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The Case of Peru, 2000-2019

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Abstract[1]

This article has three goals. First, it describes the genesis of fiscal rules in Peru and its degree of compliance. Second, it estimates the effect of fiscal rules adoption on public investment. Last, it analyzes the impact of alternative fiscal rules on public investment and public debt sustainability. Our main results are as follows. First, the implementation of fiscal rules in the year 2000 caused a 60 to 80 percent fall in public investment relative to several counterfactuals. Second, our DSGE model suggests a Structural Fiscal Rule would have increased the consumers' welfare in the period 2000-2019 more than other fiscal designs. This rule reduces the procyclicality of public investment under commodity price shocks and macroeconomic volatility under world interest rate shocks. Third, a Structural Fiscal Rule has the lowest probability of exceeding the current public debt limit (30 percent of GDP), although there is a trade-off between investment-friendly rules and fiscal sustainability issues. Nevertheless, our quantitative results are limited to short spans of analysis. With a long-run perspective, we may say that fiscal rules—despite constant modifications and recurring non-compliance—have fulfilled their original and most important goal of achieving the consolidation of public finances.

JEL classifications: E62, H50, H54, H60, H68
Keywords: Fiscal rules, Public investment, Fiscal sustainability

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1. Introduction

Can fiscal rules negatively affect economic growth? Izquierdo et al. (2018) observe two facts. First, fiscal rules are an important determinant of the composition of public spending in Latin America and the Caribbean (LAC) and second, these rules have made capital expenditures lose ground to current expenses. Also, Ardanaz et al. (2020) find, for a sample of 75 countries, comprising 17 LAC countries, including Peru,[2] that when rigid fiscal rules[3] are applied, fiscal consolidation is achieved through a reduction of public investment.

Rigid fiscal rules can undermine economic growth. There are two key reasons. First, as Végh et al. (2018) posit, public investment multipliers are greater than multipliers of other expenditure components or taxes.[4] Second, as put forward by Izquierdo et al. (2018), the stock of public capital (roads, ports, railways, and other durable public goods) is severely impaired.

In this context, the aim of this article is threefold. First, it describes the origin and degree of fiscal rules compliance in Peru. Second, it evaluates the effect of these rules on the evolution of public investment. Last, it assesses the impact of alternative fiscal rules on public investment and the sustainability of public debt.

To proceed, in Section 2 we describe how the institutional framework of fiscal legislation in Peru was built together with the main challenges faced in the process. The section is based on a review of existing legislation and interviews with former fiscal policy authorities.

Section 3 presents the main stylized facts regarding the degree of compliance with fiscal rules and the behavior of public investment. We cover the period 2000-2019 in order to consider all fiscal legislation since December 1999, when the first piece of legislation was enacted.

In Section 4 we estimate the effects of fiscal rules over public investment through the Synthetic Control Method (SCM). In particular, we find that the introduction of fiscal rules in December 1999 reduced public investment over the following five years.

[2] Ardanaz et al. (2020) argue that Peruvian fiscal rules have two characteristics of flexibility. On the one hand, they have specific escape clauses. On the other hand, the current expenditure rule excludes expenditure in infrastructure maintenance.

[3] Flexible fiscal rule is a dummy equal to 1 if i) the rule is an investment-friendly rule, ii) the country has a cyclically adjusted budget balance rule, or iii) there rules with well-defined escape clauses. Otherwise, if the rule is rigid, the dummy is 0.

[4] Jiménez and Rodríguez (2020), using hybrid TVP-VAR-SV models for Peruvian case, have found that the multiplier of capital expenditure varies between 1 and 1.2, while current spending varies between 0.3 and 0.7. However, the authors also emphasize that the multiplier of fiscal revenues is the lowest, between -0.2 and 0.

In Section 5, we show the second goal of our quantitative analysis. We calculate the effects of alternative fiscal rules on public investment and macroeconomic variables using a Dynamic Stochastic General Equilibrium Model (DSGE) calibrated for the period 2000-2019. With this framework, we find the Structural Fiscal Deficit Rule increases consumers' welfare and reduces the procyclicality of public investment under shocks to commodity prices with respect to other fiscal designs.

In Section 6, we address the relationship between fiscal rules and the sustainability of public finances. In this sense, the last goal of our quantitative analysis is to assess the impact of the current normative limits and alternative designs on the future path of public debt. We find the Structural Fiscal Deficit Rule has the lowest probability of exceeding the current public debt limit (30 percent of GDP). Moreover, there exists an important trade-off between investment-friendly rules (the golden rule) and fiscal sustainability issues.

Last, in Section 7 we present the conclusions of the study and some implications for fiscal policy.

2. Fiscal Rules in Peru

At the beginning of the 1990s, Peru's public finances were the worst in the region. Public debt reached 89 percent of GDP, and the fiscal deficit[5] was around 10 percent of GDP. The government acknowledged the problem and decided to fix it.

As a result, throughout the 1990s Peru substantially reduced the fiscal deficit and, hence, lowered public debt as a percentage of GDP. This outcome was possible through a series of policy measures taken at the onset of the decade. The policy shift included a radical adjustment of public prices in August 1990;[6] the introduction of Article 84 in the 1993 Political Constitution, which eliminated fiscal dominance, prohibiting loans from the central bank to the government; and the reorganization of SUNAT,[7] the tax collection institution.

[5] Central Reserve Bank of Peru (CRBP) data with General Government (GG) coverage.
[6] According to the 1990 report of CRBP, electricity tariffs and fuel prices increased by 784 and 3,000 percent, respectively.
[7] Although SUNAT, the Peruvian tax administration, had replaced the General Directorate of Contributions (GDC) in May 1988, nothing had changed in the tax collection apparatus, which would not be modernized until April 1991, the year in which the first steps to improve control processes were carried out, replacing unproductive programs with massive, simple and effective programs.

During this stage, the involvement of the International Monetary Fund (IMF) was crucial. Through the Central Reserve Bank of Peru (CRBP) and the Ministry of Economy and Finance (MEF), the Peruvian government signed five agreements that marked the agenda of macroeconomic policies and structural reforms of the decade. In all these agreements, the Peruvian government committed to implementing macroeconomic policies and structural reforms leading to stabilization and economic growth. In the field of public finance, policies essentially pursued the reduction of the fiscal deficit. In this way, the agreements with the IMF, which were a matter of public knowledge, guaranteed responsible and transparent public finance management.

By the mid-1990s, authorities at MEF and the CRBP began to consider what would happen to Peruvian fiscal policy after the programs with the IMF came to an end. In practice, the IMF had taken the role of a Fiscal Council,[8] with much more power than the current one.

In response, in part, to the aforementioned concern, authorities promoted the Fiscal Prudence and Transparency Law (FPTL)[9] in December 1999. This law had a two-fold purpose: first, to improve the transparency of fiscal policy through a commitment to publish a Multiannual Macroeconomic Framework (MMF) comprising the economic program and the main macroeconomic projections of the government in office, and second, to continue with the efforts to reduce public debt, through a measured reduction of the fiscal deficit limit as a percentage of GDP.

At that time,[10] the government did not have the protection of public investment nor the countercyclical role of fiscal policy among its priorities.[11] At that juncture,[12] government priorities were instead guided by a concern for social spending, due to high poverty rates.[13] The FPTL also created the Fiscal Stabilization Fund (FSF). This fund was conceived to be used in rare circumstances of severe economic crises when it becomes more difficult to access to international credit markets.[14]

[8] The Peruvian Fiscal Council carries out the technical analysis and monitoring of fiscal policies, their consistency with the economic cycle and fiscal sustainability. These are their main roles.
[9] This law was designed under the leadership of JV (see Appendix Table 8 for initials and acronyms).
[10] According to the statement of JV.
[11] Notice that FPTL implicitly had a countercyclical component, allowing the rise of fiscal deficit only in economic crisis scenarios.
[12] Interview with JV.
[13] In 1993, 57 percent of the Peruvian population was poor, understood as the percentage of the population that had at least one unsatisfied basic need (UBN). In rural areas, this percentage reached 90 percent (World Bank 2005: 3).
[14] Interview with JV.

The application of the FPTL coincided with the economic stagnation of the 1999-2001 period, years in which the Peruvian economy only grew by 1.5 percent per year. Despite the stagnation, as we will see in Figure 1 the fiscal deficit fell from 3.4 percent of GDP in 2000 to 2.8 percent of GDP in 2001. This fall was basically explained by a reduction in public investment from 4.2 percent of GDP to just 3.3 percent in the same period. The FPTL fulfilled its mission, although at the expense of public investment (see Figure 2).

The Fiscal Responsibility and Transparency Law (FRTL), enacted in May 2003, was not greatly different from the previous law, but it considered some changes that had occurred in the country in the years after the enactment of the previous law. First, the limit on the real growth of non-financial spending was raised from 2 percent of the FPTL to 3 percent per year in the new law, because authorities assumed the potential growth rate of the economy had risen.[15]

Second, by mid-2002, the government enacted the Base Law of Decentralization (BLD), Law 27783. Therefore, the FPTL had to consider article 5d of the BLD, referring to the public indebtedness of regional and local governments with the guarantee of the State, and article 5e, on the need for fiscal rules to guide the behavior of regional and local governments.

Subsequent modifications did not alter the spirit of the FRTL, except for the change introduced in June 2007, in Supplementary Credit Law, Law 29035. Previously, both the FPTL and the FRTL had put limits on the real growth of non-financial expenditure of the General Government. Law 29035 restricted the growth limit of spending to consumption spending and excluded investment spending from that limit, also limiting the coverage of the law only to the central government. It was the closest experiment to the "golden rule" in Peruvian fiscal history. The law reflected the affinity of the Minister of Economy Luis Carranza, in office during July 2006 – July 2008 and January-December 2009, for that rule, as can be seen in Carranza and Tuesta (2003).[16]

The experiment was carried out at a critical juncture. On the one hand, in the period 2003-2008, the rise in export prices at 18.5 percent per year, produced a significant increase in government revenues. On the other hand, in that period, the FSF rose significantly, from 0.4 percent of GDP in 2005 to 1.5 percent in 2009. Both developments facilitated the financing of

[15] Interview with JV.
[16] This information was confirmed in the interview with JV.

public investment. Last, this period was hit by the 2008-2009 Global Financial Crisis, which enabled the activation of the rule compliance exception clause.

As a result, in the years 2007-2009, public investment grew, in real terms, at an annual average of 26.2 percent. Such high rates had been not registered since the military government of Velasco Alvarado in 1974. As expected, despite the significant increase in revenue, the golden rule transformed the fiscal surplus of 3.1 percent of GDP in 2007 to a 1.3 percent deficit in 2009.

The last significant fiscal law reform occurred in 2013, with the enactment of Law 30099, the Law to Strengthen Fiscal Responsibility and Transparency (LSFRT), which took effect in 2015. Unlike the previous two laws, which were pro-cyclical, this was acyclical because it operated with an ex ante guide to the primary deficit as a percentage of potential GDP, from which an expenditure rule tied to structural revenues was derived. In theory, the public debt limit set in the law could induce a procyclical bias; however, public debt in those years was well below the 30 percent limit of GDP established in the LSFRT. The process of drafting and implementation of this law was long-lasting and involved the collaboration of external consultants.

The LSFRT featured three main innovations. First, to include only entities directly linked to the public budget, the coverage of public spending was reduced to the National Government. Second, given that government income strongly depends on export prices, structural revenues were to be calculated considering the long-run trend of both GDP and export prices. Third, a mechanism for the MEF external monitoring was considered necessary for compliance with fiscal rules. Opinions of the CRBP on the MMM were insufficient for that purpose. Consequently, an independent Fiscal Council was created. Strikingly, this is one of the few cases in the world of a creation of a Fiscal Council amid a fiscal slack situation and without pressure from international organizations.

Conceived in 2012 and promulgated in 2013, the LSFRT began to be applied only in 2015, when the fall in export prices had continued since 2012. One of the major difficulties of the law[17] was the estimation of trend export prices, an important component for estimating structural revenues.[18] An additional problem with the structural rule was the difficulty in transmitting its

[17] Waldo Mendoza (WM) was a member of the commission in charge for calculation methodology of the structural rule.
[18] See the report of the Ghezzi, Mendoza and Seminario Commission (2014).

operability to the political class and the media. In Congress, for example, it was thought that, through the structural numbers, the real numbers of the fiscal situation were being hidden.[19]

Due to the considerations described, in December 2016, just five months after the new government was installed, the MEF enacted LD 1276, the Fiscal Responsibility and Transparency Framework of the Non-Financial Public Sector (FRTF). This law is remarkably similar to the FPTL and the FRTL. The only difference was that it kept from the LSFRT the article that limits public debt to 30 percent of GDP. The new rules, according to the new authorities, are simpler and more transparent.

Although it is not as transparent as its promoters assert, it has three rules that, without knowing which of them is binding in a given year, limit spending, deficit and public debt. It is likely that the FRTF will last for a fairly long time, although, as in all previous cases, with partial amendments over time. Nonetheless, the fiscal crisis caused by COVID-19 may give rise to fiscal rules that could turn substantially different from current standards.

In any case, some studies suggest that the recent fiscal policy is less procyclical than the one in force at the beginning of the century. According to Rojas and Vassallo (2018), the correlation between the fiscal impulse derived from spending and the Peruvian business cycle was 0.85 in the period 2000-2008 and became -0.02 in the years 2009-2017. In other words, the execution of public spending was pro-cyclical before the financial crisis but has turned acyclical in recent years. The authors also find that while fiscal impulse derived from capital expenditure was procyclical during 2014-2017, in the same period current spending was countercyclical or neutral.

3. Fiscal Rules, Compliance and Public Investment: The Main Stylized Facts

3.1 Fiscal Rules and Compliance with Them

The first Law (FPTL) had two fundamental rules. One of them imposed a limit on the nominal fiscal deficit as a percentage of GDP. The other set a limit to the real growth rate of the non-financial expenditure of the General Government. The first rule, like all fiscal rules of the first generation, was pro-cyclical, while the expenditure rule was acyclical. The fiscal deficit rule was also pro-cyclical with respect to the performance of the international economy because public

[19] Interview with CL.

spending moves in the same direction as export prices. Figures 1 and 2 in the main text and Tables 1-3 in TechnicalAppendix A are particularly important not only to understand all changes in Peruvian fiscal rules, but also to evaluate their degree of compliance in two decades of implementation.

From Figure 1, fiscal deficits observed between 2000 and 2001 were above the fiscal limit of 1 percent of the GDP established in the FPTL. Anticipating this, transitory limits of 2 and 1.5 percent of GDP were established, ex ante, for the years 2000 and 2001, respectively. Since even the transitional limit was not fulfilled in 2000, compliance with the fiscal rule for 2001 and 2002 had to be waived.

Figure 2 shows that, unlike the fiscal deficit rule, there was compliance with the non-financial expenditure rule observed in 2000 and 2001. In the aftermath of the FPTL, however—that is, in 2002—compliance was not fulfilled.

The second fiscal law, the FRTL had a lifespan of almost 10 years. The fiscal deficit limit remained at 1 percent of GDP, and the growth limit of non-financial expenditure rose to 3 percent in real terms. This law created fiscal rules for local and regional governments.

Given the difficulty to comply with the fiscal deficit limit, in 2003 and 2004, transitional limits of 2 and 1.5 percent of GDP were established, respectively. Because the fiscal deficits observed were 1.7 and 1.1 percent of GDP, respectively, we can point out that this rule was fulfilled, although with transitory limits.

In the 2005-2008 period, characterized by a commodity price boom, fiscal limits were easily fulfilled due to a significant increase in tax revenues.

In the following two years that mark the aftermath of the Global Financial Crisis, 2009-2010, the exception clause to the fiscal rules was activated for the first time. The latter meant the establishment of a transitional fiscal deficit limit of 2 percent of GDP and the approval to use the FSF. Despite this loose limit, the fiscal deficits observed were only 1.3 and 0.2 percent of GDP, respectively, due to the rapid recovery of revenues. In the following two years, 2011-2013, fiscal and transitory limits were fulfilled. However, in 2014, the fiscal deficit limit was again breached, exceeding the transitory limit set to 0.3 p.p. of GDP.

Regarding the rule for non-financial expenditure, although during the biennium 2004-2005 it was not fulfilled, in 2006-2008 there was no breach, in part because public investment was released from that rule. In 2009, despite applying a transitory limit of 10 percent, the spending rule

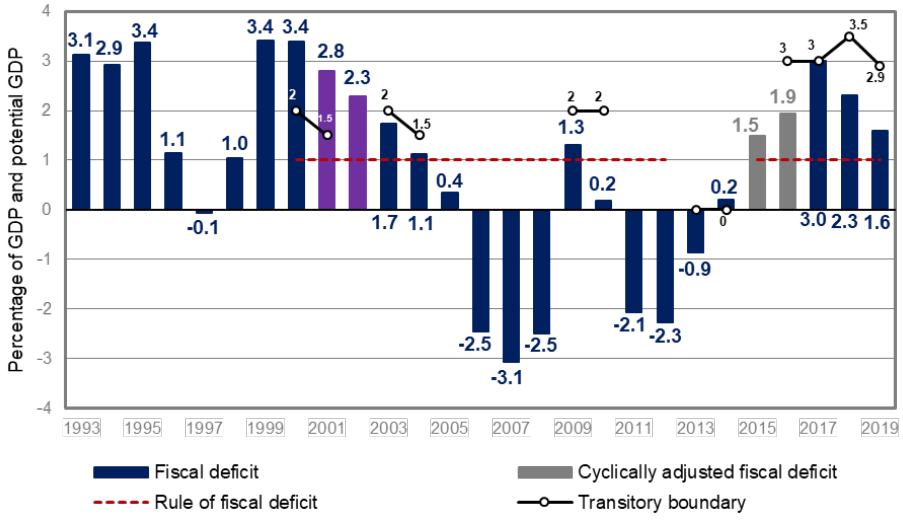
was not fulfilled because it rose by 10.2 percent. In contrast, 2010-2012 was a period of unrestricted compliance. On the other hand, given that in 2013 and 2014 there was no spending rule, non-financial public spending grew at high rates, on average 9.2 percent per year.

In October 2013, the LSFRT was promulgated, and it has been in effect since 2015. Unlike the two previous laws, it operated with an ex ante guide to the primary deficit as a percentage of potential GDP. During its life, the limit was exceeded by 0.5 p.p. of potential GDP in 2015 and what was stipulated in 2016 was fulfilled. Supreme Decree (SD) 084-2014-EF and 242-2015-EF established that the National Government's non-financial expenditure on personnel and pensions should not exceed 56,332 and 60,044 million soles for the years 2015 and 2016, respectively. As can be seen in Figure 2, both SDs were fully fulfilled.

The fiscal rules considered in the FRTF are quite similar to the FPTL and FPTL, especially the fiscal deficit rule. In relation to expenditure rules, the FRTF, unlike the first generation of rules, has more specific expenditure rules: a non-financial spending rule and a rule for current expenditure applied to the General Government. Of course, the FRTF also includes a debt rule.

For the year 2017, 2018 and 2019, the FRTF imposed a transitory limit of 3, 3.5 and 2.9 percent of GDP, respectively, which was fulfilled thanks to the activation of the exception clause as a result of the El Niño weather anomaly that wreaked havoc between February and April 2017.

Figure 1. Changes to Fiscal Deficit Rule of Non-Financial Public Sector

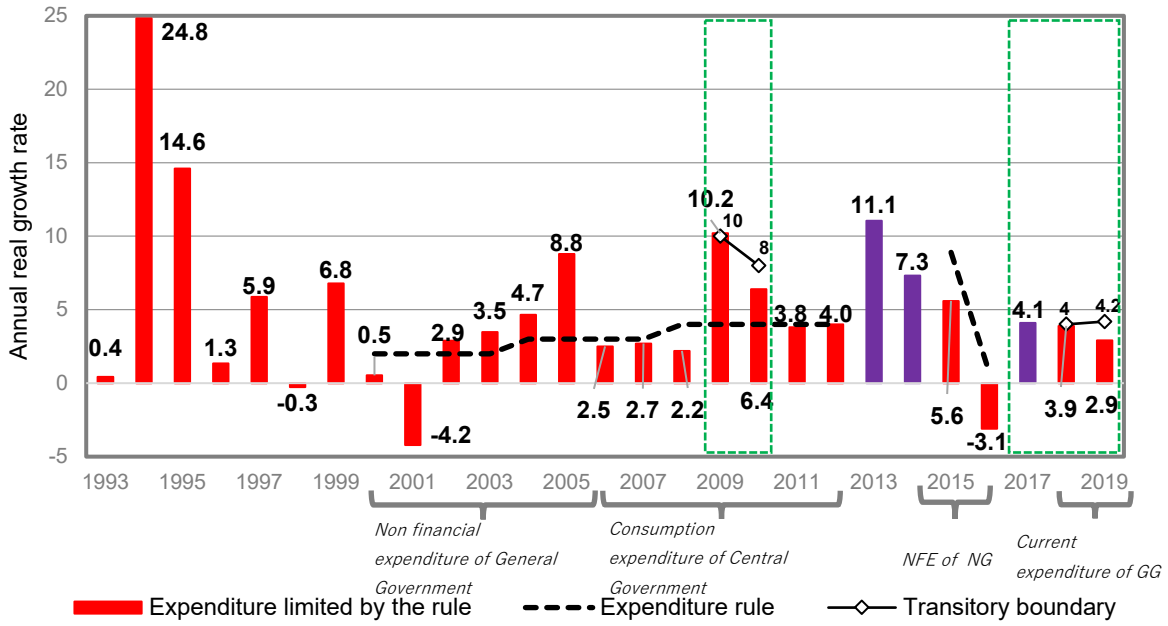


Source: Authors' calculations based on DM-STCF and Central Reserve Bank of Peru (2020).
Note: Before Covid-19 pandemic, UD 032-2019 established a transitory boundary for fiscal deficit: 2, 1.8, 1.6, 1.3 and 1 percent of GDP in 2020, 2021, 2022, 2023 and 2024. However, Legislative Decree 1457 announced exceptional suspension of Peruvian fiscal rules during 2020 and 2021.

In 2017, due to the El Niño anomaly, the rules for non-financial spending and current spending were suspended. On the other hand, in 2018 and 2019, while the current spending rule was fulfilled, the non-financial spending rule was dispensed.

Currently, due to the COVID-19 pandemic, the fiscal rules have been exceptionally and temporarily suspended. As in the whole world, with public spending growing to finance the fight against the pandemic, and revenues falling due to the significant drop in the level of economic activity, the fiscal deficit will be among the highest levels seen in recent decades.

Figure 2. Changes to Expenditure Rule of General Government



Source: Authors' calculations based on DM-STCF and Central Reserve Bank of Peru (2020).
Note: There was no expenditure rule in 2013, 2014 and 2017.

Thus, in 20 years of application of fiscal rules, it can be said that the fiscal deficit and expenditure rules were fulfilled, without considering any temporary extension, in 30 and 45 percent of years, respectively. These numbers rise if temporary limits are considered, generating compliance of 75 and 60 percent of the time, respectively. An important fact is that both the spending rule and the fiscal deficit rule were not complied with in 25 percent of the years, although 15 percent of the time there was no expenditure rule.

In sum, since the first fiscal law, the fiscal deficit limit rule, mainly and, to a lesser extent, the expenditure rule, have been breached very frequently, although the magnitude of the

modifications has been moderate and has not produced significant deviations in relation to the original rules.[20] In some cases, that of adverse economic contexts, whether external (the aftermath of the Global Financial Crisis of 2008, for example) or internal (the El Niño anomaly, among others), the rules have been complied with, but using legal transitory modifications.

Even so, from a long-term perspective, the existence of fiscal rules, despite only partial compliance, seems to have contributed to the sustained reduction of the fiscal deficit in Peru.

However, it should be noted that compliance with fiscal rules is restricted to the years of greatest economic growth and high export prices. In contrast, during years of slower growth and low export prices, the greatest changes to the deficit rule were recorded and their compliance occurred because a transitory limit was established.[21] Therefore, compliance with the fiscal deficit rule in the years 2005-2008 and 2010-2013, which were characterized by high economic growth and high export prices, is not accidental.

The reason is the extreme dependence of tax revenues on commodity prices. Under these conditions, fiscal deficit falls during commodity price booms and rises when those prices decline.[22] According to Barro (1979) and Lucas and Stockey (1983), this expected cyclical pattern of surpluses in good times and deficits in bad times would in fact be the optimal one if the fiscal authority followed an optimal fiscal policy.

However, in the last 20 years, despite constant modifications[23] and recurrent fiscal rule breaches, the target of 1 percent the current fiscal deficit to GDP has provided a medium-term guide for fiscal policy. During this long period, on average the fiscal deficit was 0.6 percent of GDP, the cyclically-adjusted deficit[24] was 0.5 percent of GDP, and public debt was reduced from 48 percent of GDP in the year 2000 and remains below the limit of 30 percent of GDP since 2007, as demanded in the Law (LSFRT, 2013).

3.2 Fiscal Rules and Public Investment

In most of the 2000-2019 period of application of fiscal laws, fiscal policy in Peru has been managed by rules that limited the fiscal deficit as a percentage of GDP or by limits to the growth

[20] See Ganiko (2020).
[21] See Ganiko (2020).
[22] See Anastacio (2020).
[23] A more detailed information of each modification is presented in Appendix A, Table 1 and 3.
[24] It is a calculation of Fiscal Council of Peru. According to official methodology of MEF (2016), the structural fiscal deficit between 2000 and 2019 was, on average, 1.1 percent of GDP.

of non-financial public spending of the General Government (periods 2000-2006 and 2017 onwards) or the growth of National Government spending on personnel and pensions (2013-2016 period) or the growth of current expenditure (2017 onwards). Only since 2013 has there been a rule that places a limit on public debt as a percentage of GDP. Nonetheless, throughout the sample, the realized public debt ratio has been much lower than the numerical limit of 30 percent of GDP.

As discussed in the previous section, most of the infractions of fiscal laws have been caused by the breach of the rule that limits the fiscal deficit as a percentage of GDP. Consequently, this seems to have been an utterly restrictive binding rule for Peruvian fiscal policy. When a rule that imposes a fiscal deficit limit as a percentage of GDP is in force, total public spending is endogenized. But, since the current part of public spending has a highly rigid component, investment becomes the most endogenous part of public spending.

In addition to this characteristic, public investment in Peru has two salient features. First, an important part of public investment is made by regional and municipal governments. In 2019, for example, 62 percent of public investment was made by subnational governments.[25] Second, a large percentage of subnational government investment is associated with the law of the mining and gas canon[26] published in July 2001. According to Law 27506, 50 percent of the income tax paid by companies producing mainly minerals and gas is allocated to local (75 percent) and regional governments (25 percent). The latter transfer 20 percent to public universities in their jurisdiction. These resources must be fundamentally used in public investment.

The MEF allocates these resources annually but does not control them, as they are not ordinary resources.[27] Consequently, the large amounts of fees transferred—given the enormous importance of mining and gas in Peru—are available for subnational public investment, and therefore their dynamics are at odds with the National Government's investment dynamics. There are regions in Peru that have accumulated hundreds of millions of soles that are not yet used due to structural difficulties faced by the Peruvian State in carrying out public investment projects.[28]

[25] The weight of subnational public investment within total public investment has been growing over time. The share of subnational investment rose from 31 percent in 2003, reached a peak of 71 percent in 2013 and in 2019 hit 62 percent.

[26] These laws preceded Law 24300 of September 1985, article 77 of the Political Constitution of 1993 and Law 26472 enacted in 1994, which assigned Subnational Governments 20 percent of the income tax derived from the exploitation of resources natural. This was repealed in 2001.

[27] Resources that belong to the central government, which are assigned to the different dependencies of the State and when they are not spent at the end of the year, return to the Public Treasury.

[28] Among other factors mentioned by Jiménez et al. (2018), these difficulties include low execution capacity of most of the new authorities, and the poor role of the Executive as articulator and promoter of investment initiatives.

This lack of investment has been worsened by the corruption scandal facing Odebrecht, a Brazilian construction company, and partner local companies named as the "Club de la Construcción."[29] Odebrecht and the members of the construction club were in charge of the most emblematic public investment projects in Peru.

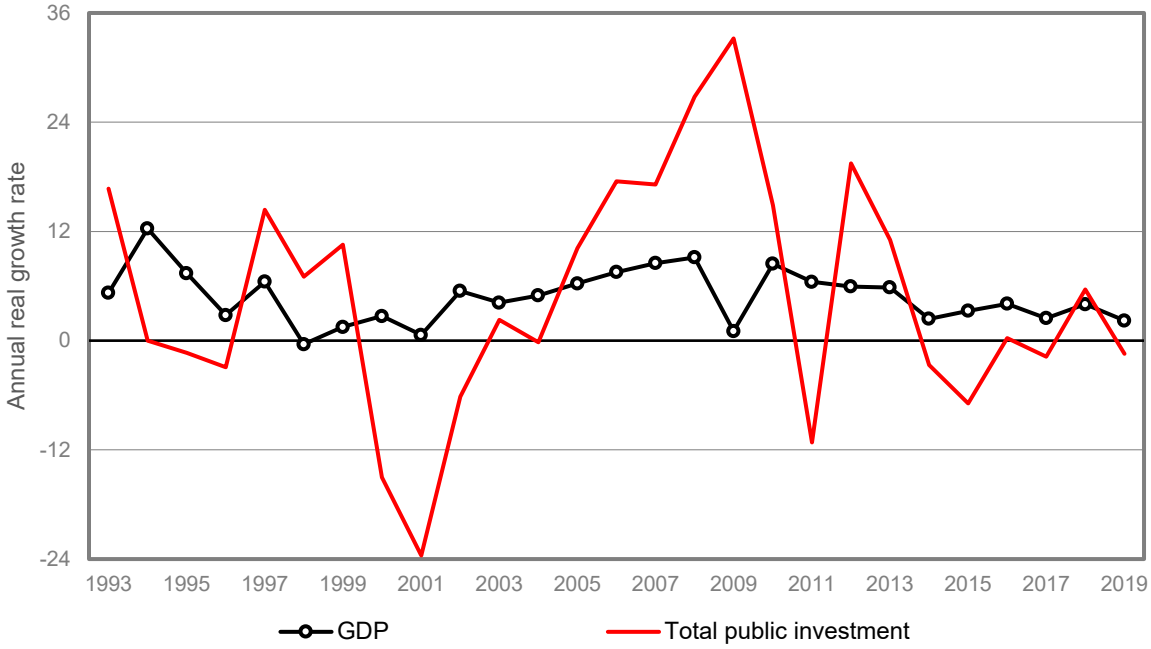
It is important to realize that, in theory, the current fiscal deficit rule implies that public investment is pro-cyclical. Given a limit to the fiscal deficit, the higher the GDP is, the greater the space for higher public spending. And, since public investment is the most endogenous component of public spending, it is the component that should grow most during the boom and the one that should contract the most during a recession.

As depicted in Figure 3, booming GDP periods witness public investment growing above GDP. Symmetrically, GDP slowdown periods mean public investment growing below GDP. For example, during the commodity prices boom of 2005-2008, GDP growth reached 7.9 percent per year, and public investment grew 22.5 percent per year. Conversely, during 2013-2016, when commodity prices fell sharply, GDP grew at a modest 3.9 percent and public investment contracted on average at 2.1 percent. The correlation coefficient between the cyclical components[30] of GDP and public investment during the 2000-2019 period is 0.7, suggesting the pro-cyclical nature of total public investment.

[29] The "Club de la Construcción" was made up of national construction companies (Obrainsa, Graña y Montero, ICCGSA, JOHESA, Grupo Plaza, Cosapi, Constructora San Martín, Málaga Hermanos, H & H Casa) and foreigners (Odebrecht, OAS, Andrade Gutierrez, Queiroz Galvao, Mota-Engil), who managed to obtain contracts for public works, allegedly by illegal means. Since 2017 they have been investigated by the Peruvian Anti-Corruption Prosecutor.

[30] We have used the HP filter to obtain the cyclical components of GDP and total, national and subnational public investment.

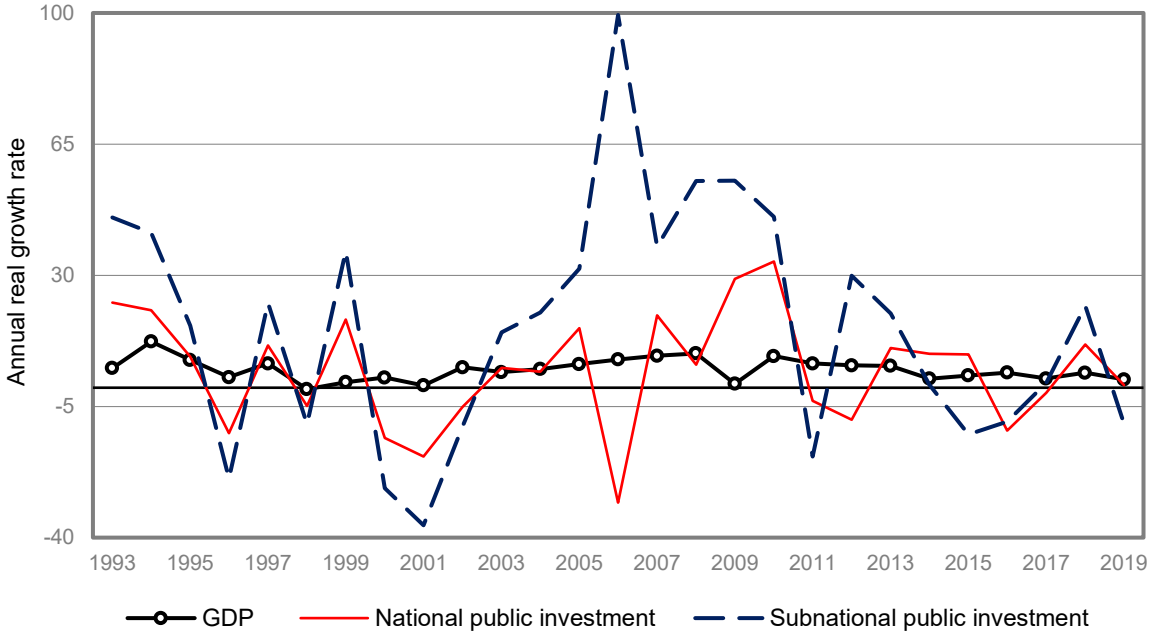
Figure 3. Public Investment of General Government and GDP



Source: Authors' calculations based on Central Reserve Bank of Peru (2020).

Figure 4 also emphasizes that the dynamics of subnational and national public investment are very related to economic cycle, in other words, both variables are pro-cyclical. The contemporaneous correlation during the 2000-2019 period between the cyclical components of GDP and National Government investment is 0.7, equal to the correlation between the cyclical components of GDP and subnational public investment computed for the same period.

Figure 4. GDP and Decomposition of Public Investment of General Government



Source: Authors' calculations based on Central Reserve Bank of Peru (2020).
Note: Subnational and national public investment for the period 1994-2002 was recalculated, and the mean shares for that period and 2003-2005 were 0.3 and 0.7, respectively.

Although the fiscal deficit limit rule induces pro-cyclicality in public investment,[31] in the long run the fiscal rule does not restrict the growth of public investment if economic growth is high on average. That is what has happened in the Peruvian economy. In the 2005-2019 period, while the average GDP growth was 5.2 percent, that of public investment was 8.8 percent.

In relation to the rules that impose a limit on the growth of current expenditure, assuming the permanence of the rule that limits the actual deficit as a percentage of GDP and the rule that limits the growth rate of current expenditure, the following clarifications can be made. First, the rule that limits the growth of current spending[32] took effect in 2007. Second, the rule is not necessarily favorable for public investment. Given the fiscal rules, public investment can rise in the expansionary phase of the business cycle, but it can be reduced in the contractionary phase.

[31] Rigorously, with the golden rule all public indebtedness is only for public investment or, what is the same, the fiscal deficit is equal to public investment.
[32] Law 29035 defined spending for 2007 as consumption expenditure (remuneration and goods and services) of the Central Government. Laws 29144, 29368, 29368 and 29812 understood spending as pensions, remuneration and goods and services for 2008, 2009, 2010 and 2011, respectively. Similarly, Law 29854 governed for 2012 and excluded expenses in maintenance of infrastructure, expenditure on goods and services of social programs framed under the Budget for Results scheme from the consumption expense (pensions, remuneration and goods and services). As of 2018, in the FRTF, the limit is for the current expense without maintenance of the General Government.

Finally, the rule for current spending will favor investment only when its growth is below the GDP growth rate.

Did the rule restrain the growth of current spending? Figure 5 suggests that this has been the case. The current expenditure growth rate[33] has been 4.6 percent in the 2007-2019 period, slightly below the 5.1 growth rate achieved prior to the existence of the rule, the 2000-2006 period.

Did the rule favor public investment? Figure 5 supports this assertion.[34] In the 2007-2019 period, the GDP growth rate, 4.9 percent, was above the current expenditure growth rate, 4.6 percent, creating a space for public investment. This greater space caused public investment to grow at an average rate of 8 percent during that period, which was not affected even by the dismal results of the 2016-2019 triennium associated with the difficulties in pursuing investment projects, linked to the corruption scandal at Odebrecht and the "Club de la Construcción."

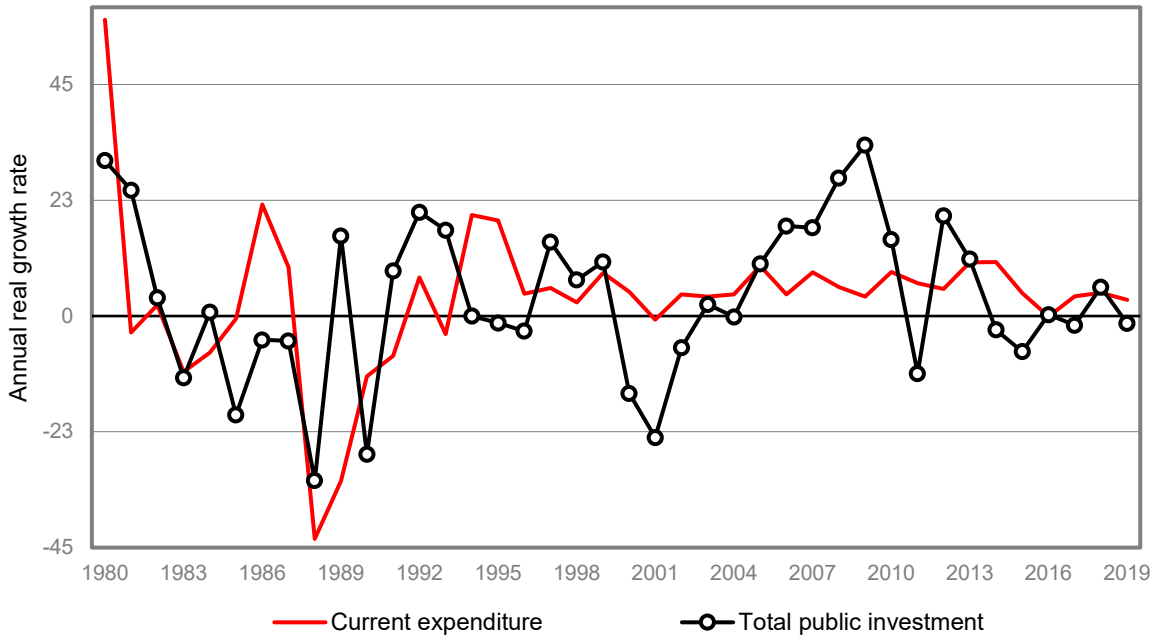
In addition, since current spending represents 75 percent of non-financial spending,[35] the rule imposes a limit on the growth of total public spending. The fact that the non-financial expenditure of the General Government remains stable at around 20 percent of GDP is a favorable collateral effect for the fiscal sustainability of the limit to the growth of current expenditure.

Finally, in 20 years of implementing fiscal laws, only in 2007 and 2008 did the fiscal rule approached a golden rule. This occurred because of the exemption of public investment from public spending growth limits, the effects of which were described in the previous section.

To conclude, the current spending rule has been favorable to public investment because of lower current spending growth compared to that of GDP. The rule provided more space for public investment, especially during boom periods. Also, given the importance of current spending in non-financial spending, the mere fact of controlling the former guarantees moderate growth of the latter.

[33] Current expenditure for 2013 and 2014 was excluded from the mean because there was no rule in those years. In addition, current expenditure for 2009-2010 was eliminated because an exceptional rule of nearly 10 percent was established.
[34] In the 2000-2012 period, the GDP growth rate was 5.5 percent, surpassing current spending that reached 5.3 percent, leading investment to grow at an average rate of 6.6 percent.
[35] Current spending had a participation of 77 percent of non-financial public expenditure during 1980-2019.

Figure 5. Current Expenditure and Total Public Investment



Source: Authors' calculations based on Central Reserve Bank of Peru (2020).

4. Fiscal Rules and Public Investment: A Counterfactual Analysis

In the previous two sections we have provided a narrative of the institutional setup of the various fiscal laws that implement fiscal rules as well as the degree of compliance with those rules. We have also described the behavior of public investment during the period 2000-2019. Given the above background, we now turn to assess the effect of FPTL on public investment in Peru.

We address the estimation of the effect of fiscal rules implementation over public investment through the SCM. Our aim is to evaluate the impact of fiscal rules implementation in 2000 on Peruvian public investment.

According to Abadie et al. (2010), the SCM quantifies the effects of events or policy interventions that take place at an aggregate level and affect aggregate entities, such as countries or subnational governments. For that purpose, the method allows for the creation of a "synthetic" or artificial control through the weighted average of data from countries that have similar characteristics as the country under study.

Despite its flexibility and rising use, the SCM has some disadvantages. For instance, the IMF (2015) highlights the presence of two potential sources of bias when this method is applied for studying the macroeconomic effects of fiscal policy reforms. According to IMF (2015), results

could be potentially biased upwards because of the difficulty of disentangling the impact of these reforms from other factors. In addition, if the researcher includes countries (in the comparator group) which also underwent fiscal policy reforms, then results could be potentially biased downwards.

4.1 The Synthetic Control Method

Following the notation of Martinelli and Vega (2019), if $J+1$ countries are observed, the first unit is the treated country exposed to the policies (fiscal rules implementation), while others remain isolated from the policy. The latter group is considered the "control group." Outcomes are observed for T periods, and the policy starts at T_0+1 (with $1 \leq T_0 < T$). The observed outcome vector for each country is $Y_j = \left(Y_{j,1}, \ldots, Y_{j,T_0}, \ldots, Y_{j,T}\right)$ and may be expressed as the sum of a treatment-free potential outcome $Y_{j,t}^N$ and the effect of the treatment $\alpha_{j,t}$ such that:

$$Y_{j,t} = Y_{j,t}^N + \alpha_{j,t} D_{j,t}$$

where $D_{j,t}$ is an indicator variable that takes the value of 1 for the treated unit after T_0 and is zero otherwise. From periods 1 to T_0, the treatment-free potential outcome $Y_{j,t}^N$ should be similar to the observed outcome for both the treated and the control countries. According to Abadie et al (2010), $Y_{j,t}^N$ is expressed as follows:

$$Y_{j,t}^N = \delta_t + \lambda_t \mu_j + \theta_t Z_j + \epsilon_{j,t}$$

where δ_t is a time-fixed effect, μ_j is a time-invariant unobserved predictor with time-varying coefficients λ_t, Z_j is a time-invariant vector of predictors with time-varying coefficient θ_t, and $\epsilon_{j,t}$ is a country-level unobserved shock.

For periods after T_0, the treatment-free counterfactual for the treated country $\left(Y_{1,t}^N\right)$ is unobserved. To estimate the treatment effect for the post-intervention periods, T_0+1 up to T, the SCM approximates the unobserved $Y_{1,t}^N$ by a synthetic control unit. This is a weighted average of potential controls that best approximates the relevant pre-intervention characteristics of the treated country.

Let the the weighting matrix be $W = \left(w_2, \ldots, w_{J+1}\right)'$ where the elements are the contributions of each control country to the synthetic control unit. Notice $w_j \geq 0$ and $w_2 + \cdots +$

$w_{J+1} = 1$. The estimator of the counterfactual is a linear combination of the observed outcomes of the potential control regions, such that:

$$\hat{Y}_{1,t}^{N} = \sum_{j=2}^{J+1} w_j Y_{j,t}$$

In this sense, the estimated treatment effect for the treated country for each period after T_0 is:

$$\hat{\alpha}_{1,t} = Y_{1,t} - \hat{Y}_{1,t}^{N}$$

According to Abadie et al. (2010), if the weighted value of the observed covariates and pre-treatment outcomes for the control pool equals those of the treated region

$$Z_{1,t} = \sum_{j=2}^{J+1} w_j Z_{j,t} \text{ and } Y_{1,t} = \sum_{j=2}^{J+1} w_j Y_{j,t}$$

for $t = 1, \dots, T_0$, and the outcome is a linear function of observed and unobserved potential confounders, then $\hat{\alpha}_{1,t}$ is an approximately unbiased estimator of $\alpha_{j,t}$.

The vector W^* is chosen to minimize the distance between pre-treatment characteristics of the treated unit (X_1) and its synthetic characteristics ($X_0 W$). The distance is measured according to the metric:

$$\sqrt{(X_1 - X_0 W)' V (X_1 - X_0 W)}$$

where X_1 is a $k \times 1$ vector including k covariates and pre-treatment outcomes for the treated region, while X_0 is a $k \times J$ matrix of the control countries. V is a $k \times k$ positive definite diagonal matrix that assigns weights according to the relative importance of the covariates and the pre-intervention outcomes.

The choice of variables in X_0 and X_1 needs to be justified on economic grounds. The general rule is that they should describe the country economic features relevant for the case at hand. Additionally, the V matrix is obtained from combinations such that the mean squared prediction error of the outcome variable is minimized over some set of pre-intervention periods.

4.2 Empirical Strategy

The outcome variable is public investment. The data are obtained from the Investment and Capital Stock Dataset of the International Monetary Fund (IMF).

In the Peruvian case, the fiscal deficit rule, despite its modifications and exceptions, is the longest-running rule. As shown in Section 2.2, with this rule, given the rigidity of current expenditure, public investment is the most endogenous component of overall public expenditure. Hence, public investment rises when tax pressure, GDP or export prices increase and boost fiscal revenue. Public investment also moves more when the numeric limit of the fiscal deficit rule is higher or more flexible.[36] All these variables expand the fiscal space for public investment. By the same token, public investment is lower when current expenditures or public debt interest payments are larger.

The treatment therefore is the adoption of the FPTL at the end of 1999 in Peru. We deem 2000 the first year of full-fledge application of the fiscal rule comprising all quantitative criteria detailed in the law. It is worth noting that the SCM cannot determine the partial effects of each rule criterion making up the FPTL. It only captures the overall event.

To capture the country characteristics that will help determine the weights for the countrol group as close as possible, we choose variables such as GDP, private investment, terms of trade, public debt,[37] human capital and a state fragility index. Moreover, we will use the terms of trade instead of export prices because of its availability in the database. The variables and their sources are shown in Table 1.

Table 1. Variables Contained in Vectors X_0 and X_1

Outcome	**Source**
Log of General Government Investment	Investment and Capital Stock Dataset
Predictors of country characteristics	**Source**
Log of GDP	Investment and Capital Stock Dataset
Log of Private Investment	Investment and Capital Stock Dataset
Log of Terms of Trade	DataMarket.com
Human capital index, based on years of schooling and returns to education; see Human capital in PWT9.	Penn World Table 9.1
State Fragility index	Marshall, M. G., & Elzinga-Marshall, G. (2017). Global report 2017: Conflict, governance, and state fragility. Center for Systemic Peace.
General government gross debt	World Economic Outlook Database and Historical Public Debt Database (International Monetary Fund)

[36] We will not include the numerical limit of fiscal deficit rule as a predictor because the synthetic unit will be based in countries without this kind of regulatory arrangement before the year 2000.

[37] We should have considered current spending among predictive variables. As we have seen, given our fiscal rules, this variable can affect negatively public investment. The reason is that we have not found enough statistical information on this variable.

As we mentioned previously, the choice of predictor variables and the control group is of utmost importance to reduce potential biases in the results.

Regarding the control group, we work with three (see Table 4) cases. The first contains LAC countries. The second group is formed by emerging markets, using the classification of the Emerging Market Bond Index from JP Morgan. Additionally, we consider commodity exporters from the IMF classification (World Commodity Exporters Database).

We set year 2000 as the treatment year. At that time, fiscal rules took effect in the Peruvian economy following the enactment of the Prudence and Fiscal Transparency Law (Law 27245, published in December 1999). The weighting matrix W^* is calculated with two alternative methods: Abadie et al. (2010) and Becker and Klößner (2018) respectively. All computational codes are available as R software packages supporting these methods.

In sum, we estimate six versions of the SCM. The one with LAC control group, treatment year set in 2000 and with a weighting matrix calculated using Abadie et al. (2010) is the baseline model.

4.3 Results

We perform six estimations of the fiscal rule adoption in 2000 on public investment measured in logs.[38] By 2005, all the estimations imply a fall between 60 and 80 percent relative to synthetic counterfactuals. In Table 2, we report the pseudo p-values calculated by permutation of placebo studies as in Abadie, Diamond and Hainmueller (2015). The pseudo p-values[39] are relatively low which mean that if we were to assign a random fiscal rule intervention in any country, the probability of obtaining a post to pre RMSPE ratio as large as Peru would range between 8 and 13 percent. Hence, there is some evidence that the fiscal adoption indeed reduced public investment.

Table 2. P-values Calculated Following Abadie, Diamond and Hainmueller (2015)

	LAC	*EMBI*	*WCE*
ADH (Abadie et al,(2010)	0.10	0.13	0.08
BK (Becker and Klößner, 2018)	0.10	0.33	0.08

Source: Authors' calculations based on several database of Table 1.

[38] An robustness exercise is provided in Technical Appendix B in which public investment was considered as percentage of GDP.

[39] Inference within SCM does not follow the classical hypothesis testing procedure. Instead, it is based on permutations. Appendix B contains the placebo studies as well as the post to pre treatment RMSPE ratios involved in the p-value calculation.

The estimated weights for the three control groups are reported on Table 3. From the general list of countries on Table 4, we selected as donor countries only those countries that did not adopt fiscal rules in the period 1995 to 2005 (five years before and five years after the fiscal rule adoption in Peru). Also, data availability for some countries chosen shrinks the donor country pool to those reported in Table 3.

In each control group, only a handful of countries receive weights. In the LAC control group, Bolivia, Mexico and the Dominican Republic explain all the weights. In the EMBI control group, Israel, Nigeria, Ukraine and Vietnam receive all the weights. This group of countries is heteregenous, and none of Latin American countries have weights. Last, in the WCE group; United Arab Emirates, Bolivia, Indonesia, Kuwait and Mexico receive weights.

Remarkably, Bolivia and Mexico receive high weights in both the LAC and WCE control groups. As explained above, country weights are calculated to match the vector of pre-treatment characteristics of Peru as close as possible. Bolivia has not yet adopted a fiscal rule, and Mexico adopted a rule only in 2006. So, Mexico and Bolivia along the countries that receive weight in the control groups behave similar to Peru during the pre-treatment period, After the treatment however, public investment in these countries tend to end up higher in 2005 relative to 1999, quite the opposite of what happened in Peru. During this turn of events, the emerging market financial crisis affected all these countries in a similar fashion, so the only distinctive feature that could explain the rather different Peruvian path is the adoption of the fiscal rule.

With the weights at hand, we build the synthetic estimates as shown in Figure 6. The best pre-treatment performance is that of the WCE synthetic public investment under BK weights while the worst performance to explain the pre-treatment log public investment is the EMBI synthetic with BK weights.

In all cases shown in Figure 6, the synthetic counterfactual of public investment is well above the observed values. To shed more light on the significance of the results, we perform a placebo study where we apply the treatment to all countries in the control groups. Figure 7 shows the gaps between the observed outcomes and the synthetic values. The behavior of the public investment gap in Peru clearly stands out from the rest of the countries.

A usual procedure is to calculate the ratios of the post-treatment root mean squared predictive errors (RMSPE) to the pre-treatment RMSPEs. A large value of this ratio means that the post-treatment synthetic counterfactual strongly deviates from its observed value relative to

the pre-treatment deviation. The ratios are depicted in Figure 8. We observe that the ratios in Peru (PER) fare relatively well in all six cases except the EMBI with BK where the ratio is only about five.

To sum up, by 2005 all the estimations performed imply a statistically important fall in public investment between 60 and 80 percent relative to synthetic counterfactuals. This result also holds when we use the ratio of public investment to GDP as the outcome variable instead of the log level of public investment. In this latter case, public investment to GDP ratio falls between one and two percentage points by 2005.

It is important to mention that the span of analysis of the SCM should be long enough to allow for the policy shift (adoption of fiscal rules) to affect outcomes. However, the span cannot be too long because the outcome of interest might be affected by other policy changes, different from the policy under analysis.

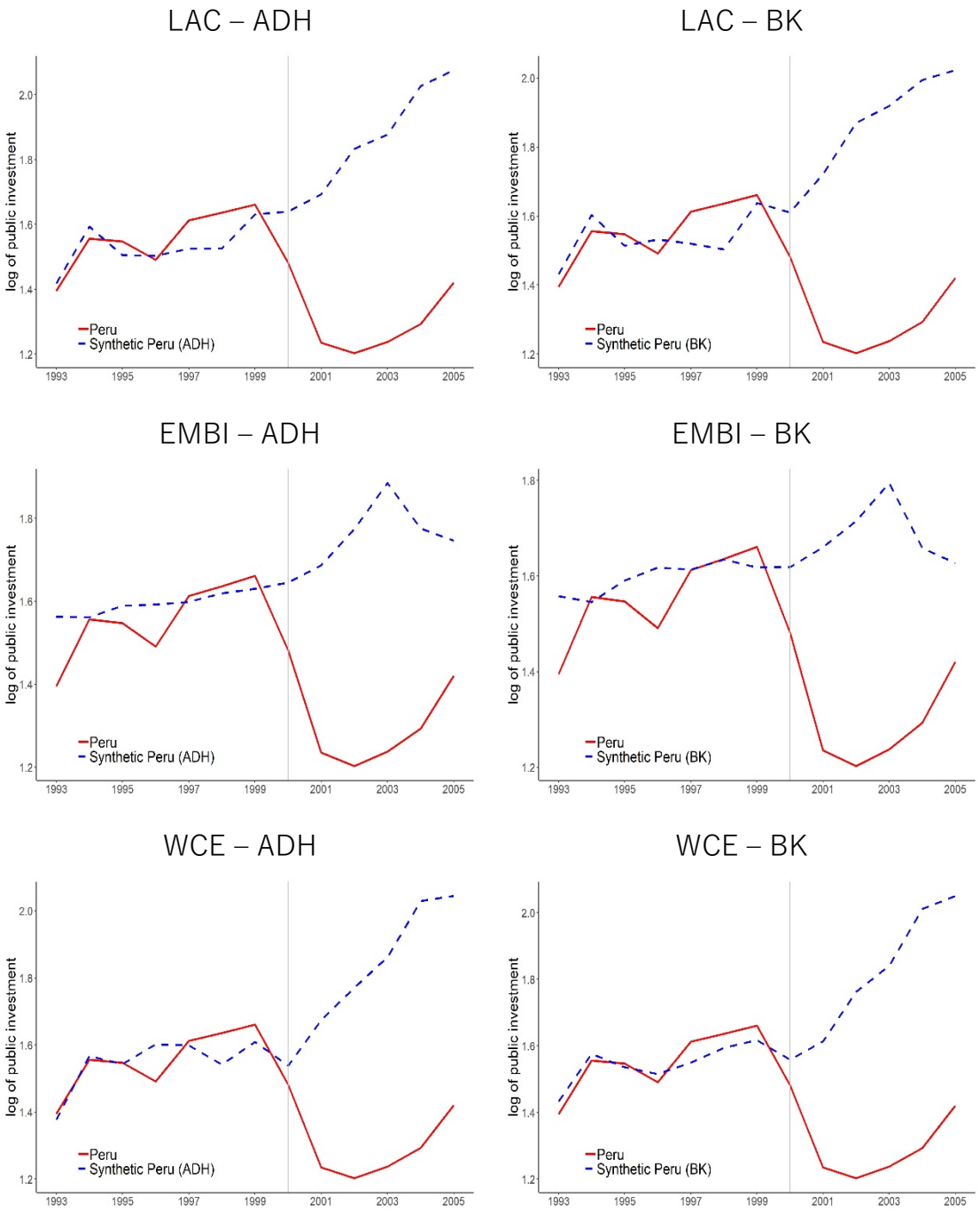
Our results provide important evidence about the hypothesis that a fiscal rule adoption might lead to a reduction in public investment if fiscal space shrinks. This was especially the case in the adoption period of the fiscal rule in Peru which concided with the adverse cyclical period (financial crisis in emerging market economies) in Peru and other emerging economies.

Table 3. Estimated Weights

	Country	Country codes	ADH weights	BK weights
LAC control group				
1	Bolivia	BOL	52.0	43.4
2	Dominican Republic	DOM	0	21.6
3	Guatemala	GTM	9.7	0
4	Honduras	HND	0	0
5	Haiti	HTI	0	0
6	Mexico	MEX	38.2	35.0
7	Nicaragua	NIC	0	0
9	Paraguay	PRY	0	0
10	El Salvador	SLV	0	0
EMBI control group				
1	United Arab Emirates	ARE	0.01	0
2	China	CHN	0	0
3	Egypt	EGY	0	0
4	Indonesia	IDN	0	0
5	Israel	ISR	66.3	75.8
6	Mexico	MEX	0	0
7	Malaysia	MYS	0	0
8	Nigeria	NGA	0.1	0
10	Philippines	PHL	0	0
11	Thailand	THA	0	0
12	Turkey	TUR	0	0
13	Taiwan	TWN	0	0
14	Ukraine	UKR	12.1	8.8
15	Vietnam	VNM	21.5	15.4
16	South Africa	ZAF	0	0
WCE control group				
1	Angola	AGO	0	0
2	United Arab Emirates	ARE	0	5.1
3	Bolivia	BOL	59.1	47.2
4	Algeria	DZA	0	0
5	Indonesia	IDN	15.5	0
6	Iran	IRN	0	0
7	Kuwait	KWT	0	17.1
8	Mexico	MEX	22.9	29.6
9	Nigeria	NGA	0	0
11	Saudi Arabia	SAU	0	0
12	South Africa	ZAF	0	0
13	Zambia	ZMB	2.5	1.0

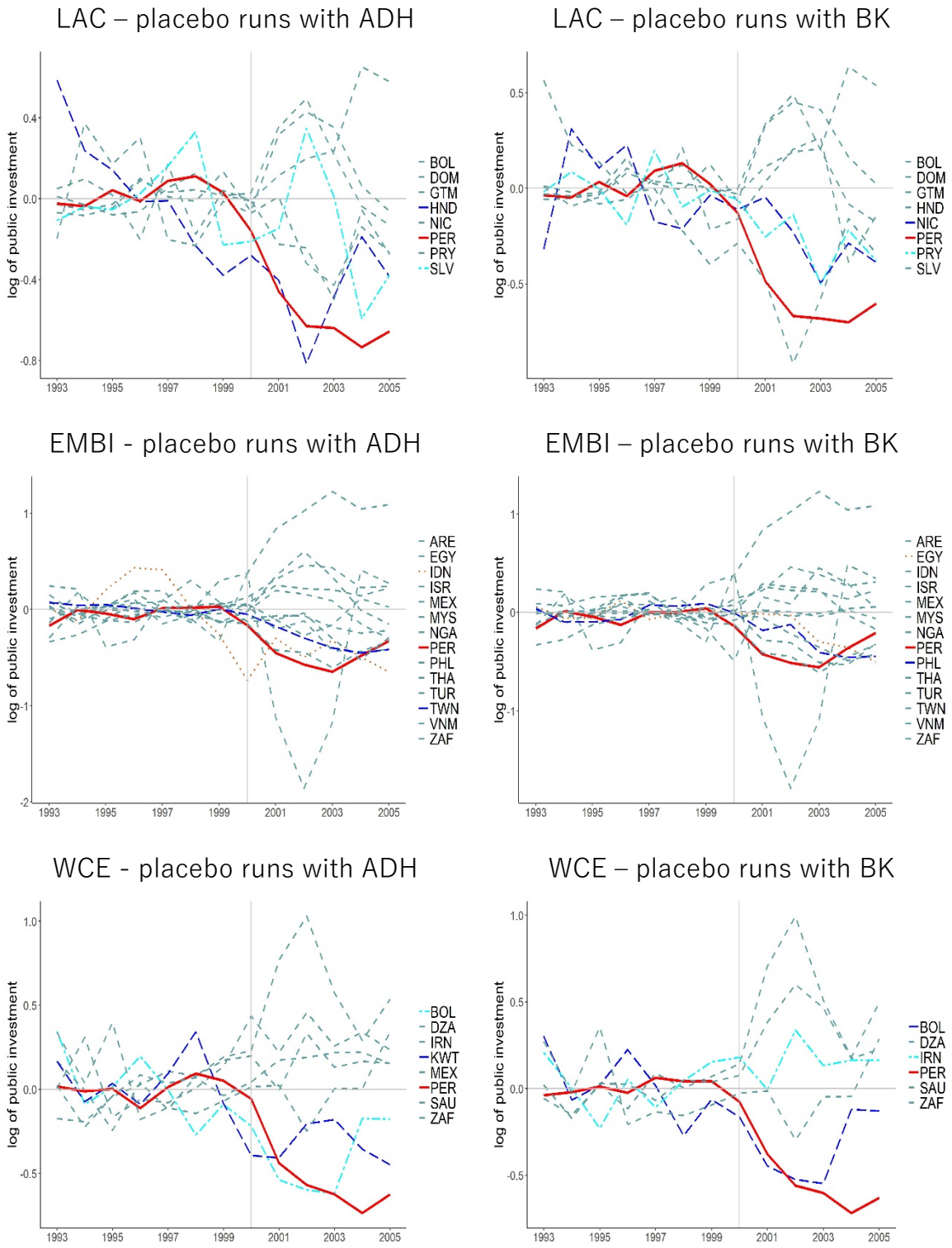
Source: Authors' calculations based on several databases of Table 1.

Figure 6. Estimated and Observed Log Government Investment



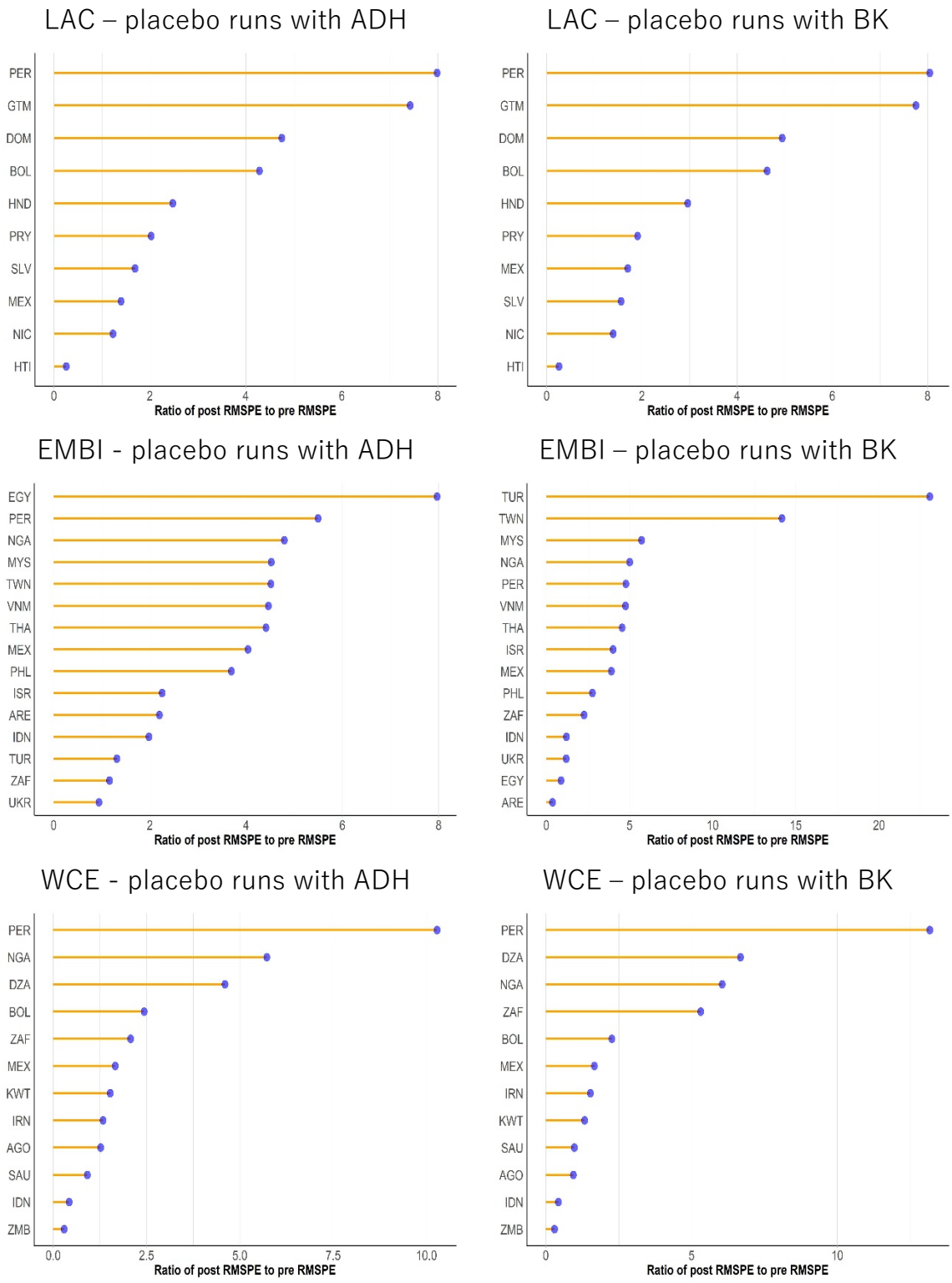
Source: Authors' calculations based on several databases of Table 1.

Figure 7. Placebo Exercise



Source: Authors' calculations based on several database of Table 1.
Note: Figure only shows those country gaps which have, in the pre-treatment period, mean squared errors less than 5 times the mean squared error in Peru.

Figure 8. Ratio of Post-Treatment RMSPE to Pre-Treatment RMSPE



Source: Authors' calculations based on several databases of Table 1.

Table 4. Classification of Countries (without Peru)

With fiscal rules

Latin America and the Caribbean	*Emerging Markets*		*Commodity exporters*	
Argentina (2000)	Argentina (2001)	Pakistan (2005)	Australia (1985)	Gabon (2002)
Brazil (2000)	Brazil (2000)	Poland (1999)	Botswana (2003)	Guinea Bissau (2000)
Chile (2001)	Chile (2001)	Czech Republic (2001)	Cameroon (2002)	Indonesia (1967)
Colombia (2000)	Colombia (2000)	Romania (2007)	Canada (1998)	Iran (2010)
Costa Rica (2001)	Hungary (2004)	Russia (2007)	Chad (2002)	Mali (2000)
Ecuador (2003)	India (2004)		Chile (2001)	Mexico (2006)
Jamaica (2010)	Indonesia (1967)		Colombia (2000)	Mongolia (2013)
Mexico (2006)	Israel (1992)		Congo (2002)	Niger (2000)
Panama (2002)	Malaysia (1959)		Ivory Coast (2000)	Nigeria (2007)
Paraguay (2015)	Mexico (2006)		Ecuador (2003)	Norway (2001)
Uruguay (2006)	Nigeria (2007)		Equatorial Guinea (2002)	Russia (2007)

Without fiscal rules (control groups)

Latin America and the Caribbean	*Emerging Markets*		*Commodity exporters*		
Bolivia	Bangladesh	Turkey	Algeria	Saudi Arabia	Congo Democratic Republic
El Salvador	China	Ukraine	Angola	Kazakhstan	Papua New Guinea
Guatemala	Egypt	United Arab Emirates	Azerbaijan	Kuwait	Syria
Haiti	Oman	Venezuela	Bahrain	Libya	Timor-Leste
Honduras	Philippines	Vietnam	Bolivia	Oman	Trinidad and Tobago
Nicaragua	Qatar		Brunei	Surinam	United Arab Emirates
Dominican Republic	South Africa		Chad	Qatar	Venezuela
Trinidad and Tobago	Taiwan		Guyana	South Africa	Yemen
Venezuela	Thailand		Iraq	Sudan	Zambia

Source: JP Morgan and IMF.
Note: Number in parentheses is the implementation year of fiscal rules according to IMF (2017).

5. Fiscal Rules and Public Investment: The DSGE Model-Based Approach

The goal of this section is to build counterfactual scenarios of the Peruvian economy with different fiscal rules and assess their effects on the economy and public investment. For this, we use a standard DSGE model for a small open economy[40,41] calibrated for the Peruvian economy in the period 2000-2019, from which we obtain impulse-response functions and calculate consumers' welfare for each scenario.

Our benchmark model closely follows García-Cicco and Kawamura (2015),[42] Melina et al. (2016),[43] and Suescún (2018)[44] but with some modifications in the fiscal policy block to allow public investment and public capital, and for matching the model with the Peruvian economic data. All the mentioned papers develop a comprehensive fiscal policy block that contains fiscal rules, tax rates, and different types of public expenditures. Additionally, Suescún (2018) provides a detailed calibration of the Peruvian economy, with crucial information for the fiscal policy block obtained from the Input-Output Tables. We describe the model in Section C of Technical Appendix C.

Regarding the set of fiscal rules, we compare the performance of the Fiscal Deficit Rule (our benchmark) with two alternative designs: a Structural Fiscal Deficit Rule, which corrects the transitory effects of the business cycle and export prices cycle over fiscal accounts; and a Current Deficit Rule (the golden rule), applied to the current deficit, such that public investment is exempt from any normative limit. The main features of these alternative rules are described in Box 1, while

[40] As mentioned in Coenen et al. (2017), these models are commonly used for counterfactual analysis, because: "…[they] have a well-identified structural interpretation, being specified on the basis of clear decision problems by economic agents and institutions, technical constraints, market clearing conditions and structural stochastic shocks to the economy".

[41] In the context of our research, this theoretical structure is used just for counterfactual but not for fiscal sustainability analysis because, by definition, DSGE models have a public debt sustainability condition which assures the system's stationarity.

[42] The authors built an RBC model with three sectors (tradable, non-tradable and commodity sectors), calibrated using Chilean data. The model has a fiscal deficit rule which can be conventional or structural. With this model, they studied the impact of the implementation of fiscal rules on households' welfare when the economy faces shocks to commodity prices.

[43] They described the DIGNAR (Debt, Investment, Growth and Natural Resources) model. With this tool, they analyzed the macroeconomic effects of the increase in public investment in natural resource-rich countries. The model added novelty elements like investment inefficiency or absorption capacity frictions and various arrangements for fiscal policy.

[44] The author showed the FMM-MTFF model and studied the implementation of macro-fiscal frameworks in the medium run. This is an RBC model with three sectors (tradable, non-tradable and commodity sectors) and additional elements which assures a better match between the model and the data. It is calibrated for the Colombian and Peruvian economy at annual frequency.

the description of how these rules enter the model is described in section C of Technical Appendix C.

In general terms, our model has:

a. Ricardians and non-Ricardians households.
b. Three productive sectors (exportable, non-tradable and commodity-exporting sectors).
c. Investment and capital goods producers.
d. Entrepreneurs who manage physical capital.
e. A fiscal authority who engages in productive and non-productive expenditures (public investment and purchases of non-traded goods, respectively).

Fiscal revenues (from final goods consumption tax, income taxes, and a commodity tax), and domestic and foreign currency public debt provide funding to public expenditures. Moreover, the model has eight exogenous processes: tradable and non-tradable sectorial productivity, tradable sector prices, commodity sector production and prices, international interest rates, current expenditures, and public investment.

5.1 Results

The calibration of the model (in annual frequency) is shown in Table 6 of Technical Appendix C. We calculated some steady-state ratios with those numbers. Table 5 compares income, labor income, and consumption tax revenues in steady state obtained from the model and Peruvian economic data. The comparison emphasizes the acceptable fit of our DSGE model, at least seen from the fiscal revenues side.

Table 5. Various Categories of Fiscal Revenues (as a percentage of total fiscal revenues)

Variables	Data*	Model
Income tax revenues**	23.2	27.6
Labor income tax revenues	7.5	6.6
Consumption tax revenues***	69.3	65.9

Source: Authors' calculations.
Note: * Sample average 2000-2018. ** Includes Corporate Income Tax revenues, Commodity Income Tax revenues and Royalties. *** Includes Valued-Added Tax revenues, Excise Tax revenues, and others.

Additionally, Table 6 compares private and public consumption, private and public investment, and trade balance in steady state obtained by the model and Peruvian economic data. The satisfactory fit of the expenditure side of our DSGE model complements the findings of Table 5. However, it is necessary to point out that the model underestimated the importance of private investment at around 4.6 percent of GDP in steady state.

Table 6. GDP Expenditure Side (as a percentage of GDP)

Variables	Data*	Model
Private consumption	65.8	70.5
Public consumption	11.3	11.0
Private investment**	16.6	12.0
Public investment	4.4	4.5
Trade balance	1.8	2.0

Source: Authors' calculations. *Note*: * Sample average 2000-2019. **Includes inventory variation.

In Table 7, we show the standard deviations of some variables calculated from the model and the data (sample 2000-2019).[45] In absolute terms, standard deviations from the model are remarkably close to the data. However, there are important caveats to highlight when we analyze these indicators. For example, consumption volatility is half of the value observed in the data. Moreover, the model cannot fit the standard deviations from exportable and non-tradable prices very well. Finally, results for the ratio of total public debt[46] to GDP are intriguing because the standard deviation from the model is around ten times lower than what we obtained from the data.

[45] We filtered the variables with the Hodrick-Prescott filter at annual frequency.
[46] The sum of the domestic public debt in soles and the foreign public debt valued at the current nominal exchange rate.

Table 7. Standard Deviation of Main Variables

Variables	Standard Deviation			
	Data*		Model	
	Absolute	Relative to GDP	Absolute	Relative to GDP
GDP	0.0249	1.00	0.0338	1.00
Commodities GDP	0.0278	1.12	0.0229	0.68
Exportable GDP	0.0434	1.74	0.0514	1.52
Non-tradable GDP	0.0337	1.35	0.0333	0.99
Consumption	0.0277	1.11	0.0157	0.46
Private investment**	0.1540	6.19	0.1557	4.61
Public investment	0.1606	6.45	0.1465	4.33
Current expenditures	0.0381	1.53	0.0550	1.63
Commodity prices	0.0925	3.71	0.0708	2.09
Exportable prices	0.0733	2.94	0.0579	1.71
Non-tradable prices	0.0882	3.54	0.0482	1.43
Public debt to GDP	0.0286	1.15	0.0030	0.09

Source: Authors' calculations. *Note*: * Sample 2000-2019. **Includes inventory variation.

5.2 Impulse-Response Functions

In Figures 9 and 10, we show the impulse response functions of the main macro-fiscal variables when the economy faces two types of external shocks: to commodity prices, and to the world interest rate shock, respectively. According to the Technical Secretariat at the Fiscal Council of Peru (2019), commodity prices and foreign interest rate shocks explained around 3/5 of GDP volatility in this country.[47]

In a scenario with a Fiscal Deficit Rule (FDR), a negative shock to commodity prices reduces GDP through a reallocation of resources from the non-tradable to exportable sector (real depreciation). On the demand side, consumption and private investment also decrease but at a lower magnitude than GDP. On the fiscal side, revenues decrease while public investment falls from its steady-state level, such that the fiscal policy response is procyclical. Notice that, due to the shock, public investment decreases both in levels and as a percentage of GDP. On the other hand, current expenditure remains at the same pre-shock level (however, it increases as a percentage of GDP). As a result, the primary balance as a percentage of GDP jumps slightly at the

[47] According to the authors, commodity prices shocks explained 52.2 percent, while foreign interest rate shocks explained around 9.0 percent of GDP volatility.

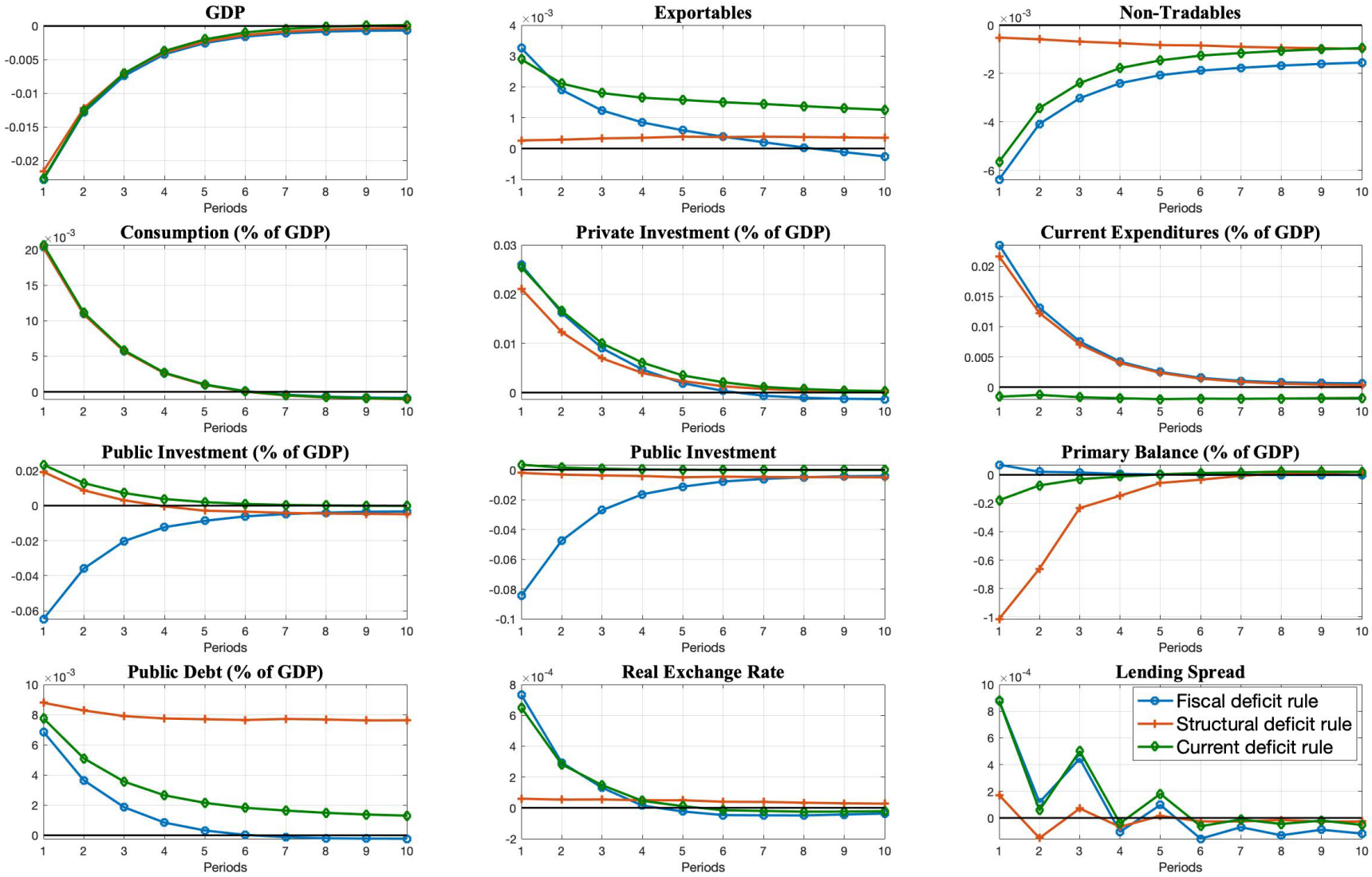
time the shock hits. In that sense, we infer from the model that the reduction of fiscal revenue is lower than the decrease in public investment under FDR. Because the primary balance as a percentage of GDP remains near its steady state level, the jump of the ratio of public debt to GDP above its steady state level is explained by the fall of GDP.

Alternative fiscal rule designs, such as a Structural Fiscal Deficit Rule (SFDR), have different consequences. A negative shock to commodity prices reduces GDP by a quantity similar to that before even when the reallocation of resources (between the exportable to the non-tradable sector) is lower than the previous case so that there is a lower real depreciation. This occurs because public investment in levels hardly reacts to the shock, although it has a countercyclical response as a percentage of GDP. The fiscal response increases the pressure on the real exchange rate. In that sense, the ratio of primary balance to GDP decreases below its steady-state value (deficit), such that the ratio of public debt to GDP reacts more strongly than before, jumping more than the scenario with FDR.

In the case of the Current Deficit Rule (CDR), the shock affects the current expenditures directly. Note that this variable decreases more than GDP, while public investment remains constant in levels (however, it jumps as a percentage of GDP) and fiscal revenues decrease with respect to their steady state. As a result, there is a primary deficit because of the shock. However, it is lower than the case of a SFDR. The fiscal impulse from the current expenditures side pressures the exchange rate, generating a real depreciation similar to the case with FDR. In this scenario, the ratio of public debt to GDP increases with respect to its steady-state level, but its contemporaneous reaction is roughly between the FDR and the SFDR case.

In conclusion, under a negative shock to commodity prices, the SFDR and the CDR act as countercyclical tools, from the public investment side. Both rules reduce the volatility of public investment but increase the volatility of public debt regarding the case of the FDR.

Figure 9. The Effect of a Negative Shock to Commodity Prices on Key Variables (one standard deviation)



Source: Authors' calculations.

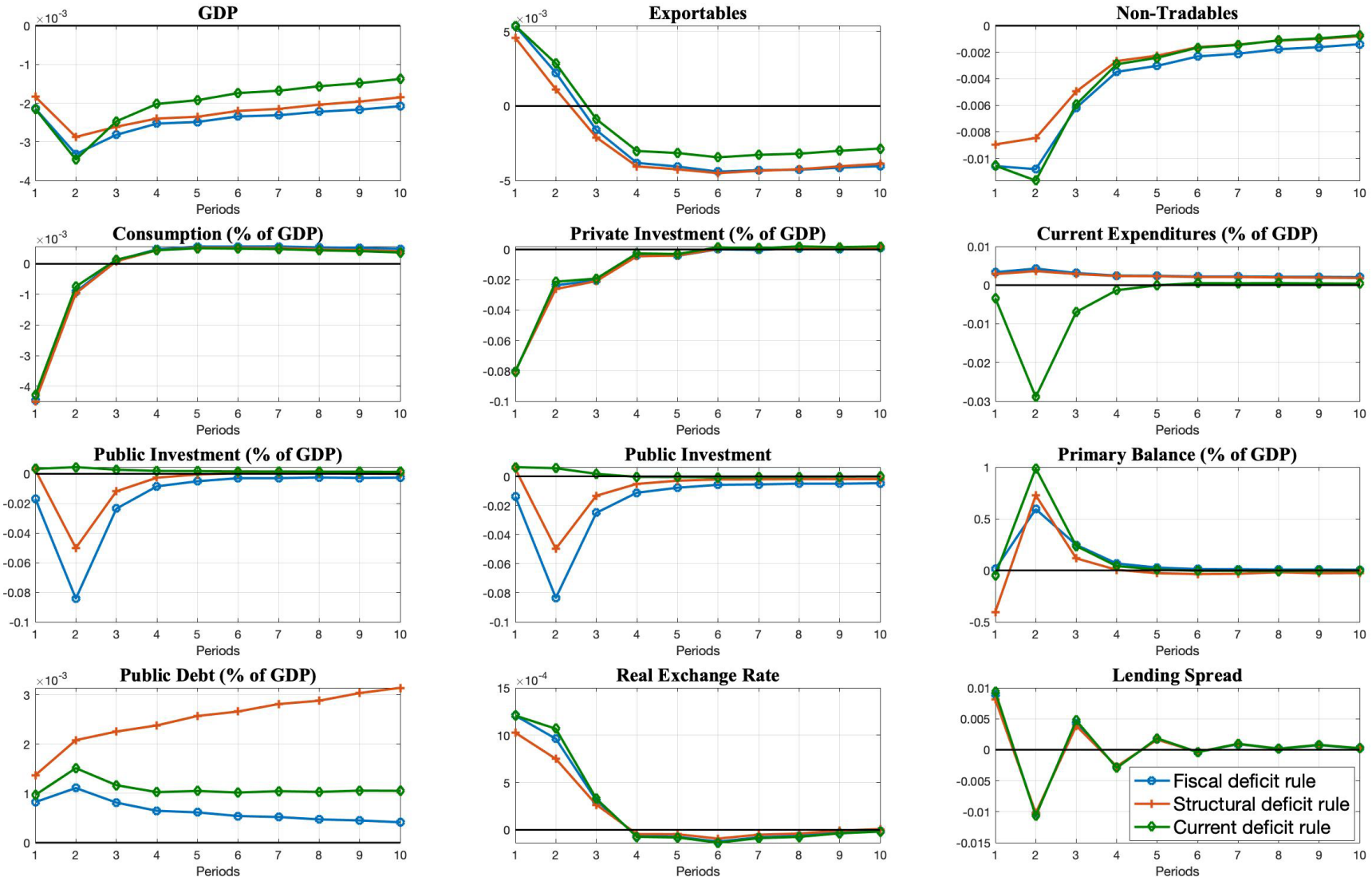
Now we analyze the scenario of a positive shock to the world interest rate. Under FDR, this shock generates a real depreciation that reallocates resources inside the economy from the non-tradable sector to the exportable one. However, the effect on the former is larger than on the latter, such that GDP decreases. On the fiscal side, this effect implies a reduction in fiscal revenues and public investment, while current expenditures as a percentage of GDP increase a little because of the fall of GDP. Consequently, there is a primary balance equilibrium at the moment of the shock. However, the ratio of public debt to GDP increases because of the increase in the cost of debt.

With SFDR, we notice that the effect on real variables is like that in the previous scenario, although at a lower magnitude. The reason is that this rule avoids considerable reductions in public investment such that the real depreciation is lower than the economy with FDR. However, this implies a reduction of the primary balance with respect to its steady-state (primary deficit) and a greater ratio of public debt to GDP than in the previous case.

In the case of the CDR, real variables reduce in the same magnitude as the case of FDR. However, the fall of GDP causes a reduction of fiscal revenues and a one-to-one contraction in current expenditures. As a result, the ratio of primary balance to GDP is in equilibrium at the time of the shock. However, the ratio of public debt to GDP increases because of the higher cost of debt.

Note that when the economy suffers an increase in the external cost of debt, SFDR does not reduce the procyclicality of public investment but only the volatility of the economy under this shock. On the other hand, CDR causes an acyclical response of public investment but a contraction in current expenditures. Even this policy is also procyclical, as it implies the ratio of public debt to GDP will not increase at the same time as in the case of SFDR.

Figure 10 The Effect of a Positive Shock to World Interest Rate on Key Variables (one standard deviation)



Source: Authors' calculations.

Finally, in Table 8 we calculate some comparative indicators between scenarios such as Ricardian and non-Ricardian households' welfare and the welfare gain for each fiscal rule.[48] Moreover, we show the fiscal multiplier of public investment under different fiscal rules in order to add other criteria (in this case their macroeconomic impact) for assessing the performance of different fiscal designs. Note these multipliers are similar to those other authors have found for the Peruvian economy.[49] An interesting result, which also has been found in Zeyneloglu (2018), is that a golden rule (CDR) causes a bigger multiplier of public investment than other rules. This result is explained by the presence of significative complementarities between public and private capital in our model (see Technical Appendix C). In that sense, a framework which favors the execution of public investment will positively impact the production of exportable and non-tradable goods. Empirical evidence also supports this model's feature. According to MEF (2017), there is statistical evidence of a complementary relationship between public and private investment in the Peruvian economy, such that an increase of 1.0 percent in public investment increases private investment by 0.73 percent at the end of the first year (estimated for the period 1Q2003-1Q2017).

In the case of welfare comparisons, when the model incorporates all eight shocks, SFDR causes greater utility in the Ricardian and non-Ricardian households. Concerning FDR, it generates a welfare gain, while CDR causes a welfare loss. When we analyze just a shock to commodity prices, the ranking is the same as in the previous case for both agents. However, when the economy faces a shock to the world interest rate, both households obtain greater utility when there is CDR, while SFDR is the worst of the three rules in terms of consumers' welfare.

[48] See section C of Technical Appendix C for more details about the calculation of these indicators.
[49] See Fiscal Council of Peru (2018).

Table 8 Comparative Indicators of the Fiscal Rules

		Fiscal Deficit Rule	Structural Fiscal Deficit Rule	Current Deficit Rule
		All shocks		
Ricardian	*Welfare (SS)*	-31.8846	-31.8336	-31.9067
	λ_W	--	-0.1573	0.0682
Non-Ricardian	*Welfare (SS)*	-482.5336	-481.5940	-482.6641
	λ_W	--	-0.1940	0.0270
		Shock to commodity prices		
Ricardian	*Welfare (SS)*	-32.1311	-32.1241	-32.1880
	λ_W	--	-0.0214	0.1756
Non-Ricardian	*Welfare (SS)*	-483.5629	-483.5102	-484.2970
	λ_W	--	-0.0109	0.1516
		Shock to the world interest rate		
Ricardian	*Welfare (SS)*	-32.4347	-32.4354	-32.4188
	λ_W	--	0.0021	-0.0490
Non-Ricardian	*Welfare (SS)*	-484.5373	-484.5529	-484.3242
	λ_W	--	0.0032	-0.0440
		Fiscal multipliers		
Public investment		1.5143	1.6048	1.6947

Source: Authors' calculations.

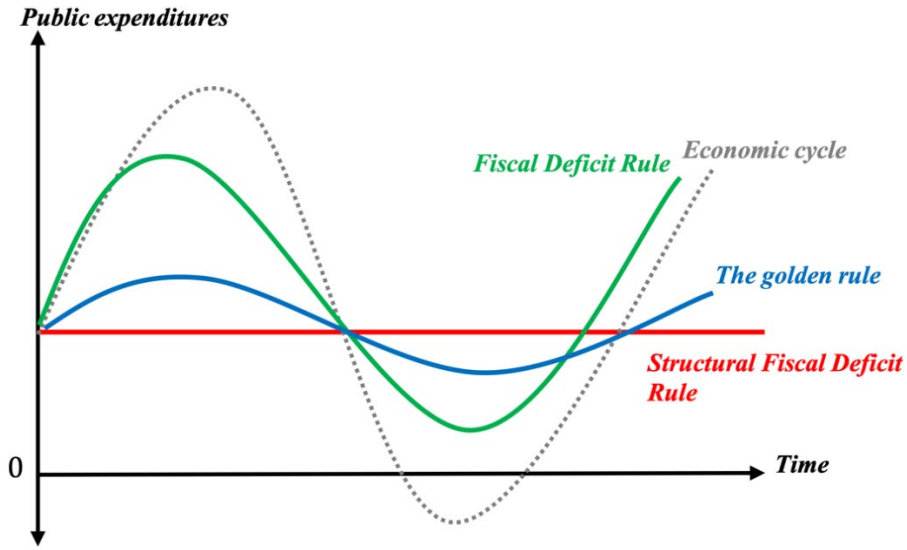
In conclusion, we built a model calibrated for the Peruvian economy in the period 2000-2019. Our results suggest the economy would have increased its welfare with SFDR more than with the other institutional designs. The main reason is that SFDR causes countercyclical public investment response under a shock to commodity prices. However, it reduces only the volatility (not the procyclicality) of the economy under a shock to the world interest rate. In the scenario of a sudden increase in foreign interest rate, the best rule -in terms of welfare- is CDR. In that sense, this exercise highlights the importance of correctly identifying the main sources of volatility in the economy to suggest a fiscal rule consistent with its economic history. However, this exercise does not take into account some critical features of the Peruvian economy such as the rigidity of current expenditures or bottleneck problems in the execution of the public investment. Moreover, it ignores operational issues in the implementation of fiscal rules, like the real-time calculation of the output gap and the commodity prices gap in case of SFDR, which can reduce their effectiveness and impact on consumers' welfare.

Box 1. The Structural and Current Deficit Rules

In this box, we briefly describe the main features of the Structural Fiscal Deficit Rule (SFDR) and the Current Deficit Rule (CDR), also known as the golden rule.

Theoretically, SFDR is acyclical and CDR is less procyclical than the Fiscal Deficit Rule. In Figure 11 we graph the theoretical response of public expenditures through the economic cycle with different fiscal rules under the assumption that fiscal revenues are the only fiscal account dependent on cyclical behavior. A well-designed SFDR does not consider the cyclical movements of GDP, and public expenditure remains in the same level during booms and busts. On the other hand, a Fiscal Deficit Rule does not correct the economy's transitory movements; consequently, public expenditures follow closely the economic cycle. In the case of the golden rule, procyclicality is lower than in the previous case and depends on the relative size of public investment and on the budgetary implementation capability.

Figure 11. Fiscal Rules, Public Expenditures, and the Economic Cycle



SFDR[50] gives greater predictability for public expenditures because it corrects the cyclical effects of GDP and export prices over the fiscal accounts (IMF, 2018). In case of Peru, Mendoza (2019) asserts that a cyclically-adjusted budget balance rule was implemented in LSFRT (since 2013, but it was effective just in 2015 and 2016).

[50] Rules like this have been implemented by Chile (since 2001), Austria (since 2017), Belgium (since 2013) and Bulgaria (since 2012).

Box 1. The Structural and Current Deficit Rules (continued)

Additionally, SFDR *"provide*[s] *more operational guidance in the sense that its target can be better controlled by the government."* In that sense, *"cyclically-adjusted balance rules aim to provide better economic stabilization than nominal budget balances."* However, its stabilization capacity is limited by the size of automatic stabilizers, and the inflexibility of the fiscal stance during busts creates macroeconomic costs, especially in prolonged recessions. Finally, its calculation and real-time monitoring are difficult.

On the other hand, CDR[51] sets a quantitative limit over the fiscal deficit net of capital expenditures (current deficit), allowing the public investment is financed by public debt while current expenditures are financed by fiscal revenues. As we described in section 2 and 3, Peru implemented a golden rule in 2007 and 2008. During those years, public investment was exempted from the aggregate public spending growth limit.

The advantages of this rule are the promotion and protection of capital expenditure (pro-growth) and its intergenerational equity (beneficiaries pay the projects). However, without a proper Public Investment Management Framework, the possibility of borrowing for investment without restrictions can lower incentives for proper cost-benefit analysis, resulting in the selection of projects with low social returns and revenues. Moreover, the golden rule can allow excessive borrowing and weaken the link between the aggregate targeted by the rule (the current deficit) and debt dynamics, creating sources of risks to fiscal sustainability. Additionally, it does not take into account either the maintenance expenditures (accounted as current expenditures) or some budgetary concepts which favor the accumulation of human capital.

[51] According to IMF (2017), rules like this are widely used around the world, in countries like Mexico (2009), Germany (1969-2010), Costa Rica (2001-2019), Japan (1947-1975 y 1994-2019), Luxemburg (1990-2003), Malaysia (1959-2019), United Kingdom (1997-2008) and Brazil (2000-2019).

Box 2. Calibration of Fiscal Rules

In this box, we describe the steps that we followed for calibrating the three fiscal rules we described previously. We consider IMF (2018) as a benchmark for this task.

We defined the fiscal deficit as follows:

$$\overline{fdr}_t = \overline{pd}_t + \overline{int}_t^{DC} + \overline{int}_t^{FC}$$

where $\overline{fdr}_t$ is the numerical target of the Fiscal Deficit Rule (FDR) at time t, $\overline{pd}_t$ is the primary deficit, and $\overline{int}_t^{DC}$ and $\overline{int}_t^{FC}$ are the interest payments in domestic and foreign currency, respectively. According to the current law, the fiscal deficit must be 2.0, 1.8, 1.6, 1.3 and 1.0 (as a percentage of GDP) for the years 2020, 2021, 2022, 2023 and 2024, respectively. Later, the government must maintain FDR at 1.0 percent of GDP.

Now, we calibrate the Structural Fiscal Deficit Rule (SFDR) in the following way. Using equations D.10 and D.11 (from Technical Appendix D) as a percentage of potential GDP, we obtain:

$$\overline{sfdr}_t^* = \overline{fdr}_t^* - \overline{\overline{fr}}_t^* + \overline{fr}_t^*$$

where $\overline{sfdr}_t^*$ is the numerical target of SFDR, $\overline{\overline{fr}}_t^*$ are the structural fiscal revenues and $\overline{fr}_t^*$ are the fiscal revenues. Then, plugging equation D.8 in the last equation, we have:

$$\overline{sfdr}_t^* = \overline{fdr}_t^* - \overline{fr}_t^* \left(\left(\frac{1}{1+OG} \right)^{\eta} - \phi^{NR} \left(\frac{PG}{1+PG} \right)^{\epsilon} - 1 \right)$$

with $\eta = 1.36$ and $\epsilon = 1$ we get[52]:

$$\overline{sfdr}_t^* = \overline{fdr}_t^* - \overline{fr}_t^* \left(\left(\frac{1}{1+OG} \right)^{1.36} - \phi^{NR} \left(\frac{PG}{1+PG} \right) - 1 \right)$$

$$\overline{sfdr}_t^* = \overline{fdr}_t (1+OG) - \overline{fr}_t^* \left(\left(\frac{1}{1+OG} \right)^{1.36} - \phi^{NR} \left(\frac{PG}{1+PG} \right) - 1 \right)$$

[52] These numbers (elasticities) come from Ministerial Resolution Nº 024-2016-EF/15.

Box 2. Calibration of fiscal rules (continued)

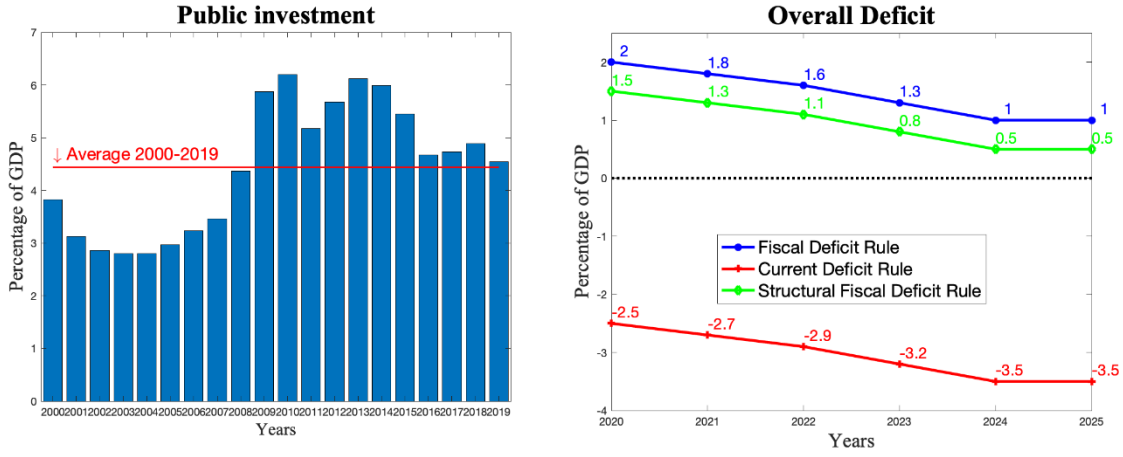
With the previous equation, we have a consistent way to calibrate SFDR with respect to the calibration of the fiscal deficit rule. Let $\phi^{NR} = 6.0\%$ and $\overline{fr}_t^* = \overline{fr}^* = 20.0\%$ be the share of fiscal revenues from natural resources and the steady-state level of fiscal revenues; moreover, $OG = -0.8\%$ and $PG = -18.6\%$ are the maximum output gap and commodity prices gaps during a typical downturn. Then, with this calibration, the numerical limit of the structural fiscal deficit rule must be 1.5, 1.3, 1.1, 0.8 and 0.5 (as a percentage of GDP) for the years 2020, 2021, 2022, 2023 and 2024, respectively. Later, we maintain the numerical rule at 0.5 percent of GDP.

Finally, we analyze the calibration of the Current Deficit Rule (CDR), defined by equation D.12 from Technical Appendix D. The problem here is to choose the numerical limit of $\overline{cdr}_t$ such that it is consistent with $\overline{fdr}_t$. Using equations D.12 and D.13 we obtain:

$$\overline{cdr}_t = \overline{fdr}_t - \bar{pi}_t$$

Therefore, we need a definition of public investment (capital expenditures) as a percentage of GDP ($\bar{pi}_t$) for consistently calibrating the current deficit rule with the fiscal deficit rule. According to the historical data, this variable has a sample average around 4.5 percent of GDP (see Figure 12 below). Then, the current deficit rule must be -2.5, -2.7, -2.9, -3.2 and -3.5 (as a percentage of GDP) for the years 2020, 2021, 2022, 2023 and 2024, respectively. Later, we maintain the numerical rule at -3.5 percent of GDP.

Figure 12. Public Investment and the Calibration of Fiscal Rules



Source: Ministry of Economy and Finance, Central Reserve Bank of Peru and authors' calculations.

6. Alternative Fiscal Rules and Public Debt Sustainability

In this section, we analyze the impact of the current and alternative fiscal rules on the future path of public debt through a standard Debt Sustainability Analysis (DSA). The main goal is to study the effect of different rules on fiscal sustainability. As in the previous section, we model three designs: the Fiscal Deficit Rule (*benchmark*), the Structural Fiscal Deficit Rule, and the golden rule.

Note that we understand the concept of fiscal sustainability as in Talvi and Végh (2000). According to these authors, public debt is sustainable if the government is solvent without much need to make significant adjustments in the planned trajectories of revenues and expenditures and, at the same time, if it is in a liquid position. Complementary definitions appear in Escolano (2010) and IMF (2013), where authors point out that fiscal sustainability is guaranteed if the ratio of public debt to GDP is stabilized around a "prudent level" in the medium run.

However, we recognize the difficulty of this task. As mentioned in Debrun et al. (2019): the DSA *"…is purely forward-looking and assessing it amounts to forecast about an unknowable future."* In that sense, the authors suggest three fundamental principles that should guide these exercises:

- ***Relevance.*** In the Peruvian case, the relevant variables for understanding the dynamics of fiscal accounts are commodity prices and GDP. According to the Technical Secretariat at the Fiscal Council of Peru (2019), commodity prices explained around 52 percent of GDP volatility during the period 1Q1998-2Q2018. Moreover, the Fiscal Council of Peru (2019) pointed out that 25 percent of forecast errors in the MEF fiscal revenues projection between the years 2008-2018 come from uncertainty surrounding commodity prices.
- ***Simplicity.*** We follow the methodology of Celasun et al. (2006),[53] although with some differences (see Section D of the Technical Appendix). For instance, we do not calibrate a joint distribution of shocks but obtain the draws from a non-parametric approach. Moreover, our fiscal block does not require the estimation

[53] Those authors proposed an algorithm for a standard stochastic DSA, which consists of the calibration of a joint distribution of shocks through the estimation of an unrestricted Vector Autoregressive (VAR) model for the macroeconomic variables (domestic and foreign variables); a set of equations that characterize the fiscal behavior, by estimating a fiscal reaction function (over the primary deficit); and the combination of the two previous steps to produce annual public debt paths.

of a reaction function, but the use of accounting identities and, if applicable, estimation of behavioral equations of fiscal revenues. With this system, we construct scenarios with different rules for the period 2020-2025. We describe the data for estimating the model in Section D of the Technical Appendix.

- ***Transparency.*** We highlight important aspects of our DSA implementation for the Peruvian case:
  - *We assume the "prudent level" of public debt is the same as the quantitative limit of the current public debt rule established in the Peruvian law (30 percent of GDP).* Therefore, this is our criterion for analyzing the sustainability of the three fiscal designs. However, we recognize this number does not come from a rigorous study of the fiscal vulnerabilities of the Peruvian economy, and it serves as only a guide for policymakers and private agents. For instance, Ganiko et al. (2016) propose a stochastic methodology for analyzing the fiscal space in emerging markets economies. The authors found that the stochastic debt limit in the Peruvian case is 40 percent of GDP.[54] As a sensitivity exercise, we also consider this limit in our analysis.
  - *The comparison between different fiscal rules requires coherence in terms of their numerical targets.* We follow IMF (2018) as a way of consistently dealing with the calibration of different rules. That paper proposes simple formulas for obtaining a numerical target for the structural budget balance and the growth of current expenditures from the fiscal deficit rule. If we do not do this, we run the risk that some fiscal designs will be stricter than others, and the comparison becomes meaningless (see Box 2 for more details).
  - *The calculus of the structural balance comes from Ministerial Resolution Nº 024-2016-EF/15.* However, this methodology requires dividing fiscal revenues among those revenues from the mining sector, the oil sector and

[54] According to the authors this is the highest level of indebtedness at which the government could arrive without compromising the sustainability of public finances, which is, minimizing the probability of falling into an unsustainable trajectory.

other sectors. For simplicity, we divide fiscal revenues only between natural resources (mining and oil sectors) and others. With this simplification, we forecast commodity prices as a whole and not mining and oil price indexes individually. Furthermore, we calculate the output gap and the commodity prices gap by the commonly known Baxter and King filter.

- *The projection of public investment is problematic.* In the case of the Fiscal Deficit Rule and the Structural Fiscal Deficit Rule, public investment is an endogenous variable. However, in the case of the golden rule, this variable is exogenous. We noted the difficulty of estimating a behavioral equation of public investment either in growth rates or as a percentage of GDP. The main reasons are the high variance of the data[55] and the absence of some fundamental explanatory variables in our system.[56] To solve this problem, we use a passive forecast with two possible scenarios: i) public investment (as a percentage of GDP) follows the trajectory proposed in the MEF Multiannual Macroeconomic Framework 2020-2023,[57] and ii) public investment (as a percentage of GDP) remains at the 2019 level (4.5 percent of GDP) for the entire forecast horizon.[58]

6.1 Results

In Figure 13, we present the median of the simulations of the primary balance (the negative of the primary deficit) and public debt for the three fiscal rules. In the case of the Fiscal Deficit Rule, notice that the median of the primary balance increases by 1.0 percentage point (p.p.) between 2020 and 2025. It implies debt interest payments of 1.6 percent of GDP on average in that period.

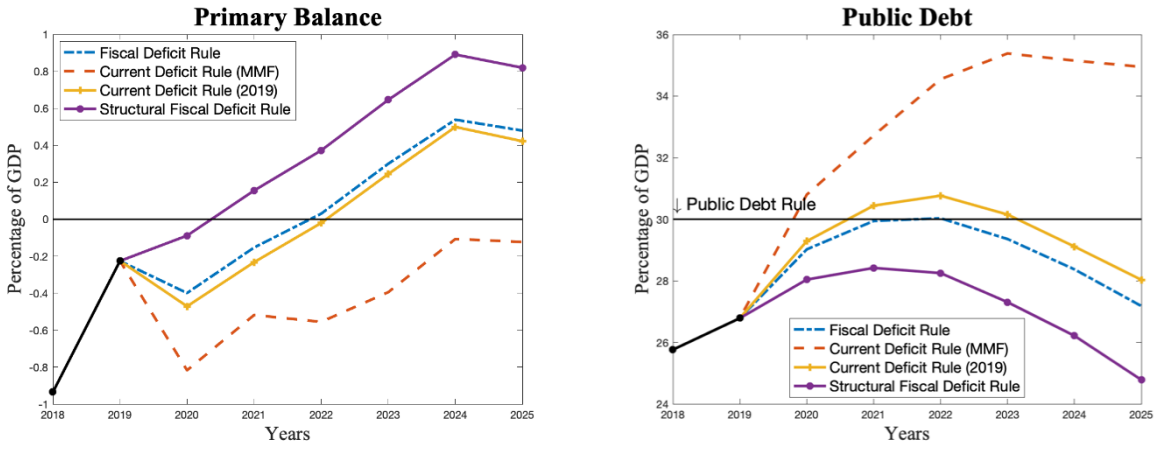
[55] The times series of the annual growth of public investment has a variance 3.7 times greater than the annual growth of fiscal revenues.
[56] Approximately 2/3 of all public investment is executed by subnational levels of government. Some important determinants of public investment at these government levels are natural resources transfers, management skills and the political cycle (see Jiménez et al., 2018).
[57] According to that document, the public investment as a percentage of GDP will be equal to 5.0, 5.0, 5.3, and 5.5 percent of GDP between the years 2020-2023, respectively.
[58] This is a contradiction with the aim of this rule. As we pointed out in Box 1, one of the advantages of the golden rule is the promotion and protection of capital expenditure. Maintaining the same level of public investment in the future goes against the pro-growth characteristic of this rule. In that sense, this is just a referential exercise.

As a consequence, the median of public debt simulations never exceeds the current numerical limit (30.0 percent of GDP) and converges to 27.0 percent of GDP in 2025.

In the case of the Current Deficit Rule, when we use the path of public investment from the MEF Multiannual Macroeconomic Framework, the primary balance increases by a lesser amount (around 0.7 p.p.) between 2020 and 2025. In consequence, the debt interest payments are 1.8 percent of GDP on average. Furthermore, public debt exceeds its numerical limit for the entire forecast horizon, such that it stabilizes around 35 percent of GDP. When we use the 2019 level of public investment as the projection for the following years, then the primary balance also increases 1.0 p.p between 2020 and 2025. However, public debt remains above the simulated path from the Fiscal Deficit Rule scenario in all periods under analysis.

In the case of the Structural Fiscal Deficit Rule, the primary balance grows faster and steeper than in the previous scenarios, since a near-to-fiscal equilibrium outcome in 2020 (-0.1 percent of GDP) to a surplus of 0.8 percent of GDP in 2025. It implies debt interest payments are around 1.5 percent of GDP on average during that period. Hence, public debt shows a rapid fall: it converges to 25.0 percent of GDP in 2025, 2.2 p.p. lower than with the Fiscal Deficit Rule and 6.7 p.p. lower than in the case of the Current Deficit Rule (when public investment follows the MEF Multiannual Macroeconomic Framework path).

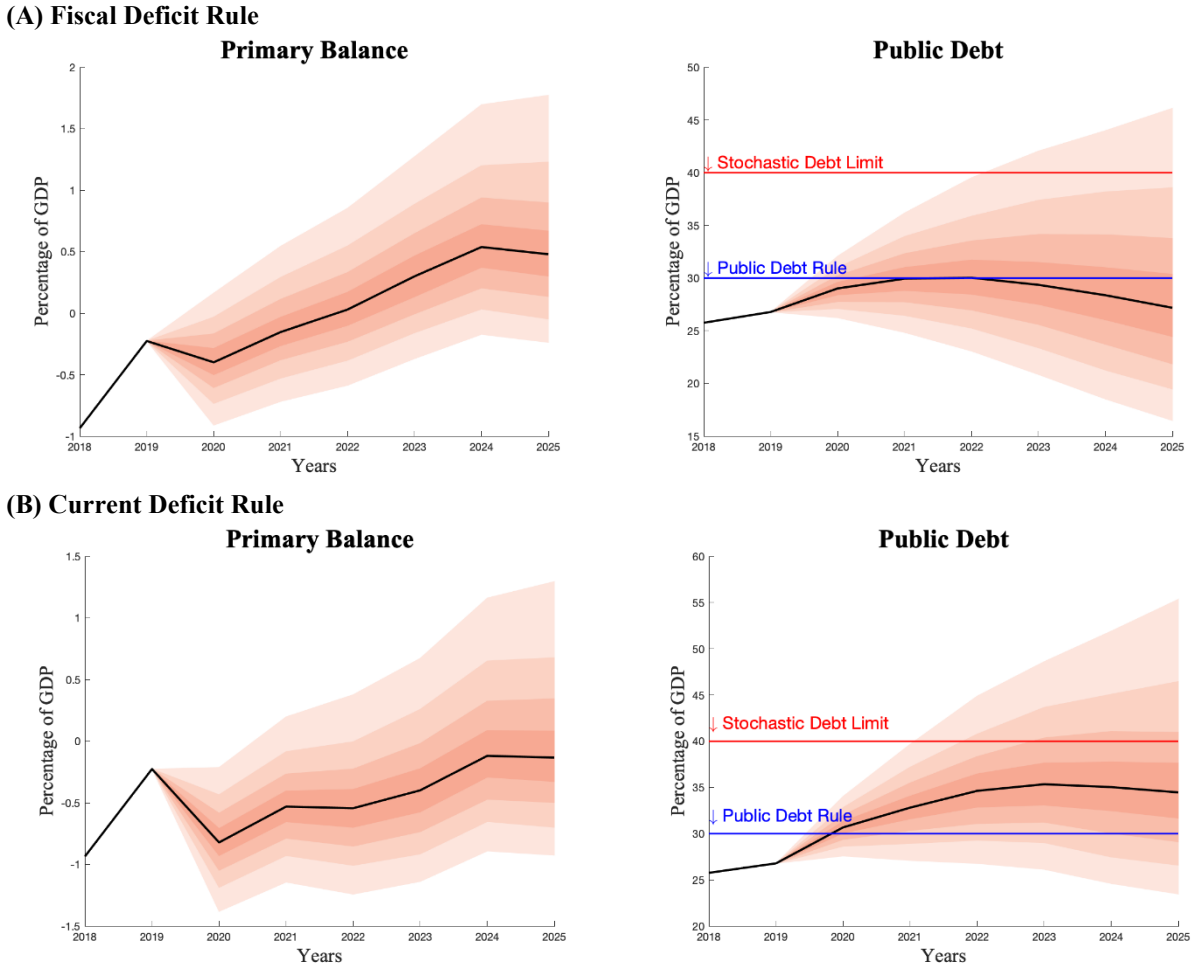
Figure 13. Median of Fiscal Variables Simulations Under Different Fiscal Rules



Source: Authors' calculations.

In Figure 14, we show the fan-charts of the primary balance and public debt for all three cases.[59] These graphs depict the uncertainty around projections of the fiscal variables. In this case, they contain observations between percentiles 10 and 90. From these graphs, we find some interesting facts. For instance, i) a large amount of public debt simulated paths under the golden rule crosses its numerical limit, ii) huge uncertainty surrounds the projection of public debt in a Current Deficit Rule scenario in comparison with the other two fiscal rules, and iii) there is a high probability the primary balance becomes positive at the end of the forecast period when the economy has a structural fiscal deficit rule.

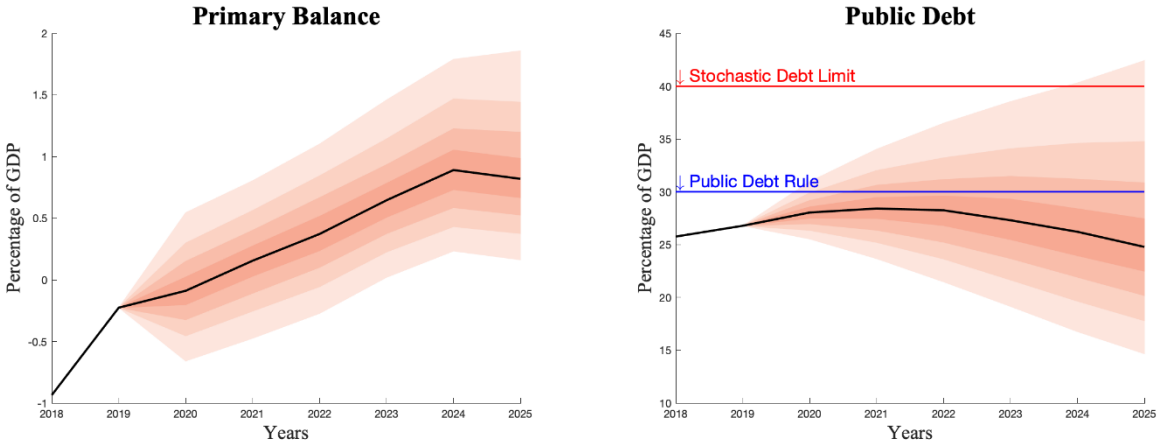
Figure 14. Simulation of Fiscal Variables under Different Fiscal Rules



[59] We don't show the case of the golden rule where public investment has the same level than the 2019's result as a percentage of GDP.

Figure 14, continued

(C) Structural Fiscal Deficit Rule



Source: Authors' calculations.

In Table 9, we show the probabilities of exceeding the current public debt limit (30.0 percent of GDP), and the stochastic debt limit found for the Peruvian economy by Ganiko et al. (2016), which is 40.0 percent of GDP. Given historical shocks, a Structural Fiscal Deficit Rule has the lowest probability of being unsustainable. If we assume the stochastic debt limit, then two rules (the Structural and the Fiscal Deficit Rule) have lower than 10.0 percent probabilities of surpassing 40.0 percent of GDP (the risk tolerance level suggested by the IMF, 2018). Note that the Current Deficit Rule is the riskiest fiscal rule in terms of sustainability.

Table 9. Probabilities to Exceed the Public Debt Limit

Base scenario	*Greater than 30.0% of GDP*	*Greater than 40.0% of GDP*
Fiscal Deficit Rule	44.2	9.8
Current Deficit Rule		
MMF's trajectory	70.8	22.0
2019's	46.4	10.7
Structural Fiscal Deficit Rule	32.5	6.0

Source: Authors calculations.

Given these results, it is crucial to highlight that there are two essential variables inside the dynamics of the primary balance: fiscal revenues and public investment. In the case of the Current Deficit Rule, the path of the primary balance (from -0.8 percent of GDP in 2020 to -0.1 percent of GDP in 2025) requires effort only on the fiscal revenues side, because public debt finances any increase in public investment. The aforementioned is the reason behind the remarkable expansion

in public debt in this scenario. As we can see in Table 10, the golden rule requires an average increase in fiscal revenues of 0.1-0.2 p.p. greater than in the other fiscal rules scenarios. However, a higher primary balance surplus needs a combination of more fiscal revenues and/or less public investment than in the other two cases. A lower ratio of public investment to GDP can be harmful to the economy in the medium and long run.

We describe the effort in collecting taxes for scenarios with a Fiscal Deficit Rule and a Structural Fiscal Deficit Rule in the following example. If the policymaker must comply with the public investment path of the Multiannual Macroeconomic Framework and the numerical rules, then fiscal revenues must increase 0.9 and 1.2 p.p. on average in the case of Fiscal Deficit Rule and Structural Fiscal Deficit Rule, respectively. In contrast, if the targets are the fiscal revenues path proposed in that document and the numerical limits, then public investment must decrease by 0.6 and 0.9 p.p. in the case of Fiscal Deficit Rule and Structural Fiscal Deficit Rule, respectively. The choice of the optimal policy in this context depends on different factors, like the magnitude of the fiscal multipliers, the rigidity of public investment spending, and the development of the tax system, among others.

In short, this exercise illustrates the trade-off between investment-friendly rules and fiscal sustainability in the Peruvian economy. A rule with a flexible public investment component has costs in terms of public debt sustainability. On the other hand, rules that prioritize fiscal sustainability demand effort in terms of primary surpluses through a combination of fiscal revenue increments and/or public investment reductions. In our opinion, there are two ways that a policymaker can face this trade-off. The first is the simple option: the fiscal authority recognizes the current public debt rule is very restricted and changes it. According to our results, if we use the stochastic debt limit (40.0 percent of GDP), then two of the three fiscal rules have an acceptable level of risk in our base scenario (lower than 10 percent). However, this normative change will not solve the main problem. The second way is the complex and demanding option: increasing long-run fiscal revenues through a fiscal reform. In this case, the policymaker protects public investment without neglecting fiscal sustainability.

Finally, it is crucial to highlight these exercises have not considered the effect of the fiscal policy measures to deal with the COVID 19 pandemic on public debt. According to the Technical Secretariat at the Fiscal Council of Peru (2020) the ratio of public debt to GDP may increase by 9.7 p.p. in 2020 because of the fiscal stimulus measures. Preliminary results using our DSA

framework suggest the probabilities of exceeding the stochastic debt limit are multiplied by three in each scenario. However, this is an interesting and novel research topic that is beyond the scope of this document.

Table 10. Simulation of Fiscal Variables under Different Fiscal Rules

(a) Fiscal Deficit Rule

FDR	2020	2021	2022	2023	2024	2025	Average 2020-2025
Fiscal Revenues	20.4	20.5	20.5	20.5	20.2	19.9	20.3
SOE Primary Balance	-0.3	0.0	0.1	0.1	0.0	0.0	0.0
Current Expenditures	15.7	15.8	15.8	15.8	15.8	15.7	15.8
Public Investment	4.8	4.9	4.8	4.4	3.8	3.6	4.4
Primary Balance	**-0.4**	**-0.2**	**0.0**	**0.3**	**0.5**	**0.5**	**0.1**
Interests	1.6	1.6	1.6	1.6	1.5	1.5	1.6
Overall Balance	**-2.0**	**-1.8**	**-1.6**	**-1.3**	**-1.0**	**-1.0**	**-1.5**
Debt	**29.0**	**29.9**	**30.0**	**29.4**	**28.4**	**27.2**	**29.0**

(b) Current Deficit Rule (MMF's)

CDR (MMF's)	2020	2021	2022	2023	2024	2025	Average 2020-2025
Fiscal Revenues	20.5	20.7	20.7	20.7	20.4	20.2	20.5
SOE Primary Balance	-0.3	0.0	0.1	0.1	0.0	0.0	0.0
Current Expenditures	16.0	16.2	16.0	15.6	14.9	14.7	15.5
Public Investment	5.0	5.0	5.3	5.5	5.5	5.5	5.3
Primary Balance	**-0.8**	**-0.5**	**-0.6**	**-0.4**	**-0.1**	**-0.1**	**-0.4**
Interests	1.7	1.8	1.8	1.9	1.9	1.9	1.8
Overall Balance	**-2.5**	**-2.3**	**-2.4**	**-2.3**	**-2.0**	**-2.0**	**-2.3**
Debt	**30.8**	**32.7**	**34.5**	**35.4**	**35.2**	**34.9**	**33.9**

(c) Current Deficit Rule (2019's)

	2020	2021	2022	2023	2024	2025	Average 2020-2025
Fiscal Revenues	20.5	20.7	20.6	20.3	20.2	20.0	20.4
SOE Primary Balance	-0.3	0.0	0.1	0.1	0.0	0.0	0.0
Current Expenditures	16.0	16.2	16.1	15.5	14.9	14.9	15.6
Public Investment	4.5	4.5	4.5	4.5	4.5	4.5	4.6
Primary Balance	**-0.5**	**-0.2**	**0.0**	**0.2**	**0.5**	**0.4**	**0.1**
Interests	1.6	1.7	1.7	1.6	1.6	1.5	1.6
Overall Balance	**-2.1**	**-1.9**	**-1.7**	**-1.4**	**-1.1**	**-1.1**	**-1.5**
Debt	**29.3**	**30.4**	**30.8**	**30.2**	**29.1**	**28.0**	**29.6**

Table 10, continued

(d) Structural Fiscal Deficit Rule

	2020	2021	2022	2023	2024	2025	Average 2020-2025
Fiscal Revenues	20.5	20.5	20.5	20.5	20.2	19.9	20.3
SOE Primary Balance	-0.3	0.0	0.1	0.1	0.0	0.0	0.0
Current Expenditures	15.7	15.8	15.8	15.8	15.8	15.7	15.8
Public Investment	4.5	4.6	4.4	4.1	3.6	3.3	4.1
Primary Balance	**-0.1**	**0.2**	**0.4**	**0.6**	**0.9**	**0.8**	**0.5**
Interests	1.6	1.6	1.5	1.5	1.4	1.3	1.5
Overall Balance	**-1.7**	**-1.4**	**-1.2**	**-0.8**	**-0.5**	**-0.5**	**-1.0**
Debt	**28.0**	**28.4**	**28.3**	**27.3**	**26.2**	**24.8**	**27.2**

Source: Authors' calculations.

7. Conclusions and Implications for Fiscal Policy

The aim of this paper was threefold. First, we described the origin and degree of fiscal rules compliance in Peru. Second, we assessed the effect of these rules on the evolution of public investment. Third, we examined the impact of alternative fiscal rules on public investment and public debt sustainability.

Regarding SCM estimations, our results indicate that by 2005, the adoption of fiscal rules in 2000, amid the reduced fiscal space implied by the emerging market crisis in 1997-1999, caused a fall in public investment between 60 and 80 percent relative to a number of synthetic counterfactuals. The application of a pro-cyclical fiscal rule, where the adjustment variable is public investment, results in an impact on public investment in the contractionary phase of the economic cycle.

Our analysis based on the DSGE model suggests the economy would have had a higher welfare if the Structural Fiscal Deficit Rule would have been implemented during the period 2000-2019. Moreover, the Structural Fiscal Deficit Rule reduces the procyclicality of public investment under shocks to commodity prices, and the volatility of the economy under shocks to the world interest rate. On the other hand, the Current Deficit Rule, also known as the golden rule, improves the economy's welfare only in the case when it faces a shock to the world interest rate. Moreover, according to our model, the fiscal multiplier of public investment is similar in all three cases (between 1.5-1.7), but slightly big when the fiscal policy implements the golden rule. This result is explained by the presence of significative complementarities between public and private capital in our model.

Similarly, the effects of the alternative fiscal rules on the sustainability of the Peruvian fiscal accounts in the medium-run (2020-2025) provided by DSA emphasize that a Structural Fiscal Deficit Rule has the lowest probability of exceeding the current public debt limit (30 percent of GDP). However, the exercise suggests the existence of a trade-off between investment-friendly rules (the golden rule) and fiscal sustainability issues. A rule with a flexible public investment component has costs in terms of public debt sustainability. For instance, if public investment as a percentage of GDP follows the trajectory proposed in the MEF's Multiannual Macroeconomic Framework 2021-2023, then public debt with a Current Deficit Rule will be 7.7 and 10.1 percentage points of GDP higher than public debt in scenarios with a Fiscal Deficit Rule and a Structural Fiscal Deficit Rule at the end of the sixth year, respectively. On the other hand, fiscal rules that prioritize fiscal sustainability demand a greater fiscal effort in terms of primary surpluses. For example, an economy with a Fiscal Deficit Rule or with a Structural Fiscal Deficit Rule will need to obtain a primary balance surplus 0.6 and 0.9 percentage points of GDP higher than a scenario with a Current Deficit Rule.

Nevertheless, the previous results are limited to a short span of time. On the one hand, SCM and DSA took the 2000-2005 and 2020-2025 periods, respectively. On the other hand, the DSGE model assessed the 2000-2019 period. In a long-term perspective, fiscal rules have fulfilled their original and main objective of achieving the consolidation of public finances in Peru. In the last 20 years, the 1 percent limit of the fiscal deficit rule has served as a medium-term guide, despite constant modifications and recurring non-compliance. On average, the actual fiscal deficit and the cyclically-adjusted deficit in the 2000-2019 period has been 0.6 percent of GDP and 0.5 percent of potential GDP.

In the whole period of analysis, given the lower current spending growth compared to that of GDP, the current spending rule has been favorable to public investment because the rule provided more space for public investment, especially during boom periods. Implicitly, controlling current spending also ensures lower volatility of the latter compared to public investment.

From the findings described above, can we suggest the most appropriate fiscal rules for Peru? First, although it is true that the fiscal deficit rule had a negative impact on public investment at the time of its implementation, because we were in the lower part of the cycle, in the long term, due to its impact on economic growth and public debt interests, it also had a positive impact.

Second, given the enormous dependence of fiscal revenues and GDP on commodity prices, the behavior of the fiscal deficit and public debt remains very sensitive to international conditions.

Under these conditions, in a long-term perspective, it seems that the most prudent action is to persist with the guidance of 1 percent as a fiscal deficit limit. To this long-term guide we should add increasing tax pressure to meet the needs of public investment and, at the same time, continue to maintain our privileged fiscal position in the context of Latin America.

However, a caveat is required. The effects of the COVID-19 epidemic on the economy and economic policy remain to be seen. This year's huge fiscal deficit, which will put public debt well above the current legal limit of 30 percent of GDP, will have enormous implications for the design of fiscal policy in coming years. The fiscal adjustment that is envisaged may fall on public investment.

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Technical Appendix A. Changes to Fiscal Rules

In December 1999 Peru enacted its first fiscal law in December 1999, the FPTL, Law 27245.[60] This Law has undergone several modifications, which are detailed in following Tables. Since that date, Peru has passed three fiscal laws (Law 27958,[61] 2003; Law 30099, 2013; and LD 1276, 2016), eight amendments of articles of the fiscal deficit rule, and13 changes concerning the expenditure rule. In addition, during the study period, the maximum fiscal deficit allowed in the modifications was 3.5 percent of GDP, while the maximum real growth of current expenditure was 10 percent.

Appendix Table 1 shows the series of changes in the Peruvian fiscal deficit ceiling and highlights the four most important laws.

Appendix Table 1. Changes to the Fiscal Deficit (FD) ceiling

Year	Record	Ceiling
1999	Law 27245	$FD \leq 1$ percent of GDP.
2001	Law 27245	$FD \leq 1{,}5$ percent of GDP.
	Law 27577	The application of the rule is suspended.
2002	Law 27577	The application of the rule is suspended.
2003	Law 27958	$FD \leq 2$ percent of GDP.
2004	Law 27958	$FD \leq 1{,}5$ percent of GDP.
2009	Law 29368	The application of the rule is suspended[62].
2010	Law 29368	The application of the rule is suspended.
2013	Law 29952	Budget balance must not be negative.
2014	Law 30099	Budget balance must not be negative.
2015	Law 30099	$SFD \leq 1$ percent of GDP.
2016	Law 30099	$SFD \leq 1$ percent of potential GDP.
	UD 002-2015	$SFD \leq 2$ percent of potential GDP.
	UD 003-2015	$SFD \leq 3$ percent of potential GDP.
2017	Law 30420	$SFD \leq 1{,}5$ percent of potential GDP.
	Law 30499	$SFD \leq 2{,}2$ percent of potential GDP.
	LD 1276	$FD \leq 2{,}5$ percent of GDP.
	Law 30637	$FD \leq 3$ percent of GDP.

[60] This law stipulated that the limit to the nominal fiscal deficit will not have to exceed 1 percent of GDP. This ceiling has not been changed.

[61] The FPTL also indicates that the growth rate of government spending in real terms could not be greater than 2 percent. This was modified by the FRTL or Law 27958, which extended the spending growth limit to 3 percent in real terms. The latter also created fiscal rules for local and regional governments.

[62] The implementation of the Fiscal Stimulus Plan triggered the suspension of the fiscal deficit rule. Moreover, a ceiling of 2 percent of GDP is established.

Appendix Table 1. Changes to the Fiscal Deficit (FD) ceiling, continued

Year	Record	Ceiling
2018	Law 30420	$SFD \leq 1$ percent of potential GDP.
	Law 30499	$SFD \leq 2$ percent of potential GDP.
	LD 1276	$FD \leq 2{,}3$ percent of GDP.
	Law 30637	$FD \leq 3{,}5$ percent of GDP.
2019	Law 30499	$SFD \leq 1{,}8$ percent of potential GDP.
	LD 1276	$FD \leq 2$ percent of GDP.
	Law 30637	$FD \leq 2{,}9$ percent of GDP.
2020	Law 30499	$SFD \leq 1{,}5$ percent of potential GDP.
	LD 1276	$FD \leq 1{,}5$ percent of GDP.
	Law 30637	$FD \leq 2{,}1$ percent of GDP.
	UD 032-2019	$FD \leq 2$ percent of GDP.
2021	Law 30499	$SFD \leq 1$ percent of potential GDP.
	LD 1276	$FD \leq 1$ percent of GDP.
	Law 30637	$FD \leq 1$ percent of GDP.
	UD 032-2019	$FD \leq 1{,}8$ percent of GDP.
2022	UD 032-2019	$FD \leq 1{,}6$ percent of GDP.
2023	UD 032-2019	$FD \leq 1{,}3$ percent of GDP.
2024	UD 032-2019	$FD \leq 1$ percent of GDP.

Source: Technical Secretariat at the Fiscal Council of Peru (2016). *Reglas Fiscales en el Perú*. Annex 1 of Discussion Note No. 002.

Appendix Table 2. Ceiling of Fiscal Deficit Rule and Actual Fiscal Deficit

Year	Ceiling (percentage)	Actual fiscal deficit (percentage)
1999	1	3.4
2000	2	3.4
2001	1.5	2.8
2002	1	2.3
2003	2	1.8
2004	1.5	1.1
2005	1	0.4
2006	1	−2.5
2007	1	−3.1
2008	1	−2.5
2009	2	1.3
2010	2	0.2
2011	1	−2.1
2012	1	−2.3
2013	No deficit	−0.9
2014	No deficit	0.2
2015	1	1.9
2016	3	2.3
2017	3	3.0
2018	3.5	2.3
2019	2.9	1.6

Similarly, Appendix Table 3 below identifies the various amendments of the expenditure rule and highlights the four most important laws.

Appendix Table 3. Changes to the Expenditure Ceiling

Year	Record	Ceiling
1999	Law 27245	Increase of non-financial spending of General Government (GG) may not exceed the annual average inflation rate plus 2 percentage points (p.p.).
2004	Law 27958	Real increase of non-financial spending of GG may not exceed 3 percent, determined on the basis of the GDP deflator.
2005	Law 28562	The application of the rule is suspended.
2006	Law 28750	The application of the rule is suspended.
2007	Law 29035	Real increase of consumption expenditure[63] of Central Government (CG) may not exceed 3 percent, determined on the basis of CRBP target (2 percent).
2008	Law 29144	Real increase of consumption expenditure[64] of CG may not exceed 4 percent.
2009	Law 29368	Real increase of consumption expenditure of CG may not exceed 10 percent.
2010	Law 29368	Real increase of consumption expenditure of CG may not exceed 8 percent.
2011	Law 29812	The average annual CPI of Lima Metropolitana was used instead of the CRBP target.
2012	Law 29854	Expenditure of maintenance of infrastructure, goods and services of social programs framed under the Budget for Results scheme, and equipment for Public Order and Security were excluded from the calculation.
2013	Law 29952	Non-financial spending rule was replaced by the Non-Financial Public Sector budget balance rule.
	Law 30099	Real increase of non-financial spending of the CG is subject to the ex-ante guidance of the SFD and the MMF forecasts.[65]
2015	SD 084-2014-EF	Non-financial spending of National Government (NG) $\leq$ 118 064 millions.
	SD 084-2014-EF	Personnel and pensions of non-financial spending of $NG \leq$ 56 332 millions.

[63] Remuneration and goods and services.
[64] The definition was extended to remuneration, goods and services and pensions.
[65] It took effect in 2015.

Appendix Table 3. Changes to the Expenditure Ceiling, continued

Year	Record	Ceiling
2016	SD 242-2015-EF	Non-financial spending of NG $\leq$ 123 108 millions.
	SD 242-2015-EF	Personnel and pensions of non-financial spending of NG $\leq$ 60 044 millions.
	LD 1276	Real increase of non-financial spending of GG should not be greater than the upper limit of the range +/- 1 p.p. of the real average 20-year GDP growth rate.
	LD 1276	Current expenditure[66] cannot be greater than the lower limit of the non-financial spending rule.
2017	Law 30499	The set of arrangements[67] must be consistent with the fulfillment of a $FD \leq 2{,}5$ percent of GDP.[68]
2018	Law 3063	The non-financial spending rule of the GG does not apply.
	Law 30637	The current expenditure of GG (without maintenance) should not exceed the result of the 20-year average of the real annual GDP growth subtracted minus 1 p.p.[69] In the 2018-2021 MMF, the ceiling is 4 percent in real terms.
2019	Law 30637	The non-financial spending rule of the GG does not apply.
2020	Law 30637	For the non-financial spending of GG, LD 1276 will apply.
		The current expenditure of GG (without maintenance) should not exceed the result of the average of 20 years of the real annual growth of the GDP subtracted less 1.5 p.p.[70]
2021	Law 30637	For the non-financial spending of GG, LD 1276 will apply.

Source: Technical Secretariat of Fiscal Council. (2016). *Reglas Fiscales en el Perú*. Annex 1 of Discussion Note 002.

[66] Excluding maintenance expenditure.
[67] It refers to the budget, indebtedness and financial balance laws, as well as supplementary credits and the SPNF budget execution.
[68] Implicitly, expenditure rules of NG are voided.
[69] This calculation will be applied during 2018-2019.
[70] This calculation will be applied during 2020-2021.

Technical Appendix B. SCM Robustness Exercise

In this excercise we consider the ratio of public investment to GDP as the outcome variable instead of the log level of public investment as considered in the main text.

The public investment to GDP ratio is taken from the IMF Investment and Capital Stock Dataset. The ratio considered in the paper is defined as the ratio of gross fixed capital formation to GDP, both the numerator and denominator are measured in billions of constant 2011 international dollars.

As predictor variables we add the one-year lag of public investment to GDP.

Appendix Table 3. Variables Contained in Vectors $\mathbf{X_0}$ and $\mathbf{X_1}$

Outcome	**Source**
Public investment to GDP	Investment and Capital Stock Dataset
Predictors of country characteristics	**Source**
Log of GDP	Investment and Capital Stock Dataset
Private investment to GDP	Investment and Capital Stock Dataset
One-year lag of public investment to GDP	Investment and Capital Stock Dataset
Log of Terms of Trade	DataMarket.com
Human capital index, based on years of schooling and returns to education; see Human capital in PWT9.	Penn World Table 9.1
State Fragility index	Marshall and Elzinga-Marshall (2017)
General Government gross debt	World Economic Outlook Database and Historical Public Debt Database (International Monetary Fund)

We perform six estimations of the fiscal rule adoption in 2000 on public investment measured in logs. By 2005, all the estimations imply a fall between one and two percentage points relative to synthetic counterfactuals. From Appendix Table 4, we see that estimators of the effects are broadly significant.

Appendix Table 4. P-values calculated following Abadie, Diamond and Hainmueller (2015)

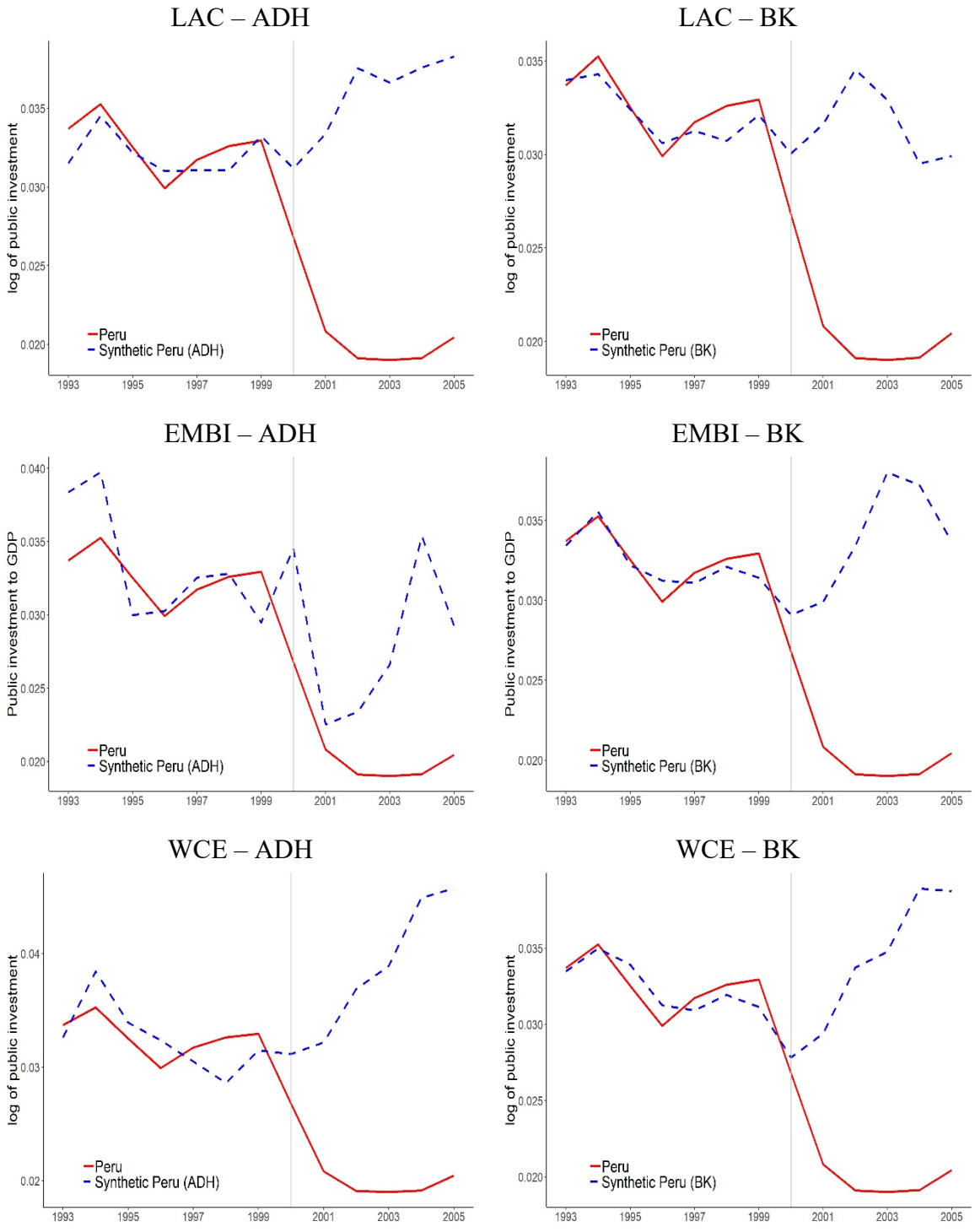
	LAC	*EMBI*	*WCE*
ADH (Abadie et al., 2010)	0.1	0.8	0.25
BK (Becker and Klößner, 2018)	0.2	0.07	0.08

Source: Authors' calculations.

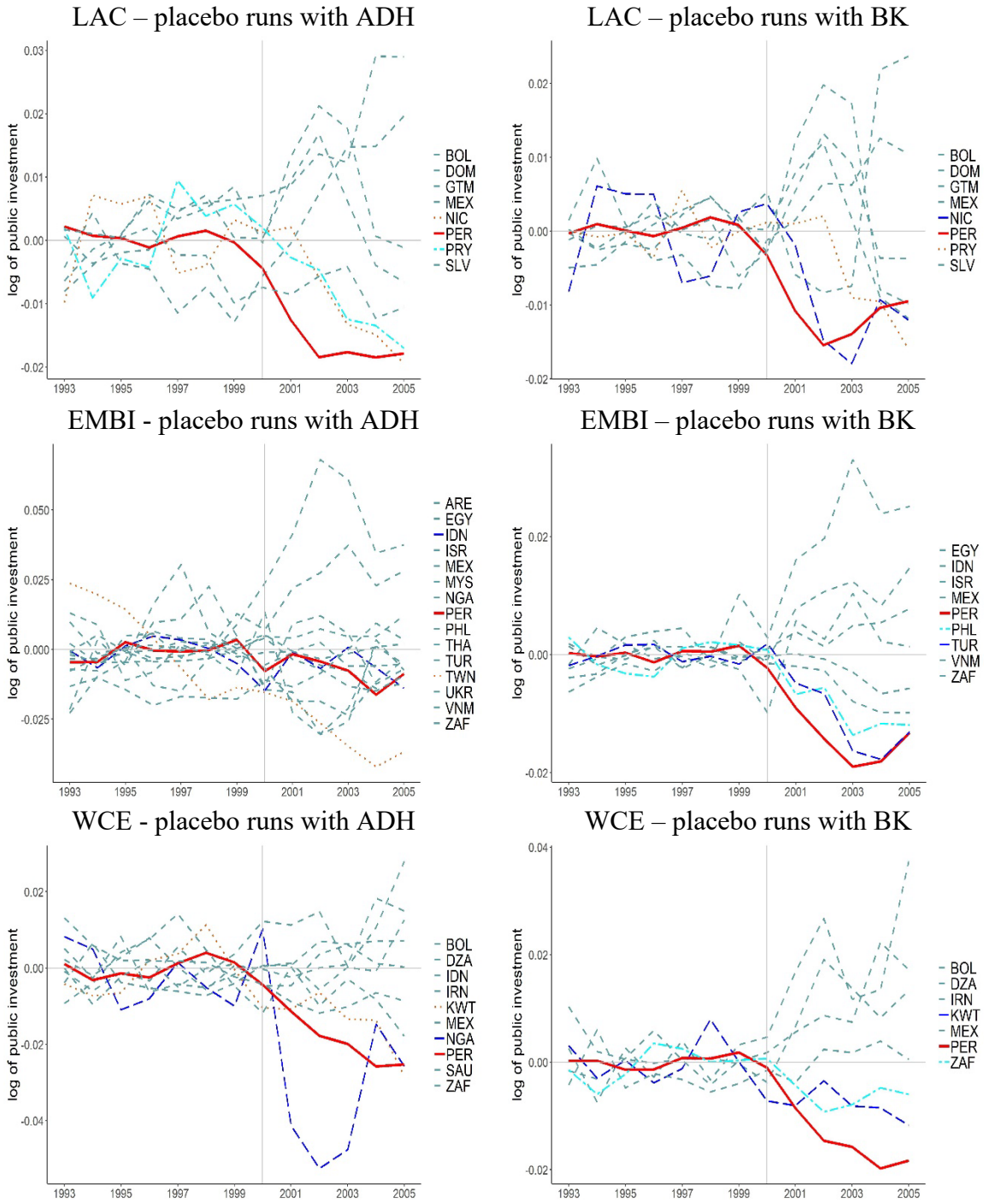
Appendix Table 5. Estimated Weights

	Country	Country codes	ADH weights	BK weights
LAC control group				
1	Bolivia	BOL	30.0	11.3
2	Dominican Republic	DOM	0.1	21.6
3	Guatemala	GTM	34.6	31.2
4	Honduras	HND	0.2	4.7
5	Haiti	HTI	0	0
6	Mexico	MEX	34.9	22.1
7	Nicaragua	NIC	0.1	0
9	Paraguay	PRY	0	10.7
10	El Salvador	SLV	0.1	20.0
EMBI control group				
1	United Arab Emirates	ARE	13.9	12.5
2	China	CHN	0	0
3	Egypt	EGY	1.3	0
4	Indonesia	IDN	0	0
5	Israel	ISR	17.4	27.0
6	Mexico	MEX	0	0
7	Malaysia	MYS	0	0
8	Nigeria	NGA	30.1	0
10	Philippines	PHL	0	0
11	Thailand	THA	0	0
12	Turkey	TUR	0.1	0
13	Taiwan	TWN	0	0
14	Ukraine	UKR	37.1	43.5
15	Vietnam	VNM	0	17.5
16	South Africa	ZAF	0	0
WCE control group				
1	Angola	AGO	0	0
2	United Arab Emirates	ARE	0	0
3	Bolivia	BOL	41.2	33.6
4	Algeria	DZA	0	0
5	Indonesia	IDN	0	0
6	Iran	IRN	0	0
7	Kuwait	KWT	0	30.5
8	Mexico	MEX	58.8	34.7
9	Nigeria	NGA	0	0
11	Saudi Arabia	SAU	0	0
12	South Africa	ZAF	0	0
13	Zambia	ZMB	0	1.2

Appendix Figure 1. Estimated and Observed Log Government Investment

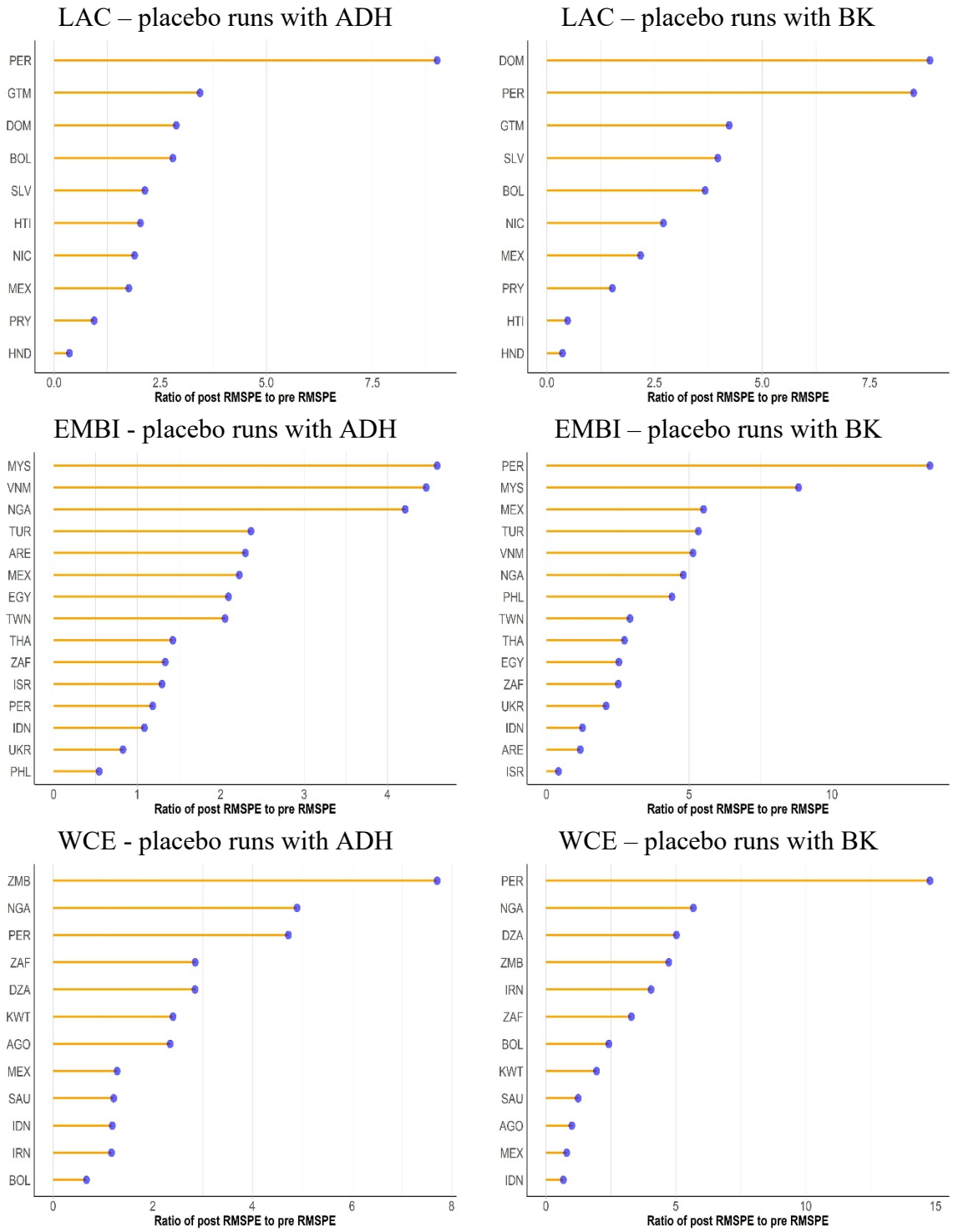


Appendix Figure 2. Placebo Exercise, continued



Note: Figure only shows those country gaps which have, in the pre-treatment period, mean squared errors less than 5 times the mean squared error in Peru.

Appendix Figure 3. Ratio of Post-Treatment RMSPE to Pre-Treatment RMSPE



Technical Appendix C. Fiscal Rules and Public Investment: The DSGE Model

The Benchmark DSGE Model

A. Households

A.1. Ricardian Households

The infinitely-lived Ricardian household solves the following program:

$$\max_{\{c_t^R, h_t^R, l_t^R, d_t^{R*}, d_t^G\}_{t=0}^{\infty}} V_t = E_0 \left\{ \sum_{t=0}^{\infty} \beta^t U(c_t^R, h_t^R) \right\}$$

subject to:

$$(1+\tau^c)p_t c_t^R + d_{t-1}^{R*}(1+r_{t-1}^*) + p_t l_t^R + p_t d_t^G = (1-\tau^w)w_t h_t^R + (1-\tau^{Co})p_t^{Co} y_t^{Co} + d_t^{R*} + p_t l_{t-1}^R (1+r_{t-1}^L) + p_t d_{t-1}^G (1+r_{t-1}^D) + \Omega_t^R$$

where V_t is the lifetime utility, β is the intertemporal discount factor, and the instantaneous utility has the following form:

$$U(c_t^R, h_t^R) = \frac{\left[c_t^R - \zeta \frac{(h_t^R)^{1+\upsilon}}{1+\upsilon} \right]^{1-\theta} - 1}{1-\theta}$$

where h_t^R represents total hours worked and c_t^R is consumption of final goods. In the case of the budget constraint, p_t is the price of the final consumption bundle,[71] d_t^{R*} is the stock of international debt, l_t^R are loans to entrepreneurs and d_t^G is the stock of government debt (both are denominated in domestic-consumption units), w_t denotes real wages, r_t^* is the world interest rate, r_t^L is the interest rates on loans, r_t^D is the interest rate on domestic public debt and Ω_t^R are profits coming from the ownership of different firms. Moreover, there is an exogenous stochastic endowment of commodities y_t^{Co} which is fully exported at an international relative price of p_t^{Co} .

Regarding the supply of labor, each Ricardian household can work in either the exportable sector or the non-tradable sector, and labor is perfectly mobile between sectors. Additionally, notice these households pay three types of taxes: a labor income tax (τ^w), a consumption tax (τ^c), and a proportional tax to the revenue generated by commodities (τ^{Co}).

The world interest rate is defined by the following equation:

[71] Where $1/p_t$ is the real exchange rate.

$$r_t^* = r_t^w + exp\left\{\phi_{d*}\left(\frac{\bar{d}_t^* - \bar{d}^*}{\bar{d}^*}\right)\right\} - 1$$

and the interest rate on domestic public debt is:

$$r_t^D = r_t^L + exp\left\{\phi_{dG}\left(\frac{\bar{d}_t^G - \bar{d}^G}{\bar{d}^G}\right)\right\} - 1$$

where d_t^* is the economy-wide external debt position,[72] $\bar{d}_t^G$ is the government domestic debt position, $\bar{d}^*$, $\bar{d}^G$, ϕ_{d*} and ϕ_{dG} are positive parameters, and r_t^w is an exogenous variable which follows an AR(1) process.

A.2. Non-Ricardian Households

There is a continuum of non-Ricardian households which do not have access to financial markets and do not receive income from profits. They solve the following program:

$$\max_{\{c_t^{NR}, h_t^{NR}\}_{t=0}^{\infty}} V_t = E_O\left\{\sum_{t=0}^{\infty} \beta^t U(c_t^{NR}, h_t^{NR})\right\}$$

subject to:

$$(1+\tau^c)p_t c_t^{NR} = (1-\tau^w)w_t h_t^{NR}$$

and the instantaneous utility is:

$$U(c_t^{NR}, h_t^{NR}) = \frac{\left[c_t^{NR} - \zeta\frac{(h_t^{NR})^{1+\upsilon}}{1+\upsilon}\right]^{1-\theta} - 1}{1-\theta}$$

Also, labor is perfectly mobile between sectors for these households.

A.3. Aggregate Consumption

The aggregate consumption good is formed by combining tradable (c_t^T), and non-tradable (c_t^N) goods in the following sense:

$$c_t = \left[\varphi^{1/\epsilon}(c_t^N)^{1-1/\epsilon} + (1-\varphi)^{1/\epsilon}(c_t^T)^{1-1/\epsilon}\right]^{\frac{\epsilon}{\epsilon-1}}$$

[72] Such that $d_t^* = (1-\kappa)d_t^{R*} + d_t^{G*}$, is the stock of international debt from households and the government.

where ϵ is the elasticity of substitution and $0 < \varphi < 1$ is the share of non-tradables in aggregate consumption.

Tradable consumption is, in turn, a Cobb-Douglas aggregation of exportable (c_t^X) and importable (c_t^M) goods:

$$c_t^T = \left(\frac{c_t^X}{x}\right)^x \left(\frac{c_t^M}{1-x}\right)^{1-x}$$

with x is the share of exportables in total expenditure in tradable goods. In this case the optimal choice of c_t^N, c_t^X,c_t^M is determined as follows:

$$\min_{\{c_t^N, c_t^T, c_t^X, c_t^M\}_{t=0}^{\infty}} c_t = \left[\varphi^{1/\epsilon}(c_t^N)^{1-1/\epsilon} + (1-\varphi)^{1/\epsilon}(c_t^T)^{1-1/\epsilon}\right]^{\frac{\epsilon}{\epsilon-1}}$$

subject to:

$$p_t c_t = p_t^T c_t^T + p_t^N c_t^N$$
$$c_t^T = \left(\frac{c_t^X}{x}\right)^x \left(\frac{c_t^M}{1-x}\right)^{1-x}$$
$$p_t^T c_t^T = p_t^X c_t^X + c_t^M$$

where p_t^T , p_t^X and p_t^N are the relative prices of tradables, exportables and non-tradables. Note that the importable good is the numeraire.

B. Production

B.1. Exportable Goods

These firms solve the following maximization program:

$$\max_{\{h_t^X, k_{t-1}^X\}_{t=0}^{\infty}} \Pi_t^X = (1-\tau^X) p_t^X y_t^X - w_t h_t^X - u_t^X k_{t-1}^X$$

subject to:

$$y_t^X = a_t^X (h_t^X)^{\alpha_X} (k_{t-1}^X)^{1-\alpha_X-\theta_X} (k_{t-1}^G)^{\theta_X}$$

where τ^X is an income tax, a_t^X is an exogenous productivity shock, k_t^X is the stock of capital in this sector, k_t^G is the stock of public capital, and u_t^X is the rental rate of capital in the exportables.

B.2. Non-Tradable Goods

Producers of non-tradable goods optimize the following program:

$$\max_{\{h_t^N, k_{t-1}^N\}_{t=0}^{\infty}} \Pi_t^N = (1-\tau^N) p_t^N y_t^N - w_t h_t^N - u_t^N k_{t-1}^N$$

subject to:

$$y_t^N = a_t^N (h_t^N)^{\alpha_N} (k_{t-1}^N)^{1-\alpha_N-\theta_N} (k_{t-1}^G)^{\theta_N}$$

where τ^N is an income tax, a_t^N is an exogenous productivity shock, k_t^N is the stock of capital in this sector and u_t^N is the rental rate of capital in the non-tradables.

B.3. Entrepreneurs

There are entrepreneurs who are the managers of the stock of capital in the exportable and non-tradable goods sectors. They start every period with a stock of capital k_{t-1}^j and outstanding loans l_{t-1}^j, where $j = X, N$.

In each sector, entrepreneurs buy new capital from capital-goods producers at price q_t^j and rent it to the firms in each sector at a rate u_t^j. After depreciation (at a rate δ), they sell the remaining stock to capital producers and repay the loans. Entrepreneurs use both loans from households and their own net worth (n_t^j). Then, their balance sheet is:

$$q_t^j k_t^j = n_t^j + p_t l_t^j$$

for $j = X, N$. The entrepreneurs face a costly state-verification problem that limits their ability to freely borrow from households. Therefore, there is a wedge $\left(rp_t^j\right)$ between the expected return on purchasing one new unit of capital and the rate at which households are willing to lend:

$$E_t \left\{ \frac{u_{t+1}^j + (1-\delta) q_{t+1}^j}{q_t^j} \right\} = (1 + r_t^L) rp_t^j$$

where $rp_t^j \equiv rp\left(\frac{q_t^j k_t^j}{n_t^j}\frac{1}{lev}\right)^{\xi_j}$ for $j = X, N$. The parameter lev is the steady-state leverage,[73] while rp is the steady-state risk premium, both assumed to be equal across sectors. Thus, $\xi_j > 0$ captures the elasticity of the premium with respect to leverage in each sector.

After repaying loans, a fraction $1 - \vartheta$ of entrepreneurs exit the market and transfer the remaining profits to Ricardian households. The same fraction enters the market every period, each receiving a startup capital injection from Ricardian households given by $\frac{\iota^j}{1-\vartheta}$. The aggregate net worth in each sector is given by:

$$n_t^j = \vartheta\left\{\left[u_t^j + (1-\delta)q_t^j\right]k_{t-1}^j - p_t l_{t-1}^j(1 + r_{t-1}^L)\right\} + \iota^j$$

for $j = X, N$.

B.4. Capital and Investment Goods

In each sector, there are firms that buy old capital, $(1-\delta)k_{t-1}^j$, and combine it with investment goods to produce new capital using the technology:

$$k_t^j = (1-\delta)k_{t-1}^j + \left[1 - S_j\left(\frac{i_t^j}{i_{t-1}^j}\right)\right]i_t^j$$

for $j = X, N$. Where $S_j(.)$ is an adjustment costs function with the following form:

$$S_j\left(\frac{i_t^j}{i_{t-1}^j}\right) = \frac{\phi_j}{2}\left(\frac{i_t^j}{i_{t-1}^j} - 1\right)^2$$

for $j = X, N$. These firms choose the optimal amount of investment maximizing its total discounted profits:

$$\max_{i_t^j} E_O\left\{\sum_{t=0}^{\infty}\Gamma_t\left\{q_t^j\left[1 - S_j\left(\frac{i_t^j}{i_{t-1}^j}\right)\right]i_t^j - p_t^I i_t^j\right\}\right\}$$

[73] The leverage is defined as $lev_t^j = \frac{q_t^j k_t^j}{n_t^j}$.

where p_t^I is the relative price of investment goods, q_t^j is the relative price of capital and Γ_t is the stochastic discount factor. Additionally, there are firms that combine imported and non-traded goods to produce investment goods. Later, they sell these goods to capital firms and the government. Their technology is:

$$i_t = \left(\frac{x_t^N}{\gamma}\right)^{\gamma} \left(\frac{x_t^M}{1-\gamma}\right)^{1-\gamma}$$

where $i_t = i_t^N + i_t^X$. The optimal choice between non-traded and importable inputs is given by the following program:

$$\max_{\{x_t^N, x_t^M\}_{t=0}^{\infty}} p_t^I i_t - p_t^N x_t^N - x_t^M$$

subject to:

$$i_t = \left(\frac{x_t^N}{\gamma}\right)^{\gamma} \left(\frac{x_t^M}{1-\gamma}\right)^{1-\gamma}$$

C. Fiscal Policy

The government levies taxes ($\tau^c, \tau^w, \tau^X, \tau^N, \tau^{Co}$), has access to domestic and international debt markets (d_t^G and d_t^{G*}), purchases non-traded goods (g_t) and invests in the economy (i_t^G). Its resource constraint is given by:

$$p_t^N g_t + p_t^{IG} i_t^G + d_{t-1}^{G*}(1 + r_{t-1}^*) + p_t d_{t-1}^G (1 + r_{t-1}^D) - rev_t = \tilde{d}_t^G$$

where rev_t denotes total revenues, which is equal to the following equation:

$$rev_t = \tau^c p_t c_t + \tau^w w_t h_t + \tau^X p_t^X y_t^X + \tau^N p_t^N y_t^N + \tau^{Co} p_t^{Co} y_t^{Co}$$

and $\tilde{d}_t^G$ is the total public debt. Like Suescún (2018), we assume a share ϖ of the total public debt is obtained from the domestic debt market. Therefore, a share $1 - \varpi$ is obtained from the foreign debt market:

$$p_t d_t^G = \varpi \tilde{d}_t^G$$
$$d_t^{G^*} = (1 - \varpi)\tilde{d}_t^G$$

In the case of expenditure policy, the government is subject to fiscal rules on the purchases of non-tradable goods and public investment. On the current spending side, we have the following specification:

$$\frac{p_t^N g_t}{p \times gdp} = \eta_t^P$$

where $p \times gdp$ is the steady-state GDP in terms of consumption units. Therefore, the purchases of non-traded goods are a share (η_t^P) of it. Notice that η_t^P is an exogenous variable which follows an AR(1) process. Additionally, we specify a Fiscal Deficit Rule which operates as a constraint on public investment:

$$p_t^N g_t + p_t^{IG} i_t^G + d_{t-1}^{G*} r_{t-1}^* + p_t d_{t-1}^G r_{t-1}^D + \eta^r \tilde{d}_t^G - rev_t = \eta_t^I \times p_t \times gdp_t$$

where η_t^I determines the numerical target of the Fiscal Deficit Rule,[74] and η^r is an adjustment factor.[75] Moreover, public capital (k_t^G) follows the next equation:

$$k_t^G = (1 - \delta^G) k_{t-1}^G + \left[1 - S_G\left(\frac{i_t^G}{i_{t-1}^G}\right)\right] i_t^G$$

where δ^G is the depreciation rate of public capital and $S_g(\cdot)$ is its adjustment cost with the following functional form:

$$S_G\left(\frac{i_t^G}{i_{t-1}^G}\right) = \frac{\phi_G}{2}\left(\frac{i_t^G}{i_{t-1}^G} - 1\right)^2$$

Finally, we assume public investment is a composite of non-tradable and importable goods, through the following technology:

$$i_t^G = \left(\frac{x_t^{NG}}{\gamma^g}\right)^{\gamma^g} \left(\frac{x_t^{MG}}{1 - \gamma^g}\right)^{1-\gamma^g}$$

such that the government chooses optimally between these two inputs by the following program:

---

[74] It follows an AR(1) process for trying to capture deviations from the Fiscal Deficit Rule and can be interpreted as public investment shocks.

[75] Following García-Cicco and Kawamura (2015) we combine the government budget constraint and the fiscal deficit rule, such that we obtain:

$$\tilde{d}_t^G - d_{t-1}^{G*}(1 + r_{t-1}^*) - p_t d_{t-1}^G (1 + r_{t-1}^D) + rev_t + d_{t-1}^{G*} r_{t-1}^* + p_t d_{t-1}^G r_{t-1}^D + \eta^r \tilde{d}_t^G - rev_t = \eta_t^I \times p_t \times gdp_t$$

Notice that the total public debt is defined as $\tilde{d}_t^G = d_t^{G*} + p_t d_t^G$. Hence:

$$\tilde{d}_t^G - (1 - \eta^r)\tilde{d}_{t-1}^G = \eta_t^I \times p_t \times gdp_t$$

Then, if $\eta_t^I \times p_t \times gdp_t$ is stationary, $\eta^r = 0$ implies that the total public debt, $\tilde{d}_t^G$, contains a unit root. In that sense, we interpreted η^r as an adjustment factor which assures a non-explosive path for total public debt. If $\tilde{d}_t^G$ is stationary, then d_t^{G*} and d_t^G also are. We calibrate η^r such that the previous equation holds in steady state $\left(\eta^r = \frac{\eta^I \times p \times gdp}{\tilde{d}^G}\right)$.

$$\max_{\{x_t^{NG}, x_t^{MG}\}_{t=0}^{\infty}} p_t^{IG} i_t^G - p_t^N x_t^{NG} - x_t^{MG}$$

subject to:

$$i_t^G = \left(\frac{x_t^{NG}}{\gamma^g}\right)^{\gamma^g} \left(\frac{x_t^{MG}}{1-\gamma^g}\right)^{1-\gamma^g}$$

D. Aggregation and Market Clearing

The following are market clearing conditions in different markets:

Labor: $(1-\kappa)h_t^R + \kappa h_t^{NR} = h_t^X + h_t^N$

Consumption: $(1-\kappa)c_t^R + \kappa c_t^{NR} = c_t$

Foreign debt: $(1-\kappa)d_t^{R*} + d_t^{G*} = d_t^*$

Total debt: $d_t^* + d_t^G = \bar{d}_t$

Loans: $(1-\kappa)l_t^R = l_t^X + l_t^N$

Private investment: $i_t = i_t^N + i_t^X$

Non-tradables: $y_t^N = c_t^N + x_t^N + g_t + x_t^{NG}$

Imports: $imp_t = c_t^M + x_t^M + x_t^{MG}$

Exports: $exp_t = p_t^X(y_t^X - c_t^X) + p_t^{Co} y_t^{Co}$

Trade balance: $tb_t = exp_t - imp_t$

Net foreign lending position: $d_{t-1}^*(1 + r_{t-1}^*) = d_t^* + tb_t$

GDP in consumption units: $p_t gdp_t = p_t^X y_t^X + p_t^N y_t^N + p_t^{Co} y_t^{Co}$

GDP – expenditure side: $p_t gdp_t = p_t c_t + p_t^I i_t + p_t^{IG} i_t^G + p_t^N g_t + tb_t$

Finally, notice there are eight driving forces in the model (a_t^X, a_t^N, p_t^{Co}, y_t^{Co}, r_t^W, p_t^X, η_t^P, and η_t^I) that follow an AR(1) processes with Gaussian innovations.

Alternative Fiscal Rules

We use two alternative designs for fiscal rules. The first is the Structural Fiscal Deficit Rule (SFDR), which directly affects public investment, while the fiscal rule on purchases of non-tradable goods does not suffer any modification. In this case we replace the original rule over public investment by the next one:

$$p_t^N g_t + p_t^{IG} i_t^G + d_{t-1}^{G*} r_{t-1}^* + p_t d_{t-1}^G r_{t-1}^D + \eta^r \tilde{d}_t^G - rev = \eta_t^I \times p \times gdp$$

where rev is the steady-state level of fiscal revenues. The second design is the Current Deficit Rule (CDR), also known as the golden rule. In this case we drop out the rule on the purchases of non-traded goods and replace the original by the next one:

$$p_t^N g_t + d_{t-1}^{G*} r_{t-1}^* + p_t d_{t-1}^G r_{t-1}^D + \eta^r \tilde{d}_t^G - rev_t = \eta_t^P \times p_t \times gdp_t$$

where η_t^P is the numerical target. In this case, the public investment is modeled as follows:

$$\frac{p_t^{IG} i_t^G}{p \times gdp} = \eta_t^I$$

where η_t^I is an AR(1) process with Gaussian innovations.

Welfare Indicators

We build the welfare indicator for Ricardian and non-Ricardian households from the following definition:

$$V_t^j = E_0 \left\{ \sum_{t=0}^{\infty} \beta^t U\left(c_t^j, h_t^j\right) \right\}$$

for $j = R, NR$. Notice that we may rewrite this equation in a recursive form:

$$V_t^j = U\left(c_t^j, h_t^j\right) + \beta E_t V_{t+1}^j$$

where: $U\left(c_t^j, h_t^j\right) = \frac{\left[c_t^j - \zeta \frac{\left(h_t^j\right)^{1+\upsilon}}{1+\upsilon}\right]^{1-\theta} - 1}{1-\theta}$ for $j = R, NR$. Finally, the welfare gain, λ_W, is obtained from:

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t U(c_t^a, h_t^a) \right\} = E_0 \left\{ \sum_{t=0}^{\infty} \beta^t U\left((1-\lambda_W) c_t^r, h_t^r\right) \right\}$$

As García-Cicco and Kawamura (2015) point out, λ_W is the percentage of the consumption sequence of equilibrium under the policy r the household is willing to sacrifice to be indifferent between the r and the alternative policy a equilibria. A lower value of λ_W implies a greater welfare gain.

Appendix Table 6. Calibration of Parameters

Parameter	Description	Value	Source
θ	Risk aversion	2.00	Suescún (2018)
ω	Frisch elasticity	1.50	Suescún (2018)
χ	Share of exportable goods in tradable consumption composite	0.50	Suescún (2018)
α_X	Importance of labor in the exportable production	0.55	Own calibration
α_N	Importance of labor in the non-tradable production	0.75	Own calibration
θ_X	Importance of public capital in the exportable production	0.10	Suescún (2018)
θ_N	Importance of public capital in the tradable production	0.10	Suescún (2018)
δ	Depreciation rate of private capital	0.080	Gupta et al (2014)
δ_G	Depreciation rate of public capital	0.035	Gupta et al (2014)
γ	Share of non-tradables in private investment	0.40	Garcia-Cicco et al (2015)
γ_G	Share of non-tradables in public investment	0.80	Own calibration
ϕ_{d^*}	Elasticity of country premium – foreign debt	0.001	Own calibration
ϕ_d	Elasticity of country premium – domestic debt	0.001	Own calibration

Parameter	Description	Value	Source
ν	Entrepreneurs survival rate	0.97	Garcia-Cicco et al (2015)
ϵ	Elasticity of substitution between tradable and non-tradable sectors	0.75	Suescún (2018)
ξ_X	Elasticity of the risk premium in the tradable sector	1.50	Own calibration
ξ_N	Elasticity of the risk premium in the non-tradable sector	1.50	Own calibration
τ^C	Consumption tax rate	0.1483	Own calibration
τ^W	Labor income tax rate	0.0230	Own calibration
τ^X	Exportable income tax rate	0.0015	Suescún (2018)
τ^N	Non-tradable income tax rate	0.0005	Suescún (2018)
τ^{Co}	Commodity income tax rate	0.1500	Own calibration
ϕ^D	Share of internal public debt	0.48	Suescún (2018)
h	Steady-state labor hours	0.30	Garcia-Cicco et al (2015)
ϕ_X	Capital adjustment cost in the tradable sector	0.10	Own calibration
ϕ_N	Capital adjustment cost in the non-tradable sector	0.10	Own calibration

Appendix Table 6. Calibration of parameters (continued)

Parameter	Description	Value	Source
κ	Share of Non-Ricardian households	0.65	Suescún (2018)
ϕ_G	Capital adjustment cost in the public sector	0.10	Own calibration
ϕ^{PCE}	Target in the current expenditures fiscal rule	0.11	Own calibration
η_0	Target in the fiscal deficit rule*	0.01/0.005 /-0.0350	Own calibration

Parameter	Description	Value	Source
η_r	Adjustment factor in fiscal deficit rule	0.033	Own calibration
β	Discount factor	0.988	Own calibration
RP	Steady state risk premium	1.033	Own calibration
r^W	Steady state foreign interest rate	1.012	Suescún (2018)

* Calibration for the Fiscal Deficit Rule (FDR)/the Structural Fiscal Deficit Rule (SFDR)/ the Current Deficit Rule (CDR). For more details see the Box 2.

Exogenous processes

Parameter	Persistence parameters	Value	Source
ρ_{a^X}	Tradable sector productivity	0.51	Own calibration
ρ_{a^N}	Non-tradable sector productivity	0.76	Own calibration
ρ_{p^X}	Tradable sector prices	0.52	Own calibration
$\rho_{y^{Co}}$	Commodity sector production	0.44	Own calibration
$\rho_{p^{Co}}$	Commodity sector prices	0.56	Own calibration
ρ_{r^W}	Foreign interest rate	0.30	Own calibration
ρ_g	Current expenditures	0.47	Own calibration
ρ_{i^g}	Public investment	0.59	Own calibration

Parameter	Standard Deviation of the shock	Value	Source
ε_{a^X}	Tradable sector productivity	0.0373	Own calibration
ε_{a^N}	Non-tradable sector productivity	0.0221	Own calibration
ε_{p^X}	Tradable sector prices	0.0628	Own calibration
$\varepsilon_{y^{Co}}$	Commodity sector production	0.0250	Own calibration
$\varepsilon_{p^{Co}}$	Commodity sector prices	0.0764	Own calibration
ε_{r^W}	Foreign interest rate	0.0104	Own calibration
ε_g	Current expenditures	0.0300	Own calibration
ε_{i^g}	Public investment	0.1163	Own calibration

Technical Appendix D. Stochastic Debt Sustainability Analysis

Simulation of Macroeconomic Variables

As a first step, we estimated an unrestricted VAR model for macroeconomic variables of the system. The econometric specification is:

$$\begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} A_1' & A_2' \\ B_1' & B_2' \end{bmatrix} \times \begin{bmatrix} x_{1,t} \\ x_{2,t} \end{bmatrix} + \begin{bmatrix} \epsilon_{1,t} \\ \epsilon_{2,t} \end{bmatrix} \qquad D.1$$

while $x_{1,t}$ and $x_{2,t}$ are vectors with p lags of those variables, so $x_{1,t} = [y_{1,t-1}, \dots, y_{1,t-p}]'$ and $x_{2,t} = [y_{2,t-1}, \dots, y_{2,t-p}]'$.

The vector of foreign variables comprises the annual growth of export prices (Δp_t^{Co}) and the international interest rate (r_t^*), while the vector of domestic variables considers the annual growth of GDP (g_t), the domestic interest rate (r_t) and the annual depreciation of bilateral real exchange rate (Δq_t).[76] On the other hand, the parameters to estimate are the vector of intercepts c_1 and c_2, as well as the matrices $\boldsymbol{A}_1$, $\boldsymbol{A}_2$, $\boldsymbol{B}_1$ and $\boldsymbol{B}_2$. The errors are $\epsilon_{1,t}$ and $\epsilon_{2,t}$ with dimensions $n_1 \times 1$ and $n_2 \times 1$, respectively.

In order to capture the main features of a small open economy, we assume that $\boldsymbol{A}_2' = 0$, such that the domestic variables do not affect the dynamics of foreign variables. The system is estimated by ordinary least squares, with $p = 1$, and with quarterly frequency information from the period 2000Q1 to 2019Q4.[77] Later, we simulate 5,000 paths for each variable of the system using the estimated coefficients and the reduced-form errors draw through the Bootstrap method.

Simulation of Fiscal Variables

In contrast to Celasun et al. (2006), we do not need to estimate a fiscal reaction function on the primary balance because we assume the strict fulfillment of fiscal rules in all the forecast period. However, we need to model the behavior of the main fiscal variables by accounting identities. In that sense the public debt interest payments denominated in domestic $\left(\bar{d}_t^{DC}\right)$ and foreign $\left(\bar{d}_t^{FC}\right)$ currencies are defined by:[78]

[76] See Appendix C for a description of the data and their sources.
[77] As mentioned by Celasun et al. (2006), quarterly projections generated by VARs are annualized.
[78] All the variables with a bar are expressed as a percentage of GDP $\left(\bar{X}_t = \frac{X_t}{\text{Nominal GDP}_t}\right)$.

$$\overline{int}_t^{DC} = \frac{r_t \bar{d}_{t-1}^{DC}}{1 + g_t} \qquad D.2$$

$$\overline{int}_t^{FC} = \frac{r_t^* (1 + \Delta q_t) \bar{d}_{t-1}^{FC}}{1 + g_t} \qquad D.3$$

In order to avoid an excess of notation, we assume that the primary balance of state-owned firms is zero in all the periods under analysis. Then, we define the overall deficit as:

$$\overline{od}_t = \overline{pd}_t + \overline{int}_t^{DC} + \overline{int}_t^{FC} \qquad D.4$$

where $\overline{pd}_t$ is the primary deficit and $\overline{od}_t$ is the overall deficit. Additionally, we include a fiscal rule over the growth of the current expenditures:

$$\Delta ce_t = \frac{\sum_{t=1}^{T} g_t}{T} \qquad D.5$$

such that the current expenditures, Δce_t, growth at the same rate of the average growth of GDP (where T is the number of time periods, including the current one). Finally, we model the fiscal revenues as follows:

$$\Delta fr_t = \alpha_0 + \alpha_1 \, \Delta fr_{t-1} + \alpha_3 \, \Delta p_t^{Co} + \alpha_4 \, \Delta p_{t-1}^{Co} + \alpha_5 \, g_t + \alpha_6 g_{t-1} + \epsilon_{3,t} \qquad D.6$$

where Δfr_t is the annual growth of fiscal revenues. Note there is another source of uncertainty in the system from $\epsilon_{3,t}$. With this basic structure we simulate the following fiscal rules:

i. Fiscal Deficit Rule

We assume the fulfillment of the fiscal deficit rule $\left(\overline{fdr}_t\right)$ in all periods under analysis. In this case, we follow the current MEF's fiscal consolidation plan, such that the respective numerical targets of this rule are 2.0, 1.8, 1.6, 1.3 and 1.0 percent of GDP for the years 2020-2024. Later, we maintain the fiscal deficit at 1.0 percent of GDP. Then we have:

$$\overline{pd}_t = \overline{fdr}_t - \overline{int}_t^{DC} - \overline{int}_t^{FC} \qquad D.7$$

where $\overline{pd}_t$ is the primary deficit as a percentage of GDP. Moreover, the ratio of public debt to GDP $\left(\bar{d}_t\right)$ evolves according to its dynamic equation:

$$\bar{d}_t = \frac{1}{1+g_t}\left[(1+r_t)\bar{d}^{DC}_{t-1} + (1+r^*_t)(1+\Delta q_t)\bar{d}^{FC}_{t-1}\right] + \overline{pd}_t \qquad D.8$$

ii. Structural Fiscal Deficit Rule

Fiscal revenues are the only component affected by the cyclical adjustment from business cycle and commodity prices cycle. Then, the structural fiscal revenues are calculated following the next equation:[79]

$$\overline{\overline{fr}}^*_t = \overline{fr}^*_t \left(\left(\frac{1}{1+OG_t}\right)^{\eta} + \phi^{NR}\left(\left(\frac{1}{1+CPG_t}\right)^{\epsilon} - 1\right)\right) \qquad D.9$$

where $\overline{\overline{fr}}^*_t$ are the structural fiscal revenues as a percentage of potential GDP;[80] OG_t and CPG_t are the output and commodity prices gaps, respectively; η and ϵ are the elasticities of the fiscal revenues to the GDP and commodity prices; and finally, ϕ^{NR} is the share of fiscal revenues from the primary sectors (mining and oil sectors).

Once we calculate the structural fiscal revenues, we get the public expenditures ($\overline{pe}^*_t$) by the next equation:

$$\overline{pe}^*_t = \overline{sfdr}^*_t - \overline{int}^{DC,*}_t - \overline{int}^{FC,*}_t + \overline{\overline{fr}}^*_t \qquad D.10$$

where $\overline{sfdr}^*_t$ is the structural fiscal deficit rule. Notice that the primary deficit (as a percentage of GDP) is defined by:

$$\overline{pd}_t = \overline{pe}_t - \overline{fr}_t \qquad D.11$$

where $\overline{pe}_t = \frac{\overline{pe}^*_t}{(1+OG_t)}$. Then, we plug equation D.11 into equation D.8 to obtain the ratio of public debt to GDP.

iii. The Golden Rule

This rule constraints the current deficit, so it affects the current expenditures directly. When this fiscal rule is active, then equation D.5 turns off. Current expenditures as a percentage of GDP are given by:

[79] See the next subsection for a detailed derivation of this equation.

[80] Any variable in terms of GDP can be expressed as a percentage of potential GDP following this equation: $\bar{X}^*_t = \bar{X}_t(1+OG_t)$.

$$\overline{ce}_t = \overline{fr}_t - \overline{int}_t^{DC} - \overline{int}_t^{FC} + \overline{cdr}_t \qquad D.12$$

where $\overline{cdr}_t$ is the current deficit rule as a percentage of GDP. Note that:

$$\overline{pe}_t = \overline{ce}_t + \overline{pi}_t \qquad D.13$$

where $\overline{pi}_t$ is the public investment as a percentage of GDP. Then, to obtain an expression of the primary deficit, we assume a passive forecast of this variable.[81] With this trajectory and equation D.12 we obtain public expenditures (equation D.14). With the model for fiscal revenues (equation D.6) we obtain the primary deficit and, consequently, the public debt (equation D.8).

Calculation of Structural Fiscal Revenues

Let fr_t be fiscal revenues and fr_t^{RN} the fiscal revenues from Natural Resources (mining and oil sectors). Following the methodology describes in the Ministerial Resolution Nº 024-2016-EF/15, the structural fiscal revenues are calculated as:

$$fr_t^* = fr_t \left(\frac{Y_t^s}{Y_t}\right)^{\eta} + fr_t^{RN} \left(\frac{P_t^S}{P_t}\right)^{\epsilon} - fr_t^{RN} \qquad D.14$$

where Y_t and P_t are the GDP and the commodity prices index, and Y_t^s and P_t^S are the potential level of GDP and commodity prices index, respectively. The latter two variables are calculated by the Baxter and King filter. Dividing equation D.14 by the potential GDP we have:

$$\overline{\overline{fr}}_t^* = \overline{fr}_t^* \left(\frac{Y_t^s}{Y_t}\right)^{\eta} + \overline{fr}_t^{RN,*} \left(\frac{P_t^S}{P_t}\right)^{\epsilon} - \overline{fr}_t^{RN,*} \qquad D.15$$

We may rewrite equation D.15 in terms of the output gap (OG_t) and the commodity prices gap (CPG_t):

$$\overline{\overline{fr}}_t^* = \overline{fr}_t^* \left(\frac{1}{1+OG_t}\right)^{\eta} + \overline{fr}_t^{RN,*} \left(\frac{1}{1+CPG_t}\right)^{\epsilon} - \overline{fr}_t^{RN,*} \qquad D.16$$

Here we assume that the fiscal revenues from Natural Resources are a constant fraction of the fiscal revenues ($fr_t^{RN} = \phi^{NR} fr_t$). With this change, we obtain a tractable equation of structural fiscal revenues as a percentage of GDP:

[81] As we pointed out above, we use a passive forecast for public investment with two possible scenarios: (i) the public investment (as a percentage of GDP) remains at the 2019's level in all the forecast horizon (4.5 percent of GDP), and (ii) the public investment (as a percentage of GDP) follows the trajectory proposed in the MEF's Multi-annual Macroeconomic Framework 2020-2023.

$$\overline{\overline{fr}}_t^* = \overline{fr}_t^* \left(\left(\frac{1}{1 + OG_t} \right)^{\eta} + \phi^{NR} \left(\left(\frac{1}{1 + CPG_t} \right)^{\epsilon} - 1 \right) \right) \qquad D.17$$

which is similar to equation D.9.

Appendix Table 7. DSA Data and Sources for the VAR Model

Macro variables	Description and sources
Annual growth of export prices	Annual growth of the quarterly export prices index (2007=100). Source: Central Reserve Bank of Peru.
International interest rate	Effective interest rate calculated as the quotient between the compound annual payments of interests in foreign money of the period "t" and the public debt in foreign money of the period "t-4". Source: Central Reserve Bank of Peru.
Annual growth of GDP	Compound annual growth of the quarterly GDP in millions of Soles of 2007. Source: Central Reserve Bank of Peru.
Domestic interest rate	Effective interest rate calculated as the quotient between the compound annual payments of interests in domestic money of the period "t" and the public debt in domestic money of the period "t-4". Source: Central Reserve Bank of Peru.
Depreciation of bilateral real exchange rate	Annual growth of the quarterly bilateral exchange rate. It is calculated as: $\Delta q_t = \frac{1 + \Delta s_t}{(1 + \pi_t)}(1 + \pi_t^*) - 1$ where Δs_t is the annual growth of the quarterly nominal exchange rate (S/ per US$), π_t is the annual inflation rate of the quarterly Peruvian CPI, and π_t^* is the annual inflation rate of the quarterly CPI from USA. Sources: Central Reserve Bank of Peru and FED St. Louis.
Fiscal revenues	General Government fiscal revenues as a percentage of GDP. Source: Central Reserve Bank of Peru.
Current expenditure	General Government current expenditures as a percentage of GDP. Source: Central Reserve Bank of Peru.
Public investment	General Government capital expenditures as a percentage of GDP. Source: Central Reserve Bank of Peru.
Primary balance	Non-financial Public Sector primary balance as a percentage of GDP. Source: Central Reserve Bank of Peru.
Interest payments	Non-financial Public Sector interest payments over public debt in domestic and foreign currencies as a percentage of GDP. Source: Central Reserve Bank of Peru.
Overall balance	Non-financial Public Sector overall balance as a percentage of GDP. Source: Central Reserve Bank of Peru.
Public Debt	Non-financial Public Sector public debt as a percentage of GDP. Source: Central Reserve Bank of Peru.

Appendix Table 8. Acronyms

Acronym	Description
ADH	Abadie, Diamond and Hainmueller
AS	Alonso Segura
BK	Becker and Klößner
CG	Central Government
CL	César Liendo
CRBP	Central Reserve Bank of Peru
DSA	Debt Sustainability Analysis
DSGE	Dynamic Stochastic General Equilibrium
FPTL	Fiscal Prudence and Transparency Law
FRTL	Fiscal Responsibility and Transparency Law
FMM-MTFF	Fiscal Management Division-Medium Term Fiscal Framework
GDC	General Directorate of Contributions
GG	General Government
IMF	International Monetary Fund
JV	José Valderrama
LAC	Latin America and the Caribbean
LSFRT	Law to Strengthen Fiscal Responsibility and Transparency
MMF	Multiannual Macroeconomic Framework
FRTF	Fiscal Responsibility and Transparency Framework of the Non-Financial Public Sector
MEF	Ministry of Economy and Finance
NG	National Government
p.p.	percentage points
RMSPE	Root Mean Squared Predictive Errors
SCM	Synthetic Control Method
SFDR	Structural Fiscal Deficit Rule
SUNAT	Superintendencia Nacional de Aduanas y de Administración Tributaria
WM	Waldo Mendoza