R&D Investment and Financial Stability

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Abstract

We examine the relationship between a country's level of investment in research and development (R&D) and financial stability. Our findings emphasize the importance of a balanced fiscal strategy that reconciles the urgency of short-term fiscal consolidation with the pursuit of long-term economic growth and productivity. Using causal mediation analysis, we evaluate both the direct impact of R&D spending on financial stability and the indirect effects mediated through government expenditure. The results reveal that while total R&D spending, including public and private contributions, directly and significantly enhances financial stability, an increase in total public expenditure—arising from higher R&D investment while holding other components of government spending constant—counterbalances this positive effect. Thus, when both direct and indirect pathways are considered, the overall causal impact is nonsignificant. These findings highlight the need for policymakers to prioritize R&D investment while carefully managing other areas of public spending to safeguard financial stability. They also underscore the critical role of private R&D investment in financial stability. A strategic fiscal framework is essential to balance innovation-driven investments with fiscal discipline, supporting long-term economic resilience and growth.

Keywords: Public expenditure; Research and development; Financial stability; Causal mediation analysis.
JEL Codes: E62; O38; G18.

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Content

1. Introduction

In recent years, fiscal matters have taken center stage in both academic research and economic policy debates. This heightened focus is largely a consequence of the significant rise in public debt levels observed across advanced and emerging economies in the aftermath of the COVID-19 pandemic. At the same time, the sharp increase in inflation experienced in many countries led central banks to implement substantial hikes in policy interest rates. While this measure was aimed at curbing inflationary pressures, it also had the unintended consequence of sharply increasing the cost of government debt servicing, as higher interest rates translate into larger interest payments. Together, these developments have revived critical discussions surrounding the growth of public debt, its potential limits, and the broader question of fiscal sustainability. In this context, the urgency of fiscal consolidation in many countries may jeopardize essential investments in R&D, which are vital for sustaining economic growth through productivity gains.

The relationship between increased R&D expenditure and the resilience of the financial system to macroeconomic shocks—i.e., financial stability—has received surprisingly little attention in the literature on innovation, economics, or finance. This oversight is notable because higher levels of spending on R&D are expected to enhance financial stability by fostering sustained growth, increased productivity, and improved export quality. Conversely, public R&D expenditure, as part of total government expenditure, could undermine financial resilience by contributing to unsustainable debt levels, widening spreads, and increasing the risk of sovereign default. Thus, the relationship between the two variables is not obvious.

Our study provides the first empirical assessment of this relationship, focusing specifically on the effects of expenditure on R&D activities and its impact on financial stability. This question is particularly critical given the short- and medium-term tensions between reducing government spending to promote immediate financial stability and maintaining robust long-term growth and productivity prospects, which are also crucial for future macroeconomic performance.

Our contribution is relevant in the current context, where in many countries, fiscal rules have either been suspended or their enforcement has been delayed, facilitating the stabilization of macroeconomic and social conditions. Although fiscal sustainability is widely recognized as a cornerstone of macroeconomic stability (Andrés and Doménech, 2006; Badinger, 2009; Corsetti et al., 2013; Golpe et al., 2023), there is ongoing debate about the most effective strategies to achieve it. Traditional approaches often emphasize the importance of containing government expenditure to prevent fiscal imbalances from reaching unsustainable levels (Alesina et al., 2015; Glomm et al., 2018; Vergés-Jaime, 2023). However, emerging research challenges this perspective, underscoring the pivotal role of institutional strength and economic structure in shaping a country's fiscal

outlook (e.g., Gomez-Gonzalez et al., 2023) and recognizing that the composition of public spending may be more critical than its overall level (Heimberger, 2023).

The economic impact of fiscal policies depends significantly on how public resources are allocated. Fiscal multipliers, which measure the effect of government spending on economic output, vary considerably across sectors (e.g., Cardi et al., 2020; Cardi and Restout, 2023). For example, public expenditure directed toward productive sectors such as infrastructure, education, or innovation may yield high positive multipliers, whereas spending in less productive areas could have negligible or even negative effects. This heterogeneity in outcomes highlights the need for a more nuanced approach to assessing the role of fiscal policy when promoting financial stability.

Previous studies have suggested both a direct positive association between R&D expenditure and financial stability and a negative indirect relationship mediated through total government expenditure. On the one hand, building on endogenous growth theories (Aghion & Howitt, 1992; Grossman & Helpman, 1991a, 1991b; Romer, 1990), which highlight R&D and innovation as pivotal engines of economic progress, the literature underscores the critical role of R&D expenditure as a driver of long-term economic performance (e.g., Ulku, 2007), productivity (e.g., Nonnis et al., 2023), and export sophistication (e.g., Uribe, 2025). In summary, by fostering growth prospects, enhancing productivity, and facilitating the creation and consolidation of knowledge-sharing networks across countries and industries, R&D investment likely plays a direct role in promoting macroeconomic resilience and financial stability.

However, a well-established branch of macrofinancial literature cautions against the potentially destabilizing effects of high government expenditure. Excessive government expenditure can lead to higher debt-to-GDP ratios, increasing economic uncertainty and constraining a government's capacity for debt repayment. This could undermine banking stability and heighten sovereign risk. Furthermore, fiscal spending can distort market allocations, exacerbating economic imbalances. Such imbalances are often amplified by the close connection between fiscal and banking risks, creating a feedback loop where not only instability in the banking sector exacerbates fiscal vulnerabilities but also fiscal weaknesses destabilize the financial system (e.g., Reinhart and Rogoff, 2009; Acharya et al., 2014). Fiscal flexibility is also crucial for enabling government support during crises, such as lender-of-last-resort interventions or direct assistance to struggling banks (Laeven and Valencia, 2018). However, excessively high government spending limits this flexibility, potentially constraining effective crisis management.

We consider both the negative and positive expected aspects by postulating a causal mediation analysis (see Imai et al., 2010; Pearl, 2022), which captures the direct effects of R&D investment on financial stability, as

well as the indirect effects when the broader impacts of government expenditure are considered. Our findings suggest that, indeed, the benefits of increased R&D expenditure on financial stability are counterbalanced by the negative effects of total government expenditure.

According to our results, the most effective way to harness the benefits of increased R&D investment on financial stability is to keep total government expenditure constant when R&D expenditure is increased. These findings highlight the importance of a deliberate and balanced approach to fiscal policy, especially in the allocation of government resources. Our analysis also emphasizes the need for careful prioritization within public budgets and programs to foster private R&D in companies, ensuring that country resources are directed toward productive investments in R&D without compromising the overall fiscal balance.

The structure of the paper is as follows. In the second section, we provide a brief review of the relevant literature that helps to position our contribution. In the third section, we describe the data, including the variables used in the model and the approach used to handle missing values. In the fourth section, we outline our methodological framework. In the fifth section, we present the main findings and robustness to a different measure of financial stress. In the final section, we present our conclusions and policy implications.

2. Literature Review

This section provides a concise overview of key findings from the literature regarding the relationships among government expenditure, R&D investment and financial stability. The discussion is organized into two subsections; the first examines the broader connection between public spending and financial stability, while the second explores the role of R&D expenditure in influencing financial stability.

2.1. Government Expenditure and Financial Stability

The relationship between government expenditure and financial stability is complex. When carefully designed and implemented, fiscal expenditure can stabilize financial systems, whereas poorly planned or unsustainable expenditure may lead to financial instability. At its core, the impact of government spending on financial stability depends on three key factors, namely, the scale and structure of expenditures, their allocation across sectors, and the sustainability of fiscal policies (Borio et al., 2023).

Duan and Ni (2024) examined the effect of fiscal expenditure on financial stability using panel data from 31 Chinese provinces between 2011 and 2022. Their findings suggest that fiscal expenditure, along with finan-

cial inclusion and technological development, contributes significantly to improving financial stability. In the same vein, Centinaio et al. (2024) and Fiordelisi and Galloppo (2018) examined the impact of government expenditure on financial markets. The former authors highlight that since the Global Financial Crisis, European stock markets have become increasingly responsive to fiscal policy announcements; they tend to react positively to declarations of fiscal expansion but negatively to announcements of fiscal consolidation. However, when evaluating the medium-term effects of fiscal decisions, Ardagna (2009), Afonso and Sousa (2011) and Centinaio et al. (2024) revealed a negative impact on financial markets of fiscal loosening and a positive impact of fiscal consolidation. This tension between short- and medium-term perspectives further emphasizes the complex nature of the relationship between fiscal matters and financial stability.

As highlighted by Panizza and Presbitero (2014), the adverse impact of public debt on economic outcomes (among which we could include financial stability) could be more pronounced if it diminishes the efficiency of public expenditure, heightens uncertainty, or fosters expectations of future financial repression. Additionally, increased sovereign risk can increase real interest rates, thereby reducing private investment. All these aspects of public debt and spending risk make a country's financial system more vulnerable to systemic shocks.

Furthermore, the interplay between the banking sector and public finances underscores the critical role of fiscal policy in maintaining financial stability. Banks are primary lenders to governments, and during times of financial distress, governments often act as the ultimate backstop for the financial system. This process creates a feedback loop where instability in the banking sector can exacerbate fiscal risk, and fiscal weaknesses can, in turn, destabilize the financial system (Reinhart and Rogoff, 2009). A strong fiscal position is necessary for governments to mitigate financial instability, even in the absence of direct public sector borrowing crises. By having sufficient fiscal space, governments can break the cycle of financial contagion and reduce the likelihood of a financial crisis. This fiscal flexibility is vital for enabling government support in times of crisis, such as through lender-of-last-resort interventions or direct assistance to struggling banks (Laeven and Valencia, 2018).

The fiscal costs of banking bailouts can be substantial. During financial crises, governments may face the difficult task of rescuing banks and supporting the broader economy. In such situations, the fiscal space available to the government determines how effectively it can mitigate the negative consequences of a financial crisis. In advanced economies, fiscal stimulus packages may help alleviate the impacts of financial instability; however, such measures can lead to rising public debt levels. For emerging market economies, however, the situation is more challenging, as they often face tighter financing constraints. The limited ability of governments in these countries to intervene may expose them to higher risks of contagion, currency depreciation, and rising interest rates, all of which exacerbate debt burdens and fiscal instability (Eichengreen and Hausmann, 2019). The fiscal aftershocks of financial crises often last for years, with governments being forced to contend with high debt-to-GDP ratios, capital outflows, and exchange rate pressures, all of which hinder recovery.

Dell'Ariccia et al. (2018) identified three channels in the literature that link sovereigns and banking risk and hence provide a theoretical link between fiscal considerations and financial stability. First, banks hold significant sovereign debt, making them vulnerable to sovereign risk (Fahri and Tirole, 2018; Broner et al., 2014). During the euro area debt crisis, banks with significant holdings of domestic sovereign bonds were found to reduce lending more sharply than others in the same country did (Acharya et al., 2018). Second, government guarantees for banks can transfer risks to sovereigns, where banking instability intensifies sovereign risk (Acharya et al., 2014; Fahri and Tirole, 2018). Third, shared shocks often affect both banks and sovereigns simultaneously, connecting their risks through economic activity (Levine, 2005; Kroszner et al., 2007).

All these channels are particularly pronounced in emerging markets, where banking sector instability is generally tied to sovereign risk (Gennaioli et al., 2014, 2018). These interactions can create "doom loops," where banking crises weaken sovereigns and vice versa, as austerity measures taken during fiscal crises often deepen economic downturns (Brunnermeier et al., 2016, 2017; Gibson et al., 2017). Renewed attention to this issue followed the rise in sovereign debt during the COVID-19 pandemic, with Mitchener and Trebesch (2023) noting the growing importance of sovereign-bank linkages.

2.2. R&D Expenditure and Financial Stability: An Inferred Link

While the effects of different investment styles (e.g., value versus growth) on the level of corporate R&D have been explored in the literature (e.g., Sayili et al., 2017), research examining the impact of R&D on financial stability remains scarce.

At a conceptual level, theories of endogenous growth from the late 1980s highlight the pivotal role of R&D and innovation in driving economic advancement, emphasizing that increased R&D expenditure can significantly enhance overall productivity (Aghion & Howitt, 1992; Grossman & Helpman, 1991a, 1991b; Romer, 1990). These frameworks position innovation, driven by R&D, as a cornerstone of sustained economic progress. Empirical evidence further supports this view, showing that countries that invest heavily in R&D often achieve stronger economic growth and improved welfare outcomes (Ulku, 2007). Similarly, Gruber and Johnson (2019) argued that government investment in R&D plays a pivotal role in driving productivity growth. Historically, greater public-sector investment in R&D has coincided with faster economic and productivity growth. The abovementioned authors claimed that the reduced role of the public sector in funding R&D has paralleled the slowdown in productivity growth. Naturally, better long-term economic prospects and growth are directly linked with greater financial stability.

At a more granular level, firms that invest more in R&D—typically characterized by higher liquidity—are expected to exhibit stronger financial resilience, enabling them to better navigate economic downturns while contributing to stability in banking and equity markets. Ahrends et al. (2018) highlighted that corporate liquidity provides firms with the flexibility to fund investments internally, reducing their dependence on external capital markets. This helps companies avoid the costs of issuing debt or equity, as well as the information asymmetry costs associated with equity offerings. Moreover, maintaining cash reserves reduces the likelihood of financial distress, ensuring that firms can meet mandatory debt obligations even during periods of insufficient operational cash flow. In turn, cash reserves are particularly vital for funding investments that require sustained effort over time and are difficult to finance externally, such as R&D expenditure (Brown et al., 2009; Brown and Petersen, 2011). Studies by Bates et al. (2009), Falato et al. (2013), and He and Wintoki (2016) have shown that high-tech and R&D-intensive firms tend to hold more cash than manufacturing firms do, contributing significantly to the long-term increase in corporate cash holdings. All these findings underscore the relationship between higher R&D expenditure and greater financial stability, driven by the financial resilience of firms with substantial cash reserves and high R&D intensity.

3. Data

Table 1 provides an overview of the data utilized in the causal mediation analysis presented in Section 4. The primary analysis draws on yearly data from 2000 to 2022, covering 44 countries: Argentina, Austria, Belgium, Brazil, Bulgaria, Canada, China, Colombia, Costa Rica, Denmark, Egypt, Finland, France, Germany, Greece, Guatemala, Hong Kong, Hungary, Iceland, India, Ireland, Israel, Italy, Japan, Korea, Mexico, the Netherlands, Norway, Panama, Paraguay, Peru, Portugal, Romania, Russia, Singapore, South Africa, Spain, Sweden, Thailand, Tunisia, Turkey, the United Kingdom, the United States, and Uruguay.

To maximize the sample size to address our research question, the dataset was assembled while accounting for data limitations across the cross-section of countries and over time (in particular, we removed the year 2023 from our sample owing to data limitations). We conducted a detailed analysis of missing values both across countries and over time to inform the selection of outcome and treatment indicators, as well as other covariates identified in the literature, which are essential for our mediation analysis. Further details on data preprocessing and the analysis of missing patterns are provided in Appendix A.

Our final dataset includes two treatment variables, namely, government expenditure as a percentage of GDP, which was sourced from the World Economic Forum, and total R&D expenditure as a percentage of GDP, i.e.,

the total expenditure (current and capital) on R&D by all resident companies, research institutes, universities and the government, which was sourced from the World Development Indicators of the World Bank.

We also consider two versions of the Financial Stress Index (FSI) developed by Ahir et al. (2023) for the International Monetary Fund (IMF), i.e., one based on data for December (DEC) and another constructed using the annual average (PROM). The FSI by Ahir et al. (2023) was created through a combination of computer algorithms and human expert oversight and is accessible on the IMF website for 110 countries.

Additionally, our dataset includes 11 country-level variables capturing macroeconomic, institutional, and financial dimensions, which are used in the empirical analysis as confounders in both the outcome and mediator equations. These indicators were selected from an initial dataset of 111 variables, ensuring that each variable had at least 70% of its data available, and all theoretical concepts needed for our identification strategy were considered (see Appendix A for details).

We addressed missing values (4.07% in government expenditure and FSI indicators) using a two-step approach. First, we imputed missing values with the closest available value for each country. When this approach was not feasible, we applied Random Forest (Breiman, 2001) via the MissForest implementation by Stekhoven and Bühlmann (2012). This method leveraged the information from the original dataset of 111 variables to impute missing values and completed each row in the dataset using a large dataset of covariates to predict in-sample the missing values. This approach allowed us to create a balanced panel of data, from which we selected the 15 variables in our main analysis. The selected variables are detailed in Table 1.

As shown in Table 1, the two versions of the Financial Stress Index range in value from 0 to 1.93 (end-of-year) and 0 to 1.11 (annual average), demonstrating sufficient variation for the analysis. The average values of the index are close to those reported for 110 countries by the original authors, all of which are near zero.

Notably, higher values of the index indicate higher levels of financial stress. With respect to R&D expenditure, the dataset exhibits considerable variability, with values ranging from 0.02% to 5.71% of the GDP. For overall government expenditure, the range spans from 0.09% to 0.35% of the GDP. The other variables in the dataset similarly reflect substantial heterogeneity, providing the variation needed to identify the causal effects of expenditure on financial stability.

Table 1. Summary Statistics of the Main Variables

Indicator	Abreviation	Source	Mean	Median	Std.Dev	Max.	Min.
Financial Stress Index DEC	DEC_FSI	Ahir et al. (2023).	0.06	0	0.18	1.93	0
Financial Stress Index PROM	PROM_FSI	Ahir et al. (2023).	0.05	0	0.13	1.11	0
Research and development expenditure (% of GDP)	GrossRD_ spend_GDP	WDI	1.46	1.18	1.13	5.71	0.02
General government total expenditure, % GDP	public_total_ spend_GDP	WEO	36	35	12	65	9
Rule of Law Index	rule_law	World Bank	0.67	0.76	0.95	2.12	-1.2
Control of Corruption	corruption_ index	World Bank	0.67	0.59	1.06	2.46	-1.44
Current Account Balance % GPD	current_ account	WEO	0.28	-0.34	5.95	30.16	-23.89
(Exports+Imports)/GDP	openness	Own calculation DoT-IMF/ WEO	0.68	0.51	0.59	3.76	0.14
Annual Growth of the Real Exchange Rate	real_ exchangerate_ growth	Own calculation IFS-IMF	0	0	0.05	0.3	-0.22
Reserves/GDP	reserves_GDP	Own calculation IFS-IMF	0.17	0.12	0.2	1.43	0
24 months window stock exchange index standard deviation	sd_stock_ market_ exchange	Own calculation Bloomberg	1263.23	451.44	3345.02	83852.25	0.01
24 months window exchange rate standar deviation	sd_ exchangerate	Own calculation IFS	20.4	0.96	66.16	1138.68	0
Annual Growth USD	gdp_usd_ growth	Own calculation WEO	0.06	0.06	0.11	0.52	-0.63
International Reserves and Liquidity, Liquidity, Total Reserves excluding Gold, US Dollar	reserves	IFS-IMF	142769.46	36623.34	416972.43	3859167.96	338.23
Financial Openness Index	kaopen	Chinn-Ito	1.34	2.3	1.38	2.3	-1.93

Source: The table shows the summary statistics for the 15 variables selected for the causal mediation analysis in Section 4.

4. Causal Mediation Analysis

To examine the causal pathways through which a country's expenditure on R&D influences financial stability (FS), we employed causal mediation analysis (see, for instance, VanderWeele (2016) or Pearl (2022) for recent reviews of the methodology).

This approach allowed us to decompose the total effect of R&D on FS into *direct* and *indirect* effects. The indirect effect operates through the mediator variable, Government Expenditure (G), whereas the direct effect captures the portion of the effect of R&D on FS that is not mediated by G. Our general framework is described as follows.

Outcome Variable (FS): Represents a financial stability index, which is measured by one of the two versions of the financial stress indicator (DEC) and (PROM) in Table 1. The former is used in the main analysis, and the second is used as a robustness exercise. *Mediator Variable (G):* Represents government expenditure (including R&D). We assume that R&D expenditure influences total government expenditure G and, in turn, that G influences our Financial Stress Indicator. *Treatment Variable (R&D):* Represents national expenditure, both private and public, allocated to research and development. *Control Variables:* To account for confounding factors, we included the following controls in both the mediator and outcome equations, as defined in. Table 1: Economic growth rate (in USD): $Growth$; Real exchange rate growth: ΔFX; Stock market volatility: $StockVol$; Foreign exchange market volatility: $FXVol$; Reserves: International reserves: $Reserves$.

The mediation analysis involved estimating two equations, namely, the mediator model, which specifies how R&D influences G in our case, and the outcome model, which specifies how both G and R&D influence FS.

4.1. Mediator Model

We estimated the following regression to quantify the effect of R&D on the mediator variable G while controlling for potential confounders:

$$G = \alpha_0 + \alpha_1 R\&D + \alpha_2 Growth + \alpha_3 \Delta FX + \alpha_4 StockVol + \alpha_5 FXVol + \alpha_6 Reserves + \varepsilon.$$

4.2. Outcome Model

Next, we estimated the effects of R&D and G on FS via the following:

$$FS = \beta_0 + \beta_1 R\&D + \beta_2 G + \beta_3 Growth + \beta_4 \Delta FX + \beta_5 StockVol + \beta_6 FXVol + \beta_7 Reserves + v.$$

In a linear context, we can define the following:

- Total Effect (TE): The total causal effect of R&D on FS is given by the following : $TE = \beta_1 + \beta_2 \alpha_1$

- Direct Effect (DE): The direct effect of R&D on FS, independent of G, is given by the following: $DE = \beta_1$

- Indirect Effect (IE): The effect of R&D on FS mediated through G is calculated as follows: $IE = \beta_2 \alpha_1$

- Proportion Mediated (PM): The proportion of the total effect mediated by G is as follows: $PM = IE/TE$

In practice, for estimation of the mediation effects, we followed a simulation-based approach using nonparametric bootstrapping. This approach ensures robust estimation of the direct, indirect, and total effects while accounting for the variability and possibly nonlinearities observed in the data.

4.3. Bootstrapping for Counterfactual Estimation

A nonparametric bootstrap was performed by repeatedly sampling the data with replacement. That is, for each bootstrap sample: 1) the mediator and outcome models were refitted; 2) counterfactual values of the mediator and the outcome were calculated under different treatment scenarios (e.g., with different levels of R&D investment); and 3) a distribution of the direct, indirect, and total effects was generated across all bootstrap samples.

4.3.1. Effect Estimation

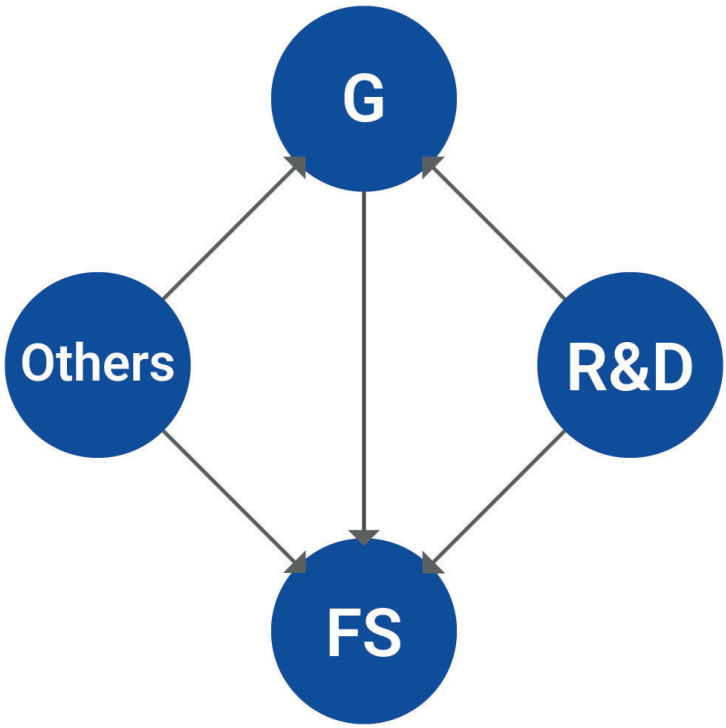
The Indirect Effect was estimated as the average difference in counterfactual outcomes due to changes in the mediator. *The Direct Effect* was estimated as the average difference in counterfactual outcomes when the mediator is held constant. *The Total Effect* was estimated as the combined difference in outcomes across treatment scenarios.

4.4. Construction of Confidence Intervals

The confidence intervals for the effects (DE, IE, TE) and the proportion-mediated (PM) effects were derived from the empirical distribution of bootstrap estimates. All in all, the nonparametric bootstrap process we followed aimed to minimize parametric assumptions, allowing for robust inference even in cases of nonnormality or heteroscedasticity in the data.

Figure 1 illustrates the primary causal assumptions underlying our model. As shown, we posit that R&D expenditure influences financial stability through both direct and indirect pathways, with the indirect effects being mediated by total government expenditure. The remaining variables serve as controls and are considered potential confounders of not only the mediation process but also, as indicated in the outcome equation, of R&D itself as well.

Figure 1. Direct and Indirect Effects of R&D on Financial Stability



Note: Our main causal assumptions are embedded in Figure 1; each variable is a node in the plot, while the arrows represent the direction of the causal assumption.

Before estimation, all variables were standardized by removing their means and dividing by their standard deviations. This transformation allowed us to estimate a beta coefficient model, facilitating the interpretation of the results despite the heterogeneous measurement units of the original variables.

5. Results

The results of the outcome model, mediator model, and causal mediation analysis are summarized in Table 2. The findings reveal several important insights into the relationship between public spending and financial stability. First, the direct effect of R&D expenditure on financial stability is found to be positive and statistically significant at the 95% confidence level. Specifically, a one-standard-deviation increase in R&D expenditure is associated with a 0.07-standard-deviation decrease in the financial stress index. This suggests that higher R&D investment contributes positively to financial stability, potentially by fostering innovation and economic growth.

However, the indirect effects of R&D expenditure, as mediated through total public expenditure, present a contrasting picture. These indirect effects are also statistically significant at the 95% confidence level but have the opposite sign, amounting to 0.08-standard-deviation increase in the financial stress index. This finding indicates that the increase in total government expenditure, which may follow increased R&D spending, may dampen the positive impact of R&D on financial stability. The increase in public expenditure could introduce inefficiencies or fiscal pressures that negate some of the benefits of R&D investment (both public and private).

When considering the total causal effect, which incorporates both the direct and indirect pathways, the results suggest that the overall effect is not statistically significant (p-value = 0.39). This implies that while R&D investment has a positive direct effect on financial stability, the counteracting indirect effect through total public expenditure reduces the overall significance of the causal relationship.

In summary, these findings highlight the complexity of the impacts of fiscal policy on financial stability, suggesting that while targeted investment in R&D can foster stability, broader increases in government spending might dilute these benefits. Moreover, the results shown in Table 2 carry important implications for how public and private spending on R&D is linked to financial stability. They emphasize, for example, the necessity of considering both the direct and indirect effects of R&D government expenditure. While an increase in R&D spending can directly enhance financial stability, its benefits may be diminished if such an increase is not accompanied by reductions in other areas of public expenditure.

Table 2. Summary of Main Results

Panel A: Outcome Model of Financial Stress

	Effect	Std. Error	T- statistic	P-value
R&D Expenditure	-0.0659	0.0373	-1.7670	0.0775
Government Expenditure	0.1827	0.0421	4.3360	0.0000
Growth	0.0088	0.0460	0.1920	0.8476
Real Exchange Rate Growth	-0.0769	0.0451	-1.7040	0.0887
Stock Market (vol)	0.0565	0.0313	1.8020	0.0719
FX Market (vol)	0.0227	0.0316	0.7170	0.4735
Reserves	-0.0438	0.0358	-1.2240	0.2212
F-Statistic	6.64			
P-value	<.001			

Panel B: Mediator Model of Government Expenditure

	Effect	Std. Error	T- statistic	P-value
R&D Expenditure	0.4628	0.0238	19.4600	<.001
Growth	-0.2065	0.0338	-6.1040	<.001
Real Exchange Rate Growth	0.1053	0.0336	3.1320	<.001
Stock Market (vol)	0.0425	0.0234	1.8130	0.07
FX Market (vol)	-0.0854	0.0235	-3.6290	<.001
Reserves	-0.4214	0.0233	-18.1040	<.001
F-Statistic	144.8			
P-value	<.001			

Panel C: Causal Mediation Analysis

	Estimate	Lower CI	Upper CI	P-value
Average Causal Mediation Effect	0.0845	0.0496	0.1200	<0.001
Average Direct Effect	-0.0659	-0.1204	0.0000	0.0420
Total Effect	0.0187	-0.0243	0.0800	0.3940
Proportion Mediated	4.5291	-35.5325	37.3700	0.3940
Sample Used	1012			
Simulations	1000			

Note: The result of our causal mediation analysis using the end-of-the-year version of the FSI index.

Alternatively, increases in private R&D expenditure could lead to greater financial stability while maintaining constant total government expenditure. Specifically, if government spending as a share of GDP increases without adjustments in other budgetary categories, the resulting fiscal expansion could undermine financial stability. This is due to the broader negative effects of increasing total government expenditure on the financial system. Focusing solely on the direct effect would overestimate the positive impact of public R&D spending on financial stability and could lead to misguided policy recommendations.

For R&D spending to be truly effective in promoting financial stability, it needs to be integrated into a comprehensive fiscal policy that balances investment in innovation with control over other areas of government spending. Reductions should be made in nonproductive or inefficient components of the public budget, which may not contribute to long-term economic health and could, in fact, exacerbate financial instability. The challenge lies in ensuring that fiscal policies foster growth in key sectors, such as R&D, while maintaining overall fiscal discipline.

The results highlight the importance of managing public finances in a way that supports both immediate investments in R&D and broader economic stability. If R&D spending is viewed in isolation, without considering the wider fiscal context, then its potential to improve financial stability may be limited. A more effective approach would involve using public expenditure on R&D as part of a strategic fiscal framework that includes careful management of total government spending. By doing so, it is possible to ensure that public investment in R&D can achieve its full potential, supporting financial stability and contributing to sustainable macroeconomic development. In summary, an increase in R&D expenditure is expected to enhance financial resilience only if total government expenditure remains constant.

Moreover, our results highlight the critical role of private R&D investment, which, in principle, can contribute to both conditions necessary for generating financial stability improvements through innovation: 1) it can increase total R&D expenditure, and 2) it can do so while keeping total government expenditure constant. This perspective emphasizes the importance of industrial policies that do not directly dictate the sectors and products in which a country should specialize but instead prioritize public-private partnerships that encourage private investment in innovation. These policies provide government support for industries chosen by the market, thereby fostering innovation and enhancing financial stability.

5.1. Robustness

In Table 3, we present the results of our causal mediation analysis, substituting the end-of-year version of the Financial Stress Index (used in Table 2) with the average-based version (PROM). As shown, this change does not alter our conclusions. In fact, with this version of the index, the significance of the variables in both equations increases, and the overall causal effect in the mediation analysis is more clearly identified.

Table 3. Summary of Main Results

Panel A: Outcome Model of Financial Stress

	Effect	Std. Error	T- statistic	P-value
R&D Expenditure	-0.0986	0.0363	-2.7200	<.001
Government Expenditure	0.1922	0.0410	4.6900	<.001
Growth	-0.2455	0.0448	-5.4860	<.001
Real Exchange Rate Growth	0.0456	0.0439	1.0380	0.2995
Stock Market (vol)	0.0392	0.0305	1.2870	0.1984
FX Marklet (vol)	0.0255	0.0308	0.8280	0.4077
Reserves	-0.0440	0.0348	-1.2630	0.2068
F-Statistic	6.64			
P-value	<.001			

Panel B: Mediator Model of Government Expenditure

	Effect	Std. Error	T- statistic	P-value
R&D Expenditure	0.4628	0.0238	19.4600	<.001
Growth	-0.2065	0.0338	-6.1040	<.001
Real Exchange Rate Growth	0.1053	0.0336	3.1320	<.001
Stock Market (vol)	0.0425	0.0234	1.8130	0.07
FX Market (vol)	-0.0854	0.0235	-3.6290	<.001
Reserves	-0.4214	0.0233	-18.1040	<.001
F-Statistic	144.8			
P-value	<.001			

Panel C: Causal Mediation Analysis

	Estimate	Lower CI	Upper CI	P-value
Average Causal Mediation Effect	0.0889	0.0514	0.1300	<0.001
Average Direct Effect	-0.0986	-0.1565	-0.0300	0.0080
Total Effect	-0.0097	-0.0523	0.0500	0.7540
Proportion Mediated	-9.1847	-64.3791	84.2200	0.7540
Sample Used	1012			
Simulations	1000			

Note: The result of our causal mediation analysis using the end-of-the-year version of the FSI index.

6. Conclusions and Policy Implications

This study examines the relationship between a country's level of investment in R&D and financial stability, providing important insights for policymakers involved in fiscal management. Our findings indicate that while R&D spending has a direct and significant positive effect on financial stability, this benefit can be diminished by the broader fiscal impact of increased government expenditure. Specifically, the indirect effects of higher public spending—because of increased R&D investment—can introduce inefficiencies and fiscal pressures that counteract some of the positive impacts of R&D. Therefore, the benefits of R&D spending for financial stability are largely dependent on the overall fiscal context.

The results emphasize the need for a balanced approach to fiscal policy, particularly regarding the allocation of public resources. Increasing public R&D investment alone is insufficient to guarantee financial stability. Instead, it must be part of a strategic fiscal framework that carefully manages total government expenditure. If R&D spending is not offset by reductions in other, less productive areas, then the advantages of increased innovation could be undermined by escalating overall public debt. Consequently, maintaining fiscal discipline remains essential to preserving financial stability in the face of increased public investment.

There are two equally valid ways to read our results. On the one hand, policymakers should focus on reallocating public resources to prioritize R&D while keeping total government spending in check. This requires a thorough reassessment of public spending, redirecting funds away from less effective or nonproductive areas toward those with greater potential for long-term economic growth and stability, such as innovation. R&D investments can drive economic progress, improve productivity, and enhance long-term resilience, all of which is crucial for enduring economic stability.

On the other hand, private R&D investment emerges as a key mechanism for harnessing the stabilizing effects of R&D and innovation while keeping government expenditure under control. Therefore, our results highlight the importance of industrial and other policies that focus on incentivizing increases in private R&D spending rather than directly increasing public R&D, which could risk expanding total government expenditure.

Overall, the results highlight the importance of expenditure-neutral fiscal policies. Increasing R&D spending without accompanying reductions in other areas can exacerbate fiscal imbalances and undermine financial stability. Policymakers must create a fiscal framework in which R&D investments are part of a broader strategy that ensures fiscal responsibility. This approach involves setting clear fiscal targets and reallocating public resources toward productive investments while minimizing inefficient spending, or alternatively, focusing government support in accompanying private initiatives rather than as a substitute for them.

For R&D spending to have a sustained impact on economic stability, it must be incorporated within a comprehensive fiscal strategy that balances short-term fiscal concerns with long-term economic goals. Governments should undertake reforms that increase the prominence of R&D in general, fostering innovation without compromising overall fiscal health. By doing so, they can encourage economic growth and strengthen their fiscal capacity to handle future challenges.

In summary, our findings suggest that the effectiveness of R&D investment in promoting financial stability depends on maintaining fiscal discipline. To maximize the potential of R&D to drive economic growth and improve stability, it should be part of a carefully managed public spending framework. This approach aims to ensure that innovation is supported while keeping government finances sustainable, leading to long-term economic health and resilience.

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Appendix A

We gathered annual data from 2000 to 2023 on public R&D spending and financial stability indicators, along with several confounding factors identified in related studies. While there are various interpretations of what constitutes financial stability and how it should be measured, we adopted the conventional approach, which defines financial stability in terms of the characteristics of episodes of financial instability and views it as a state in which such episodes are unlikely to occur (Allen and Wood, 2006).

We examined a total of 21 different financial stability indicators, which have been widely used in both the academic literature and the everyday work of financial supervisors and practitioners. Unfortunately, several of these indicators were found to have significant issues with missing values, both over time and across countries.

In Figure A1, we show the analysis by country, highlighting the missing values, whereas Figure A2 presents the analysis by year. As illustrated, the number of missing values is also notably high in this case. However, the data quality for the indicators DEC_FSI, PROM_FSI, DEC_FCI, and PROM_FCI is considerably better, both across countries and over time, compared to the other indicators are.

Some missing patterns are also evident for the variables of public spending and public spending on R&D, as shown in Figures A3 and A4. Specifically, as shown in Figure A3, the original dataset contains numerous missing values, with some countries having no data in any of the R&D categories. The most complete variable is total government expenditure. Figure A4 reveals that for three of the five variables measuring total government expenditure in R&D, the data quality is poor, with nearly all values missing for the years prior to 2014 and in 2023.

On the basis of the joint analysis of Figures A1 to A4, we focus on four variables—DEC_FSI, PROM_FSI, Gross-RD_spend_GDP, and public_total_spend_GDP—and select a total of 44 countries with at least 70% observation rate for each of these four variables.\

Using the restricted subset of 44 countries, we repeated the analysis of the missing patterns for the key response and treatment variables in our study. The results are presented in Figures A5 and A6. On the basis of the new figures, we decided to focus on a sample period that excludes the year 2023. The missing data patterns for these variables, analyzed by country, are detailed in Figure A7. Notably, certain countries—such as Tunisia, Peru, Paraguay, and Guatemala—have up to seven years of missing data out of a total of 23 years. This issue is limited to the Government Expenditure in R&D variable. After excluding the year 2023 and focusing on the 44 countries with better data quality, we found that 4.07% of missing values in the four key variables presented in Figure A7 were missing.

Figure A1: Missing Patterns of Financial Stability Indicators by Country

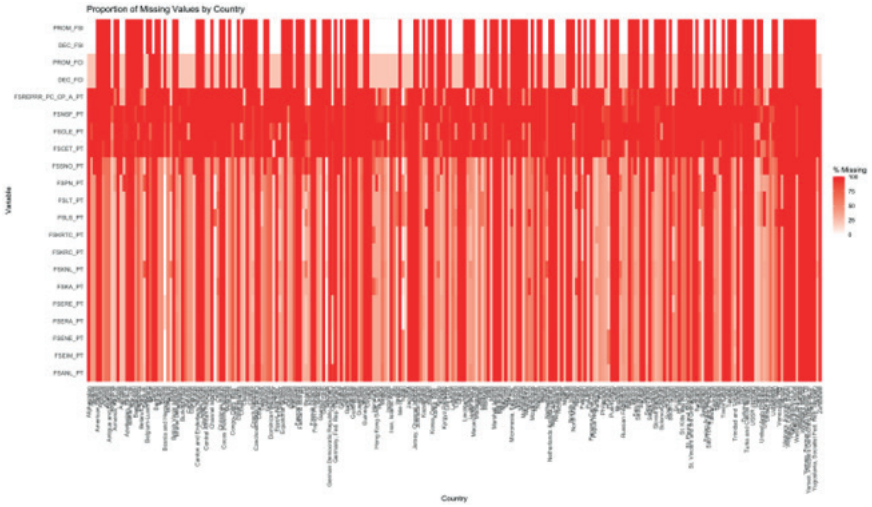


Figure A2: Missing Patterns of Financial Stability Indicators by Year

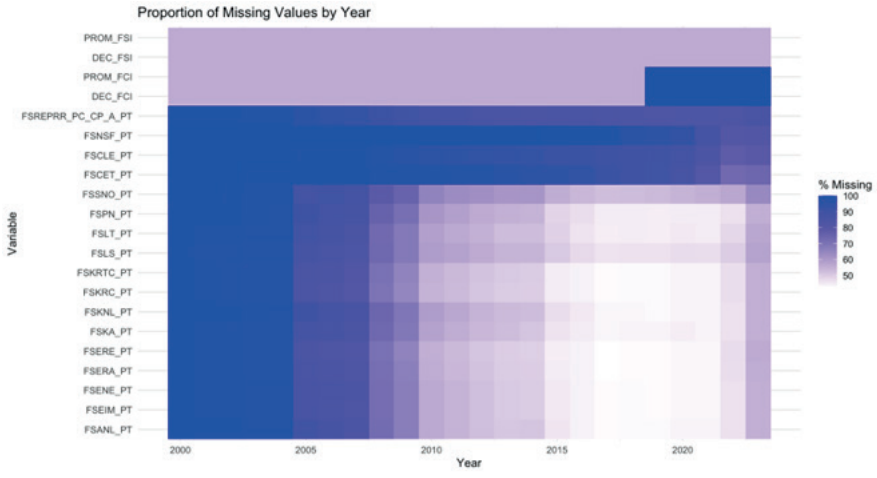


Figure A3: Missing Patterns of R&D Expenditure Variables by Country

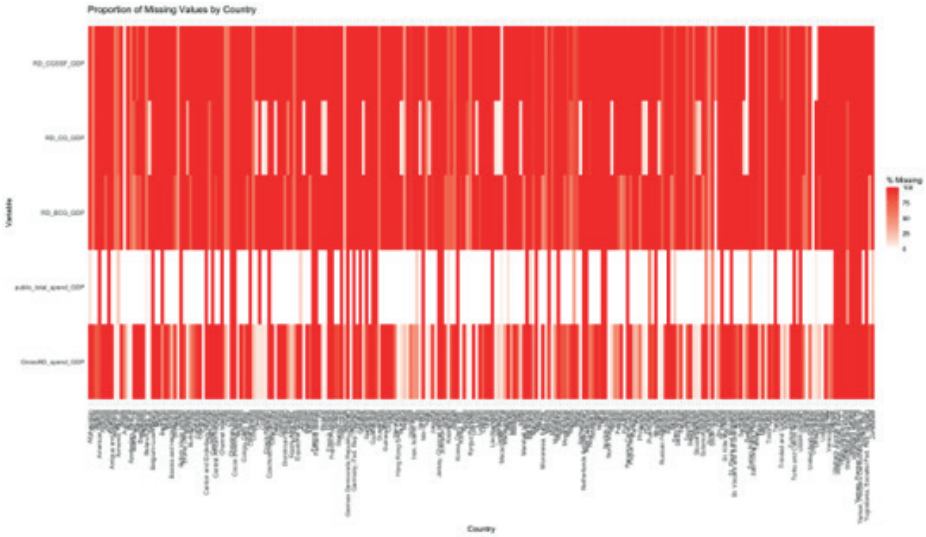


Figure A4: Missing Patterns of Financial Stability Indicators by Year

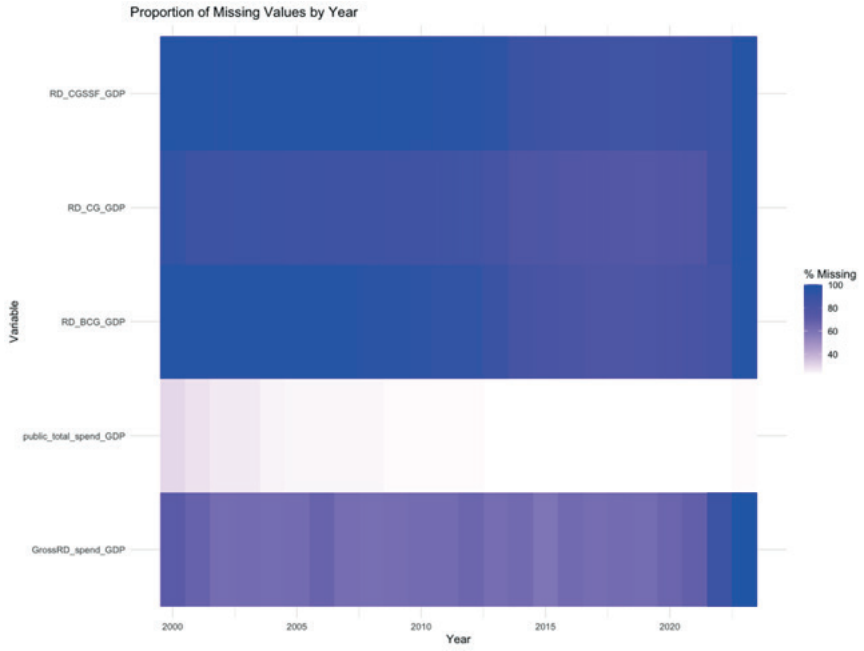


Figure A5: Missing Patterns of Key Variables by Country in Our Restricted Sample

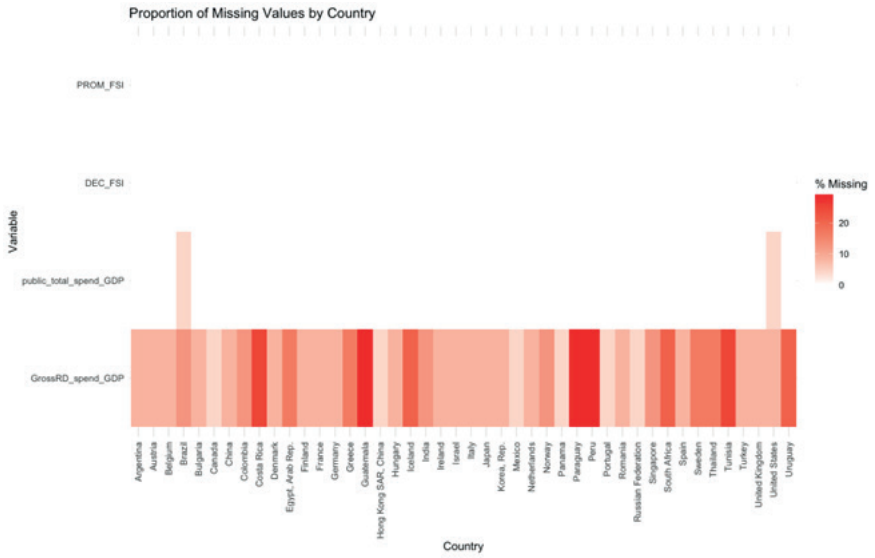


Figure A6: Missing Patterns of Key Variables by Year in Our Restricted Sample

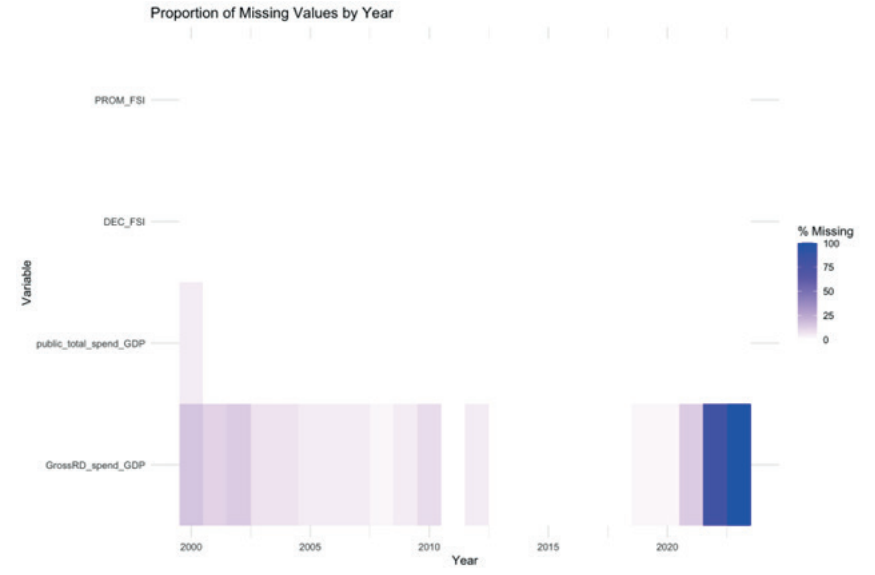
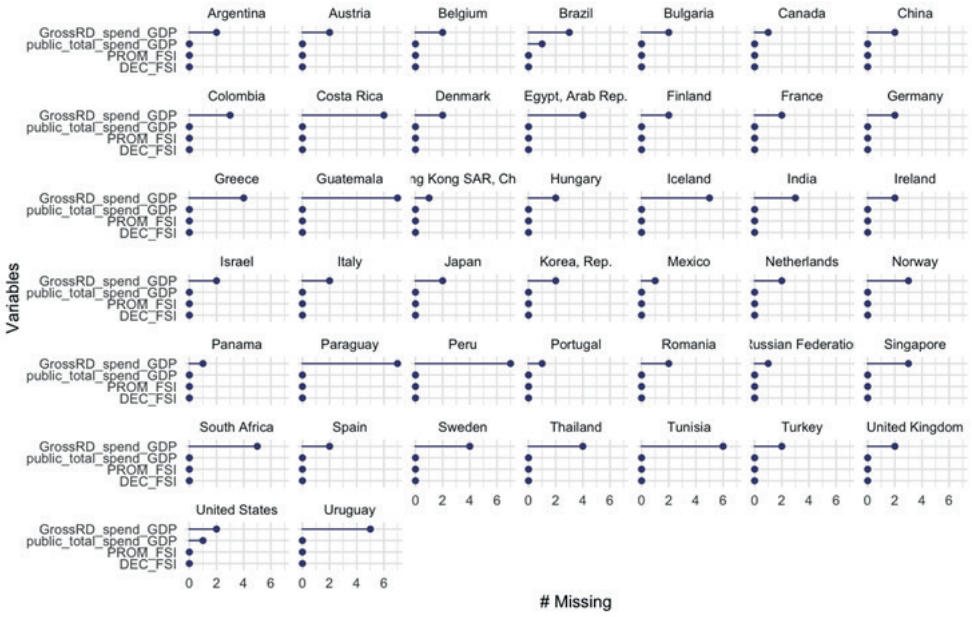


Figure A7: Missing Values of the Four Key Variables by Country



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