PART I

A Complexity Approach to Sustainable Development

I   Introduction

I.I   MOTIVATION FOR THIS BOOK

"*A priority not reflected in the budget is pure demagogy*". This saying has gained popularity in the past decade among economists, political analysts, and mainstream media outlets in Mexico.[1] This expression reflects not only the political and economic circumstances of a particular country but fits the reality of budgetary decisions made by many governments worldwide. Examples of these practices abound, either for populist reasons or for lacking knowledge of how budgetary decisions affect the economy's performance. When incoherent spending plans emerge in democratic societies, they tend to elicit a strong negative response from opposition parties or society at large. Unfortunately, budgetary proposals of this sort are not rare, so countries and their societies have to endure disappointing results down the road.

Today, it is not difficult to find cases of societal dissatisfaction with a government's budgetary proposal. For instance, in recent years, a government in the UK collapsed in less than 50 days due to a disastrous budgetary proposal. The so-called mini-budget, as termed by the media, did not sit well with a large sector of the population, financial markets, and international organisations since it lacked a sound commitment to achieve a set of promised goals (BBC News, 2022). In another case, the minister for agriculture of India promised in 2021 to raise the target of agricultural credits. Yet, when presenting the national budget, the potential beneficiaries did not perceive any

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[1] The phrase stems from an older aphorism commonly used in the Mexican political parlance between the 1960s and 1990s: *A friendship not registered in the payroll is pure demagogy*. This phrase was popularised by the satirical writer Carlos Monsiváis. Both versions refer to the asymmetry between stated intentions and real financial commitments.

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real intent to improve their livelihoods. Protest leader Kirankumar Visa declared: "Forget about the targets […] There is not even one measure to either raise farmers' income or generate jobs" (Bhardwaj, 2021).

While expenditure dissatisfaction may not always be a society-wide movement, specific sectors – often represented by lobbying groups – frequently attempt to reflect their agenda in the government's budgetary allocation. For example, in early 2022, the South African Federation of Trade Unions (with 800,000 members) mobilised protests in Pretoria with the aim of affecting the national budget. Its general secretary, Zwelinzima Vavi, demanded the government not only a set of policies to hike workers' income but also to commit more resources to service delivery, schools, hospitals and police stations (Business Tech, 2022). Thus, there was a clear request to modify policy priorities through government expenditure across a large set of issues.

Perhaps, when writing this book, the most mediatic example of social protest to modify governments' priorities is the Just Stop Oil movement. These protests have taken place in several European countries and became highly visible in mainstream media due to polemic actions such as defacing world-renowned paintings and clos-ing motorways. Independently of whether this movement is right or wrong, their motivation has a clear budgetary target: eliminating subsidies and tax breaks for new fossil fuel extraction (Lu, 2022). Thus, these movements justify their actions by the need to make their voice heard against demagogic politicians claiming that climate change is a high priority when, in fact, they do not tackle this issue in their national budgets.

Like these examples, we can find similar others around the world, in both rich and poor countries, and across different develop-ment issues. Overall, they commonly exhibit three related features. First, they have a set of (development) goals in mind. Often, these are goals expressed by the government in official documents or campaign promises that a large societal sector agrees upon. Second, there are

specific actions by the government to achieve those goals, often materialised in terms of a budget. Protests like the ones mentioned above emerge when these expenditure actions do not seem conducive to the goals broadly agreed upon. Thus, there is a perception of policy incoherence as the state's priorities are not reflected in the budget. Third, as a response to this incoherence, lobbying groups exert pressure on governments to align their stated priorities with the budget and, sometimes, push their own agendas into the governments' priorities. That being said, different societal actors can read, from government budgets, how seriously committed a government is to achieving its development goals or campaign promises. However, such reading is not always straightforward.

While priorities on big issues such as climate change and agricultural subventions may be easily identifiable by stakeholders and the media, there exist many other development dimensions where such identification is not possible if they do not receive enough media attention. For instance, budgets (or a large part of them) may not be disclosed truthfully by governments; expenditure data may be too aggregate to make a clear connection between the expenditure and specific policy issues; certain policy interventions are inherently more expensive, which is not always easy to observe from just looking at data; expenditure patterns may carry an inertial or historical component that does not reflect the current government's priorities; and there may be fiscal, political, and bureaucratic rigidities limiting the flexibility and scope with which a government can reallocate resources. Moreover, the opacity in government expenditure data has been historically a political tool for governments attempting to obfuscate their true priorities, as unclear data limit society's auditing capabilities.

Nevertheless, in the last decades, there has been a shift towards fiscal transparency, at least in democratic societies. With the aim of making budgetary data more accessible, multiple international initiatives have emerged to strengthen the growing 'Open Government' agenda. Hence, today, we can find large

repositories of open-spending data for national and subnational governments, with various degrees of quality and resolution. Despite these remarkable efforts, the challenge of understanding policy prioritisation remains daunting since it is not just about reading true intentions through budgets but also about how such expenditure translates into development. Thus, budgetary transparency is only the first step towards a bigger challenge: *understanding the expenditure–development relationship*. This inquiry is precisely our motivation for elaborating an analytic computational framework, applying it to answer diverse questions related to sustainable development, and writing this book.

1.2   cutting-edge methods for challenging goals

Let us switch from the expenditure side to the development end. Here, we can say that efforts to quantify societal progress predate and are more notorious than the advances in fiscal transparency. Nowadays, many development indicators support evidence-based policymaking on specific issues. Historically, different communities of consultants and academics use specific indicators, in isolation from each other, according to their domain of expertise. In the last decades, however, the development community has shifted towards integrating several domains into a multidimensional and complexity perspective. The leading initiative is the United Nations 2030 Agenda of the Sustainable Development Goals (SDGs), which has catalysed the construction of more development indicators across a broader spectrum of policy issues (e.g., poverty, inequality, social inclusion, environmental sustainability, and public governance). Several academics and consultants have jumped into the SDG bandwagon, giving place to numerous studies analysing interrelationships between SDGs.

While these efforts have been instrumental in shifting the overall discussion of development towards a systemic framework, they remain disconnected from budgets and, hence, from policy prioritisation. That is so because they tend to focus on the 'output' side of the

expenditure–development relationship. Without understanding the role of government spending (the input), insights derived exclusively from indicator-based studies are somehow limited, especially when advising governments on the prioritisation of development issues. One would imagine that understanding the expenditure–development link more explicitly and the policy prioritisation process would be a primary task in an agenda that seeks to persuade governments to commit to budgetary actions in the pursuit of global goals. Unfortunately, this is not yet the case, at least not when it comes down to quantitative frameworks that operate in large multidimensional settings.

From our experience, we have come to realise that there is a lack of analytic tools to address policy prioritisation (from a systemic point of view). Because of that, efforts in promoting data transparency seem wasted. In general, governments do not get serious about promoting policy evaluations for measuring the impact of budgetary allocations on development outcomes. More specifically, there are five popular practices among governments and consultants that, in our opinion, need to be addressed to make substantial progress in policy coherence.

First, the process through which governments arrive at their development strategies (reflected in documents such as development plans, agendas to promote industrial transformation, and campaign platforms) tends to be, at best, *ad hoc* and, in the worst cases, completely arbitrary. Second, even if development plans result from legitimate democratic or professionalised processes such as national consultations and diagnostic frameworks, the data indicate that budgets rarely reflect the declared priorities. Third, traditional evaluation tools do not address systemic problems. In particular, studies employing techniques such as micro-econometrics and field experiments need to be extremely narrow to produce causal statements with the available data. Fourth, even with good data, conventional studies do not consider the myriad political-economy factors that mediate the expenditure–development relationship (such as inefficiencies and corruption). Not accounting for the political economy precludes an

accurate mapping between budgets and outcomes. Fifth, to make things even more difficult, such political-economy mediation often takes place at various scales (micro, meso, macro), so the use of aggregate data in regression analyses is insufficient to provide convincing advice.

Oddly, when we started this research programme, mainstream economists and political scientists in academia did not seem interested in tackling these issues. In development economics, a social norm, where the gold standard was to perform micro-level studies of causal impacts, had emerged. In political science, the most relevant research used aggregate expenditure data to estimate the distribution of budgetary changes. Unfortunately, the latter studies showed no intention of establishing a connection with the outcomes generated by expenditure changes. Overall, a systemic focus seemed to be irrelevant in the minds of conventional analysts, as if complications associated with inadequate policy prioritisation did not exist. For us, the data, the published research, the methods employed, the proposed solutions, and the policy practices indicated quite the opposite.[2]

Outside economics and political science, different research communities have long been interested in problems related to a systemic view of development. However, they did not usually share the right combination of tools and theories. For example, development studies journals started publishing some analyses using network metrics and complexity ideas, but their usual readership lacked the skills to properly embrace cutting-edge ideas coming from network and complexity sciences. In contrast sustainability scholars and network scientists were already investigating networks

[2] As scholars, we are aware that it is common to observe conformity with dominant ideas and a tendency to dismiss proposals attempting to defy the status quo. For example, complexity economics has been subjected to such dismissals for more than three decades (Arthur, 2021). Nevertheless, today, many ideas and methods stemming from this community have transformed practices in key economic affairs such as financial regulation (through the measurement of systemic risk), industrial strategy (by better understanding firm dynamics), and international trade (by quantifying the economic sophistication of nations).

of SDGs using state-of-the-art methods but without incorporating the critical expenditure–development connection, or its political-economy elements. Other fields that have historically focused on systems thinking (such as system dynamics) were also studying SDGs but their tools could only work at the macro level, missing causal mechanisms involving the political-economy process.

Both of us had worked for some time in the intersection between economics and complexity science. Hence, we were familiar with the methodological gaps between intriguing problems raised by social scientists and their unawareness of cutting-edge methods. Thus, it became clear that, if we wanted to push the boundaries of understanding the expenditure–development link, we had to take on some of these challenges and formulate a new analytical framework that would combine ideas and methods from various disciplines. Importantly, due to the urgency of providing well-grounded advice for closing the development gaps of the 2030 Agenda, any proposal would have to be empirically usable, easy to scale, and flexible enough to accommodate budgetary data with different levels of granularity. Furthermore, our framework would need to become a contributing factor in the capacity-building of policymakers and their analysts.

1.3 THE 'POLICY PRIORITY INFERENCE' RESEARCH PROGRAMME

In 2018, and in collaboration with Florian Juárez-Chávez, we published a paper entitled "*How do governments determine policy priorities? Studying development strategies through spillover networks*" (Castañeda et al., 2018). This work was our first attempt to discern the expenditure–development relationship from a systemic point of view. There, we opted for a computational approach because it allowed us to explicitly model some critical political-economy mechanisms that mediate the expenditure–development link while, at the same time, allowing us to work in a multidimensional setting. On the empirical front, we discarded using statistical methods, such as regression analysis and machine learning, since they were inadequate when

working with many development indicators (perhaps hundreds) and relatively short time series of development indicators.

Accordingly, we had to develop a framework in which a theoretically rich computational model would supplement the lack of data. This approach would allow us to generate synthetic series that preserved essential features of the empirical data, bypassing the need for gigantic development datasets and enabling scalability. The lack of disaggregated budgetary information for many countries meant that we had to model how a government allocated resources in a system where bureaucrats mediated their use and where development indicators impacted each other through spillovers. For this reason, precisely, we decided to refer to our research programme as 'Policy Priority Inference' (PPI).

Following this paper, we kept enriching our model, accessing new datasets, developing better calibration methods, and tackling more specific empirical challenges such as quantifying policy resilience (Castañeda and Guerrero, 2018), measuring policy coherence (Guerrero and Castañeda, 2021b), and estimating the effectiveness of the rule of law (Guerrero and Castañeda, 2021a). While starting as a typical research programme within the boundaries of academia, it suddenly turned into an ambitious agenda with policy implications. This take-off occurred when members of the Bureau for Latin America & the Caribbean of the United Nations Development Programme (UNDP) read our first publication and invited us to their New York offices to give a workshop. Around the same time that we were working on our first PPI paper, the United Nations had given the UNDP the mandate of coordinating much of the activities related to the 2030 Agenda. Such coordination involved facilitating analytic tools that governments could use to inform policy prioritisation towards the SDGs. Thus, our initial work seemed relevant to the UNDP's new tasks.

We quickly realised that the need for new analytic frameworks was more pressing than we originally had imagined. It was clear, from these interactions, that the models and empirical methods provided,

at that time, by economists and other communities were insufficient, as the SDGs suddenly shifted the discussions to the domain of complex systems. Our adoption of a non-conventional approach implied that we had many methodological challenges ahead, conceptual, technical, and data-related. The evolution of PPI resulted from cross-fertilisation between our academic work and our engagement in policy projects. In collaboration with the UNDP, we conducted more than ten projects where we had to adapt PPI to address highly specific empirical questions that local and national governments wanted to address.

Recurrent questions inspired by real policy problems created the need to make more realistic assumptions, which is not straightforward with more conventional frameworks. Some examples of these assumptions include the differentiation between indicators where a government has relevant intervention programmes and where it does not; allowing for fiscal rigidities that limit the government's ability to reallocate funds; enabling systemic impacts for the identification of development accelerators; and incorporating the substitutability between private and public (internal and external) sources of funding to produce advances in different development issues. Many of these elements were absent in the scholarly literature, at least in the quantitative one, so it was up to us to push the frontiers and propose ways to account for them.

During this exciting process, we received the support of different institutions that complemented the efforts of the UNDP. The Alan Turing Institute (Omar's home institution) provided, all along this process, financial means and other resources; the United Kingdom's Engineering and Physical Sciences Research Council and Economic and Social Research Council funded various parts of this research; the National Laboratory of Public Policy, at the Centre for the Research and Teaching of Economics (CIDE, Gonzalo's home institution), organised workshops with public servants, which were helpful to inform, validate, and socialise PPI; the Mexican National Council of Science and Technology funded, in part, Gonzalo's