DEVTECH

AN ASSESSMENT OF THE GOVERNMENT OF PUERTO RICO 2023 TAX REFORM

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EXECUTIVE SUMMARY

This study considers the economic impact of the Tax Reform Proposal of 2023 of the Government of Puerto Rico. The purpose of the study is to measure the impact of the proposed Corporate and Individual Income Tax changes on the current economic conditions (from a cyclical and conjunctural perspective), long-term economic growth, fiscal revenues (or scoring the reform), and population and jobs.

In terms of the impact of the proposed reform given the cyclical economic conditions, the study finds that the proposed reform is a positive development given the economic headwinds that Puerto Rico is facing. At the time of writing, the economy of Puerto Rico continues to face the twin challenges of historic high inflation and continued monetary tightening by the Federal Reserve. The proposed tax reform will both assist in slowing inflation directly and deliver supply-side incentives (to both investment and labor market participation) to help accommodate growth without inflation and buffer the economy from the monetary policy adjustment.

Turning to long-term growth, the study finds the statistically and economically significant result that tax reform will spur economic growth. In the case of Puerto Rico, the results suggest nearly one percent higher real GNP growth as a result of the reform, when compared to the counterfactual of no reform. This result is robust in the data and is consistent with the empirical literature studying similar reforms other jurisdictions.

With regard to cost, the study distinguishes between the static cost of the reform, as calculated by the Puerto Rico Treasury Department (Hacienda), and the dynamic costs. The latter reflect the revenue recovery from tax revenues that accrue to the government from higher growth resulting from the tax reform. The study scores the reform proposal dynamically and compares the revenue to the static estimate, finding that higher economic growth and other related economic factors help the Government of Puerto Rico recover roughly 50 percent of the static cost (foregone tax revenue) of the reform.

Finally, the study considers the impact of the proposed reform on the population of Puerto Rico, which is particularly relevant because of the trend decline in population over the past decade. The reform proposal has the ability to generate an increase in population of 15,000 citizens in the scenario of reform versus no reform (holding all other elements equal). This compares to an average loss of population of approximately 80,000 citizens per year prior to the COVID-19 pandemic.

There are numerous limitations that should be acknowledged due to a variety of factors, including time and data constraints. The scope of this study is constrained by data availability and the pace of the legislative and Fiscal Plan certification processes and hence we acknowledge the fertile territory for more future work in this area to refine the results over time. A more important limitation is the constraint on data. We transparently outline the econometric approach used, which is focused on the dynamic scoring of the proposed reform.

Insofar as the study leverages time-series data, it is limited in its ability to explore nuances in policy reforms over time, simply because there are too few annual datapoints after 1965. Taking the timeseries approach allows the study to be fully methodological consistent with previous versions of the model, since this version contains the same previous equations plus those associated with the reformed taxes. The power of the timeseries analysis is to deliver the relationship between reform and growth and tie back to the very successful model behind the Fiscal Plan, which allows for a clear result on revenues, growth, etc., grounding in Puerto Rico data. The study presents the modeling approach and results first, and then reports the findings for the cyclical economic outturn, long-term growth, fiscal revenues, and population growth, in that order.

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ACRONYMS

GDP	Gross Domestic Product
GNP	Gross National Product
IMF	International Monetary Fund
NAIRU	Non-accelerating Inflation Rate of Unemployment
SUR	Seemingly Unrelated Regression
SUT	Sales and Use Tax
SURI	Unified Internal Revenue System
WEO	World Economic Outlook

INTRODUCTION

As a small island economy, Puerto Rico faces numerous challenges in maintaining a stable and growing economy. These challenges include population decline, long-term growth concerns, and vulnerability to climate and external economic shocks. With the current economic environment in the United States, there are both short-term and long-term challenges confronting Puerto Rico's economy. Reductions to corporate and personal income taxes in Puerto Rico can be a supportive policy for addressing these challenges as they can help counteract short-term growth slowdowns and inflationary pressures while also stimulating long-term growth. In this technical report, we will discuss how reductions to corporate and personal income taxes can help Puerto Rico counteract these economic challenges using highly reputable economic research and historical examples to support our arguments.

To start, one may consider how reducing taxes can help Puerto Rico counteract short-term growth slowdowns that may come from monetary tightening from the Federal Reserve in the United States. In such situations, businesses may slow down their investment, and consumers may cut back their spending as borrowing costs increase. Reducing taxes can help offset these negative impacts by providing consumers with more disposable income, thereby increasing consumption and stimulating the economy. Additionally, tax reductions can provide businesses with more capital to invest, creating more jobs and spurring economic growth. An American Economic Review study found that individual income tax reductions have a positive effect on GDP growth, with a one percent reduction in taxes increasing GDP by 2.2 percent within two years (Mertens and Ravn, 2013).[1]

Furthermore, implementing tax reductions can be a counter-inflationary measure that helps keep costs down as inflation surges in the United States due to factors such as commodity shocks, global value chain disruptions, or large amounts of fiscal stimulus. As a small island economy, Puerto Rico is particularly vulnerable to external inflationary pressures, as the economy is heavily reliant on imports, particularly energy and food imports. By reducing the tax burden on consumers and businesses, tax reductions can help to keep prices down and mitigate inflationary pressures in the short run. Moreover, tax reductions can be supportive policies not just for short-term growth, but for families, jobs, labor force participation, and other long-term structural economic challenges. Reducing taxes can provide an incentive for businesses to invest and innovate in Puerto Rico, creating more productive jobs and boosting labor force participation rates. Additionally, tax reductions can increase the disposable income of families, allowing them to save more and invest in their future, counteracting the population decline challenges facing Puerto Rico's economy. In the United States lowering taxes has been shown to spur long-term growth. For example, the Tax Cut and Jobs Act of 2017 is estimated to have increased GDP growth in 2018 and 2019.[2]

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1. Mertens, Karel, and Morten O. Ravn. 2013. "The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States." American Economic Review, 103 (4): 1212-47.
2. Mertens, K. (2019), U.S. Tax Cuts Boost Economy—but for How Long? https://www.dallasfed.org/research/economics/2019/0604

TAX REFORM IN PUERTO RICO

Puerto Rico's tax system has undergone numerous changes and reforms over the past decades.[3] These changes have resulted in complex and confusing regulations, discouraging investment and entrepreneurship. Factors such as government bankruptcy, global macroeconomic shocks , and natural disasters have also contributed to the gradual decrease in the tax base. To address this challenge, Puerto Rico has moved to simplify its tax system by reducing tax rates, promoting equity , and improving revenue collection. A review of the current tax system is necessary to ensure that it meets the principles of simplicity, tax equity, neutrality, and administrative economy. The gradual implementation of the Unified Internal Revenue System (SURI) has provided technological tools to taxpayers to allow them to carry out electronic transactions, saving time and money. Despite these achievements, Puerto Rico's Governor has appointed an advisory group to comprehensively review the tax system and propose additional reforms to further support a fair, efficient, and growth-promoting tax system. The proposed tax system must be designed to simplify processes, procedures, and tax burdens, allowing individuals and small businesses to meet their obligations with reasonable effort and without having to hire professionals. It should also recognize the efforts of local entrepreneurs and put them on equal footing with other taxpayers who enjoy substantial incentives.

THE CURRENT REFORM'S IMPACT ON ECONOMIC GROWTH

General Results from Prior Work

The impact of tax reductions on economic growth and fiscal revenues depends on a variety of factors, including the size and scope of the reductions, the economic conditions at the time the reductions are implemented, and the specific tax policies being pursued. Lowering income taxes can have several positive effects on the economy.

The economic profession's view on the impact of reductions in corporate and personal income tax rates on economic growth and fiscal revenues is a topic of ongoing debate and research. There are several general technical points that economists often consider when evaluating the impact of tax reductions discussed below.

On the supply-side, reducing taxes incentivizes economic growth as economic agents perceive a higher return to economic activities resulting from lower taxes (akin to a wage increase or higher profits). One of the main arguments in favor of tax reductions is that they can stimulate economic growth by increasing incentives for individuals and businesses to work, save, and invest. By reducing the tax burden on individuals and businesses, lowering taxes can increase the return on investment, which can in turn lead to higher levels of

3. See Annex A for a brief description of the different tax reforms in Puerto Rico since 1948.

investment, innovation, and economic growth. Indeed, several pieces of the literature find that economic growth follows tax reductions (Ferede et al., 2012; Mertens and Montiel, 2018;[4] Zidar, 2019;[5] Ljungvist and Smolyansky, 2018;[6] Nguyen et al, 2021;[7] Cloyne et al, 2018).[8] Moreover, there are also compelling theoretical frameworks that deliver both theory and evidence that tax reductions "pay for themselves" up to a certain point (Mankiw and Weinzierl, 2006).[9] That means that an increase in economic growth will generate additional revenues via income taxes, which will at least partially compensate for the loss in revenue from reducing taxes in the first place.

Conversely, the opposing view studies the demand-side effects of tax reductions. This view argues that tax reductions can lead to higher budget deficits and reduced government spending, which can reduce aggregate demand and slow economic growth both through demand effects, and ultimately through government investment declines. Additionally, tax reductions can exacerbate income inequality if the benefits accrue mainly to high-income individuals and businesses. The literature in this area finds either that reducing taxes does not increase economic activity, or present mixed results based on different types of tax reductions (Lee and Gordon, 2005;[10] Angelopoulos et al., 2007;[11] Piketty et al., 2014;[12] Zidar 2019).[13]

Puerto Rico has some characteristics that make "off-the-shelf" results from the literature inappropriate. Being an unincorporated territory, its economy is closely tied to that of the U.S., with which it also shares its currency. Furthermore, there is a complete ability to migrate. Thus, competitiveness in Puerto Rico is of crucial importance, as an unfavorable business and work environment will quickly generate snowball effects that will cause rapid economic decline and population losses as economic agents can move easily to the U.S.

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4. Karel Mertens & Jose Luis Montiel Olea, 2018, "Marginal Tax Rates and Income: New Time Series Evidence," *Quarterly Journal of Economics* 133 (4), 1803-84.

5. Owen Zidar, 2019, "Tax Cuts for whom? Heterogenous Effects of Income Tax Changes on Growth and Employment," *Journal of Political Economy* 127(3), 1437-72.

6. Alexander Ljungqvist & Michael Smolyansky, 2018, "To Cut or Not to Cut? On The Impact of Corporate Taxes on Employment and Income." NBER Working Paper 20753.

7. Nguyen et al., 2021, "The Macroeconomic Effects of Income and Consumption Tax Changes," *American Economic Journal: Economic Policy* 13(2), 439-66.

8. Cloyne et al., 2018, "Taxes and Growth: New Narrative Evidence from Interwar Britain," NBER Working Paper 24659.

9. Gregory Mankiw, Matthew Weinzierl, 2007 "Dynamic scoring: A back-of-the-envelope guide", Journal of Public Economics, Volume 90, Issues 8-9.

10. Lee Y, Gordon R. 2005. Tax structure and economic growth. Journal of Public Economics. 89(5): 1027–1043.

11. Konstantinos Angelopoulos, George Economides, Pantelis Kammas, 2007, Tax-spending policies and economic growth: Theoretical predictions and evidence from the OECD, European Journal of Political Economy, Volume 23, Issue 4, 2007.

12. Piketty, Thomas, Emmanuel Saez, and Stefanie Stantcheva. 2014. "Optimal Taxation of Top Labor Incomes: A Tale of Three Elasticities." American Economic Journal: Economic Policy, 6 (1): 230-71.

13. Zidar, Owen, 2019. "Tax Cuts for Whom? Heterogeneous Effects of Income Tax Changes on Growth and Employment". Journal of Political Economy Volume 127, Number 3 June 2019.

Methodology

There is no single model that delivers a unified macro-fiscal projection. The projection reflects a confluence of approaches and tools used to diagnose the economy of Puerto Rico. This diagnosis is described below, and partitioned into two broad areas: first, the base projections, which serve as the departure point and reflect baseline trends in economic activity. Second, the macroeconomic projection under macro-fiscal policy adjustment, which reflects the impact of the Government of Puerto Rico's planned reduction in corporate and individual income tax marginal rates. The updated macroeconomic model for Puerto Rico, which includes modeling of corporate and individual income tax reforms, is fully consistent with the macroeconomic model that has been used for the Fiscal Plan for the past six years. This report documents the approaches and provides references. The accompanying functional Excel-based model operationalizes these concepts for the benefit of the reader.

MODELING APPROACH

The general methodology used is consistent with that used in the International Monetary Fund's (IMF) macroeconomic projections for its member countries in the context of surveillance and lending programs. The model jointly estimates four different indicators of interest: changes in real gross national product (GNP), changes in population, changes in real corporate income tax revenue, and changes in real individual income tax revenue. In addition, there is a separate module for estimating inflation.

Where DevTech's methodology differs from that of the IMF's in its approach to projecting real GNP growth from 2016 to 2026 is identifying macroeconomic drivers of growth that are not necessarily endogenous to economic policies, allowing for the identification of a path for real GNP growth going forward. Population is a critical determinant for the growth of any economy, and given Puerto Rico's status as a U.S. territory, the ability to migrate into or away from the island makes this variable an even greater anchor on growth (Figure 1). The population of the island has declined every year in the last decade, accompanied by GNP declines in nine of the ten years. The Krueger report gives an accounting of the drivers of this dynamic. The critical assumption here is that a trend-based policy-neutral population outlook, such as that of the United Nations, can be used as an anchor on growth. DevTech incorporated additional anchors, including the impact of the broader U.S. economy on Puerto Rico (which could be argued to be a "pull" factor for Puerto Rico labor), as well as food and fuel prices (IMF World Economic Outlook [WEO]).

Seemingly Unrelated System Estimation

System of Equations for Real GNP, Population, and Real Corporate and Income Tax Revenue

$$\begin{pmatrix} \Delta GNP\mathrm{t} \\ \Delta POP\mathrm{t} \\ \Delta CIT\mathrm{t} \\ \Delta IIT\mathrm{t} \end{pmatrix} = f \begin{pmatrix} X_1 & 0 & 0 & 0 \\ 0 & X_2 & 0 & 0 \\ 0 & 0 & X_3 & 0 \\ 0 & 0 & 0 & X_4 \end{pmatrix} + \begin{pmatrix} \epsilon_{1,t} \\ \epsilon_{2,t} \\ \epsilon_{3,t} \\ \epsilon_{34t} \end{pmatrix}$$

Estimation by seemingly unrelated regression (SUR) is a statistical technique used to estimate multiple regression models that are potentially correlated with each other. The benefit of using SUR is that it allows researchers to account for the correlation between the error terms in multiple regression models, which can lead to more accurate parameter estimates. In simpler terms, SUR helps researchers to more accurately estimate the effects of multiple variables that may be related to each other. In this case, the changes in corporate or personal income tax are driven by real GNP growth, but these also drive real GNP growth, as they affect the investment and savings decisions of households and the capital budgeting decisions of firms. These, in turn, drive job market outcomes, which are critical to population decisions.

It is crucial to understand that the baseline scenario presented here is intended to reflect a set of macroeconomic projections that articulate the current policies and current economic conditions extended forward. The base projection is intended to reflect a starting point for calculating the tradeoffs of potential future policies. The scenario presented – which by construction assumes a continuation of current conditions – serves as a tool for costing measures and informing policy making in Puerto Rico. It is not and should not be interpreted as a viable economic scenario because it does not incorporate any package of measures, policies and/or financing that would resolve the inconsistency of existing fiscal deficits in Puerto Rico and its ability to access markets to finance these fiscal deficits.

Equation 1. Real GNP Growth

$$\Delta GNP_t = \alpha_{100} + \alpha_{111}\Delta GNP_{t-1} + \alpha_{112}\Delta U.S.GDP_t + \alpha_{113}\Delta U.S.GDP_{t-1} + \alpha_{114}\Delta rOil_t \ldots$$
$$+\alpha_{115}StormCost_t + \alpha_{116}\, I_{'05\text{-}end}\, \Delta GNP_{t-1} + \alpha_{117}\Delta NetFedTransfer_t + \alpha_{118}\Delta Capital_t + \ldots$$
$$\ldots + \alpha_{119}\Delta Capital_{t-1} + \alpha_{120}\, Covid\text{-}_t\, \Delta NetFedTransfer_t + \alpha_{121}\, I_{\Delta CIT,t} + \epsilon_t$$

Equation 1 is the basis for the real GNP growth forecast under the current policies presented below. The change in real GNP (ΔGNP) is a product of its past growth in the prior two years, the U.S. output gap (*U.S.Gap*), the change in the working-age population in the current and prior year (*L*), and oil and food price indices (*Oil* & *Food*). In addition, an indicator is included for years after 2002 to indicate the years after the post 1996 reforms took effect ($I_{'03\text{-}'15}$), and which have been marked by very slow growth. In terms of robustness, the selection of 2002 as a break point does not make a difference in the direction of growth forecasts – all specifications point to negative growth, and in some cases, the model projects a sharply negative future growth profile. The forecast of real GNP growth is projected from Equation 1 using IMF projections published in the latest WEO for U.S. real GDP variables, the United Nations working age population forecasts for Puerto Rico, and the IMF food and fuel price indices. This yields a real GNP growth profile for Puerto Rico, which allows for the calculation of an output gap for Puerto Rico as well, which is used for inflation.

Given the high persistence in GNP growth, the model incorporates past values as a determinant of future economic growth. The real GNP growth forecast for 2023 to 2051 is anchored on macroeconomic drivers of growth that are not necessarily endogenous to economic policies and therefore can identify a policy-agnostic

path for real GNP growth. The two critical exogenous external factors are the impact of the broader U.S. economy on Puerto Rico, incorporated as U.S. GDP growth, and changes in world oil prices. The forecast of real GNP growth is projected using the Budget and Economic Outlook from the Congressional Budget Office and the IMF WEO projections.[14] The IMF is also the source for fuel price indices.[15] In addition to the exogenous factors, the model incorporates several non-fiscal aspects that affect growth. These include storm intensity on the island, transfers received from the U.S. Federal Government (and how they related to COVID intensity on the island), and current and prior year capital growth.

Finally, this model allows for estimating how much Puerto Rico's GNP will change when there is tax reform. If there is no tax reform, this factor will not affect the dynamics of GNP growth. The source for previous tax reforms comes from the Puerto Rico Department of the Treasury, and from the Yearly Economic Reports to the Governor, prepared by the Puerto Rico Planning Board.[16]

Population

Equation 2. Population Growth

$$\Delta POP_t = \alpha_{200} + \alpha_{211}\Delta GNP_{t-1} + \alpha_{212}\Delta POP_{t-1} + \alpha_{213}\Delta U.S.GDP_{t-1+} \alpha_{214}\, I_{'97\text{-}end}\, \Delta POP_{t-1} + \ldots$$

$$\ldots. + \alpha_{215}\Delta NetFedTransfer_t + \alpha_{216}\, I_{'05\text{-}end} + \alpha_{217}\, I_{'05\text{-}end}\, \Delta GNP_{t-1} + \alpha_{218} StormCost_t + \ldots$$

$$\ldots + \alpha_{220}\, I_{'05\text{-}end}\, \Delta Capital_{t-1} + \alpha_{221}\, I_{\Delta IIT,t-1} + \epsilon_t$$

Changes in population also exhibit high persistence. To account for this, the model includes the previous value of change in population to project future population growth. There is one crucial exogenous factor that affects changes in the population in Puerto Rico: the growth in the US economy. Given Puerto Rico's status as a U.S. territory, people have the ability to migrate into or away from the island. A stronger U.S. economy offers more employment opportunities outside of the island, which pressures population down. The model incorporates changes in the real U.S. GDP to account for this. Internal factors certainly generate incentives to either migrate or stay on the island. Puerto Rico's GNP growth, U.S. federal transfers, storm intensity on the island, and growth of capital, could potentially all be factors that explain changes in population, so they are incorporated into the model.

Finally, it is important to acknowledge that fiscal factors change incentives to stay or migrate. In particular, having reforms that increase or decrease individual income taxes will certainly affect the disposable income of taxpayers and be a factor in the decision-making of staying or leaving. Hence, the model includes whether there was such individual income tax reform on the prior year.

14. Sources: https://www.cbo.gov/publication/58848 ; http://www.imf.org/external/np/res/commod/Table1a.pdf

15. Source: http://www.imf.org/external/np/res/commod/index.aspx

16. Source: https://jp.pr.gov/informe-economico-al-gobernador/

Corporate Income Tax Revenue

Equation 3. Real Corporate Income Tax Revenue Growth

$$\Delta CIT_t = \alpha_{300} + \alpha_{311}\Delta GNP_{t-1} + \alpha_{312}\Delta CIT_{t-1} + \alpha_{313} I'_{05\text{-}end} + \alpha_{314} I'_{05\text{-}end}\,\Delta CIT_{t-1} + \ldots + \alpha_{315} I_{\Delta CIT,t} + \epsilon_t$$

In this estimation, the focus is on understanding the relationship between corporate income tax and several different factors that may impact it at the macro level. Specifically, the analysis regresses corporate income tax on its own past values (lags), lagged real GNP growth, structural breaks in the economy of Puerto Rico, and statutory changes in the corporate tax rate.

By including the lagged values of corporate income tax, the analysis can examine how changes in the tax rate in the past may impact current tax revenues. The lagged GNP variable is included to control for changes in the overall economic conditions in Puerto Rico that may also affect corporate income tax revenues. The structural breaks variable allows for the possibility that significant changes in the economy of Puerto Rico could impact the relationship between corporate income tax and the other variables in the equation. Finally, the statutory changes in the corporate tax rate variable allows for the analysis of how reforms changing the tax rate may impact corporate income tax revenues.

Individual Income Tax Revenue

Equation 4. Real Individual Income Tax Growth

$$\Delta IIT_t = \alpha 400 + \alpha 411\Delta GNP_{t-1} + \alpha 412\Delta IIT_{t-1} + \alpha 413\Delta POP_{t-1} + \alpha 414\, I_{\Delta IIT,t-1} + \epsilon t$$

In this estimation, the focus is on understanding the relationship between personal income tax and several different factors that may impact it. Specifically, the analysis regresses personal income tax on its own past values (lags), lagged GNP, population, and statutory changes in the personal income tax rate.

By including the lagged values of personal income tax, the analysis can examine how changes in the tax rate in the past may impact current tax revenues. The lagged GNP variable is included to control for changes in the overall economic conditions in Puerto Rico that may also affect personal income tax revenues. The population variable is included to control for changes in the number of taxpayers, as this can impact the overall amount of personal income tax revenue collected. Finally, the statutory changes in the personal income tax rate variable allows for the analysis of how changes in the tax rate itself may impact personal income tax revenues.

Inflation

Equation 5. Inflation

$$\pi_t = \alpha_0 + \alpha_1 \pi_{t-1} + \alpha_2 Gap_t + \alpha_3 \Delta Oil_t + \alpha_4 \Delta Food_t + \epsilon_t$$

An ordinary Phillips curve estimation is used to project inflation in Puerto Rico during the forecast period.[17] Inflation is a function of past inflation, and food and fuel price indices, reflecting pass-through from international prices.[18] Alternative specifications might have included measures of cyclical unemployment on the right-hand side (e.g., an "unemployment gap"). In the case of Puerto Rico, given the declining population, the uncertainty introduced by the unknown structural unemployment rate or the non-accelerating inflation rate of unemployment (NAIRU) (or the "unemployment gap") would make the estimation less accurate than using a measure of the output gap.

The estimated coefficients are used to push forward the inflation forecast. As varying policy scenarios have arisen that include potential structural breaks in inflation, the inflation forecast (staring in December 2022) reflects 50 percent exogenous U.S. inflation and 50 percent Phillips curve.[19] The 50 percent split is intended to reflect the uncertainty inherent in these scenarios, which could include factors outside the control of the Commonwealth or that would not fully reflect the knock-on effects due to the enlarged output gap that would emerge following a very large fiscal adjustment.

MODEL RESULTS

The model fit is graphed and presented below. It shows good fitting of real GNP and population data over nearly six decades. However, the recent population trend reversal due to COVID-induced economic decline and one-off transfers is evident in the graph, as picked up by the model. The real GNP growth equation also captures the same dynamics, albeit with less dramatic recent growth. In contrast, fitting the real corporate and personal income tax growth equations is more challenging, starting with the fact that the model captures relationships at the macro level. In addition, there are significant structural breaks in tax regimes and economic drivers in Puerto Rico, accompanied by a series of reforms and policy shocks that restrict the number of available observations to subsamples defined by these breaks. Even with institutional break controls such as the Mainland Tax Reform of 1996 to 1997, limited data make estimating these equations challenging. For instance, corporate income tax variability increased sharply after the 2016 default (with a similar, albeit less pronounced increase in individual income tax). However, these data challenges do not limit

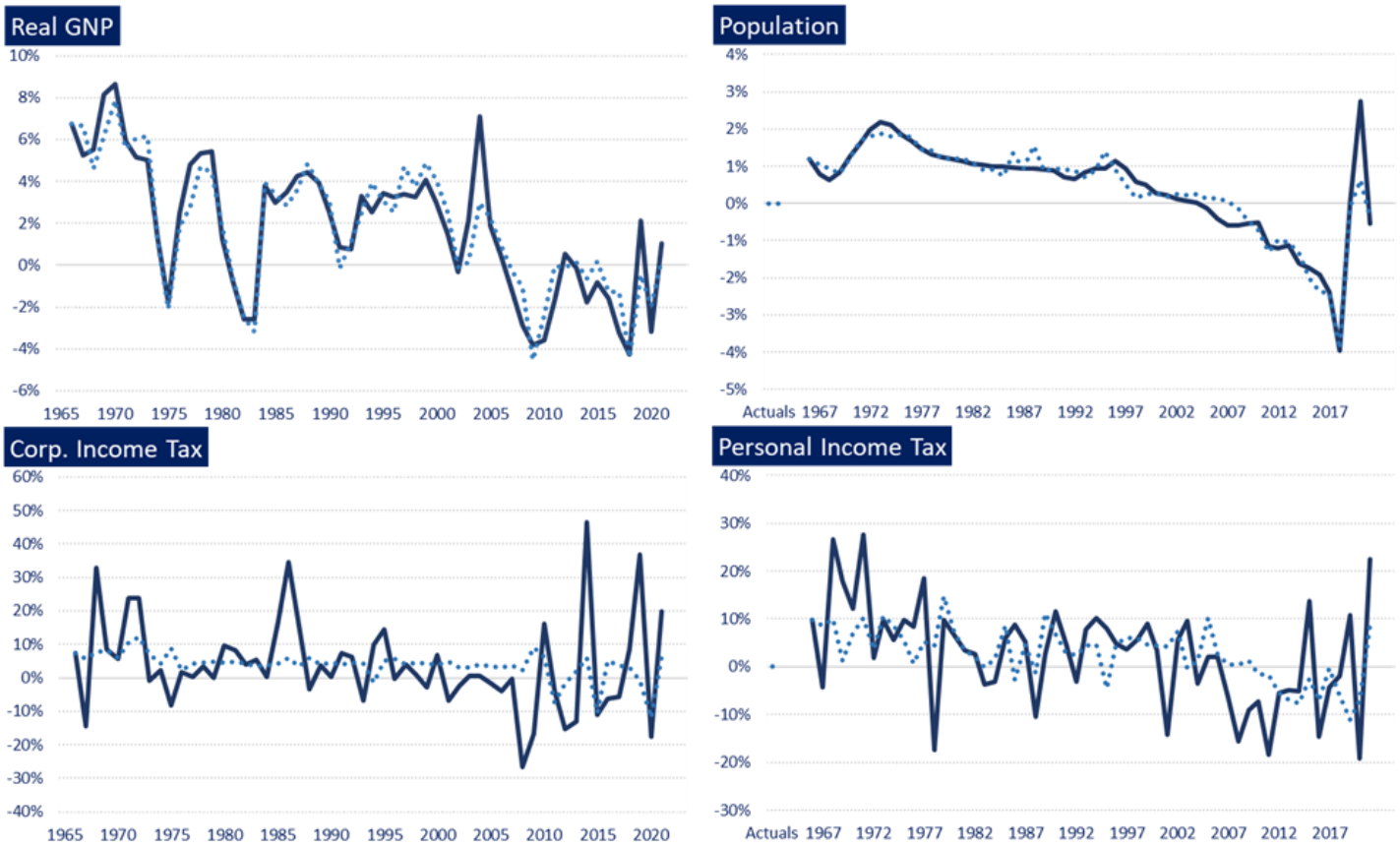
17. Philips Curve literature is vast, see e.g., on the consistency between growth and inflation forecasts, e.g. Dotsey, M., S. Fujita, and T. Stark., 2011, Federal Reserve Bank of Philadelphia Working Paper No. 11-40.

18. See Cecchetti, S. and R. Moessner, 2008, Commodity prices and inflation dynamics. BIS Quarterly Review, 2008.

19. On the impact of U.S. monetary policy and its influence U.S. and Puerto Rico's inflation see Rodríguez, C., 2008, Universidad de Puerto Rico, Recinto de Río Piedras. Ensayos y Monografías Número 139.

the system estimation. The point estimates from these equations are interpreted cautiously and backed by a separate, granular modeling of fiscal outcomes for Puerto Rico. Thus, the system provides important fiscal inputs into growth equations, and fiscal outcomes come from a dynamic structural fiscal modeling built on this model's growth and population estimates.

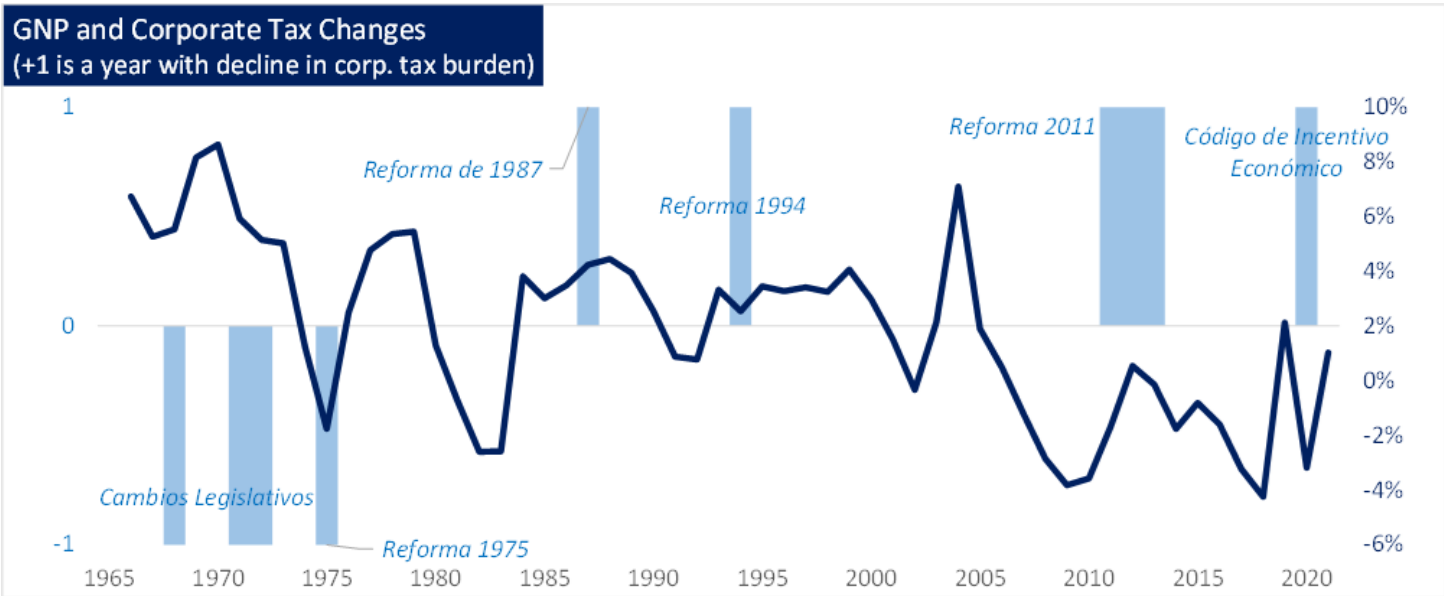
Figure 1: Fit of the Model



The bar graph presented below depicts real GNP growth in Puerto Rico over a range of years from 1965 to the present, with bars overlaid to indicate the occurrence of corporate income tax reforms. The aim is to provide insight into the impact of these reforms on real growth in the economy of Puerto Rico. Given the complex and diverse nature of tax reforms implemented over time, a simple indicator is used that takes on the value of 0 if no reform or 1 or -1 to signal the occurrence of a reform with a decrease or increase in tax burden, respectively. However, the available data lacks the necessary granularity to distinguish the specific nature of the tax reforms that occurred in Puerto Rico from 1965 to the present. Instead, the graphs provide a general indication of whether a given tax reform led to an increase or decrease in the tax burden, and how this may have affected real GNP growth over time. It should be noted that the indicator takes a negative value for tax increases since these are expected to have a detrimental effect on real GNP growth in Puerto Rico. This variable is indicative of the reforms occurring in 2023 and is used to capture the impact of reforms on real GNP and population growth. It represents years in which statutory changes occurred in the tax burden for corporate taxpayers in Puerto Rico. Note that we do not show individual income tax years

because these are a subset of corporate income tax changes, which move in the same direction in most years. Sales and Use Tax (SUT), and other taxes are outside the scope of this assessment and of the 2023 reform . As can be seen, all reforms after 1975 are aimed at reducing the tax burden, which is why the bars are above the horizontal axis.

Figure 2: Real GNP Growth and Corporate Tax Reforms



The table below presents the estimated coefficients from a SUR analysis with four equations for GNP, population, corporate tax revenue, and income tax revenue in Puerto Rico. The table includes four columns: the first column indicates the dependent variable of the regression, the second column shows the estimated coefficient for each independent variable, the third column displays the corresponding p-value, and the fourth column provides a definition of each variable. The estimated coefficients and p-values can be used to assess the statistical significance and magnitude of the relationship between each independent variable and the dependent variable, while the variable definitions provide context for interpreting the results. The SUR analysis takes into account the potential correlations between the different equations in the system, providing more accurate estimates of the relationships between the variables.[20]

20. Note that a Durbin-Watson statistic of 1.65 suggests that there may be some degree of positive autocorrelation in the residuals, which means that the errors in the model may be correlated with each other. While this can be interpreted as a potential risk of bias in coefficient estimates, wider confidence intervals, and reduced statistical power, the degree to which a Durbin-Watson statistic of 1.6 is problematic depends on the specific context of the analysis, such as the sample size, the number of variables in the model, and the nature of the data. In general, a Durbin-Watson statistic between 1.5 and 2.5 is considered acceptable, but further analysis may be necessary to fully understand the implications of the autocorrelation for the specific research question at hand.

Table 1: Estimation Results

	Dependent V	Independent V	Coef. No.	Estimate*100	Prob.	Independent Variable Name
1	ΔGNP_t	Constant	100	-1.85	-	*Constant*
2	ΔGNP_t	ΔGNP_{t-1}	111	55.66	-	*Real GNP growth, lagged*
3	ΔGNP_t	$\Delta U.S.GDP_t$	112	82.99	-	*Mainland real GDP growth*
4	ΔGNP_t	$\Delta U.S.GDP_{t-1}$	113	-18.60	0.09	*Mainland real GDP growth, Lagged*
5	ΔGNP_t	$rOil_t$	114	-1.17	0.01	*Real Oil Price*
6	ΔGNP_t	$StormCost_t$	115	-0.11	-	*Storm Cost, FEMA Hazus*
7	ΔGNP_t	$I_{'05\text{-}end}\ \Delta GNP_{t-1}$	116	-33.02	0.01	*Real GNP growth, lagged * GNP Structural Break, 2005-06*
8	ΔGNP_t	$\Delta NetFedTransfer_t$	117	0.73	0.06	*Real growth in Federal net transfers*
9	ΔGNP_t	$\Delta Capital_t$	118	51.82	0.00	*Real Investment*
10	ΔGNP_t	$\Delta Capital_{t-1}$	119	-25.69	0.05	*Real Investment, lagged*
11	ΔGNP_t	$Covid\text{-}_t\ NetFedTransfer_t$	120	6.28	0.32	*Covid impact * Real growth in Net Federal Transfers*
12	ΔGNP_t	$I_{\Delta CIT,t}$	121	0.86	0.03	*Corporate Tax Reform*
13	ΔPOP_t	Constant	200	0.28	0.07	*Constant*
14	ΔPOP_t	ΔGNP_{t-1}	211	5.99	0.06	*Real GNP growth, lagged*
15	ΔPOP_t	ΔPOP_{t-1}	212	77.82	-	*Lagged population growth*
16	ΔPOP_t	$\Delta U.S.GDP_{t-1}$	213	-7.22	0.07	*Mainland real GDP growth, Lagged*
17	ΔPOP_t	$I_{'97\text{-}end}\ \Delta POP_{t-1}$	214	-58.48	-	$I_{'97\text{-}end}\ \Delta POP_{t-1}$
18	ΔPOP_t	$\Delta NetFedTransfer_t$	215	0.05	0.70	$\Delta NetFedTransfer_t$
19	ΔPOP_t	$I_{'05\text{-}end}$	216	-1.66	-	*GNP Structural Break, 2005-06*
20	ΔPOP_t	$I_{'05\text{-}end}\ \Delta GNP_{t-1}$	217	-15.99	0.00	*Real GNP growth, lagged * GNP Structural Break, 2005-06*
21	ΔPOP_t	$StormCost_t$	218	-0.04	-	$StormCost_t$
22	ΔPOP_t	$I_{'05\text{-}end}\ \Delta Capital_{t-1}$	220	63.94	-	*Real Investment, lagged * GNP Structural Break, 2005-06*
23	ΔPOP_t	$I_{\Delta IIT,t-1}$	221	0.49	0.00	*Individual Tax Reform, lagged*
24	ΔCIT_t	Constant	300	3.50	0.23	*Constant*
25	ΔCIT_t	ΔGNP_{t-1}	311	11.41	0.53	*Real GNP growth, lagged*
26	ΔCIT_t	ΔCIT_{t-1}	312	-1.14	0.79	*Change in Corporate Tax Revenue, lagged*
27	ΔCIT_t	$I_{'05\text{-}end}$	313	-4.76	0.22	*GNP Structural Break, 2005-06*
28	ΔCIT_t	$I_{'05\text{-}end}\ \Delta CIT_{t-1}$	314	-38.46	0.10	*Change in Corporate Tax Revenue, lagged*
29	ΔCIT_t	$I_{\Delta CIT,t}$	315	18.56	0.78	*Corporate Tax Reform*
30	ΔIIT_t	Constant	400	1.35	0.38	*Constant*
31	ΔIIT_t	ΔGNP_{t-1}	411	-27.83	0.02	*Real GNP growth, lagged*
32	ΔIIT_t	ΔIIT_{t-1}	412	110.25	0.02	*Change in Individual Tax Revenue, lagged*
33	ΔIIT_t	ΔPOP_{t-1}	413	207.51	0.05	*Lagged population growth*
34	ΔIIT_t	$I_{\Delta IIT,t-1}$	414	-7.79	0.01	*Individual Tax Reform, lagged*

Memo:

Equation	*R-squared*	*DW*
ΔGNPt	0.87	1.65
ΔPOPt	0.90	1.67
ΔCITt	0.11	1.87
ΔIITt	0.20	1.80

IMPACT ON REAL GNP GROWTH

An estimated coefficient of 0.86 (result 12 of the estimation table) for an indicator that is zero if there is no reform, one if there is a tax reduction, and -1 if there is a tax increase, means that on average, a tax reduction is associated with an increase in real GNP growth of one percentage point, and a tax increase is associated with a decrease in real GNP growth of one percentage point. Hence, the system estimation suggests that corporate income tax decrease reforms boost GNP growth by one percent the year after they are implemented. In 2025 the increase in Puerto Rico GNP will be $390 million compared to the "no reform" scenario, and in 2026, it would be $227 million higher.

This estimate is a powerful result, as it suggests that growth is consistently supported by tax reductions (or is hindered by increases). Two important caveats are in order. First, this is a reassuring result, insofar as a tax reduction brings immediate relief to taxpayers in the same way that a wage increase or decline in inflation/ prices brings increases in income/ profitability. Nevertheless, while the coefficient on the tax indicator may be statistically significant, the magnitude of the effect may be small relative to other factors that influence long-term economic growth, such as productivity growth, demographic changes, technological advancements, and sound policy management. Therefore, the estimated coefficient should be interpreted with caution and in the context of other factors that affect long-term economic growth.

FISCAL STIMULUS FROM TAX REFORM AND ITS IMPACT ON SHORT-TERM GROWTH

The model estimates the impact of tax reform on Puerto Rico's economy by examining the relationship between tax revenues and economic growth. By using a dynamic SUR model, we can estimate how tax reform affects economic growth over time. The model captures the impact of tax reform by considering both the immediate revenue dividend returned to taxpayers, which works like a short-term fiscal stimulus, and the dynamic impact of revenue recovery over time, as described by Mankiw and Weinzierl (2006). The dynamic SUR model allows an estimate of the impact of tax reform on Puerto Rico's GNP, population, corporate income tax, and individual income tax both with and without tax reform. This allows for a "first-order" measure of the impact of tax reductions on short-term growth. Notwithstanding the data limitations discussed above for the tax equations, they provide valuable insight into the impact of tax reductions on the economy from the impact of the fiscal stimulus that the funds retained by taxpayers generates.

In the case of the corporate tax, the model suggests just over $140 million in stimulus in the first year of the reform. This combines with approximately $200 million for the individual tax reform in the first year of its impact (2025), and these amounts vary slightly from year to year. Note that the data suggest that the corporate taxpayer base is more sophisticated in tax planning and anticipating reductions and can fully reflect the measures almost immediately. For the individual income tax, the immediate impact is in population and labor force (as more people join the labor force), but the fiscal impact takes a year and enters the equation with a lag.

The table below shows several calculations that size the fiscal cost of the 2023 tax reform. The left panel shows the "static" cost calculated by the Government of Puerto Rico, which simply calculates the change in potential revenue collection from the statutory tax rate and bracket changes. This amount is around $545.5M per year. The model estimation can be done with and without the tax reform proxies. The average fiscal loss over the period of 2026 to 2030 is roughly 49 percent of the estimated amount (left panel of the Table), or $267 million per year. Hence, the Government of Puerto Rico stands to recuperate dynamically roughly 50

percent of the static loss. On the right panel, we give the closed-form solution given by Makiw and Weinzierl (2006) for the percentage of static tax revenue loss that is recuperated from dynamic scoring of a tax reform, which reflects the growth and other economic effects that offset the static revenue loss.

Table 2: Static and Dynamic Scoring: Comparison between DevTech Puerto Rico Estimates and Calibrated results following Mankiw & Weinzierl (2006)

DevTech - PRI Estimates			Mankiw & Weinzierl (2006)		
		Parameter		DevTech - PRI	Mankiw & Weinzierl - US
		α	capital share	48.8%	34.0%
Static Scoring	$ 545.5	$1-\alpha$	labor	51.2%	66.0%
Dynamic Scoring	$ 278.1	$\tau_{Capital}$	capital tax	21.1%	25.0%
2025-30	51.0%	τ_{Labor}	labor tax	18.9%	25.0%
		$1-\frac{\alpha\tau_k+(1-\alpha)\tau_n}{(1-\tau_k)(1-\alpha)}$		50.5%	49.5%

The results of the table above are presented for the United States as a whole (as shown by Makiw and Weinzierl [2006] for U.S. parameter values) and for Puerto Rico (as calculated by the Government's Fiscal plan model and estimates based on official tax and national accounts data). The results are consistent with the theoretical underpinning of the canonical Mirrlees (1971) framework, as developed by Mankiw and Weinzierl (2006). Under this framework, one can expect (for reasonable parameter values for the U.S. economy) a dynamic recovery of approximately 50 percent of the cost of the tax reduction, compared to the static estimate. In this case, the Government of Puerto Rico has sized the reductions at approximately $545.5 million. The nature of the modeling here is that the fiscal stimulus reflects the savings difference that is permanently returned to taxpayers. Hence, holding all else equal, we can identify the dynamic recovery of revenue in the model, and it suggest that approximately half that amount will be injected into the economy as compared to the static model.

IMPACT ON POPULATION, LABOR FORCE

The model results suggest an immediate jump in population (and concurrent labor market participation) as the increase in real wages from the reduction in individual income taxes works as a wage increase. This effect tends to be stronger in Puerto Rico's labor market, which shows traits consistent with monopolistically competitive employers . An estimated coefficient of 0.49 (result 23 of the estimation table) for the indicator that is one if there is a tax reduction, and -1 if there is a tax increase, means that on average, a tax reduction is associated with an increase in population growth of 0.49 percentage point, and a tax increase is associated with a decrease in population growth of 0.49 percentage point. Hence, the system estimation suggests that the population of Puerto Rico will grow by half percent on the year following an individual income tax reduction, rather than the counterfactual trend population decline. This is an estimated increase of around 15,000 persons in the population of Puerto Rico.

ANNEX A. BRIEF DESCRIPTION OF SELECTED TAX REFORMS IN PUERTO RICO

Since at least 1948, Puerto Rico made significant periodic changes to its tax system,[21] with the establishment of the Industrial Tax Exemption Act of that year, for example, generating important discussion and criticism.[22] The law provided tax exemptions to foreign manufacturing companies operating on the island, with the goal of incentivizing economic development. While some supported a temporary exemption, it was ultimately approved for an extended period. The government took various measures to create a favorable investment climate, such as property appraisal and revaluation in 1951, resulting in equity in tax treatment with respect to property tax. The Income Tax Law implemented in 1954 was also intended to promote private investment and align Puerto Rico's tax system with that of the United States. The law introduced changes such as favorable treatment for capital gains, an optional fixed deduction on adjusted gross income, and deductions for contributions to retirement funds. A rate of 20 percent was established on net income for corporations and partnerships.

In 1956, a general reform of consumption taxes was developed, including a review of the classification between essential and luxury goods, to lower rates on various products and eliminate taxation on candy, gas, buses, tires, etc. Between 1974 and 1975, amidst a severe economic and fiscal crisis, a tax reform was implemented in Puerto Rico to restructure the local tax system. The Tobin Commission on Tax Reform was created to stimulate economic growth,[23] promote social equity and simplification, and increase revenue collection. The commission made a number of recommendations that were adopted to varying degrees, including: adopting a new definition of taxable income, reducing the number of exemptions and deductions, increasing the personal exemption and dependent credit, including inflation adjustment in income, and maintaining the income tax since it was efficient and had strong collection capacity. The corporate tax was considered to be bounded by a maximum rate of 40 percent, with rates on corporations in Puerto Rico not to exceed those in the U.S., and capital gains adjusted for inflation through the Consumer Price Index. Another study evaluated the existing consumption tax system and presented three possible tax schemes: a selective consumption tax (excise), a general and unique sales tax, and a value-added tax (VAT). In summary, the Tobin Report recommended that the tax system collect revenues equitably and prioritize property taxes. It also recommended improving tax compliance and adjusting revenue for inflation. The tax reform of 1975 aimed to increase revenue collection, stimulate economic growth, promote greater social equity and simplification, and stabilize Puerto Rico's fiscal situation. The commission's studies helped to create a tax system that was more efficient and effective, resulting in increased revenue collection.

21. This document will draw liberally from sources cited in the References appendix, among them García López, J.G., (2018), Las Reformas Contributivas en Puerto Rico durante el compar 1975-2015: un análisis comparative. OP No. 9 - March 2018. https://bit.ly/3EAheON.
22. https://bit.ly/3KQQe1t
23. https://bit.ly/3ZkuLSv

In 1987, the Secretary of the Treasury proposed a tax reform to achieve objectives related to equity, strengthening of the family, encouraging saving and investment, simplification, and revenue neutrality. The 1987 reform introduced changes such as reducing tax rates, reducing maximum marginal tax rates, changing tax bases, modifying personal exemptions and standard deductions, introducing income segmentation and gradual adjustment, and simplifying tax compliance processes. The 1987 Reform also included changes in corporate income tax, such as the alternate minimum contribution, reduced tax rates, and the introduction of contribution recovery for differences in tax rates. Additionally, the general 5 percent tax was introduced on all durable goods except motor vehicles.

The tax reform of 1994 was guided by principles of fair taxation based on individuals' ability to pay, a simple tax structure, and the generation of minimum distortion in the economic and social system. The aim was to reduce the tax burden on the middle class by reducing tax rates and to stimulate investment flows and mobility of resources into productive activities by reducing taxes on dividends paid to non-residents, eliminating retention on income payments received from non-residents for interests, and postponing capital gains tax payments if the proceeds from the sale of a business were reinvested in another business. The reform resulted in a reduction in the tax burden, as effective tax rates decreased in all income scales. All tax laws were codified into a single document known as the Puerto Rico Internal Revenue Code, simplifying the tax system.

Overall, both the 1987 reform and the tax reform of 1994 were aimed at reducing the tax burden, simplifying the tax system, and promoting economic growth. These reforms resulted in changes such as reduced tax rates, changes in tax bases, modifications to personal exemptions and standard deductions, introduction of income segmentation and gradual adjustment, and simplification of tax compliance processes. These reforms also aimed to stimulate investment flows, promote saving and investment, and strengthen families.

Prior to the proposal of the 2006 tax reform, several measures were enacted that brought changes to the tax system in Puerto Rico. In 2002, legislation was passed to raise specific excise taxes such as those on cigarettes and beer. A study commissioned by the Government of Puerto Rico in 2003-2004 by Bearing Point revealed inadequacies and inefficiencies in the tax system. The study identified that the system was incomplete, inefficient, allowed for tax evasion, and could not ensure required revenue generation. The study recommended implementing an eight percent VAT, but this proposal was not implemented. Another tax reform proposal was outlined by the Fiscal Reform Committee (2005) and recommended imposing a flat tax rate of 10 percent on individual incomes, corporations, and consumption tax, but this proposal was also not implemented due to being regressive.

In 2006, Law No. 117 of 2006 was passed. It aimed to reform the tax system. The 2006 reform proposed a seven percent Sales and Use Tax (SUT) to replace the 6.6 percent general excise tax and aimed to increase

revenue collection for the public treasury, allowing for additional legislation to reduce the burden on wage earners as a result of income tax payments. The SUT exemptions were limited to prescription drugs, raw materials for manufacturing, exported products, and fuels purchased by the Electric Power Authority for the production of electric power. The 2006 tax reform proposed reducing individual income tax rates, establishing four income scales, increasing exemptions and deductions, and introducing the SUT. The model used for the reform was mainly based on the tax systems of Hawaii, New York, and Florida. The proposed changes aimed to promote equity, simplify the system, and improve compliance.

Puerto Rico's tax reform of 2011 was enacted via the Special Law Declaring the Fiscal Emergency State (Law No. 7 of 2009), which brought about several changes, including new taxes, and increased special taxes. The changes included revising the low and high-income scales of individual taxes, raising the contribution on property, increasing cigarette and beer taxes, and implementing a five percent tax on the determined contribution. Additionally, the temporary tax Law No. 154 of 2010 imposed a four percent tax on foreign corporations' transactions, representing approximately $1.8 billion or 23 percent of net revenues to the General Fund.

The objectives of the 2011 Reform (Law No. 1 of 2011) were to provide tax relief to individuals and corporations, promote economic development and job creation, simplify the tax system, and reduce tax evasion. The reform proposed changes to income scales and rates for both stages. Taxpayers with incomes of $40,000 or less received a 15 percent reduction in income tax, those with incomes between $40,000 to $100,000 received a 10 percent reduction, and those with incomes over $100,000 obtained a seven percent reduction. The reform also expanded income scales, eliminated most detailed deductions and additional deductions, allowing individuals to choose from nine established deductions. The penalty for married couples was eliminated, and the earned income tax credit increased annually by 0.5 percent until it reached a maximum of six percent of earned income in the 2016 tax year, with a maximum credit of $600. The reform also increased the contribution limits to qualified pension plans. It provided tax credits and reductions to corporations, such as a maximum tax rate reduction from 39 percent to 30 percent for companies with incomes over $2.5 million, a reduction in tax rates for non-exempt companies generating a net taxable income of $750,000 or less to 20 percent, and a credit of seven percent on tax liability subject to the payment of the Christmas bonus. The total tax relief for corporations represented approximately $260 million over the following six years if the reform had been approved.

The two stages of the 2011 reform were expected to provide tax relief of up to $1.2 billion during the first six years. However, due to the reduction in revenues and the inherited fiscal crisis, the second proposed stage of the reform was not implemented.

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