMF	International Monetary Fund
EBC	European Banking Commission

OECD	Organization for Economic Cooperation and Development
G3	US, Europe and Japan (collectively)
NiGEM	National Institute Global Econometric Model
NIESR	National Institute of Economic and Social Research
UK	United Kingdom
CORP	Domestic Commercial Loans
HH	Domestic Household Loans
NONBKCRED	Non-Bank Credit to the Private Sector
FDIC	Federal Deposit Insurance Corporation
ROE	Return on Equity
T-Bond	Treasury Bond
FRBNY	Federal Reserve Bank of New York
FDIC-SOB	Federal Deposit Insurance Corporation's Statistics on Banking Database
OCIF	Office of the Commissioner of Financial Institutions of PR
OCIF-SIF	Office of the Commissioner of Financial Institutions' Financial Sector Database
SVAR	Structural Vector Autoregression Model

Introduction

With the advance of Globalization and the contagion phenomena manifested during economic crises, such as the Latin American Debt Crisis in the 1980's and the **2008 Global Financial Crisis**, increasing concern has enclosed the international regulatory agenda of the Financial Services Industry. Most notably, the Basel Accords (herein referred to as the accords or, simply, the regulatory standards) are once again under scrutiny, with significant parts of the Basel III Framework having been published at the time of this study[2].

The main objective of this study was to simulate the expected near and medium-term impacts of the latest Financial Regulatory Reform under way (i.e., Basel III, or simply the reform) in the economy of Puerto Rico (PR) and contrasting those results with similar information pertaining to the United States' (US) economy. The following research questions were addressed:

1. How significant are the reform measures in the context of Capital Structure requirements?
2. How near are commercial banks from compliance with regulatory requisites?
    a. What is the difference between the proposed regulatory minimum and recent market conditions in terms of capital level?
    b. How much time will be allowed for meeting the new proposals?
3. How important is bank credit intermediation in the economy?
    a. What is the size (in terms of assets) of the Commercial Banking Industry in comparison with the national economy (in terms of GDP)?
    b. What percentage of the credit intermediation process is conducted by the Commercial Banking Industry?
    c. What is the total effect on economic output from one dollar of demand in the Financial Industry?
4. Is there a difference between the projected economic impacts of the Basel III regulatory reforms in PR and US?
    a. What is the difference in terms of the projected economic variables between two simulation scenarios (i.e., regulatory & base), in each economy?
        i. What is the difference in real lending rates between the regulatory change scenario and the base scenario?
        ii. What is the difference in private sector credit growth between the regulatory change scenario and the base scenario?
        iii. What is the difference in nominal GDP growth between the regulatory change scenario and the base scenario?

[2] In the United States and Puerto Rico the accords were enacted into law via the **Dodd-Frank** and the **Consumer Protection Acts**.

Our simulation was embodied through a Stress-Test approach that would allow us to quantify the economic cost, as put forth in the last research question. Importantly, such approach was based on the Institute of International Finance (IIF, 2010 & 2011) methodologies put forth in the ***Interim Report on the Cumulative Impact on the Global Economy of Proposed Changes in the Banking Regulatory Framework*** (Sands et al., 2011), and, the succeeding paper on the ***Cumulative Impact on the Global Economy of Changes in the Financial Regulatory Framework*** (Suttle et al., 2010); we adjusted these as necessary, especially in the case of PR.

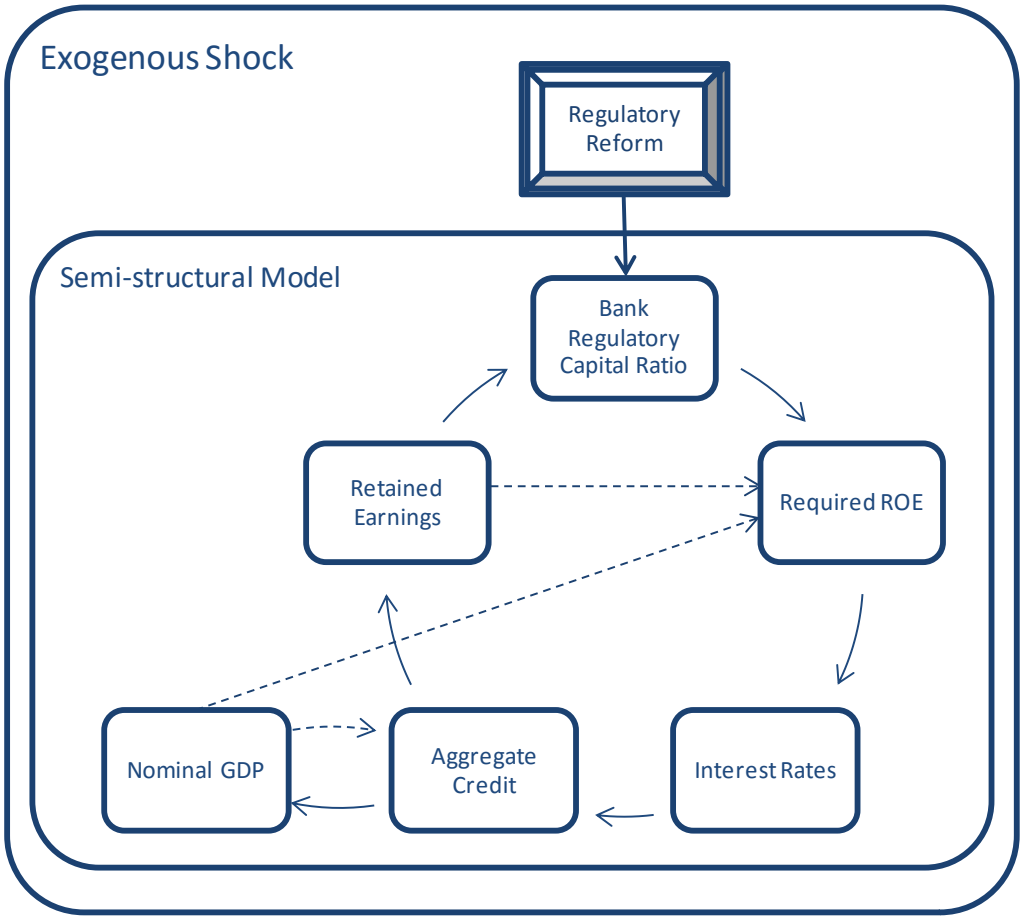


Figure 1: This simplified model summarizes the main forces within our simulation construct. It starts with exogenous shocks caused by the Basel III Reform; those effects are then propagated via a semi-structural model[3] of the Commercial Banking Industry and other Macroeconomic components (i.e., Aggregate Credit and GDP). The solid arrows show the flow of effects in each simulated year, whereas the dashed arrows show one-year lagged effects.

The main rationale for our modeling framework is that financial regulatory reforms induce exogenous shocks on the balance sheet composition (i.e., the capital structure) of banks. This shock is

[3] While most variables are set endogenously, many critical variables (e.g., risk-weights of assets, capital redefinition effects, and official interest rates) are set through exogenous estimates, as explained in the Methodology and Research Results sections; throughout the rest of this paper we call these exogenous variables: *"decision variables"*.

then propagated endogenously through a leftward shift in the bank capital supply curve, which presses banks to make a tradeoff between raising the interest rates charged on lending, coupled by a leftward shift in the loans' supply curve as banks decrease the amount of risky assets on their balance sheets (i.e., deleverage). This shift in aggregate credit impacts GDP and bank profitability, which, endogenously affects the capital structure, closing the cycle, and so on. Finally, in addition to the endogenous channels mentioned, GDP and retained earnings have a lagged effect of one year on investor required return, and GDP has a lagged effect of one year on aggregate credit. Figure 1 (above) shows a simplified map of our model framework (lagged effects are illustrated with dashed arrows).

The simulation constructed to address the last research question was the main focus of this study and the results of each hypothetical test follow:

i. The simulated average annual impact on Real Lending Rates in the Puerto Rican economy is equal to that in the US economy.
   This hypothesis wasn't rejected; the average impact on real lending rates in PR was 125 basis points vs. 124 basis points in the US economy.
ii. The simulated cumulative impact on Private Sector Credit growth (in percentage points) in the Puerto Rican economy is equal to that in the US economy.
   This hypothesis was rejected; the cumulative impact on private sector credit growth was approximately -7.8% in PR vs. 10.1% in US.
iii. The simulated cumulative impact on Nominal GDP growth (in percentage points) in the Puerto Rican economy is equal to that in the US economy.
   This hypothesis was rejected; our estimate points to a less significant deviation from baseline GDP in Puerto Rico at -1.7%, vis-à-vis -4.2% in the US.

Our ultimate purpose is to contribute to the academic pool of literature on the subject of regulatory costs of compliance, from the perspective of PR's economy. Many other studies have been published on this topic by important regulating and academic bodies, albeit for other economies, with estimated impacts on *Real* GDP ranging from -0.01% to -0.80% for a one-percentage point increase in regulatory capital minima.[4] While said findings are directionally consistent with our own results, there are important differences and we make no claim as to whether our approach is superior. On the other hand, we believe that our approach is sound and, at least, suitable for the comparison of the two economies at hand.

[4] The results of our simulation point to a cumulative effect on *Nominal* GDP of -0.4% and -1.2% for each percentage-point increase in regulatory capital minima for PR and the US, respectively.

Literature Review

International Regulations: The Basel Committee on Banking Supervision (BCBS) and the Basel Accords

Shortly after the collapse of the Bretton Woods System of Managed Exchange Rates, in 1973, amidst the widespread financial turmoil, the international banking agenda was conflicted with two main challenges: (1) closing the gaps in international supervisory coverage, and (2) rethinking its regulatory practices. As a result, in 1974 the members of the G-10 nations (the ten most powerful economies in the world) went on to create the Committee on Banking Regulations and Supervisory Practices (later renamed the Basel Committee on Banking Supervision; henceforth BCBS, or simply, the Committee). The main objective of which was that of "enhancing financial stability by improving supervisory knowhow and the quality of banking supervision worldwide" through the "regular cooperation between its member countries on banking supervisory matters" (Basel Committee on Banking Supervision, 2014, pg. 1).

Aside from the guiding principles of supervisory practices, the BCBS began focusing on capital adequacy in the early 1980's as the onset of the Latin American Debt Crisis intensified concerns over capital adequacy and exacerbated the international financial outlook. Thus, "a weighted approach to the measurement of risk"(Basel Committee on Banking Supervision, 2014, pg. 2) was published in the "International Convergence of Capital Measurement and Capital Standards" framework, in 1988, establishing a new capital measurement system widely known as the Basel I Accord (Basel Committee on Banking Supervision, 2014).

Basel I standards suggested a minimum capital to risk-weighted assets (hereafter RWA's) ratio of 8% in order for a bank to be deemed adequately capitalized, with the numerator (capital) of this ratio divided into tier 1 and tier 2 (where tier 1 meant the quality of being more subordinated claims than the latter) capital, and the denominator being the sum of risk-weighted assets on and off the balance sheet. Notably, the risk-weighting methodology focused exclusively in the credit risk exposure of banks. After several amendments that sought to improve its specifications regarding the definition of capital and the risk-weighting methodology, the "Market Risk Amendment to the Capital Accord" was issued, in 1996, to include a capital requirement for market risk "arising from exposure to foreign exchange, traded debt securities, equities, commodities and options" (Basel Committee on Banking Supervision, 2014, pg. 3).

Nevertheless, there were significant weaknesses within the Basel I standards. One of the most salient of these was the overly broad asset categorization levels. As shown in Table 1, below, commercial assets had a 100% risk-weight whereas government assets had a 0% risk-weight. Such a generalization allowed banks to engage in regulatory arbitrage by, for example, granting riskier and more profitable commercial loans, and having no penalty in terms of additional capital requirements. Another major critique was over the framework's lack of attention to other important types of risks, namely: operational risk, reputation risk, systemic risk, and others (Balthazar, 2006).

Type of Assets (non-exhaustive)	Risk-Weight (percent)
Cash; assets involving the governments of OECD countries	0
Assets involving banks located in OECD countries; cash items in the process of collection	20
Loans secured by mortgages on residential property	50
Assets involving businesses; personal consumer loans; assets involving non-OECD governments (unless the transaction is denominated and funded in the same currency)	100
Source: (Larson, 2011)	

Table 1

Basel II

In 2004, almost a decade after the Market Risk Amendment, the BCBS released its "International Convergence of Capital measurement and Capital Standards: A Revised Framework". This document, commonly known as Basel II, was aimed at improving the risk-weighting methodology and advancing financial innovations in risk measurement and control (Basel Committee on Banking Supervision, 2014). This second Accord was comprised of three pillars:

1. Minimum (risk-weighted) capital requirements
2. Supervisory review process
3. Disclosure requirements (market discipline)

Pillar 1 adjusted the risk weighting methodology through the implementation of standard, simplified credit risk models that were better calibrated to the internal or economic capital estimates of banks. Specifically, three major risk-weighting approaches were introduced (i.e., Standardized Approach (SA), Internal Risk Based Foundation Approach (IRBFA), and Internal Risk Based Advanced Approach (IRBAA)),

each with increasing degrees of complexity and decreasing levels of capital requirements, respectively. Additionally, three approaches were introduced for the risk-weighting of *operational* risks, namely the Basic Indicator Approach (BIA), Standardized Approach (SA) and the Advanced Measurement Approach (AMA), also with increasing (decreasing) degrees of complexity (capital requirements). This tradeoff between complexity and requirements was put into effect mainly as an incentive to improve risk management practices for banks (Balthazar, 2006).

The second pillar, Supervisory Review process, introduced requirements geared towards the management of several risk dimensions not covered in the first, such as reputation, credit concentration, strategic risks, and so on. Particularly, it established a minimum capital level above that under pillar 1, in order to cover for these additional risks. Further, regulatory oversight expectations and practices' guidance are put forth through this axis (Balthazar, 2006).

Pillar 3 set the basis for disclosure requirements for underlying risk management results and the implementation decisions resulting from the first two pillars, including such aspects as the risk-weighting methodology in place, internal loss experience and several risk exposure categorizations. As suggested by its name, market discipline, the objective of this last pillar was to push banks to align their risk management practices with market expectations (Balthazar, 2006).

Critics of the second accord questioned the independence of credit rating agencies as well as the lack of uniformity in the rating agency selected. The Internal Risk Based (IRB) approaches were also criticized because internally produced estimates required more regulatory review and, with extremely complex methodologies, could result in cases of banks' self-regulation. Another critique was that the use of a fixed capital level enabled the procyclicality of risk transmission. That is, during expansionary economic phases, banking models understated the risk probabilities and their holdings of capital were relatively lower than if they were near the trough of a cycle, and vice versa (Larson, 2011). Moreover, the generalized lack of treatment of systemic risk stemmed from the microprudential view that minimizing the default probability of each bank would inevitably lead to a stable banking sector. Such a view, however, failed to account for the spillover of externalities, especially as they interact with the procyclicality of systemic risk (Schwerter, 2011).

The 2008 Global Financial Crisis

Evidently, despite ongoing efforts by the BCBS and other regulating bodies, supervisory guidance and standards had a long way to go, as demonstrated by the latest debacle (i.e., the Great recession, the

Global Financial Crisis, the Financial Crisis, or simply the crisis or recession). In fact, Banks and other Financial Institutions were at the center of this latest recession, which had a profound impact on the global economy and aroused much controversy in all sectors of society and the academic community, since its onset in January, 2008 (National Bureau of Economic Research, 2008).

Numerous opinions about the factors that caused the Global Financial Crisis have been voiced to this day with no definitive consensus. Most sources point to a combination of some or all of the following factors: mid 1990's deregulation of mortgage loan practices (i.e., increase in subprime mortgages); easy Monetary Policy following the 9/11 events; ill-advised and reckless decisions from borrowers; unethical behavior of mortgage originators and securitisers; and faulty credit insurance function in the form of credit default swaps (see, for example, (Horwitz, 2012), (Bexley, James, & Haberman, 2010), (Brigham & Ehrhardt, 2011)). In fact some authors are confident that the crisis could have been prevented altogether (Chan, 2011).

Some of the major consequences and effects in the US included the failure of 465 banks and a decrease in home prices of nearly 30% during the period 2008-2012, aside from the characteristic losses in economic output and employment levels (see Exhibit 1). The losses in wealth and, in some cases, solvency caused a rippling effect throughout the rest of the economy as the increased risk aversion led capital funding supply, particularly from banks, to dry up; the lack of capital funding impacted other business sectors and eventually employment and domestic production were also damaged (Foglia et al., 2011).

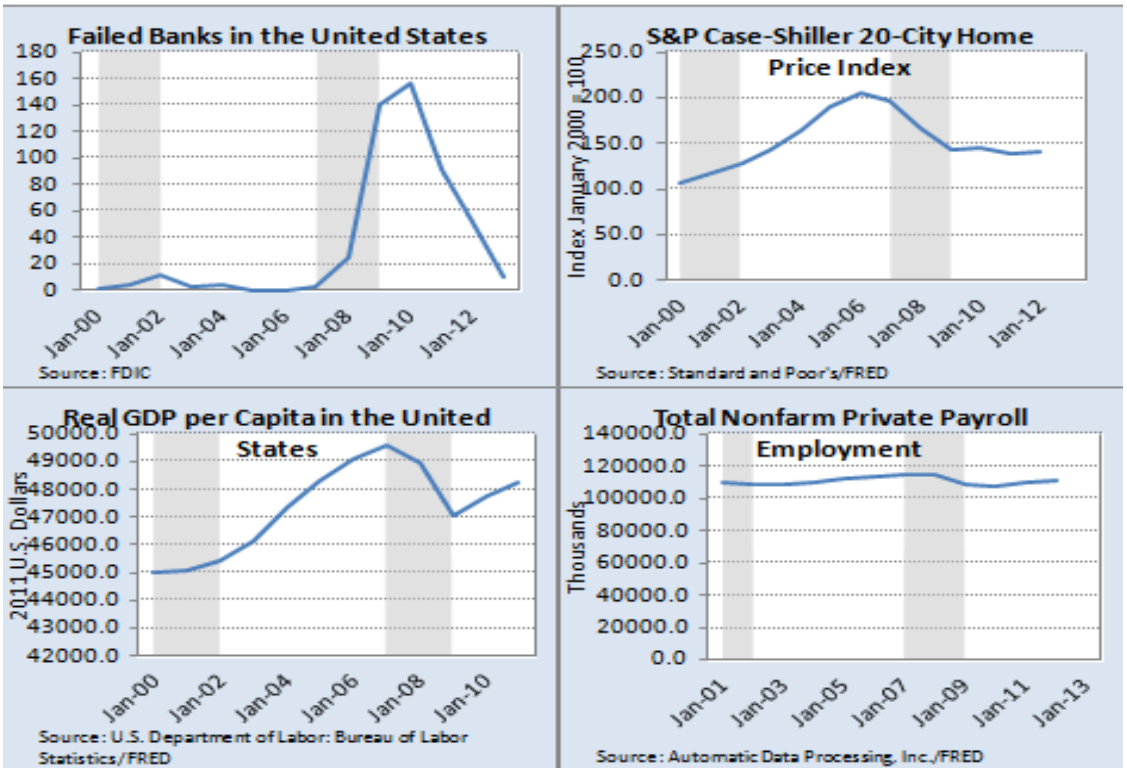


Exhibit 1: As shown in the four panels, the 2008 Financial Crisis (second shaded bars) had profound effects in both the Banking Industry and the overall Economy of the US.

Likewise, the economy of PR suffered dire consequences during the 2008 Financial Crisis, as portrayed in Exhibit 2 (below). Some of them were visible in the closing of three banks (30% of the industry count at that time), a decrease of approximately 11% in home prices during the period 2008-2012 and significant losses in economic output and employment levels. The actual timing of the recession in PR was slightly prior to the US in the context of increasing costs to the construction industry and decreases in the manufacturing index, which was the main productive factor in the economy. These decreases were mainly the consequence of increasing material costs and were exacerbated by a shortage of funding supply (Puerto Rico Planning Board, 2006). Moreover, these events resulted in the close of government during 2006 and a protracted recession that was significantly amplified by the global recession (Puerto Rico Planning Board, 2009).

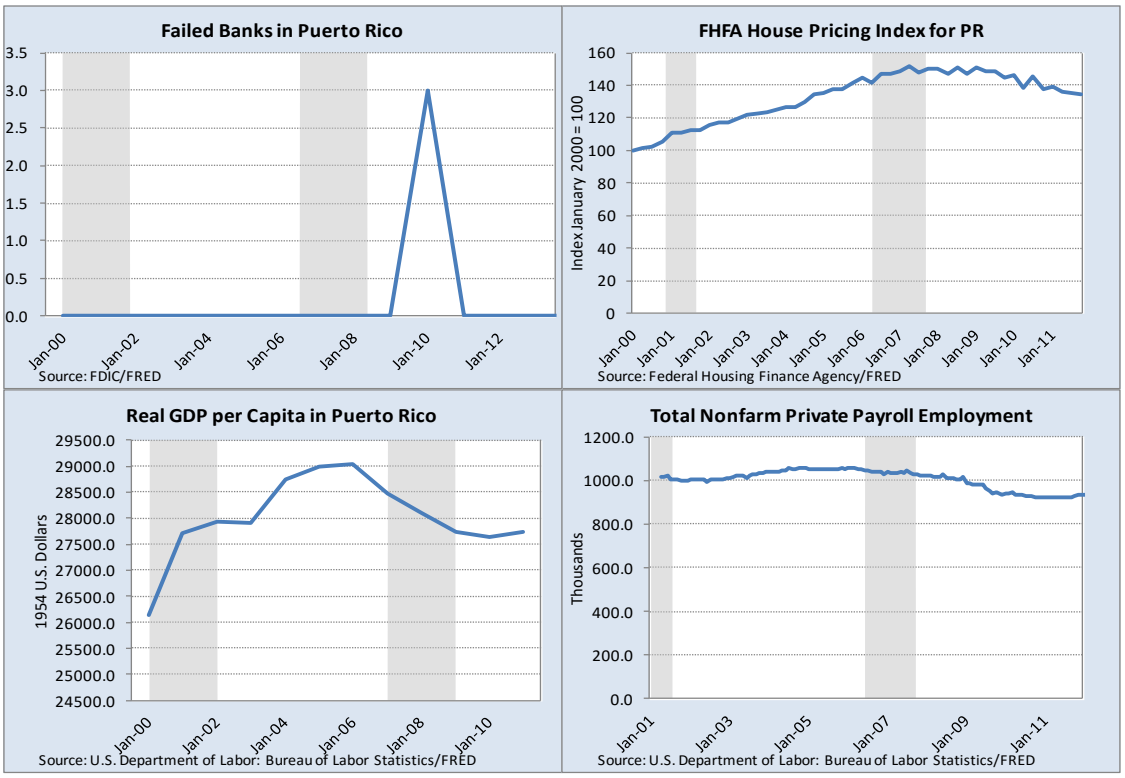


Exhibit 2: Similar to the US, the 2008 Financial Crisis had profound effects in both the Banking Industry and the overall Economy of PR (albeit somewhat lagged).

Why Required Rates of Return (and Interest Rates) decreased during the Financial Crisis

Interest rates, or more generally required returns, can be calculated as the sum of (1) the time value of money (otherwise known as the *real* risk-free rate of return), (2) supply and demand forces in the capital markets, (3) the expected rate of inflation, and (4) the risk involved. Fundamentally, while the first factor accounts for the additional compensation required to forego additional consumption today (i.e., saving), the second and third factors adjust this base price for temporary market forces or imperfections (i.e., "market dynamics" and "inflation"), and is commonly known as the *nominal*, or monetary, risk-free rate of return. The fourth factor, risk premium, is added for investment-specific characteristics that increase the uncertainty of returns.

The first factor affecting the risk-free rates of return was a significant and sustained decrease in real economic growth, as portrayed in Exhibit 1 and Exhibit 2, above. Real risk-free rates of return have been shown to have a positive relationship with the real growth rate in the economy (Reilly & Brown, 2009). Furthermore, economic outlook during the Global Financial Crisis was especially complicated by

the unprecedented nature of many of the market dynamics taking place at the time. As explained by Kohn, central banks were tested "as they had not been tested for many decades", mainly because of the deepness and pervasiveness of the economic impact, and because the structure of financial markets had evolved more than what participants and regulators realized at that point (2010, p. 1). In addition, Williams noted: "Banking and financial crises tend to be followed by slow recoveries, in part reflecting the time needed for the financial sector to heal" (Williams, 2009, p. 1). Thus, the impairments on economic activity and time value of money at the time were deep-rooted.

A second factor, capital markets' response, was shaped in part by the flight to safety and liquidity that was triggered by the uncertainty of market participants during the crisis. As reluctance grew, capital markets and other funding sources dried up; and with little backing to support it aggregate demand dropped while many entities were forced to sell assets. These events deepened the recession and increased the demand for Treasury Bills and Bonds, all else constant, which resulted in lower yields on these holdings.

In response, monetary policy actions by the Fed were focused on reducing the cost of borrowing by easing financial conditions. Some of them included "the reduction in the target federal funds rate from 5.25% to effectively zero" (Board of Governors of the Federal Reserve System, 2014, p. 1), introduction of new types of liquidity facilities to banks and other financial entities, lending dollars to other central banks, and conducting large-scale purchases of longer-term securities (Kohn, 2010). Together, these measures were successful in lowering both short and long-term interest rates in order to spur economic activity.[5]

Expected inflation also influenced the nominal risk-free rate of return. As explained by Reilly & Brown (2009), a market estimate of the expected rate of inflation can be derived from the difference between Inflation-Indexed Treasury securities and their non-indexed counterparts. This differential, commonly called the Breakeven Inflation Rate, implies the *expected* average annual growth of inflation over the term of the underlying instrument.[6] As shown in Figure 2 (below), inflation expectations decreased significantly over the period September-2008 through October-2009. These were in line with

[5] Notably, while increased reserves are expected to encourage bank lending, reduce the cost of borrowing, and increase money supply and spending, banks' behavior was better aligned with the Keynesian model of the liquidity trap (much like during the Great Depression), in which increased money supply fails to lower interest rates and the effects on financial markets and the economy are therefore subdued (Kohn, 2010).

[6] This is so because the differential can be viewed as the required premium for foregoing the protection against inflation provided by Treasury inflation-protected securities (TIPS).

the economic theory up until the Global Financial Crisis, which widely supported the notion of disinflation during recessionary periods[7]. Consequently, the inflation adjustment factor in the nominal risk-free rate of interest was pressured down over the period.

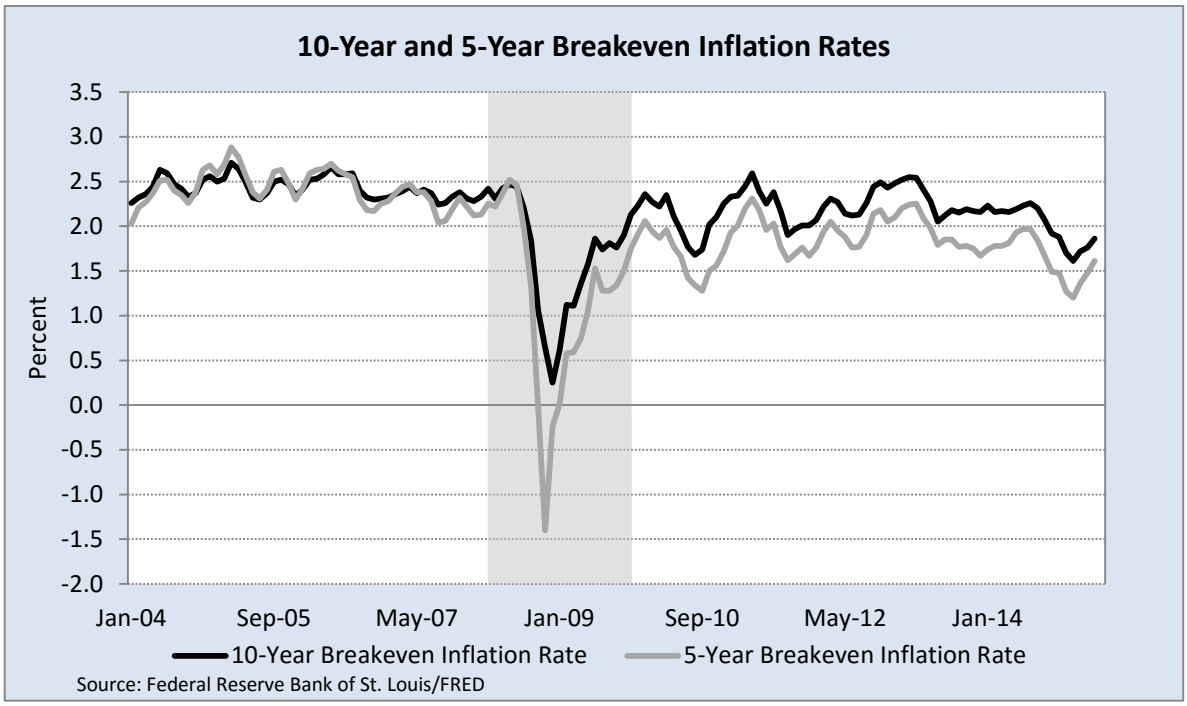


Figure 2: As shown by the 10-Year and 5-Year Breakeven Inflation Rates, inflation expectations were reduced sharply during the 2008 Global Crisis, which, theoretically, would cause nominal risk-free rates of return to decrease, ceteris paribus.

The final adjustment factor to the required rate of return is the risk premium or spread. Common sources of uncertainty recognized in the academic literature for driving the spread over official rates (i.e., risk-free rates) include: (1) business risk, (2) financial risk, (3) liquidity risk, (4) exchange rate risk, and (5) country or political risk (Reilly & Brown, 2009). Notably, the dynamics of these last five factors are out of the scope of our review. However, we believe these are the main drivers of the spread differences between the average lending rates in PR and the US, as we explain in the Profit & Loss Block discussion of the Methodology Section.

Responding to the Global Financial Crisis

Indeed, the rippling effect through the Financial Industry was one of the most important aspects of the turnout. Thereupon, regulators began the latest regulatory overhaul process by considering the

[7] It should be noted that recent studies show that various opposing forces influenced the inflation dynamics during the latest recession, which attenuated the disinflation effects. For a discussion of inflation dynamics in the context of the Global Financial Crisis, see Gilchrist et al., (2015).

transmission channels between the Financial Sector and the Economy. This was an important aspect of the calibration and assessment of regulatory measures taken to increase the stability of financial systems.

Analogously, regulating bodies gave considerable attention to the **systemic contagion** dimension of financial crises, sparking a new perspective on prudential policy altogether. With the ever increasing efficiency and integration of global markets, large banking institutions that go bankrupt nowadays have a much greater potential to destabilize international markets than fifty years ago. Hence, regulators are focusing on *macroprudential policymaking*: its definition, what it involves, and how it interacts with other aspects of public policy. It's become widely acknowledged that this is a necessary part of any sound prudential framework (e.g., (Schwerter, 2011), (Financial Stability Board, 2012).

What do regulators have available to account for the effects of transmission channels?

Early efforts in systemic risk supervision have focused on two of its forms: timely and cross-sectional buildup. Structural imbalances have historically been supervised or controlled through liquidity, maturity, and credit levels. Empirical findings suggest that capital and liquidity ratios are key factors in predicting a resulting financial crisis. Moreover, models published suggest that an inverse relationship exists between higher capital and liquidity ratios and the probability of a crisis because the higher ratios lead to a smoothing of the credit supply during economic cycle fluctuations (Basel Committee on Banking Supervision, 2012b). On the other hand, concentrations inherent in the amplification channels and their interconnectedness (cross-sectional assessments) have usually been accounted for with metrics, network models, and macro stress tests.

Macroprudential tools and methodologies continue being researched and developed in order to cope with the latest and upcoming changes in the financial system. The most common tools found in the regulatory practices among the different national economies include network models and stress testing. Most recently, the BCBS concluded that a model encompassing the advantages of network models and stress testing (i.e., a hybrid model) would provide the most value for regulatory purposes. Accordingly, it has outlined an action plan to build a framework that will include not only oversight tools but the related operating and information gathering practices needed. Notwithstanding, as in many, or almost all, aspects of regulation the final calibration will have to be geared partially to each country and/or economic condition (Financial Stability Board, International Monetary Fund, & Bank for International Settlements, 2011).

Basel III

Continuing its response to the latest developments, the BCBS issued its latest overhaul to the Basel Accords in 2010, with two separate guidance materials titled "International framework for liquidity risk measurement, standards and monitoring" and "A Global Regulatory Framework for More Resilient Banks and Banking Systems" (commonly known as Basel III). In its latest guidance, it maintained the previous three-pillar structure while it tightened the definitions of capital, set significantly higher minimum capital and liquidity ratios, and introduced supplemental *macroprudential* measures to address systemic risk.

Under Pillar I, it introduced a **new ratio of common equity tier 1 capital-to-RWA (CET1 ratio)** set at a minimum of 4.5%, raised the minimum Tier 1 ratio from 4% to 6% and redefined the eligible capital to be included in each Tier. Additionally, it introduced a **Capital Conservation** Buffer of common equity equal to 2.5% of RWA, which would constrain shareholder payouts increasingly as it approaches 0%. Topping it off, it introduced a **countercyclical buffer** of common equity to RWA, ranging from 0% to 2.5%, to be applied when the Regulator perceives an unacceptable buildup of systemic risk (Basel Committee on Banking Supervision, 2011). Thus, the effective minima for CET1, Tier 1 and Total capital ratios were set at 7-9.5%, 8.5-11% and 10.5-13%, respectively.

In terms of Credit Risk weighting methodologies (the denominator of the Capital to RWA ratio), it set forth several measures to strengthen the risk assessments of complex securitizations, trading assets and derivatives, and counterparty exposures. The changes are mainly of a rising nature, especially in the trading book assets portion of the balance sheet.

Conjointly, a new **3% leverage ratio** proposal (its details were expected to be finalized during 2017) stands as the main non-risk based measure that supplements the risk-based minimum capital requirements (Moody's Analytics, 2011).

Finally, it introduced a capital surcharge ranging from 1% to 2.5% to Global Systemically Important Financial Institutions (G-SIFI), conditioned by the systemic importance score these institutions obtain in the systemically important banks (SIB) identification methodology. It was suggested in a consultative document that banks at the higher end of the importance spectrum be imposed an additional 1% loss absorbency requisite. The process of design and implementation for G-SIFI, complementary D-SIFI (domestic systemically important financial institutions) and the so-called "near-

SIFI" (institutions with assets ranging from $30-$50 billion) assessment frameworks was underway at the time of this study and would be a pertinent topic for further research when finalized (Rea, 2011).

Likewise, Pillar 2 was enhanced to better address risk management and supervision topics such as: firm-wide governance and risk management, off-balance sheet and securitization activities, risk concentrations, sound compensation practices, stress testing and Supervisory Colleges. Pillar 3 was augmented through several additional disclosures regarding off-balance sheet, securitization exposures and detailed representations of the regulatory capital components and their calculations.

In terms of liquidity risk supervision, it set forth two new ratios: the Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR). The purpose of the first ratio is to ensure that banks have enough liquid assets available to cover the funding needs of a 30-day stress period; the second ratio was designed to address maturity mismatches in the entire Balance Sheet and to provide an incentive for banks to shift their debt structures to a more conservative or stable position.

Together, these capital and liquidity requirements[8] target *microprudential* regulation, which aims to raise individual bank resilience during periods of stress, and lays a *macroprudential* overlay to avert buildups of systemic risks across the banking sector and their procyclical amplification over time. It's the BCBS' point of view that these two regulatory approaches are complimentary, as greater resilience at the individual bank level reduces the risks of systemic shocks.

Nonetheless, critics of the Basel III framework point to a number of missing elements for the adequate regulation of financial stability (e.g., a risk-weighted leverage ratio; a more thorough treatment of prociclicality; adjustments for the Net Stable Funding ratio; and the internalization of negative externalities from financial institutions) (Schwerter, 2011). Moreover, Hong declared that, while the new regulatory framework did cover some important gaps in the Basel II Framework, it has important shortcomings including: regulation of form (Banks) instead of function (Banking) and ignoring market risk sensitivities in favor of time to market (2011). Triana recommended that the RWA calculations be discarded entirely and a 100% capital charge be applied to all riskier, CDO-like assets (2010).

[8] For a wholistic overview of the proposed reform measures visit the BCBS' website at http://www.bis.org/bcbs/basel3/b3summarytable.pdf, which shows a summarized breakdown and how they fit into the traditional framework's pillar structure.

Dodd-Frank Wall Street Reform and Consumer Protection Act: Notices of Proposed Rulemaking (NPR's) on regulatory capital enhancements

In order to implement the Basel III framework via the Dodd-Frank Wall Street Reform and Consumer Protection Act in the US, the Federal Reserve Board declared, in its June 7, 2012 press release, the proposal of three NPR's: (1) *Regulatory Capital Rules: Regulatory Capital Implementation of Basel III, Minimum Regulatory Capital Ratios, Capital Adequacy, and Transition Provisions*, (2) *Regulatory Capital Rules: Standardized Approach for Risk-weighted Assets; Market Discipline and Disclosure Requirements*, and (3) *Regulatory Capital Rules: Advanced Approaches Risk-based Capital Rule; Market Risk Capital Rules* (Federal Reserve Board, 2012). While the first two NPR's were applicable to all depository institutions, bank holding companies with total consolidated assets of $500 million or more, and savings and loan holding companies, the third one was applicable only to those banking organizations defined as core banks.[9]

Collectively, the proposals –and other guidance materials that are beyond the scope of this study– were evaluated in the BCBS' Regulatory Consistency Assessment Programme. They were found to be in compliance, or largely compliant, in 12 out of the 13 Basel Framework components assessed. Moreover, regarding the single non-compliant component (i.e., the securitization approach), the assessment points out that the related assets accounted for nearly 2.1% of total assets in the Balance Sheet and its relative importance could remain low in the future (Basel Committee on Banking Supervision, 2012a).

How the BCBS calibrated the final framework

Since studies showed that there was no one optimum structure for all countries alike, capital requirements were calibrated, principally, through the use of input from three common analytical tools: cost-benefit analysis, bottom-up analysis, and top-down analysis.

The cost-benefit analysis conducted by the Long-term Economic Impact Group estimated, on the one hand, the expected value of output losses prevented (namely, the benefit) as a function of the capital and liquidity requirements, under the assumption that long-run output would continue its pre-crisis growth trend. On the other hand, the costs of reform were estimated using a number of DSGE, semi-structural and reduced-form macroeconomic models that assumed all effects would be passed

[9] A core banking organization, in the US, was generally defined as a bank having consolidated total assets of $250 billion or more, or having consolidated on-balance sheet foreign exposure of $10 billion or more, or a subsidiary of another core bank (Office of the Comptroller of the Currency, 2010).

through to the lending rates in the banking industry and would ultimately impact investment, consumption and final output. In comparing the range of results for the benefits and costs, each percentage point reduction in the probability of a crisis meant nearly a 0.8% benefit in terms of output not foregone; each percentage point increase in the capital ratio translated into a benefit of approximately 0.34%, on average. On the other hand, the costs for each percentage point increase translated into a 0.09% decline in output (which would be supplemented by a 0.08% decline resulting from meeting the liquidity standards). Thus, the potential net benefits of raising capital and liquidity standards were approximately 0.25% of economic output, annually (Basel Committee on Banking Supervision, 2010a).

The bottom-up analysis conducted by the BCBS sampled several national jurisdictions; in the study, national supervisors solicited individual bank-level data regarding the effect that the new capital definitions and requirements would have had on banks had they been implemented fully by the end of year 2009, ceteris paribus. By not taking into account the managerial responses to such changes, the study was created as a benchmark of the purely definitional effects of the reform. Its overall findings suggest that well-diversified, internationally active banks with over €3 billion of Tier 1 capital would have had a 5.7% decline, on average, in CET1 capital ratio and the other banks would have had a decline of 2.9%, on average. Moreover, the shortfalls for meeting the CET1 final minimum requirement of 7% were €577 billion and €25 billion for each group of banks, respectively (Basel Committee on Banking Supervision, 2010c).

In the top-down analysis, several countries examined the probability distribution of return on risk-weighted assets (RORWA) for the banking industry over an extended period of time (responses ranged from 5 to 29 years). After plotting the distribution, values that were far out in the left tail (i.e., high net losses) were used as a proxy for the amount of capital market participants would expect banks to hold in order to be considered a going concern. Likewise, capital buffers were assessed using the probability distribution of RORWA under stressed market conditions or crises periods (Basel Committee on Banking Supervision, 2010b).

Estimated economic costs of regulation

Most of the research papers published on the same topic as ours share one driving rationale: the new regulations increase the funding costs of banks, which in turn pass on these costs to lenders via higher spreads and ultimately result in lower credit demand and GDP growth, all else constant. We'll

mention several such studies next and discuss them briefly for referential purposes. However, we haven't found any studies dedicated to the economy of PR that we could discuss or otherwise comment on.

One of the most renowned papers on the effects of Basel III was authored by the Macro Assessment Group of the Basel Committee on Banking Supervision (MAG) and published by the Bank for International Settlements (BIS). In the study, MAG compiled and averaged individual model (or "satellite models" as referred to in the study) results as provided by National Banking Authorities, the International Monetary Fund (IMF) and the European Banking Commission (EBC), to obtain estimated effects on interest rates, lending volumes and GDP caused by changes to the capital ratios. The results were, in turn, augmented to account for spillover effects and the proposed Basel III changes to capital, in order to obtain the final "global" effect from the transition to Basel III Standards. The findings suggested a *cumulative effect on economic output, interest rates, and lending volumes of nearly -0.10%, 12.2 bps and -1.47%, respectively, for a one-percentage point increase in the target capital ratio under a 12-year simulation*, *for an aggregate of 17 national economies*. With a distance to adjust of 1.3% of common equity pending, to achieve the new minimum[10], the estimated cumulative loss was 0.13% of economic output. Noteworthy factors excluded from the models were: business model shifts, shadow banks' lending, idiosyncratic buffers, and, most significantly, supply-side sufficiency in the bank capital markets (Macroeconomic Assessment Group, 2010).

Another paper commissioned by BIS, ***Basel III: Long-term impact on economic performance and fluctuations***, suggested similarly that a *one-percentage point increase in the capital requirement would translate roughly into a cumulative loss of 0.09% in GDP, for a one-percentage point increase in the target capital ratio of the aggregate economies including US, Italy and the Euro Area*. This study adopted a two-step approach by considering, first, the impact of the new rules on interest rate spreads and, second, by feeding these spreads into macroeconomic models. Its most salient disclosed limitation was the lack of accounting for the role of monetary policy (see Angelini et al., 2011).

The Organization for Economic Co-operation and Development (OECD) published, in 2011, its own study on the effects of Basel III on the Economies of US, Europe and Japan (G3). The results suggested *a cumulative effect on output and interest rates of nearly -0.19% and 20.5 bps, respectively, for a one-percentage point increase in the target capital ratio in a 5-year period for the US economy.*

[10] The remaining 1.3% is calculated as the difference between the 7% minimum ratio and the common equity level of 5.7%, estimated by the BCBS in its Quantitative Impact Study (Basel Committee on Banking Supervision, 2010c).

After scaling these results for the estimated distance to adjust of 3.1% common equity, the total cumulative effects were -0.59% and 63.6bps on economic output and lending spreads, respectively[11]. Similar to our study, these results assumed no active monetary policy response; however, it did disclose that monetary policy could offset the reductions by about 30 to 80 basis points. The methodology employed accounting identities based on the notion that banks adjust their lending spreads to compensate for changes in funding costs (i.e., changes in capital structure). They then utilized interest rate semi-elasticities from a macroeconomic model, called the OECD New Global Model, to estimate the effect of spread changes on GDP and scale them based on the banking industry's share of credit intermediation in the economy in question. Thus, the link from lending spread changes to GDP effects is one of the main differences between that paper and our own. Another significant difference is the assumption that increased capital demand won't affect the *marginal* cost of funding. Nevertheless the main rationale is unchanged (see (Slovik & Cournede, 2011)).

Two other renowned papers were published by the IIF: 1) ***Interim Report on the Cumulative Impact on the Global Economy of Proposed Changes in the Banking Regulatory Framework***, and, 2) ***The Cumulative Impact on the Global Economy of Changes in the Financial Regulatory Framework*** ((Suttle et al., 2010), (Sands et al., 2011)).

In its interim report, the expected impact of the banking regulatory reform is assessed through four iterative models, including a bank balance sheet model supplemented by a profit and loss model and a capital supply model, and one macroeconomic model linking the aggregate credit path to the broader economy. The models were run under two different scenarios, one base scenario containing neutral long-term assumptions of GDP, inflation and regulatory pressures and one regulatory scenario imposing a series of assumptions which reflect, on a best efforts basis, the key regulatory reform provisions. The logic of the modeling framework likewise posits that higher capital ratios require raising capital, which puts upward pressure on the cost of capital and leads bank to pass along this added cost through higher interest rates on their loans. Higher liquidity, taxes and compliance charges also squeeze profit margins, exacerbating the pressure on bank capital markets. According to the findings of this study, *the effect on Real GDP, real interest rates, and lending volumes, would be -0.8%, 39 bps, and -3.7%, respectively, for a one-percentage point increase in the target capital ratio under a 10-year*

[11] The average (unweighted) impact on the G3's economic output and lending spreads, as provided in the study, was -0.20% and 14.4bps, respectively, for a one-percentage point increase in the target capital ratios. After scaling for the distance to adjust (3.7%), the total estimated impact stood at -0.73% and 51.1bps, respectively.

simulation period of the US economy. The *cumulative* impacts would be -2.7%, 136 bps and -13.1% on Real GDP, real interest rates, and lending volumes, respectively.

In the final report published by the IIF, the approach and general results were similar to those of the interim report. However, three main methodological differences were: 1) the more advanced state of the regulatory agenda, which allowed for a more accurate assessment of quantitative shocks; 2) the use of the National Institute Global Econometric Model (NiGEM) of the UK's National Institute of Economic and Social Research (NIESR), which provided a more intricate link from the credit shocks to the GDP effects (as well as their interactions), especially in terms of behavioral feedback; 3) the addition of major financial hubs, including the United Kingdom and Switzerland; and, 4) the addition of scenarios within the simulation, namely core reform, benign funding, and accelerated adjustment scenario.[12] The difference between the central and base scenarios of this stress-testing approach resulted in *a cost in terms of Real GDP foregone of 0.5%, an increase in lending spreads of 67 bps, and a decrease in lending volumes of 8.3%, for a one-percentage point increase in the target capital ratio under a 10-year simulation period of the US economy*. That is equivalent to *cumulative* effects on real economic output, lending spreads and volumes of -1.1%, 147 bps and -17.4%, respectively. Notably, these are less stringent in terms of GDP but more so in terms of lending spreads and volumes than the interim report.

Table 2 provides a quick summary of the main results from the studies mentioned.

Reference/Citation	Cumulative effect on GDP growth	Country/Area
Bank for International Settlements (2010), "Assessing the macroeconomic impact of the transition to stronger capital and liquidity requirements - Final Report", Basel.	-0.31%*	Global (17 jurisdictions)
Slovik, P. and B. Cournède (2011), "Macroeconomic Impact of Basel III", *OECD Economics Department Working Papers*, No. 844, OECD Publishing.	-0.59%	US
	-1.14%	Europe
	-0.47%	Japan
	-0.73%	US/Europe/Japan
Suttle, P. et al. (2010), "Interim Report on the Cumulative Impact on the Global Economy of Proposed Changes in the Banking Regulatory Framework, Institute of International Finance Special Committee on Effective Regulation.	-2.7%	US
	-4.4%	Europe
	-1.5%	Japan

[12] The core reform scenario is a central or "most likely" scenario, whereas the benign funding scenario assumes very elastic funding markets for banks (much like the pre-2007 conditions), and the accelerated adjustment scenario assumes that changes programmed for 2018-2019 happen far more quickly.

Sands, P. et al. (2011), "*Cumulative Impact on the Global Economy of changes in the Financial Regulatory Framework*", Institute of International Finance Special Committee on Effective Regulation.	-1.1%	US
	-3.9%	Europe
	-3.4%	Japan
	-0.5%	UK
	-2.9%	Switzerland
*We scaled the one-percentage capital effect using the distance to adjust estimate provided by the OECD (Slovik & Cournede, 2011).		

Table 2

Methodology

Our stress-testing simulation of the banking industry initiated with observable figures from financial reports and other macroeconomic data (until end 2010).[13] Subsequently, by relying on the historical relationships between variables, we projected the outcomes for years 2011-2020 under two different scenarios: Base and Regulatory. As suggested by their names, the Base and Regulatory scenarios simulated the status quo and the proposed regulatory changes, respectively. Our estimated macroeconomic effects are then calculated as the differences between the scenarios in the projected variables.

At a high level, the logic behind our model is that, as regulatory reforms alter the balance sheet composition, banks' profits are squeezed, which prompts a tradeoff between raising the prices (or interest rates) charged on lending and decreasing the amount of risky assets held on the balance sheet, all else constant. In our model, we assumed that the bulk of transitional costs would be imposed by the changes in Pillar I requirements. Further, we omitted G-SIFI consideration and other regulatory proposals in the simulation for Puerto Rico, which we discuss later, due to the relatively small size of Banks therein.

Notably, our modeling approach was inspired by the two IIF studies discussed in the Literary Review. Still, we've adjusted the proposed methodologies as necessary, especially in the case of PR. Thus, our simulation drew on Accounting Identities and Financial Reports to simulate banking industry finances and its macroeconomic effects in US and PR. Particularly, each simulation was broken down into four iterative blocks, with the first three comprising a stress-test model of the Commercial Banking Industry and the fourth one providing a macroeconomic model link to nation-wide outputs.

Next, we provide a discussion of the main features, variables and logic of each model block. For a complete list of variables and equations see Appendixes A and B, respectively.

1. Balance Sheet Block
2. Capital Supply Block
3. Profit & Loss Block
4. Macroeconomic Block

[13] Several estimates and assumptions were necessary for data classification in both historical and forward-looking data; we explain these either as they fit into the different sections of the study or in the Assumptions sub-section of the Methodology section.

Balance Sheet Block

This first block is divided into major asset classes which are assigned average risk-weights (we assign different risk-weights from one scenario to the other to recreate the changes in the risk coverage provisions). The major asset classes in the block are: Cash, Government Securities, Interbank loans in the trading book, Interbank loans in the banking book, Domestic commercial loans in the trading book, Domestic commercial loans in the banking book, Mortgage loans, Other consumer loans, loans to Foreign parties, Fixed assets and Other assets.

Of these, Cash, Government Securities and Interbank Loans are assumed to be decision variables for banks, based on their Liquidity and Reserve targets.[14] On the other hand, Loans to Foreign Parties, Other Assets, and Fixed Assets are assumed to follow paths based on Nominal GDP growth.

Many studies regarding the drivers of credit growth, to this date, have found interest rates and economic output to be significant predictive factors. While some have found other significant factors such as monetary policy, exchange rate flexibility and consumer sentiment to affect the underlying relationship of the first two (see (Elekdag & Han, 2012) and (Cascione, 2012)), we neglected these factors and defined credit growth as a function of the growth of the first two factors (interest rates and economic output) in both economies, for simplicity.

Notwithstanding, over the period 1995-2009, the level of financial deepness in PR was boosted by the industry's access to various non-core-deposit funding sources. Therefore, **new restrictions on this type of funding should translate into a protracted period of bank deleveraging and a decreased lending capacity that will impact economic growth of PR adversely** (Abel, Bram, Deitz, Klitgaard, & Orr, 2012). This necessary deleveraging phenomenon has been confirmed by several important figures in the Banking Industry. For instance, according to the Commissioner of Financial Institutions of PR, Rafael Blanco, lending capacity is dependent on the quality of the underlying loans' portfolio (Carmona, 2013b). Further, estimates have pointed to a sustained "eradication" of non-performing loans until the long-run trend – a Noncurrent Loans to Loans ratio of approximately 2%– is met (see (Alemán, 2012) and (Carmona, 2013b)). Accordingly, we estimated the dollar amount of loans that banks need to sell in

[14] Our Liquidity Targets, in terms of Cash and Government Securities are based on the new provisions for LCR and NSFR Ratios; in terms of Interbank Lending, the Targets are based on Reserve Requirements (see (Board of Governors of the Federal Reserve System, 2015). It should be noted that the estimation of said targets are out of the scope of this study and, therefore, our figures were extended from the IIF's Interim Study (see Suttle et al., 2010). Said targets are listed in the Table of Equations (Appendix B).

order to achieve the long-term average Noncurrent Loans to Loans ratio and subtracted this amount from the projected growth of bank credit to the private sector in PR.

However, an important consideration underlying any deleverage estimate is the likelihood that it would've taken place regardless of the Regulatory Reform. Devlin & McKay (2008) provided two major reasons for bank deleveraging: (1) minimizing the cost of capital through credit rating conservation and (2) complying with regulatory capital minimums. For our purpose, we assumed that each of these reasons was equally significant and probable, and that therefore, the expected deleveraging amount in the Base Scenario was equal to one half of that in the Regulatory Scenario. That is, we assumed that banks in PR would deleverage their balance sheets to minimize the cost of capital, even if the reform wasn't implanted, and that the added costs of compliance with the regulatory reform would double this last amount.

Finally, we stress the fact that deleveraging episodes, or credit crunches, can have complex feedback effects on macroeconomic activity (Devlin & McKay, 2008), which make it impractical for us to attempt to model all of the expected effects in PR. Further, credit rationing and recessionary periods can alter the short-term relationship between interest rates and credit growth because of borrowers' inability to receive loans (even at higher prices), lower loan demand stemming from weak economic outlooks, and general risk averseness from banks (Lara, 2013). Consequently, and given the sustained recessionary and deleveraging episodes in PR over most of the period 2004-2009, we assumed that a regression model of credit growth, estimated with data from this time range, would be irrelevant for our projections. Therefore, we extended the credit growth model effects for the US economy to the PR simulation.

Thus, Domestic commercial loans and household loans' growth (i.e., Private Sector Credit) was modeled using a Regression function of the prior year's growth of Nominal GDP, growth in the Real Lending Rate and the difference in Real Lending Rate between both scenarios. The main assumptions underlying our calibration of Credit Growth are that banks face (1) a downward sloping demand curve with respect to price (real lending rates), and (2) an upward sloping demand curve with respect to economic activity (GDP). Further, we defined Private Sector Credit as the sum of *Bank* Credit to the Private Sector (CORP+HH) and *Non-Bank* Credit to the Private Sector (NONBKCRED; that is, Private Sector Credit = CORP+HH plus NONBKCRED).

The first term, growth of CORP+HH is itself a function of three terms: (1) GDP growth in the prior period; (2) the change in the real rate of lending between the current period and the prior period; and (3) the difference in the real rate of lending between the regulatory and base scenarios.

Additionally, a deleveraging constant was subtracted from private sector credit in the PR model, during each of the initial seven years projected. As shown in Table 6, below, our total estimated deleverage is approximately $6.6 Billion to be deleveraged in seven equal installments of $943 Million over the period 2010-2016. In turn, the deleveraged amount will reduce bank liabilities (Devlin & McKay, 2008), which in our model translates into a reduced reliance on wholesale deposits.

Estimated Deleveraging by PR Banking Industry		
	Regulatory Scenario	Base Scenario
Noncurrent Loans (2009)	$8.0 Billion	
Average Loans (2009)	÷$62.7 Billion	
Noncurrent Loans to Loans (2009)	12.78%	
Less: Avg Noncurrent Loans to Loans (1992-2006)	(2.25)%	
Total Deleverage %	10.53%	5.27%
Total Deleverage	$6.6 Billion	$3.3 Billion
Deleverage per year % (2010-2016)	**1.50%**	**0.75%**
Deleverage per year (2010-2016)	**$943 Million**	**$472 Million**
Source: FDIC; Author Estimates		

Table 3

In addition to the Balance Sheet Model Impact of the Deleveraging estimates, we assumed that the average loss on the assets shed would be 65% (see Table 4), subtracted from Other Earnings in the Profit & Loss Block, based on actual losses experienced by banks during various non-performing loans' sales conducted in 2013 (Carmona, 2013a). In turn, the assets shed from the Banks' Balance Sheets are assumed to be transferred and recognized by the Shadow Banking System at their acquisition value of 35%. Further, we defined Non-bank credit as a function of Bank credit. Therefore, the effects from our modeled banking industry on private credit will be amplified through the Non-Bank Credit channel.

Impact of Deleveraging on Other Earnings		
	Regulatory Scenario	Base Scenario
Total Deleverage	$6.6 Billion	
Times: Estimated Loss	x 65%	
Total Impact on Other Earnings	**$(4.3) Billion**	**$(2.1) Billion**
Impact on Other Earnings (2010-2016)	**$(613) Million**	**$(307) Million**
Source: FDIC; Author Estimates		

Table 4

A second major section of the balance sheet block is composed by liabilities and capital. The groupings of **liabilities** are: Retail Deposits, Interbank Deposits, Wholesale Borrowings and deposits of Foreign Parties. All of them follow a path based on GDP growth, with the exception of Wholesale Borrowings (M3). We calculate the level of M3 as the additional funding required after subtracting capital and other liabilities from total assets. Further, the allocation between long-term and short-term Wholesale Borrowings is assumed to be a decision variable based on the funding target of banks, as shaped by Basel III requirements, extended from the IIF's own Interim Report (Suttle et al., 2010).

Our **capital** portion of the balance sheet block is broken down into Regulatory Capital and Regulatory Adjustments (capital components no longer eligible as Regulatory Capital under Basel III rules). Regulatory capital is further broken down into Core Tier 1 Capital (calculated via the Core Capital Supply Model), Non-Core Tier 1 Capital and Tier 2 Capital. In the PR Model, we project the level of Non-Core Tier 1 Capital as a function of Short-term Wholesale Borrowings, whereas the level of Tier 2 Capital is a function of Risk-weighted assets.[15] In the US Model, we define the level of Non-Core Tier 1 Capital as a function of Risk-weighted assets, whereas the level of Tier 2 capital is calculated as the corresponding prior period amount plus the amount of capital redefined from Tier 1 to Tier 2 under Basel III (see Capital Supply Block section).

Much like a balance sheet or statement of condition, our industry-level balance sheet block provides a semi-structural snapshot of the industry and drives the Key Capital and Liquidity metrics. Thereupon, we simulated and measured compliance with the main Basel III regulatory provisions through the Capital and Liquidity metrics calculated in this block by changing the requirements of underlying liquidity targets, risk-weights and regulatory minima from one scenario to the other.

Additionally, the balance sheet structure provides the input levels that drive the issuance of Core Tier 1 Capital as well as the Market-Required Return on Capital in the second block (Bank Core Capital Supply Model), the profitability of banks in the third block (Profit & Loss block), and the growth of credit from non-bank sources and Nominal GDP in the fourth block (Macroeconomic Block).

[15] As we will explain in the Capital Supply Block, the amounts of capital redefined from Tier 1 to Tier 2 Capital (hence REDEF) are, accordingly, subtracted from and added to each of the Capital Tiers, respectively, as calculated under the approach described in this block's discussion, for both simulated Economies.

Capital Supply block

Through the Capital supply block, we estimate the level of Core Tier 1 Capital (or CET1 Capital) as the sum of (1) prior period CET1, (2) CET1 issued in the current period, (3) regulatory redefinition-of-capital effects on CET1 caused by Basel III rules (REDEF), and (4) Earnings Retained from the current period. The amounts of CET1 capital issued (latest item 2), or extinguished (latest item 3), are based partly on official and private sector estimates, and partly on our own assumptions, as explained in the answer to Research Question II (below).

The last issuance component, Earnings Retained (latest item 4), is assumed to be a decision variable set by banks. The yearly Retention Ratios (RR) used in the US model were extended from the IIF's Interim Study (Suttle et al., 2010). These figures were then scaled by multiplying them by the average ratio of RR's from the PR to the US Banking Industries.

A second key objective of this model is the projection of a market-determined required return on capital. We call this target rate of return the Shadow Price of Equity (RROE) and it is defined by a function of three factors (plus one intercept):

1. Difference between the prior year's growth of GDP and realized ROE
2. Difference between the prior year's regulatory capital and the regulatory minimum (including the capital conservation buffer), and,
3. Difference between the long-term required ROE and prior year's realized ROE

Each of these factors is multiplied by an elasticity coefficient to determine the additional ROE required by investors in order to increase their holdings of bank equity. The logic behind it is that equity investors will require additional compensation based on the movements of these factors. For example, whenever GDP growth (used herein as a proxy for economy-wide return on capital) surpasses the realized ROE from banks, investors would require additional compensation to allocate funds to a relatively underperforming industry. Likewise, the second and third determinants measure whether banks fall short of meeting the regulatory requirements, or of meeting the long-term target ROE, respectively, and thereupon, whether they are "unsafe" or "unprofitable". Our elasticity coefficients are set at 0.5 for the first two terms and 0.1 for the third. Thus, we assume that banks face a relatively inelastic demand curve in terms of these three factors, individually, but relatively elastic in total. The sum of these three factors is added to the intercept (which represents the long term target return on equity) to obtain the shadow price of equity. We set these long term targets at 9.5% and 10% for PR and US, respectively, based on the average return on equity for both economies over the period 2001-2009.

Further, we restrict the shadow cost of equity to a maximum of 19%, in any given year, based on the assumption that any rate over such target would be infeasible.

Profit & Loss block

As the name suggests, this block is based on the commonplace financial report of income. The income and expense categories therein are broken down into the same investment (assets) & funding (liabilities & capital) vehicles as in the balance sheet. We use two base rates, representing the Effective (or Overnight) Fed Funds rate and the 10-Year T-Bond rate, and add a spread-over-base rate for each asset or liability group. Finally, the levels of assets and liabilities are multiplied by a base risk-free rate plus a spread or risk premium.

Because the Banking Industry in PR is under the jurisdiction of the Federal Reserve Bank of New York (FRBNY), it participates in the market for Federal Reserve balances, shoulders requirements on reserve balances and regulatory capital, and shares the opportunities afforded by the regulator to depository institutions such as discount window lending. That is, Banks in the island participate in and are directly affected by "monetary policy" actions (Board of Governors of the Federal Reserve System, 2005). In fact, the Banking Industry in PR commonly uses the official US T-Bonds and the Fed Funds Rate as the base over which risk premiums are added to determine the pricing of lending and funding instruments.

Likewise, we assumed that the spreads on interbank loans and deposits, and loans and deposits to foreign customers would be the same as those in the US, because these are widely shared between both economies and because banks have less pricing power over these asset and liability classes. Therefore, we use the same base rates and spreads (i.e., the yields) for most asset and funding sources, with the exceptions of retail deposits and private sector lending (which for our purpose is the sum of commercial and household lending).

We assumed that retail deposits' cost of funding would be held at 100 basis points spread over the cost of retail deposits in the US, based on the average additional cost of funding in PR during the period 2009-2012. Persistently high deposit rates in PR are mostly attributed to the government's substantial financing needs, which have "crowded" out private investment, as well as to the increased competitive pressure from investment companies' for local savings (Abel et al., 2012).

As mentioned, we calculate the nominal rate of return on lending can be calculated as the sum of the lending rate of Treasury securities plus risk premiums (including inflation premiums). Consequently, in order to calculate the Real Rate of Lending in each Economy we subtract the inflation rate in the GDP deflator from the nominal risk-free rate plus risk premium. Moreover, in order to maintain the same underlying risk-free rate in both economies, we assume that the expected inflation premiums are equal. Thus, differences in the lending spreads between both economies are due entirely to the risk premiums.

On the other hand, we estimated the spread on lending to the private sector as the weighted average of two figures. First we used a reduced-form model of return on equity which we set equal to the shadow cost of equity and solve out for the unknown spread over official rate of return on assets. Second, we added a fixed premium of 112 bps to the spread assigned to the US banking industry, based on the differential between yields on assets between both banking industries over the period 2009-2012.[16] Finally, in the case of PR we assigned weights of two-thirds and one-third to each estimate, respectively, whereas we used the first estimate directly for the case of US (that is, we assigned a weight of one to the first estimate). Lastly, this estimated spread is used to calculate the real rate of interest charged by banks on their lending to the private sector by adding it to the official 10-Yr T-Bond rate and subtracting the inflation portion of the GDP deflator.

For the non-interest income and expense figures, we assumed a growth pattern following GDP as a regressor, with the exception of the income tax rate which we set at 30% throughout the entire simulation periods, except as pointed out in the assumptions sub-section. Additionally, we imposed a number of penalties or charges in the regulatory scenario to incorporate some estimates of the effects of regulatory provisions, which we discuss in detail in the assumptions' sub-section.

Macroeconomic block

As mentioned above, and as its name suggests, this blocks translates the industry-wide outputs from our first three blocks into macroeconomic variables for the country's economy. The variables

[16] Markedly, the credit scores published by Equifax Credit Trends provide strong empirical evidence of a higher risk premium in PR. For example, the Island had the fifth lowest average credit score in all of the states and territories of the US, as of the end of 2012 (Dedrick, 2013). As explained by a Puerto Rican subject-matter expert, FICO scores of 680 or more is considered "good" for Puerto Rican Banks, which compares significantly with the analogous score of approximately 760 or more for US Banks (Carmona, 2014). Moreover, country or political risk would be generally higher in PR due to the ongoing fiscal crisis therein, which can be linked backwards to, at least, the closing of the central government in 2006.

included in our model are Nominal GDP, GDP deflator, Output gap, Bank credit to the private sector, and Non-bank credit to the private sector. Together, the last two variables represent growth in private sector credit from banks and non-bank sources, and are used to determine Nominal GDP growth.

We projected Nominal GDP growth with a multiple regression function dependent on private sector credit growth. Specifically, we assumed that commercial, household, and nonbank loans' growth (i.e., ΔCORP/CORP, ΔHH/HH and ΔNONBKCRED/NONBKCRED) drive economic activity.[17] Beyond that, we adjusted the sampled GDP figures of PR by subtracting net unilateral transfer payments sent by the Federal Government of the US. The rationale for this modification is that even though transfer payments aren't formally included in GDP, they afford significant additional income[18] to residents; therefore they are largely included as personal consumption or some other domestic expenditure that is, for the most part, independent of lending activity.[19] Moreover, transfers have a low correlation with private sector credit growth which suggests a lack of a confounding relation.[20] Thus, by eliminating this noise factor, the significance and goodness-of-fit of our regression model for the economic output of PR increased substantially, as evidenced by the changes in p-values of the F-statistics (from 40.37% to 0.11%) and in R^2 figures (from 9.57% to 90.96%). Notwithstanding our sampling adjustment in the credit-GDP effects model, we precluded a corresponding adjustment to the credit growth model, since the trajectory of transfers after receipt is much more inextricable.

The sample data used for model calibration encompassed the period 1993-2009 for the US and 2004-2012 for PR (different sample periods due to data constraints). Our regression models are shown in Table 5, next.

[17] We excluded the growth of non-bank credit from the GDP model of PR because its significance level was low (i.e., less than 15%). However, this variable is still a significant influence to the modeled results in PR, since it is one of the two private sector credit components.

[18] The amount of Net Federal Government Transfers was approximately 13% the size of PR's GDP, on average, over the period 1990-2009.

[19] While obviously there are some amounts of transfer payments that can be linked directly to credit growth, especially in the housing credit component, we simplified our modeling framework here by removing transfers entirely.

[20] Fitted linear regression models for our three private sector credit components failed to find a significant relation with transfer payments. Specifically, the p-values for the single-factor ANOVA test (i.e., the F-test statistic) were 84%, 16%, and 73% for CORP, HH, and NONBKCRED, respectively.

Multiple Regression Model for Nominal GDP				
	US		PR	
Multiple R	0.8885		0.9672	
R Square	0.7894		0.9355	
Adjusted R Square	0.7408		0.9096	
Standard Error	0.0102		0.5354	
Observations	17		8	
Significance F	0.0001		0.0011	
Variables	*Confidence Interval (90%)*		*Confidence Interval (90%)*	
Intercept	1.712088	4.278129	1.556127	2.444849
ΔCORP/CORP	0.080656	0.231848	0.040704	0.111966
ΔHH/HH	0.02238	0.255242	0.120869	0.226076
ΔNONBKCRED/NONBKCRED	0.010284	0.319805	Excluded	Excluded

Table 5: Our Nominal GDP Regression Models were tested at a 10% significance level. We evaluated the validity of least squares regression by examining the plots of residuals versus the independent variables (linearity and homoscedasticity), the normal probability plots (normality), and by comparing the Durbin-Watson statistics with their bound test critical values (independence of errors). Thereupon, we concluded that least-squares regressions were appropriate (see Appendix C for Residual Analyses). [21]

Notably, the change in Non-Bank credit was a significant factor in the US model but not in PR. This finding is in line with the message of the growing body of literature on the topic of Shadow Banking. Studies on the size and importance of the Shadow Banking System suggesting that this sector can "complement traditional banking by expanding access to credit or by supporting market liquidity, maturity transformation, and risk sharing" (International Monetary Fund, 2014, p. 2). This role is especially marked in the US because of it having, "by far", the largest Shadow Banking System in the world, under various measurement methodologies. In Figure 3 (below) we show two measures of Shadow Banking ("narrow" and "conservative"), provided by the Financial Stability Board (FSB) for various major global economies, which highlight the importance of the shadow Banking System in the US[22]. We also include the total financial assets of deposit-taking institutions to further support the relative significance of market-based lending.

[21] While none of the regression assumptions were violated –as evidenced by residual plots showing no apparent patterns, normal probability plots showing only modest departures from normality, and a Durbin-Watson test statistic that was above the upper critical value (i.e., 1.77 > 1.71), in the US model– the Durbin-Watson test statistic was inconclusive in the case of the PR model because it was between the lower and upper critical values (i.e., 2.29 < 3.11 < 3.44).

[22] While there are many different measurement methodologies and definitions for shadow banking that focus on the nature of the entities, the instruments, the markets, or other criteria (see International Monetary Fund, 2014, p. 4), the measures provided in Figure 3 are based on the conservative and narrow definitions provided by the FSB (Financial Stability Board, 2014). The definitions provided are:

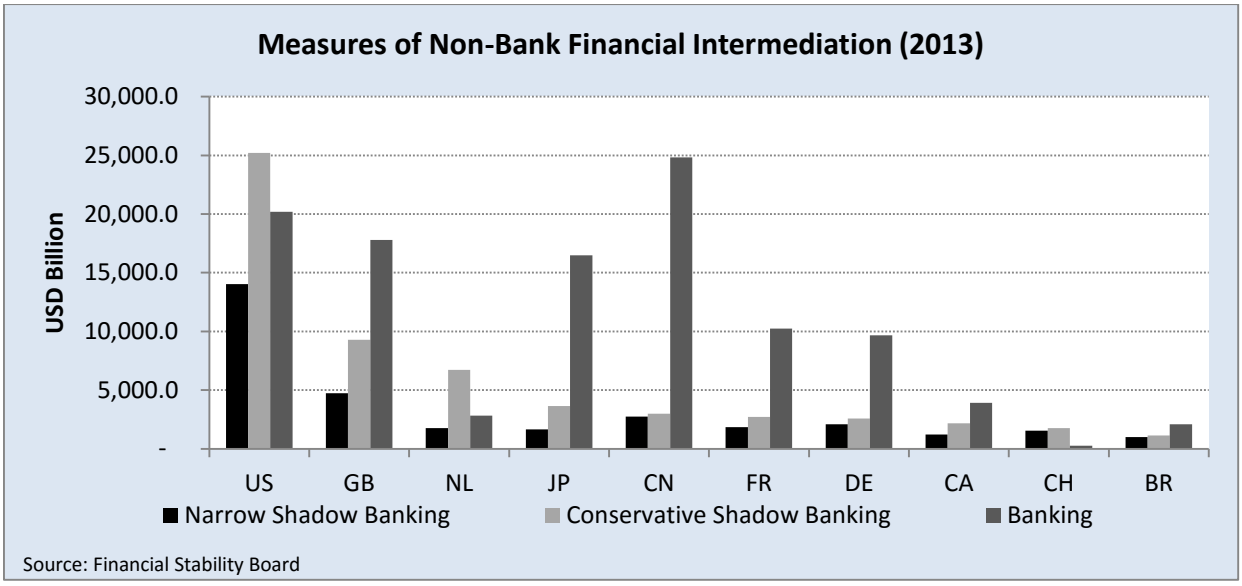


Figure 3[23]: The two measures of Non-Bank Financial Intermediation published by the Financial Stability Board (2013) show that the US has the largest Shadow Banking Industry in the world (more than double the size of the second largest) and that its share of intermediation is higher than that of Commercial Banking itself, depending on the measurement criteria.

Conversely, as pointed by Lara, PR's financial system is "incomplete and fragmented" and "there is no diversity or amplitude of institutions, markets and products" (2013, p. 15). Even though alternative funding sources such as credit unions, investment companies and government banking have increased over the past decade, these sources still represent a small percentage of financial system assets (Abel et al., 2012). Moreover, the regression coefficient for a model including the Non-bank credit segment of PR suggests an average impact on GDP growth therein of -0.0042% for every one-percentage increase in Non-Bank credit.

The remaining variables, GDP deflator and output gap have been extended from the estimates provided by the IIF in its own interim study, due to lack of data for PR (Suttle et al., 2010).

Data Sources

Most of the data for our simulations were gathered from the Federal Deposit Insurance Corporation's Statistics on Banking Database (FDIC-SOB), the Puerto Rico Planning Board's

a. Conservative Measure: credit intermediation involving entities and activities outside the regular banking entities (with the exception of insurance companies, pension funds and public financial institutions)
b. Narrow Measure: subset of the conservative measure that filters out entities that are not part of a credit intermediation chain and those that are prudentially consolidated into a banking group (e.g., self-securitization assets, Equity Investment Funds, equity REITs, and other financial institutions created for the sole purpose of performing intra-group activities)

[23] US=United States; GB=United Kingdom; NL=Netherlands; JP=Japan; CN=China; FR=France; DE=Germany; CA=Canada; CH=Chile; BR=Brazil

Macroeconomic Data Center and the Office of the Commissioner of Financial Institutions' Financial Sector Data (OCIF-SIF). Wherever data were unavailable or impractical to obtain, we either estimated the data or used a simplifying assumption, as discussed throughout. Further, for simplicity and practicality, we used many of the same underlying research assumptions and calibrations as in the IIF's own framework, as explained above. We believe that such extensions are suitable, especially since both economies' Financial Systems are regulated by many of the same laws, or very similar ones, and because both economies share many practices and markets (Lara, 2013).

Assumptions

We made major assumptions regarding the specifics of the regulatory requirements and their effects. They were:

1. Higher risk-weight of trading book assets imposed as a four-fold increase in the average risk-weight of trading book assets in our regulatory scenario, to reflect the higher capital charges imposed upon these. For interbank assets, this translates to a change from 10% to 40%, whereas for commercial loans, the change is from 25% to 100%.
2. Higher minimum Tier 1 ratio and Total Regulatory Capital ratios[24] in our regulatory scenario as per the Basel III phase-in schedule (see Table 9 below for figures and timing).
3. Capital buffers of 7.3% and 5.9% for PR and US, respectively, which include the additional capital required under Pillar 2 provisions and (presumably) for other prudential purposes; these are added to the Tier 1 regulatory minima to arrive at the *effective* regulatory capital minima.
4. Redefinition of Tier 1 capital for PR and US estimated at $1 and $195 billion, respectively, of eligible holdings under Basel II (which will need to be replaced due to their conversion to Tier 2); we projected their replacement in equal installments over the period 2014-2019.
5. Equity issuance of 1.5% and 1.0% of current year RWA's for PR and US, respectively, in order to reach the regulatory minima and reduce capital market pressures.
6. Higher holdings of liquid assets in response to the LCR requisites; we assume that banks will increase gradually their Cash plus Government Securities to Total Assets ratio to 22% over the period 2010 to 2013 and then decrease them back to 18% in the remaining projection years, whereas in the base scenario we assume that the ratio is held at 19.5% in the period 2010-2014 and then decreased steadily to 15% throughout the rest of the period in the base scenario.
7. A shift in the mix of wholesale borrowing to long-term holdings in response to the NSFR; we assume that the shift will take place in the period 2010-2012 and then held throughout the projected period.
8. Higher cost of wholesale borrowing caused in part by higher demand in response to the NSFR and also due to Dodd-Frank's proposal to end "Too-big-to-fail" guarantees in favor of living wills;

[24] We include the Capital Conservation Buffer as part of the regulatory capital minima; since banks are expected to set these figures as their targets in order to avoid payout restrictions. Therefore, our regulatory minima are technically *effective* minima instead.

we assume an additional spread of 200 basis points on wholesale borrowing costs in the regulatory scenario of the US.

9. Higher cost of funding from retail deposits in PR over the US by 100 basis points reflecting the average premium therein over the period 2009-2012.
10. Lower growth of credit from non-bank sources due to new restrictions on securities' trading activities; we assume that the growth of credit from non-bank sources would be 1% lower than in the base scenario.
11. Higher pressure on employee compensation leading to a decrease in the growth of Non-interest costs; we assume that this will translate into non-interest costs growing by 2.5% less than Nominal GDP in the period 2011-2016, in our regulatory scenario.
12. GDP deflators are the same in both economies because the openness of the economy of PR to that of the US establishes price feedback from the markets therein.[25]
13. The GDP deflator from the base scenario is higher than in the regulatory scenario because inflation pressures are higher in the former due to faster expansion of economic activity.
14. Deleveraging in PR was assumed to be carried out in 7 equal installments over the period 2010-2016 by shedding enough Non-performing loans to arrive at a Non-performing Loans to Loans ratio of 2.25%. The deleveraged assets are modeled as yearly reductions in Commercial and Household Loans in the Balance Sheet Block by $943 million (half the total, each). This write-off reduces Non-Interest Earnings in the Profit & Loss Block by $613 million and increases the size of Non-bank credit by an equal amount. These deleveraging amounts are incorporated in the regulatory reform scenario and we impose half of these amounts in the base scenario.

[25] We're unable to test this assumption because significant deflator or output gap data for PR were unavailable.

Research Results

The main objective of this study was to assess the potential near and medium-term impacts of the Financial Regulatory Reform in the economy of Puerto Rico and compare them with those of the US. The following questions were addressed during the course of this study:

I. How significant are the reform measures?

Since Puerto Rico's laws and regulations are superseded by Federal laws, our main focus was on US-specific regulations, followed by internationally agreed-upon standards of regulation, as necessary. With that in mind, the provisions giving rise to the bulk of the transitional costs in both Economies are:

1. **Rise of the required ratio of tier 1 and total capital-to-RWA, and redefinition of tier 1 equity**, thereby augmenting the loss absorbing quantity and quality of eligible instruments. In addition to redefining the stock of tier 1 capital, a **new ratio of common equity tier 1 capital-to-RWA (CET1 ratio)** was introduced, supplemented by a capital conservation buffer and an oscillating countercyclical buffer (with the purpose of curbing buildups of systemic risk and fluctuating at the discretion of local authorities).
2. **Adjustments to the risk-weights of assets** were introduced, especially in the trading book portion of holdings, with the adjustments being mainly of a rising nature.
3. A **3% leverage ratio** was introduced (its details were expected to be finalized during 2017) that would stand as a non-risk based measure to supplement the risk-based minimum capital requirements (Moody's Analytics, 2011).
4. A new **liquidity ratio (LCR)** was established to safeguard and gauge a bank's ability of enduring a stressful event(s), as defined by the regulating authorities, as well as a **funding ratio (NSFR)** fostering long-term funding and ensuring deposit-loan equilibrium in each period, especially during crises.

Thus, new and higher minimum levels of capital were imposed in order for a bank to be considered adequately capitalized. Banks would need to hold a minimum 6% Tier 1 ratio (4% in Basel II), 8% total capital ratio (unchanged), and a new 4.5% CET1 ratio. Additionally, a conservation buffer of 2.5% was imposed on all capital ratios as well as a countercyclical buffer ranging from 0% to 2.5%, to be added to the aforementioned minima. Thus, the effective minima for CET1, Tier 1 and Total capital ratios were set at 7-9.5%, 8.5-11% and 10.5-13%, respectively, to be fully implemented by 2019. That is equivalent to maximum increases of 9.5%, 7% and 5%, to the minimum common equity, tier 1 and total capital ratios, respectively, at the height of the regulatory agenda.

Another important squeeze to the numerator of the Capital to RWA ratio was the redefinition of eligible tier 1 capital. That is, a number of previously eligible Tier 1 Capital components would be

transferred, or "phased" out, to Tier 2 Capital in equal installments over the period 2014-2018. We estimated the impact of capital redefinitions in the Banking Industry using a weighted average of two other estimates. First, we assigned a 75% weight to the industry figures published by JP Morgan (2010) of $140 billion to be subtracted from the tier 1 capital balance of US Banks. Second, we use the figures provided by the BCBS (2010) in their quantitative impact study, which resulted in a projected impact of redefinition of minus 41.3% for "group-one" banks and minus 24.7% for "group-two" banks[26]. Then, we multiplied the projected impact for each of the groups by their proportion of the banking industry. This second estimate was assigned a 25% weight in the final impact estimate. Thus, the amount of Tier 1 capital that would need to be replaced in the US Banking Industry would be $195 billion, to be replaced in five equal installments over the period 2014-2018, as required by the phase-in schedule of deductions from Basel III rules.

To scale these estimated impacts to the case of PR, we used the proportion of PR Tier 1 Equity to US Tier 1 Equity (i.e., 0.61%). Since no Puerto Rican bank met the eligibility criteria to be classified as a group 1 bank, as of 2010, our estimate resulted in $1.6 billion to be replaced in five equal installments over the 2014-2018 period. The next Table 6provides our estimated figures.

US Estimate of Redefinition Effect					
Bank Group (A)	Industry Composition (B)	Core Tier 1 (C)	Industry Estimate* (D)	Official Sector Estimate** (F)	Estimated Effect (G)
1	60%	$623.3 billion	N/A	$257.4 billion = 41.3% x (C)	N/A
2	40%	$415.6 billion	N/A	$102.6 billion = 24.7% x (C)	N/A
Total	**100%**	**$1,038.9 billion**	**$140 billion**	**$360 billion**	**$195 billion**
PR Estimate of Redefinition Effect					
Bank Group (A)	Industry Composition (B)	Core Tier 1 (C)	Industry Estimate[1] (D)	Official Sector Estimate (F)	Estimated Effect (G)
1	0%	$0	N/A	$0 = 41.3% x (C)	N/A
2	100%	$6.4 billion	N/A	$1.6 billion = 24.7% x (C)	N/A
Total	**100%**	**$6.4 billion**	**$0.9 billion**	**$1.6 billion**	**$1 billion**

*Source: JP Morgan (2010)
**Source: BCBS (2010)
1. PR/US Tier 1 Equity Proportion of 0.61% was used to scale Estimates

Table 6

[26] In said study group-1 banks are defined as those having over €3 billion in Tier 1 capital and group-2 banks as all others.

As mentioned in the second reform provision (in response to research question I), there are numerous changes to the risk-weighting of assets, most of which affect the trading book assets on the Balance Sheet. In our study, we applied the same estimated weights as the IIF, which point to a four-fold increase in the average risk-weight of trading book assets. Hence, the Base and Regulatory scenario weights assigned for the asset groups in our model were the following:

Asset-Class	Risk-weight (Base)	Risk-weight (Regulatory)
Cash	0%	0%
Government Bonds	0%	0%
Trading Book Assets (Inter-bank)	**10%**	**40%**
Banking Book Assets (Inter-bank)	25%	25%
Trading Book Assets (Corporate)	**25%**	**100%**
Banking Book Assets (Corporate)	100%	100%
Mortgage Assets	100%	100%
Other Consumer Loans	100%	100%
Foreign Assets (High-grade)	25%	25%
Foreign Assets (Risky)	100%	100%
Fixed Assets	100%	100%
Other Assets	100%	100%

Table 7

Importantly, even though we incorporated the shocks of the third and fourth points, mentioned above, into our simulation model, we limited our analysis to the first and second provisions due to our limited time and resources.

II. How near are commercial banks now from compliance with regulatory requisites?

a. What is the difference between the proposed regulatory minimum and recent market conditions in terms of capital level?

As mentioned, the regulatory reform has rendered several capital components ineligible for the Core Tier 1 capital calculation. Thereupon, in our estimate we began with the Total Equity and adjusted it by deducting goodwill and other intangibles, and perpetual preferred stock. Hence, we obtained the following figures for commercial banks, as of December 31, 2010[27]:

[27] While there are Tier 1 and Tier 2 minima, in addition to the minima provided in Table 5, we believe that the main recapitalization effort from banks will be aimed at the new provision for CET 1 ratio, as this is generally the costliest component of regulatory capital holdings.

Country	Core Tier 1 Capital Ratio	Core Tier 1 After Redefinition Effects	Minima plus Buffers*	Distance to Adjust
United States	11.7%	9.4%	12.9%	3.5%
Puerto Rico	12.0%	9.8%	14.3%	4.5%
*We assume that banks hold the average buffer above minima as they did from 1992-2008 (i.e., 5.9% and 7.3% for US and PR, respectively).				
Source: IIF & Author Estimates				

Table 8

Even though both the US and PR banking industries were already well-capitalized (CET 1 ratios above 7%), if the case was such that buffers required under Pillar 2 arrangements or other idiosyncratic buffers were maintained, the distances to adjust were significant in both cases at 3.5% and 4.5%, for US and PR, respectively.

By examining the trend of estimated CET1 Ratios over the period 1992-2012, we identify two distinct patterns for this ratio over the sub-periods 1992-2009 and 2009-2012.[28] Further, we assume that the stable sideways trend of CET1 Ratios over the pre-2009 period represents a time in which banks, in general, were already in line with their targets, whereas the post-2009 period is representative of the adjustments carried out by banks in order to meet the new compliance minima. Thus our two benchmark issuance speeds were 1.5% and 1.0% for PR and US, respectively, as shown in the regression equations in Exhibit 3 (below). Thereupon, we used the average growth benchmarks as a proxy for the adjustment speed with which banks would progress towards their target capital ratios (i.e., regulatory minima plus idiosyncratic buffers).

[28] We assume that the trend disruptions in the period 1999-2004 are related to the implementation of Basel II issuance and implementation.

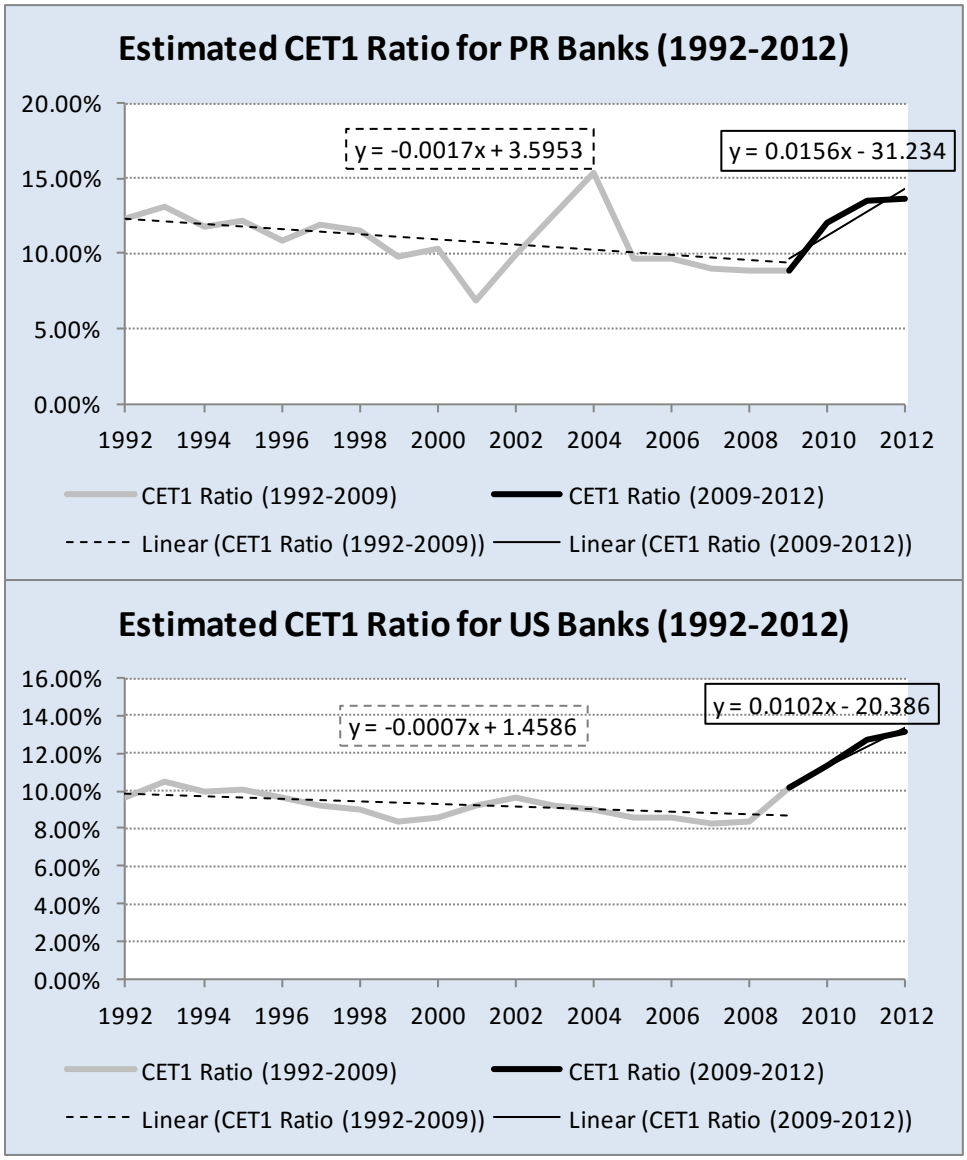


Exhibit 3

b. How much time will be allowed for meeting the new proposals?

The full implementation of regulatory proposals was arranged in a phase-in schedule, such that an extended adoption timeframe would allow for a lesser impact on the economy, especially in terms of stability. This type of arrangement corresponded to the general finding that a shorter transition period would result in greater impacts on economic outputs and growth rates across the economies modeled (see (Macroeconomic Assessment Group, 2010). Hence, the current timeline adopted in the FDIC's Regulatory Capital Final Rule is given in the following table.

Phase-in Schedule*						
Item	**2014 (%)****	**2015 (%)**	**2016 (%)**	**2017 (%)**	**2018 (%)**	**2019 (%)**
Minimum Tier 1 Leverage Capital Ratio		4.0				
Minimum Common Equity Tier 1 Risk-based Capital Ratio	4.0	4.5				
Minimum Tier 1 Risk-based Capital Ratio	5.5	6.0				
Minimum Total Risk-based Capital Ratio		8.0				
Buffer						
Capital Conservation Buffer			0.625	1.25	1.875	2.50
Minimum Common Equity Tier 1 Plus Capital Conservation Buffer		4.5	5.125	5.75	6.375	7.00
Minimum Tier 1 Capital Plus Capital Conservation Buffer		6.0	6.625	7.25	7.875	8.50
Minimum Total Capital Plus Conservation Buffer		8.0	8.625	9.25	9.875	10.50
Deductions/Adjustments						
Phase-in of certain deductions and adjustments (%)	20	40	60	80	100	
*Source: FDIC; Earnst & Young **Applicable to Advanced-Approaches Banks only						

Table 9

III. How important is bank credit intermediation in the economy?

a. What is the size (in terms of assets) of the Commercial Banking Industry in comparison with the national economy (in terms of GDP)?

The Commercial Banking Industry in PR had approximately $72 Billion in Assets as of 2010 (Lebrón, Marrero, & Sierra, 2013). Compared with a GDP of approximately $98 Billion, the banking industry was 74% as big (PR Planning Board, 2014). This measure of financial deepness declined steadily over the period 2007-2010 for all financial industries in PR (with the exception of Credit Unions, AEELA and Government banks, which didn't offset the overall decline). Since the normal expectation for financial deepness is growth commensurate with a country's economic development (Lara, 2013), or higher, this is a signal of other economic problems underlying the economy and its banking industry.

Conversely, bank assets in the US were greater as a percentage of GDP when compared with their counterparts in PR for the same year as above; that is, financial deepness at the end of 2010 was 82.5% ($12,346 billion/$14,964) vis-à-vis 74%, in the US and PR, respectively. Moreover, this number has

increased steadily for the former's banking industry over the period 2007-2010. Consequently, this factor conveys a positive signal in regard to the progression therein.

b. What percentage of the credit intermediation process is conducted by the Commercial Banking Industry?

Our estimate of the share of credit intermediation conducted by the Commercial Banking Industry was based on the total assets in the financial sector, as of 2010, as published by the Office of the Commissioner of Financial Institutions of PR (OCIF for its Spanish acronym) (Lebrón et al., 2013). Particularly, banks play a crucial role in the economy of PR -even more so than in other developed economies- because of the limited supply of alternative funding from its financial sector (Abel et al., 2012). As shown in the next graph (Figure 4), the most significant share was that of the Commercial Banking industry, at 43.6%. This figure compares significantly with the amount of credit intermediation assets held by the Commercial Banking Industry in the US at 23.6%, as of 2010, (Board of Governors of the Federal Reserve System, 2013), as shown in Figure 5, which points to a greater dependence on Commercial Banks in the Puerto Rican economy than in the latter's.

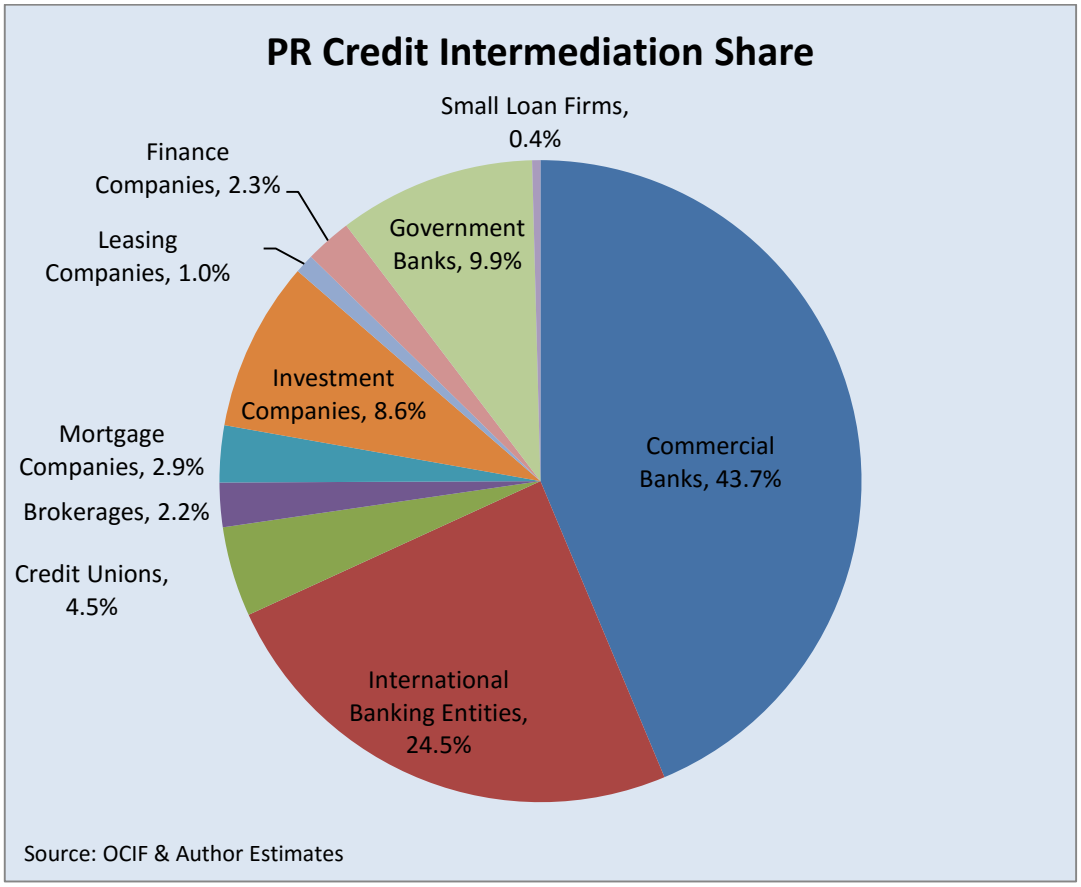


Figure 4

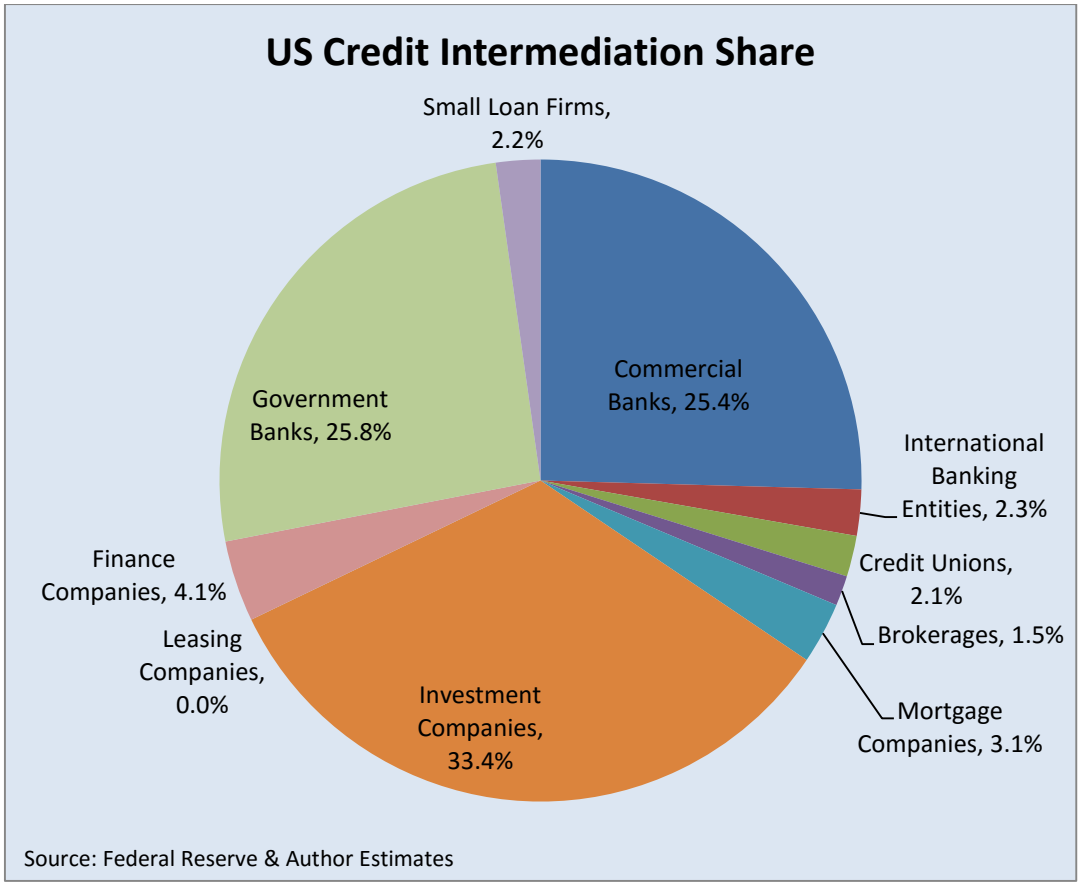


Figure 5

c. What is the total effect on economic output from one dollar of demand in the Financial Industry?

The latest Total Requirements multiplier for the Financial Industry of PR was estimated at 2.7 for the year 2002. Conversely, it was estimated at 1.64 for the US, for the same year, or a ratio of 1.64 at that point. In order to test the probability that this ratio was actually equal to one or less, we conducted a one-tailed t-test of variance with data from the US multiplier, published by the Bureau of Economic Analysis, for the period 1997-2013.[29] We concluded that the US multiplier is, on average, significantly lower than that of PR in 2002, as shown in Table 10, below. Based on this knowledge, and assuming that the Total Requirements multiplier has been fairly stable over the medium term in PR, we expect that a one-dollar impact in the demand of the Banking Industry of the former will yield a lower impact on its economic output than in the latter's, all else constant.

[29] Instead of conducting the normal probability test directly on the ratio, we tested the probability of a US multiplier of 2.7 or more from the sample of US multipliers over the period 1997-2013. Thus, our test was regarded as statistical evidence that the US multiplier is expected to be lower than that of PR in 2002.

Total Industry Output Requirement (US|1997-2013)	
Mean	1.6978
Count	17
Standard Error	0.0266
Normal Probability Test for Total Industry Output Requirement	
X Value	2.7017
Z Value	9.1522
P(X>2.7017)	0.0000
Source: BEA and Author Estimates	

Table 10

IV. Is there a difference between the projected economic impacts of the Basel III regulatory reforms in PR and US?
   a. What are the differences in terms of the projected economic variables between the two simulated scenarios, in each economy?
      i. What is the difference in Real Lending Rates between the regulatory change scenario and the base scenario?
      ii. What is the difference in Private sector credit growth between the regulatory change scenario and the base scenario?
      iii. What is the difference in Nominal GDP growth between the regulatory change scenario and the base scenario?

The last question was the main focus of this study and, in order to answer it, we tested whether or not the simulated results obtained for the Puerto Rican economy were different to those obtained for the US economy, as published by the IIF in its own study. The resulting answers for the hypotheses were:

i. The simulated average annual impact on Real Lending Rates in the Puerto Rican economy is equal to that in the US economy.
   This hypothesis wasn't rejected; the average impact on real lending rates in PR was 125 basis points vs. 124 basis points in the US economy.
ii. The simulated cumulative impact on Private sector credit growth (in percentage points) in the Puerto Rican economy is equal to that on the US economy.
   This hypothesis was rejected; the cumulative impact on private sector credit growth was approximately -7.8% in PR vs. 10.1% in US.
iii. The simulated cumulative impact on Nominal GDP growth (in percentage points) in the Puerto Rican economy is equal to that in the US economy.
   This hypothesis was rejected; our estimate points to a less significant deviation from baseline GDP in Puerto Rico at -1.7%, vis-à-vis -4.2% in the US.

Analysis & Discussion of Findings

Perhaps the most salient feature shared by all the variables' projected paths, as shown in Exhibit 4 (below), is a slump at or near 2014, after which the slopes revert and stay course throughout most or all of the remaining years. Notably, such timing of impacts is similar to what other studies found, notwithstanding the scale (see (Macroeconomic Assessment Group, 2010) and (Angelini et al., 2011)). In this and other studies, those outcomes reflect the leading adjustments carried out by the banking industry to their business models and portfolios in order to assimilate new or enhanced compliance requisites imposed by Basel III.

In this study specifically, as banks strive to raise equity at a faster pace than the national economic output during the first four years of our projection horizon, market pressures build up in the form of higher required return on capital. This is exacerbated by the simultaneous tightening of profit margins. Importantly, we assumed that banks would make a trade-off between raising spreads on loans and deleveraging their balance sheets, whereas loan demand would decrease in response to the higher interest rates. Lastly, lower credit flows were expected to decelerate economic activity as measured by GDP. Nevertheless, after the initial adjustments, market pressures eased to some extent, primarily because the difference between equity issuance and economic activity narrowed, and also because profit margins stabilized as they approached their long-term target (i.e., 10% and 9.5% for US and PR, respectively). Consequentially, economic effects leveled off as the regulatory scenario outcomes began to converge or ceased to diverge with those of the baseline. Exhibit 4 summarizes our simulation findings graphically for both economies.

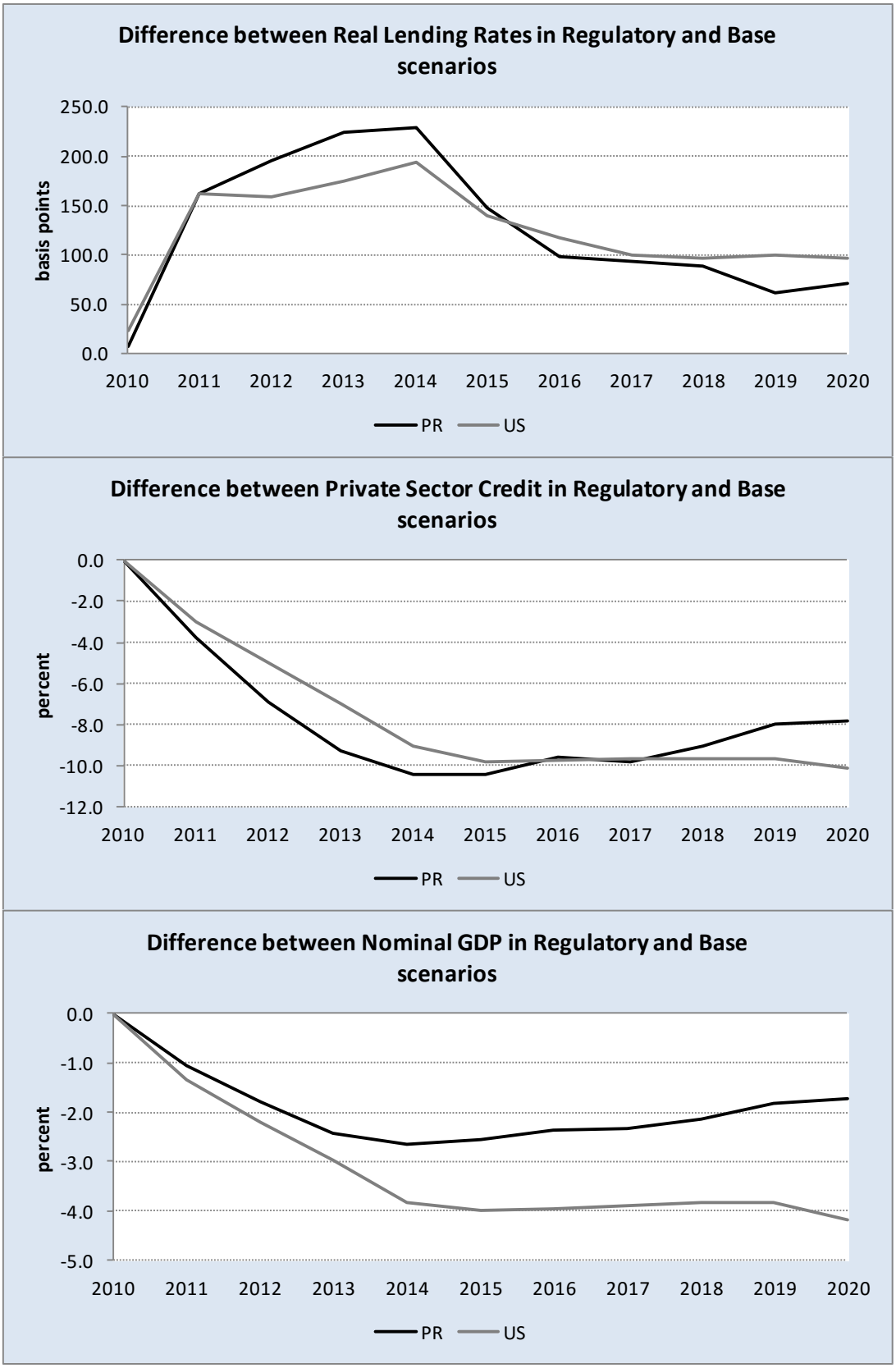

Difference between Real Lending Rates in Regulatory and Base scenarios
basis points
250.0
200.0
150.0
100.0
50.0
0.0
2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
PR
US
Difference between Private Sector Credit in Regulatory and Base scenarios
percent
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
PR
US
Difference between Nominal GDP in Regulatory and Base scenarios
percent
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
PR
US

Exhibit 4

Cumulative Effects

As explained above, our modeling approach was based on Balance Sheet and Income Statement identities, which were linked to a Capital Supply Model in order to estimate the additional Regulatory Capital accumulated under each scenario. These models were, in turn, linked to a Macroeconomic Model that translated the major Industry findings into national economic effects. The main differences in results for both economies, provided in Table 11 (below), were estimated in terms of Real Lending Rates (loan pricing); Private Sector Credit (loan volume); and Nominal GDP.

Simulation Results in Summary

	Puerto Rico		United States		Difference	
Real lending rate (percent)	Avg 2011-2015	Avg 2011-2020	Avg 2011-2015	Avg 2011-2020	Avg 2011-2015	Avg 2011-2020
Base	*4.0*	*4.1*	*2.5*	*2.4*	*1.5*	*1.9*
Regulatory change	*5.5*	*5.5*	*3.9*	*3.6*	*1.7*	*1.9*
Impact (bps)	*161*	*125*	*142*	*124*	*19*	*1*
Private sector credit (2010=100)	2015	2020	2015	2020	2015	2020
Base	*112.1*	*124.1*	*132.4*	*168.6*	*-20.2*	*-44.5*
Regulatory change	*100.5*	*114.4*	*119.4*	*151.5*	*-18.9*	*-37.1*
Impact (%)	*-10.4*	*-7.8*	*-9.8*	*-10.1*	*-0.6*	*2.3*
Nominal GDP (2010=100)	2015	2020	2015	2020	2015	2020
Base	*110.4*	*124.8*	*128.8*	*167.6*	*-18.4*	*-42.9*
Regulatory change	*107.6*	*122.6*	*123.6*	*160.6*	*-16.1*	*-38.0*
Impact (%)	*-2.6*	*-1.7*	*-4.0*	*-4.2*	*1.4*	*2.5*

Table 11

Our results point to a slightly higher impact on loan pricing in the economy of PR by 19bp, on average, through the first half of the simulation, and an equal average impact (or an immaterial difference of 1bp) to both economies, over the entire simulation period. Since lending spreads are the sole difference between both economies' lending rates in our model, we rule out any differences due to inflation or risk-free rates. Further, the three variable factors that shaped the lending spreads were: 1) the difference between growth of equity and economic activity, 2) the difference between the long-term, required ROE, and the realized ROE, and 3) the excess of capital above the regulatory minimum

(including the Capital Conservation buffer).[30] Out of these, the defining forces were the higher level of deleveraging in PR which further impaired bank profitability, vis-à-vis the US (factor #2), along with the greater level of equity issuance in PR, in order to meet a more distant regulatory plus idiosyncratic buffer (factor #1). Specifically, both of these assumptions translated into higher pressure to lending spreads from capital markets via the capital supply models, in PR over the US, especially until 2016 (at which point the seven assumed installments of deleveraging finalize).

Coincidentally, the second variable tested, Private Sector Credit, was most significantly influenced by the greater level of deleveraging in PR, both directly and indirectly. In the simulation, lending volumes were more heavily disrupted in PR than in the US, over the first half of the projections' horizon. First, as banks sell assets to the Shadow Banking Sector, the overall level of credit is reduced by 65% of the write-off amount.[31] Second, the reductions in banking credit are compounded over the rest of the simulation years. Third, deleveraged amounts are amplified through the Shadow Banking Model because the growth of banking credit is its main driver in our framework. Fourth, the higher growth of lending spreads in PR, during the first half of the simulation, exacerbates the cumulative impact on private credit. Collectively, the first three are analogous to a leftward shift of the supply curve, combined with a leftward move along the demand curve in response to higher interest rates (fourth effect) which causes another leftward shift of the supply curve in the following period, all else constant.

This trend, however, reverses during the second half of the simulation when these effects are extinguished and quickly overcome by the lower impact on GDP growth in PR, during the second half of the projection period. In fact, as the difference from baseline GDP narrows progressively from 2016 onward, private sector credit in the regulatory scenario starts to grow faster than in the base scenario as evidenced by the positive slope of the PR series in the middle Panel of Exhibit 4 (above). All in all, the results of our simulation point to a slightly *higher* impact by the end of the first half of the simulation by 0.6% ((-10.4%) – (-9.8%)=-0.6%) in PR, and a *lesser* cumulative impact by the end of the entire simulation by 2.3% ((-7.8) – (-10.1) = 2.3%) in PR.

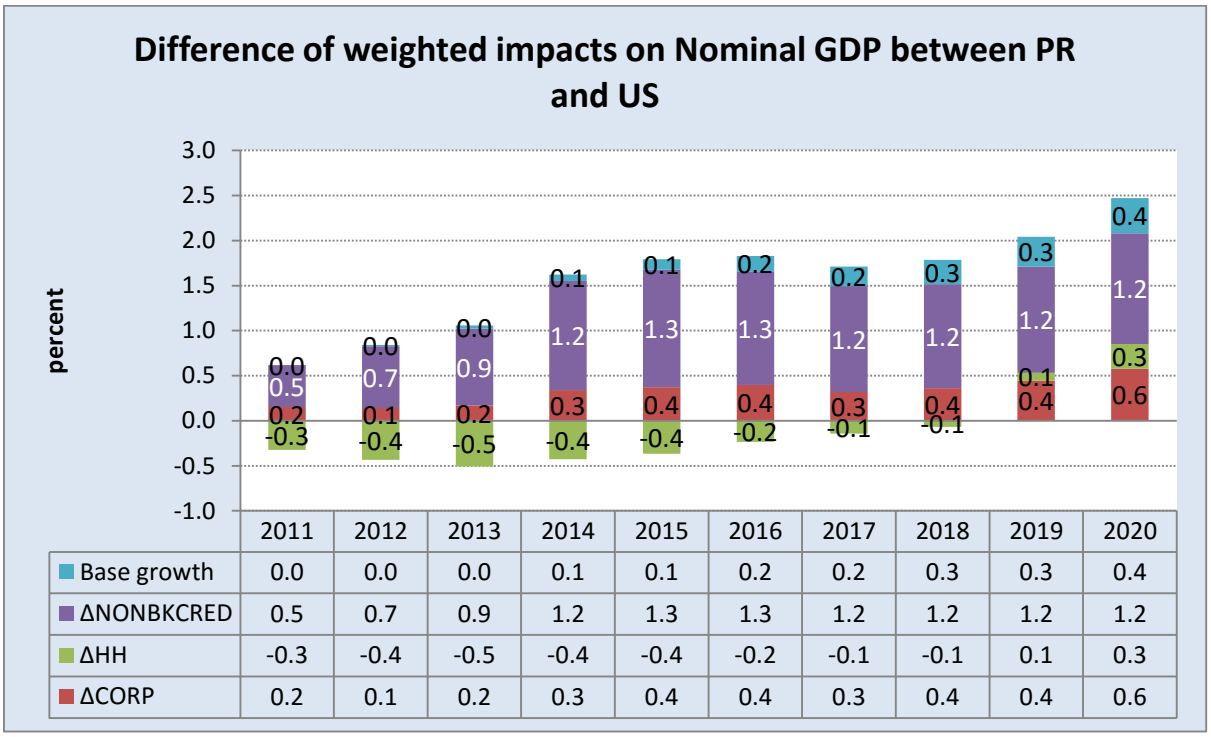
Together, these market developments serve as input to our GDP estimates, which in turn point to a significantly lower cumulative impact on the *nominal* economic output growth in PR by 2.5% (impact

[30] The fourth factor is a fixed long-term target set at 9.5% and 10% for PR and US, respectively. See Methodology section for details.

[31] That is, bank credit and shadow banking credit are reduced and augmented by 100% and 35%, respectively, as banks sell and transfer the loans from their own balance sheets to the shadow banks' balance sheets at 35% of the book value written-off.

of -1.7% in PR vs. -4.2% in US), as of the last projection year. The impact in PR halfway through the projection horizon was lower too by 1.4% (-2.6% in PR vs. -4.0% in US).[32]

Even though the effects on lending markets for both economies are relatively close and the fixed effects (i.e., the regression coefficients) from the banking industry's outputs are collectively larger in PR, the added impacts from shadow banking pressures in the US more than offset those effects. Moreover, as the simulation progresses, the compounding effects amplify the significance of shadow banking effects via the rest of the components, regardless of their independent contributions in any given year. This phenomenon can be observed through the difference of cumulative contributions from each predictive factor, from one economy to the other, as provided in Figure 6 (next).



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Base growth	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4
ΔNONBKCRED	0.5	0.7	0.9	1.2	1.3	1.3	1.2	1.2	1.2	1.2
ΔHH	-0.3	-0.4	-0.5	-0.4	-0.4	-0.2	-0.1	-0.1	0.1	0.3
ΔCORP	0.2	0.1	0.2	0.3	0.4	0.4	0.3	0.4	0.4	0.6

Figure 6

[32] Indeed, assigning the same shadow banking impact from the US GDP model (scaled by the percentage of intermediation conducted by the sector in each economy) to the PR model yields a cumulative impact therein of 5.2% and 6.3% of Nominal GDP foregone, and 12.5% and 11.7% reduction of private sector credit, halfway and throughout the simulation period, respectively.

Concluding Remarks & Recommendations

We conclude that the evidence substantiates a lower cumulative cost of transition from Basel III Reform on the Economy of PR in comparison with the US. As discussed, we believe that our model results are, at least, directionally consistent with the underlying characteristics of the economies at hand.

That being said, various enhancements could be achieved through the use of input-output multiplier methods or otherwise more sophisticated macroeconomic models incorporating feedback and non-linearities between the countries' macroeconomic variables. Also, other modeling approaches (e.g., DSGE models and SVAR's) that provide detailed breakdowns of the variation sources and more robust projected effects within the different countries would go a long way in explaining and supporting the differences between the contrasting economies. Further, the lack of rational optimizing agents, feedback effects and dynamic correction terms in our modeling framework, especially in the macroeconomic portion of the simulation, is a significant limitation because it amounts to assuming that past relations between variables are fixed throughout the projected horizon. Other potential improvements are:

- The use of bootstrapping techniques for the interest rate paths' projections
- The incorporation of G-SIFI, D-SIFI, and "near-SIFI" frameworks to the modeling approach
- A more sound feedback mechanism for deleveraging
- The incorporation of spillover effects, especially between the US and PR
- Incorporation of an output gap estimate specific to the economy of PR
- A more risk-sensitive division of assets, especially in terms of delinquencies as this has been cited overly as one of the most significant issues facing the Banking Industry of PR
- Survey of Banking Institutions to better assess, understand and calibrate the decision variables, and to guide expectations of business model changes

Another important consideration is the sample size. Due to the low volume of available data for some of the variables, the prediction power of the regression models and the hypotheses tests could be weak. Moreover, other methods of time-series analysis could better reflect the time-varying relations that are inherent within any economic time-series, such as in this study.

Despite these shortcomings, we believe that our findings are a significant contribution to the academic literature on the effects of Regulatory Reform brought about by the Basel III Framework and the resulting legislations. Indeed, being the first such study specific to the Economy of PR, it sets a precedent for discussion and further scrutiny. Thus, it would be a sensible effort to backtest the projections in both economies in order to reassess the findings in light of the actual Financial Sector responses and

macroeconomic developments, especially as financial disclosures align with the actual Regulatory Reform requisites. Nevertheless, it should be clear that our results don't *forecast* economic or industrial results of these countries but rather *project* the cumulative *impacts* without regard to other economic forces or agents.

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Appendix A

Model Variables		
Model Block	Variable	Definition
Balance Sheet Block	TA	Total Assets
	CASH	Cash
	GOV	Government bonds
	LIQ/TA	Liquid asset ratio
	IB	Domestic Interbank Loans
	IB(TB)	Domestic Interbank Loans in the Trading Book
	IB(BB)	Domestic Interbank Loans in the Banking Bank
	CORP	Domestic non-financial Loans
	CORP(TB)	Domestic non-financial Loans in the Trading Book
	CORP(BB)	Domestic Non-financial Loans in the Banking Book
	HH	Household Loans
	MORT	Mortgages
	CC	Other Loans
	EXTA	Foreign Loans
	EXTA(HG)	High-grade Foreign Loans
	EXTA(EM)	Risky (EM) Foreign Loans
	OTHERA	Other Assets
	Fixed Assets	Fixed Assets
	Other Assets	Other Assets
	RWA	Risk-weighted assets
	w_i	Risk-weight of Asset i
	$ASSET_i$	Asset i
	M1	Retail Deposits
	M2	Domestic financial Deposits
	M3	Wholesale (non-capital) Deposits
	M3(ST)	Wholesale Short-term Deposits
	M3(LT)	Wholesale Long-term Deposits
	EXTL	External Liabilities
	T2	Tier II Capital
	T1	Tier I Capital
	CET	Core Capital
	NONCORE	Non-core Capital
	REGCAP	Regulatory Capital
	REGADJ	Regulatory Adjustments
	CAP	Balance Sheet Capital
	REGCAP/RWA	Regulatory Capital
	BIS	Specifed Regulatory mínimum
	BUFCAP	National buffer (%pts)
	T1/RWA	Tier I
	CET/RWA	Core Tier I
	BIS(T1)	Specifed Regulatory minimum for Tier 1 Capital
	BUFCAP(T1)	National buffer (%pts)
	REQ(P2)	Buffer required by national supervisors under Pillar 2

		arrangements
	EXCESS	Excess buffer maintained by the banking system
	LEVRAT	Leverage ratio
	CASH/ASSETS	Cash/Assets
Core Capital Supply Block	NETNEWCET	Net issuance (extinguishment) of CET1 capital
	NEWCET	Required new issuance of CET1 capital
	RROE	Shadow price, or ex ante aspiration of the rate of return on equity that banks try to achieve.
	REDEF	Redefinition of capital effects
	PROFRET	Retained income
	PROFRET/PROF	% of profits retained
P&L Block	INTEARN	Interest earnings
	FFUNDS	Key policy rate
	BOND	10yr bond yield
	SPREAD (BANK)	Lending spread on Domestic Financial Loans
	SPREAD	Lending spread on Domestic Non-financial Loans
	EXTARATE(HG)	Rate of Return on External High-grade Loans
	SPREAD (EXTA)	Lending Spread on External (Risky) Loans
	REALRATE	Real Borrowing Rate
	INTEXP	Interest expenses
	M1FUNDSPREAD	Spread of Retail Funding Costs over official Key Policy Rate
	M2FUNDSPREAD	Spread of Domestic Financial Funding Costs over official Key Policy Rate
	M3(ST)FUNDSPREAD	Spread of Short Term Wholesale Funding Costs over official Key Policy Rates
	M3(LT)FUNDSPREAD	Spread of Long Term Wholesale Funding Costs over official Key Policy Rates
	RATEEXTL	Average interest rate on external funding
	NIE	Net interest earnings
	OOE	Other earnings
	NIC	Non-interest costs
	Operating profits (pre-credit losses)	Operating profits (pre-credit losses)
	CREDLOSS	Credit Losses (-)
	OTHERGL	Other gains or losses
	EXTRAGAINS	Extraordinary gains, net
	PROFIT	Income before tax
	TAX	Income Taxes
	POSTTAXPROFIT	Net Income
	ROE	Return on Equity
	ROA	Return on Assets
Macroeconomic Block	PGDP	GDP deflator
	OUTPUTGAP	Ibid
	NONBKCRED	Private sector credit from the Non-bank Industry
	BANKCRED+NONBKCRED	Private sector credit
	NOMGDP	Nominal GDP

Appendix B

Variable Equations			
Model Block	Variable	$f(x_t)_{BASE} \mid 2010 \leq t \leq 2020$	$f(x_t)_{REG} \mid 2010 \leq t \leq 2020$
Balance Sheet Block	TA	CASH + GOV + IB + CORP + HH + EXTA + OTHERA	CASH + GOV + IB + CORP + HH + EXTA + OTHERA
	CASH	TA x 7.5% | t = 2010 TA x 7.0% | t = 2011 TA x 6.5% | t = 2012 TA x 6.0% | t = 2013 TA x 5.5% | t = 2014 TA x 5.0% | t = 2015 TA x 5.0% | t = 2016 TA x 5.0% | t = 2017 TA x 5.0% | t = 2018 TA x 5.0% | t = 2019 TA x 5.0% | t = 2020	TA x 7.5% | t = 2010 TA x 7.0% | t = 2011 TA x 6.5% | t = 2012 TA x 6.0% | t = 2013 TA x 5.5% | t = 2014 TA x 5.0% | t = 2015 TA x 5.0% | t = 2016 TA x 5.0% | t = 2017 TA x 5.0% | t = 2018 TA x 5.0% | t = 2019 TA x 5.0% | t = 2020
	GOV	TA x 12.0% | t = 2010 TA x 12.5% | t = 2011 TA x 13.0% | t = 2012 TA x 13.5% | t = 2013 TA x 14.0% | t = 2014 TA x 14.0% | t = 2015 TA x 13.0% | t = 2016 TA x 12.0% | t = 2017 TA x 11.0% | t = 2018 TA x 10.0% | t = 2019 TA x 10.0% | t = 2020	TA x 12.5% | t = 2010 TA x 14.0% | t = 2011 TA x 15.5% | t = 2012 TA x 16.0% | t = 2013 TA x 14.5% | t = 2014 TA x 15.0% | t = 2015 TA x 14.0% | t = 2016 TA x 14.0% | t = 2017 TA x 13.0% | t = 2018 TA x 13.0% | t = 2019 TA x 13.0% | t = 2020
	LIQ/TA	(CASH + GOV)/TA	(CASH + GOV)/TA

	IB	M1 x 1.21% | t = 2010 M1 x 1.16% | t = 2011 M1 x 0.74% | t = 2012 M1 x 0.70% | t = 2013 M1 x 0.69% | t = 2014 M1 x 0.70% | t = 2015 M1 x 0.71% | t = 2016 M1 x 0.72% | t = 2017 M1 x 0.70% | t = 2018 M1 x 0.67% | t = 2019 M1 x 0.65% | t = 2020	M1 x 1.22% | t = 2010 M1 x 1.18% | t = 2011 M1 x 0.76% | t = 2012 M1 x 0.72% | t = 2013 M1 x 0.72% | t = 2014 M1 x 0.74% | t = 2015 M1 x 0.75% | t = 2016 M1 x 0.76% | t = 2017 M1 x 0.73% | t = 2018 M1 x 0.71% | t = 2019 M1 x 0.68% | t = 2020
	IB(TB)	IB - IB(BB)	IB - IB(BB)
	IB(BB)	IB(BB)/(33.3%) | t = 2010 IB(BB)/(33.3%) | t = 2011 IB(BB)/(50.0%) | t = 2012 IB(BB)/(50.0%) | t = 2013 IB(BB)/(52.0%) | t = 2014 IB(BB)/(53.5%) | t = 2015 IB(BB)/(55.5%) | t = 2016 IB(BB)/(56.5%) | t = 2017 IB(BB)/(55.5%) | t = 2018 IB(BB)/(55.5%) | t = 2019 IB(BB)/(54.5%) | t = 2020	IB(BB)/(33.3%) | t = 2010 IB(BB)/(33.3%) | t = 2011 IB(BB)/(50.0%) | t = 2012 IB(BB)/(50.0%) | t = 2013 IB(BB)/(52.0%) | t = 2014 IB(BB)/(53.5%) | t = 2015 IB(BB)/(55.5%) | t = 2016 IB(BB)/(56.5%) | t = 2017 IB(BB)/(55.5%) | t = 2018 IB(BB)/(55.5%) | t = 2019 IB(BB)/(54.5%) | t = 2020
	Δ(CORP+HH)/(CORP+HH)	$\alpha + \beta_1(\Delta NOMGDP/NOMGDP)_{t-1} + \beta_2 \Delta REALRATE + \beta_3(REALRATE_{REG}-REALRATE_{BASE})$	$\alpha + \beta_1(\Delta NOMGDP/NOMGDP_{t-1}) + \beta_2 \Delta REALRATE - \beta_3(REALRATE_{REG}-REALRATE_{BASE})$
	CORP	CORP(TB) + CORP(BB)	CORP(TB) + CORP(BB)
	CORP(TB)	CORP - CORP(BB)	CORP - CORP(BB)

	CORP(BB)	CORP x 75.00% | t = 2010 CORP x 78.75% | t = 2011 CORP x 81.00% | t = 2012 CORP x 80.75% | t = 2013 CORP x 80.50% | t = 2014 CORP x 80.75% | t = 2015 CORP x 81.25% | t = 2016 CORP x 81.25% | t = 2017 CORP x 82.25% | t = 2018 CORP x 83.25% | t = 2019 CORP x 84.00% | t = 2020	CORP x 75.00% | t = 2010 CORP x 78.75% | t = 2011 CORP x 81.00% | t = 2012 CORP x 80.75% | t = 2013 CORP x 80.50% | t = 2014 CORP x 80.75% | t = 2015 CORP x 81.25% | t = 2016 CORP x 81.25% | t = 2017 CORP x 82.25% | t = 2018 CORP x 83.25% | t = 2019 CORP x 84.00% | t = 2020
	HH	MORT + CC	MORT + CC
	MORT	HH – CC	HH – CC
	CC	HH x 28.00% | t = 2010 HH x 30.75% | t = 2011 HH x 31.75% | t = 2012 HH x 34.25% | t = 2013 HH x 35.25% | t = 2014 HH x 37.25% | t = 2015 HH x 39.75% | t = 2016 HH x 41.50% | t = 2017 HH x 43.50% | t = 2018 HH x 45.25% | t = 2019 HH x 46.75% | t = 2020	HH x 28.00% | t = 2010 HH x 30.75% | t = 2011 HH x 31.75% | t = 2012 HH x 34.25% | t = 2013 HH x 35.25% | t = 2014 HH x 37.25% | t = 2015 HH x 39.75% | t = 2016 HH x 41.50% | t = 2017 HH x 43.50% | t = 2018 HH x 45.25% | t = 2019 HH x 46.75% | t = 2020
	EXTA	$\alpha + \beta(\Delta NOMGDP/NOMGDP)$	$\alpha + \beta(\Delta NOMGDP/NOMGDP)$
	EXTA(HG)	EXTA x 30%	EXTA x 30%
	EXTA(EM)	EXTA x 70%	EXTA x 70%
	OTHERA	Fixed Assets + Other Assets	Fixed Assets + Other Assets
	Fixed Assets	$\alpha + \beta(\Delta NOMGDP/NOMGDP)$	$\alpha + \beta(\Delta NOMGDP/NOMGDP)$
	Other Assets	$\alpha + \beta(\Delta NOMGDP/NOMGDP)$	$\alpha + \beta(\Delta NOMGDP/NOMGDP)$
	w_i	w_i | i={CASH, GOV, IB(TB), IB(BB), CORP(TB),CORP(BB) HH, EXTA, OTHERA}	w_i | i={CASH, GOV, IB(TB), IB(BB), CORP(TB),CORP(BB) HH, EXTA, OTHERA}
	$ASSET_i$	$ASSET_i$ | i={CASH, GOV, IB(TB), IB(BB), CORP(TB),CORP(BB) HH, EXTA, OTHERA}	$ASSET_i$ | i={CASH, GOV, IB(TB), IB(BB), CORP(TB),CORP(BB) HH, EXTA, OTHERA}

	RWA	∑wiASSETi	∑wiASSETi
	M1	α + β(ΔNOMGDP/NOMGDP)	α + β(ΔNOMGDP/NOMGDP)
	M2	α + β(ΔNOMGDP/NOMGDP)	α + β(ΔNOMGDP/NOMGDP)
	M3	TA - M1 - M2 - EXTL - CAP	TA - M1 - M2 - EXTL – CAP
	M3(ST)	M3 x 42% | t = 2010 M3 x 34% | t = 2011 M3 x 25% | t = 2012 M3 x 20% | t = 2013 M3 x 15% | 2014 ≤ t ≤ 2017 M3 x 10% | 2018 ≤ t ≤ 2020	M3 x 42% | t = 2010 M3 x 34% | t = 2011 M3 x 25% | t = 2012 M3 x 20% | t = 2013 M3 x 15% | 2014 ≤ t ≤ 2017 M3 x 10% | 2018 ≤ t ≤ 2020
	M3(LT)	M3 - M3(ST)	M3 - M3(ST)
	EXTL	α + β(ΔNOMGDP/NOMGDP)	α + β(ΔNOMGDP/NOMGDP)
	CAP	REGCAP + REGADJ	REGCAP + REGADJ
	T2	α + βRWA - REDEF | PR	α + βRWA - REDEF | PR
		$T2_{t-1}$ - REDEF | US	$T2_{t-1}$ - REDEF | US
	T1	CET + NONCORE	CET + NONCORE
	CET	CET_{t-1} + NEWCET + PROFRET + REDEF	CET_{t-1} + NEWCET + PROFRET + REDEF
	NONCORE	α + βM3(ST) | PR	α + βM3(ST) | PR
		α + βRWA | US	α + βRWA | US
	REGCAP	T1+T2	T1+T2
	REGADJ	0 | PR | 2014 ≤ t ≤ 2018	64 x 0.61% | PR | 2014 ≤ t ≤ 2018
		0 | US | 2014 ≤ t ≤ 2018	64 | US | 2014 ≤ t ≤ 2018
	BIS	8.000% | 2010 ≤ t ≤ 2020	8.000% | 2010 ≤ t ≤ 2015 8.625% | t = 2016 9.250% | t = 2017 9.875% | t = 2018 10.50% | 2019 ≤ t ≤ 2020
	BUFCAP	REGCAP/RWA - BIS	REGCAP/RWA – BIS
	BIS(T1)	4% | 2010 ≤ t ≤ 2020	4.000% | 2010 ≤ t ≤ 2014 4.500% | t = 2015 5.125% | t = 2016 5.750% | t = 2017 6.375% | t = 2018 7.000% | 2019 ≤ t ≤ 2020
	BUFCAP(T1)	T1/RWA-BIS(T1)	T1/RWA-BIS(T1)

	REQ(P2)	7.3% | PR	7.3% | PR
		5.9% | US	5.9% | US
	EXCESS	BUFCAP(T1)-REQ(P2)	BUFCAP(T1)-REQ(P2)
	LEVRAT	TA/REGCAP	TA/REGCAP
	CASH/ASSETS	CASH/TA	CASH/TA
Core Capital Supply Block	NetNEWCET	NEWCET + REDEF + PROFRET	NEWCET + REDEF + PROFRET
	NEWCET	0 | PR	Max[(1.5% x RWA) - NETNEWCET,0] | PR
		0 | US	Max[(1.0% x RWA) - NETNEWCET,0] | US
	RROE	Target + θ_1(CET growth - Nominal GDP growth)$_{t-1}$ + θ_2(Target-Realized ROE)$_{t-1}$ + θ_3(EXCESS)$_{t-1}$	Target + θ_1(CET growth - Nominal GDP growth)$_{t-1}$ + θ_2(Target-Realized ROE)$_{t-1}$ + θ_3(EXCESS)$_{t-1}$
	REDEF	0 | PR	0 | PR | 2010 ≤ t ≤ 2013 - 208 Million | PR | 2014 ≤ t ≤ 2018 0 | PR | 2019 ≤ t ≤ 2020
		0 | US	0 | US | 2010 ≤ t ≤ 2013 - 39 Billion | US | 2014 ≤ t ≤ 2018 0 | US | 2019 ≤ t ≤ 2020
	PROFRET/POSTTAXPROFIT	0.00% | PR | 2010 ≤ t ≤ 2012 6.43% | PR | 2013 ≤ t ≤ 2020	32.14% | PR | t = 2010 19.29% | PR | 2011 ≤ t ≤ 2013 16.07% | PR | t = 2014 6.430% | PR | 2015 ≤ t ≤ 2020
		0.00% | US | 2010 ≤ t ≤ 2012 10.0% | US | 2013 ≤ t ≤ 2020	50.00% | US | t = 2010 30.00% | US | 2011 ≤ t ≤ 2013 25.00% | US | t = 2014 10.00% | US | 2015 ≤ t ≤ 2020
	PROFRET	POSTTAXPROFIT x (PROFRET/POSTTAXPROFIT)	POSTTAXPROFIT x (PROFRET/POSTTAXPROFIT)
P&L Block	INTEARN	FFUNDS x CASH + BOND x GOV + BOND x IB(TB) + (BOND +SPREAD$_{IB}$) x IB(BB) + (BOND + SPREAD$_{CORP}$) x CORP + (BOND + SPREAD$_{CORP}$) x HH + EXTARATE(HG) x EXTA(HG) + (BOND + SPREAD$_{EXTA}$) x EXTA(EM)	FFUNDS x CASH + BOND x GOV + BOND x IB(TB) + (BOND +SPREAD$_{IB}$) x IB(BB) + (BOND + SPREAD$_{CORP}$) x CORP + (BOND + SPREAD$_{CORP}$) x HH + EXTARATE(HG) x EXTA(HG) + (BOND + SPREAD$_{EXTA}$) x EXTA(EM)

	FFUNDS	0.13% | 2010 ≤ t ≤ 2015 0.50% | t = 2016 1.00% | t = 2017 1.25% | 2018 ≤ t ≤ 2019 1.50% | t = 2020	0.13% | 2010 ≤ t ≤ 2015 0.50% | t = 2016 1.00% | t = 2017 1.25% | 2018 ≤ t ≤ 2019 1.50% | t = 2020
	BOND	3.86% | t = 2010 4.00% | t = 2011 4.25% | 2012 ≤ t ≤ 2013 4.50% | t = 2014 4.25% | t = 2015 4.00% | 2016 ≤ t ≤ 2017 3.75% | t = 2018 3.50% | 2019 ≤ t ≤ 2020	3.86% | t = 2010 4.00% | t = 2011 4.25% | 2012 ≤ t ≤ 2013 4.50% | t = 2014 4.25% | t = 2015 4.00% | 2016 ≤ t ≤ 2017 3.75% | t = 2018 3.50% | 2019 ≤ t ≤ 2020
	$SPREAD_{IB}$	0.75%	0.75%
	$SPREAD_{CORP}$	2.13% | PR | t = 2010 1.61% | PR | t = 2011 2.16% | PR | t = 2012 2.26% | PR | t = 2013 2.42% | PR | t = 2014 2.67% | PR | t = 2015 2.93% | PR | t = 2016 3.23% | PR | t = 2017 3.46% | PR | t = 2018 3.98% | PR | t = 2019 3.99% | PR | t = 2020	2.20% | PR | t = 2010 2.83% | PR | t = 2011 3.62% | PR | t = 2012 4.00% | PR | t = 2013 4.31% | PR | t = 2014 3.96% | PR | t = 2015 3.92% | PR | t = 2016 4.15% | PR | t = 2017 4.35% | PR | t = 2018 4.49% | PR | t = 2019 4.70% | PR | t = 2020

		1.27% | US | t = 2010 0.15% | US | t = 2011 0.62% | US | t = 2012 0.62% | US | t = 2013 0.83% | US | t = 2014 0.84% | US | t = 2015 0.88% | US | t = 2016 1.10% | US | t = 2017 1.17% | US | t = 2018 1.42% | US | t = 2019 1.46% | US | t = 2020	1.49% | US | t = 2010 1.38% | US | t = 2011 1.73% | US | t = 2012 1.87% | US | t = 2013 2.33% | US | t = 2014 2.07% | US | t = 2015 2.00% | US | t = 2016 2.12% | US | t = 2017 2.16% | US | t = 2018 2.34% | US | t = 2019 2.39% | US | t = 2020
	EXTARATE(HG)	3.00% | t = 2010 2.80% | 2011 ≤ t ≤ 2015 3.00% | 2016 ≤ t ≤ 2020	3.00% | t = 2010 2.80% | 2011 ≤ t ≤ 2015 3.00% | 2016 ≤ t ≤ 2020
	$SPREAD_{EXTA}$	6.00% | 2010 ≤ t ≤ 2011 6.20% | t = 2012 6.50% | t = 2013 6.25% | 2014 ≤ t ≤ 2020	6.00% | 2010 ≤ t ≤ 2011 6.20% | t = 2012 6.50% | t = 2013 6.25% | 2014 ≤ t ≤ 2020
	REALRATE	BOND + SPREAD – PGDPG	BOND + SPREAD – PGDPG
	INTEXP	(FFUNDS + M1FUNDSPREAD) x M1 + (FFUNDS + M2FUNDSPREAD) x M2 + (FFUNDS + M3FUNDSPREAD) x M3(ST) + (BOND + M3FUNDSPREAD) x M3(LT) + EXTLRATE x EXTL	(FFUNDS + M1FUNDSPREAD) x M1 + (FFUNDS + M2FUNDSPREAD) x M2 + (FFUNDS + M3FUNDSPREAD) x M3(ST) + (BOND + M3FUNDSPREAD) x M3(LT) + EXTLRATE x EXTL
	M1FUNDSPREAD	1.25%	1.25%
	M2FUNDSPREAD	0.00%	0.00%
	M3(ST)FUNDSPREAD	0.00%	0.00%
	M3(LT)FUNDSPREAD	0.00% | t = 2010 2.00% | 2011 ≤ t ≤ 2020	0.00% | t = 2010 2.00% | 2011 ≤ t ≤ 2020
	RATEEXTL	0.10%	0.10%

	NIE	INTEARN - INTCOST	INTEARN – INTCOST
	OOE	$\alpha + \beta(\Delta NOMGDP/NOMGDP)$	$\alpha + \beta(\Delta NOMGDP/NOMGDP)$
	NIC	$\alpha + \beta(\Delta NOMGDP/NOMGDP)$	$\alpha + \beta(\Delta NOMGDP/NOMGDP)$
	PROFIT	NIE + OOE - NIC + EXTRAGAINS	NIE + OOE - NIC + EXTRAGAINS
	TAX	PROFIT x 30% | t = 2010 PROFIT x 40% | t = 2011 PROFIT x 30% | 2012 ≤ t ≤ 2020	PROFIT x 30% | t = 2010 PROFIT x 40% | t = 2011 PROFIT x 30% | 2012 ≤ t ≤ 2020
	POSTTAXPROFIT	PROFIT – TAX	PROFIT - TAX
	ROE	POSTTAXPROFIT/CAP	POSTTAXPROFIT/CAP
	ROA	POSTTAXPROFIT/TA	POSTTAXPROFIT/TA
Macroeconomic Block	NOMGDP growth	$\alpha + \beta_1\Delta CORP/CORP + \beta_2\Delta HH/HH \mid PR$	$\alpha + \beta_1\Delta CORP/CORP + \beta_2\Delta HH/HH \mid PR$
		$\alpha + \beta_1\Delta CORP/CORP + \beta_2\Delta HH/HH + \beta_3\Delta NONBKCRED/NONBKCRED \mid US$	$\alpha + \beta_1\Delta CORP/CORP + \beta_2\Delta HH/HH + \beta_3\Delta NONBKCRED/NONBKCRED \mid US$
	PGDP	1.4% | t = 2010 2.0% | t = 2011 2.5% | t = 2012 2.9% | t = 2013 2.7% | t = 2014 2.8% | 2015 ≤ t ≤ 2019 2.7% | t = 2020	1.4% | t = 2010 2.0% | t = 2011 2.5% | t = 2012 2.9% | t = 2013 2.7% | t = 2014 2.8% | 2015 ≤ t ≤ 2019 2.7% | t = 2020
	OUTPUTGAP	-2.80% | t = 2010 -1.40% | t = 2011 -0.20% | t = 2012 0.80% | t = 2013 0.40% | t = 2014 0.50% | t = 2015 0.70% | t = 2016 0.50% | 2017 ≤ t ≤ 2019 0.40% | t = 2020	-2.80% | t = 2010 -1.40% | t = 2011 -0.20% | t = 2012 0.80% | t = 2013 0.40% | t = 2014 0.50% | t = 2015 0.70% | t = 2016 0.50% | 2017 ≤ t ≤ 2019 0.40% | t = 2020
	BANKCRED	CORP+HH	CORP+HH
	ΔNONBKCRED/NONBKCRED	$\alpha + \beta\Delta BANKCRED/BANKCRED$	$\alpha + \beta\Delta BANKCRED/BANKCRED$

Appendix C

SUMMARY OUTPUT FOR US GDP REGRESSION MODEL

Regression Statistics	
Multiple R	0.888504
R Square	0.78944
Adjusted R Square	0.740849
Standard Error	1.016939
Observations	17

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	50.40526	16.80175	16.24668	0.00011
Residual	13	13.44415	1.034165		
Total	16	63.84941			

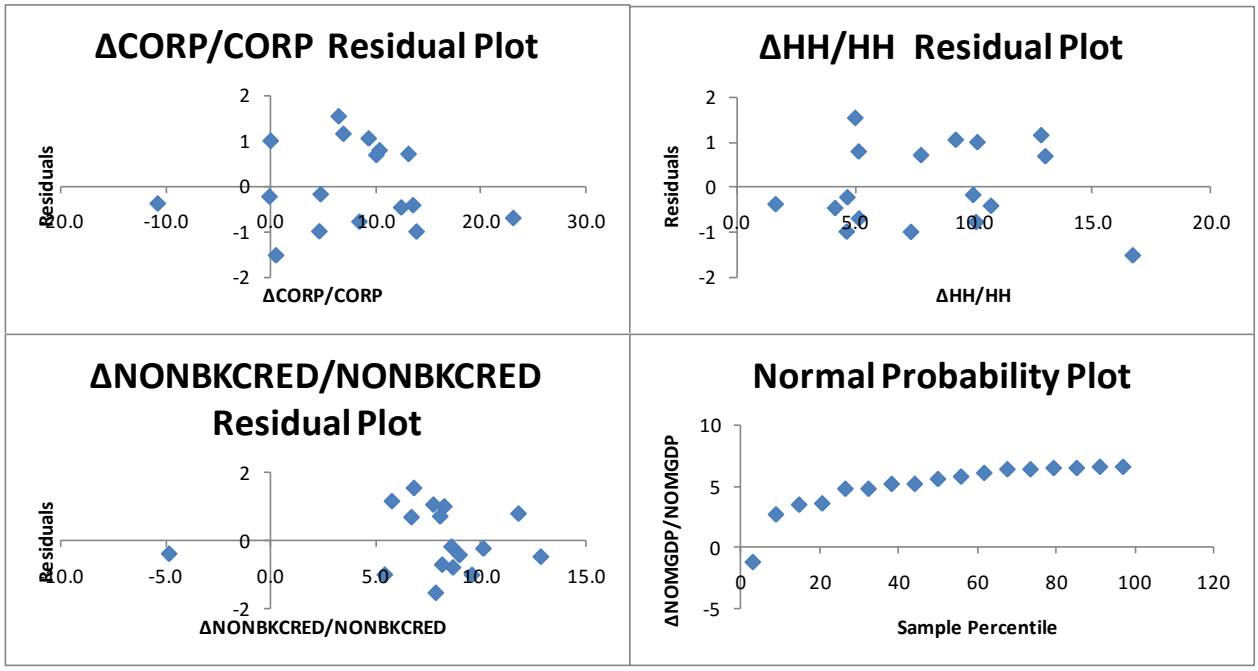
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 90.0%*	*Upper 90.0%*
Intercept	2.995109	0.724488	1.859301	0.085762	1.712088	4.278129
ΔCORP/CORP	0.156252	0.042687	3.660383	0.00288	0.080656	0.231848
ΔHH/HH	0.138811	0.065746	2.111338	0.054675	0.02238	0.255242
ΔNONBKCRED/NONBKCRED	0.165045	0.087389	1.888616	0.081459	0.010284	0.319805

RESIDUAL OUTPUT

Observation	*Predicted ΔNOMGDP/NOMGDP*	*Residuals*
1	4.115941	0.984059
2	5.160722	1.139278
3	5.49707	-0.79707
4	4.175776	1.524224
5	7.016424	-0.71642
6	5.983372	-0.48337
7	5.623692	0.776308
8	5.362588	1.037412
9	3.644471	-0.24447
10	5.038532	-1.53853

11	4.891819	-0.19182
12	5.828852	0.671148
13	5.804963	0.695037
14	6.433912	-0.43391
15	6.115628	-1.01563
16	3.609526	-1.00953
17	-0.90329	-0.39671

RESIDUAL ANALYSIS



We test Linearity and Homoscedasticity with the Residual Plots for each of the independent variables (no apparent pattern).

We test the Normality assumption with the Normal Probability Plot (shows no substantial departure and robustness of regression analysis enables us to conclude that Normality assumption isn't an issue in this case).

We test for autocorrelation among residuals with the Durbin-Watson statistic and conclude that errors are independent (because $d = 1.77 > 1.71 = d_{U,10\%}$).

SUMMARY OUTPUT FOR PR GDP
REGRESSION MODEL

Regression Statistics	
Multiple R	0.967187
R Square	0.935451
Adjusted R Square	0.909632
Standard Error	0.535423
Observations	8

ANOVA

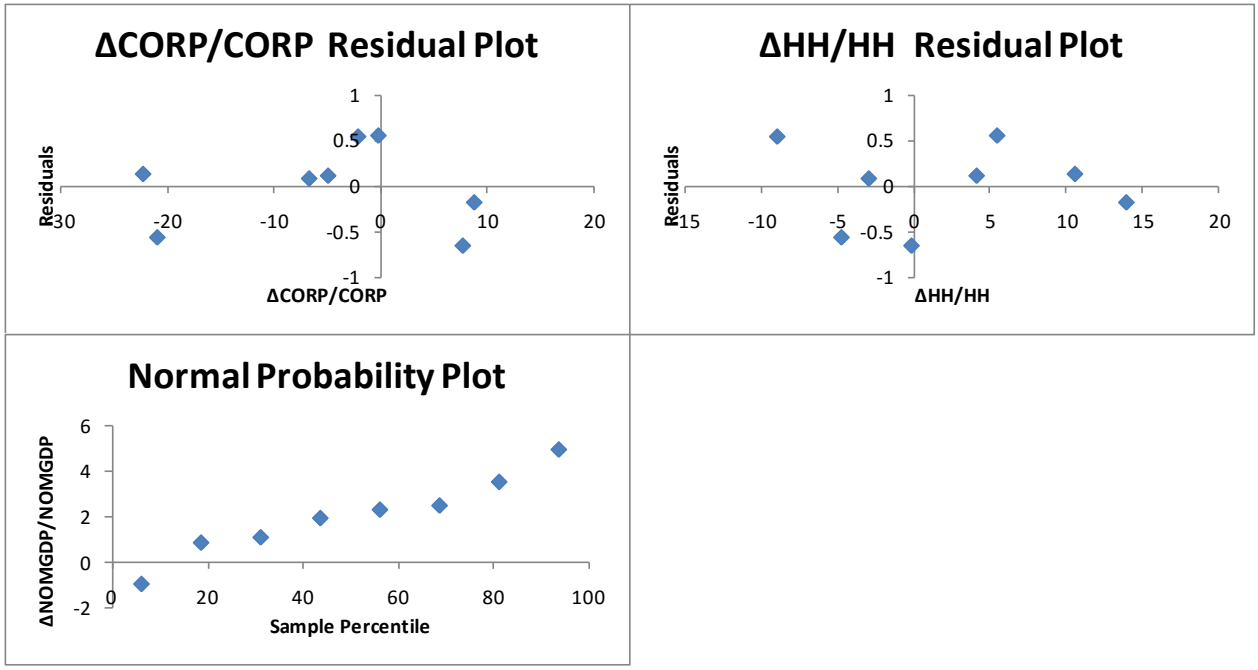
	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	20.77297	10.38648	36.23056	0.001059
Residual	5	1.433387	0.286677		
Total	7	22.20635			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 90.0%*	*Upper 90.0%*
Intercept	2.000488	0.220521	9.071625	0.000272	1.556127	2.444849
ΔCORP/CORP	0.076335	0.017682	4.316978	0.007592	0.040704	0.111966
ΔHH/HH	0.173473	0.026105	6.645074	0.001164	0.120869	0.226076

RESIDUAL OUTPUT

Observation	*Predicted ΔNOMGDP/NOMGDP*	*Residuals*
1	5.088234	-0.18388
2	2.928892	0.554009
3	2.555429	-0.66196
4	2.335552	0.110494
5	0.96959	0.079617
6	-0.42842	-0.57008
7	0.274503	0.542385
8	2.134378	0.129409

RESIDUAL ANALYSIS



We test Linearity and Homoscedasticity with the Residual Plots for each of the independent variables (no apparent pattern).

We test the Normality assumption with the Normal Probability Plot (shows no substantial departure and robustness of regression analysis enables us to conclude that Normality assumption isn't an issue in this case).

We test for autocorrelation among residuals with the Durbin-Watson statistic and the test result of independence is inconclusive (because $d_{L,10\%} = 2.29 < 3.11 = (4\text{-}d) < 3.44 = d_{U,10\%}$).