Research Article

Thresholds Are Everywhere:
A Systems Approach to Public Policy

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Abstract

The analysis of public policies often fails to account for effects beyond mere cost-benefit analysis. Incorporating elements from the literature on system dynamics, complexity and legitimacy, the present paper develops a framework to understand long-term effects and important constraints for public policies. We call it the thresholds framework, considering the existence of different thresholds in the life of a policy. The framework relies on the application of conceptual lenses to understand essential aspects of the social reality. Using the proposed conceptual repertoire, the paper applies the framework to a specific policy, the Brazilian Worker Food Program (WFP), which currently benefits around 20 million employees working for 250,000 companies in Brazil. The thresholds framework incorporates legitimacy and complexity issues and it is sufficiently flexible for the pursuit of different strategies of inquiry. It may be used to guide the design of business programs in dynamic contexts, such as the ones found in modern social cause environments.

Keywords: public policy; system dynamics; complexity science; legitimacy; worker food programs.

Introduction

After analyzing recent decades of American foreign policy, Monat and Ganon (2017) concluded that it lacks systems thinking, thus producing a stream of shortsighted policies with unintended, dire consequences, such as the rise of ISIS and other terrorist groups. In the same vein, Morecroft (2015) stresses that event-oriented thinking very often leads to public policies that target symptoms instead of root causes. Such issues are not new. Public policies in different contexts often show the hallmarks of poor design and linear thinking (Dodgson, Hughes, Foster, & Metcalfed, 2011; Lee et al., 2017; Magro & Wilson, 2013; Stroh, 2015). Examples of inefficacious policies include the building of new roads to alleviate traffic congestion, the war on drugs in America, the interventions to tackle the skyrocketing obesity epidemic, and the zero tolerance policies on forest fires (Buchanan, 2000; Ludwig & Rogoff, 2018; Morecroft, 2015; Sterman, 2000).

In fact, notwithstanding systems science's long academic history, there seems to be slow progress towards the incorporation of its major tenets into the repertoire of managers and state agents. Societies as a whole – and actors in the public policy ecosystem in particular – often fail to understand the systemic causes of complex social problems. The typical response tends to produce superficial and inefficacious policies, which frequently exacerbate the root causes of the problems (Sterman, 2000).

As the list of problems faced by modern societies and organizations keeps growing, there is a clear need for better policies. In this paper, using a conceptual repertoire drawn from the literature on system dynamics, complexity science and legitimacy, we present a framework with the goal of addressing that gap. Thus, the research question springs from the perceived need to cope with the systemic complexity in the policy space faced by organizations and governments. Specifically, we use the case of the Brazilian Worker Food Program (hereafter referred to as WFP) to illustrate the framework's contribution to the analysis of public policies. In other words, we aim to offer a systemic framework, using a real and relevant case, which can be used to analyze or produce better policies (Stroh, 2015), especially in complex systems. We believe this framework is sufficiently flexible to allow for the pursuit of different strategies of inquiry.

The paper is organized as follows. We begin by presenting the thresholds framework and outlining the methodology used in the study. Next, we apply the framework to the WFP, while presenting the context, characteristics and history of similar programs throughout the world. We conclude by discussing the results under the light of the proposed framework, acknowledging limitations and making suggestions for future studies.

Thresholds Framework

All public policies have a life cycle. The thresholds framework considers the relevance of thresholds in determining transitions of phase (i.e., growing, maturing and declining) during the life cycle of a public policy. Those thresholds involve both the physical aspects of a policy, such

as the number of people reached in the different stages of implementation, and the symbolic aspects, such as legitimacy support for the policy. While in this paper we rely on system dynamics as the quantitative grammar of the framework, the elements drawn from complexity science are treated as conceptual lenses, in a qualitative fashion, with the goal of increasing the discernment of a policy's effects. To enhance the comprehensiveness of the framework, we incorporate elements usually associated with complexity science, namely power laws, networks and evolving ecosystems. Finally, we draw on legitimacy literature to understand how public policies make headway and on what basis challenges to their existence may arise over time. Therefore, as the thresholds are the backbone of our proposed framework (Figure 1), we follow with the three theoretical bodies: system dynamics, complexity science, and legitimacy.
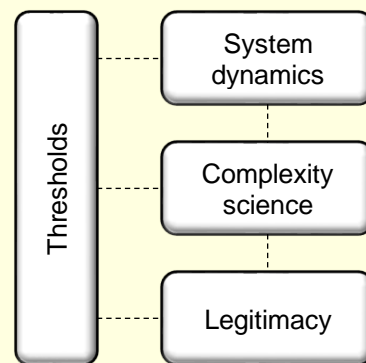

Figure 1. Thresholds framework

Elements from system dynamics

System dynamics is a simulation method pioneered by Forrester (1961) and further described in works by Sterman (2000) and Ford (2010). It focuses on understanding the structures in a system that dynamically produce certain behavioral patterns. The method is especially suited for modeling complex social systems, where several actors interact under the influence of factors playing out over a long time horizon.

System dynamics propitiates a 10,000 meters view of the system, portraying its structures and policies in an aggregate manner. A staple tool in the repertoire of the field is the use of causal loop diagrams (CLDs), which illustrate the causal interrelationships among the different variables producing the phenomenon under analysis. This simulation method is essential to understanding dynamic complexity as commented by Ford (2010):

> Climate change, pandemics, and boom and bust in real estate are complex dynamics that challenge our understanding. We are unable to anticipate the dynamic consequences of policies adopted today, especially when there are long delays between our actions and the system's reactions. Our understanding is also limited by the complexity of the feedback processes that control system behavior. Our actions may be partially erased by the system's internal responses, and the system's apparent resistance to our interventions is confusing. Sorting out the effects of delays and multiple feedbacks is beyond our cognitive abilities, so we look to the past for lessons. But how are we to interpret past patterns in climate change, pandemics and boom-and-bust cycles? Our understanding of the dynamics of historical patterns is limited

by the same complexities that make it difficult to think about the future. There are many interpretations of past behavior, and we are left with limited understanding of both past trends and current problems (p. xi).

From system dynamics literature, the major characteristics of social phenomena associated with public policies are endogeneity, delays, nonlinearities, and path dependence. Considering that many policies are ineffective or sub-optimal, we draw on the system archetypes stream from the same literature.

Endogeneity

The hallmark of system dynamics is its endogeneity viewpoint (Richardson, 1999). In this view, there is no simple, unidirectional relationship between variables, but usually a set of feedback loops linking all the variables together. Hence, the exogeneity that is part of common sense analysis is misleading. All variables are meshed in dynamical, reciprocal causal interrelationships. In this view, the dynamics of all systems arise from their internal structure. Self-reinforcing and balancing feedback loops define how the system behaves over time. Random perturbations, in turn, can be amplified by the system's feedback structure, creating different patterns in space and time. As Richardson (1999) puts it,

> The concepts of feedback and circular causality are essential to reliable policy analysis. Experience with dynamic, nonlinear models of feedback systems repeatedly shows that failure to take account of existing feedback effects in the analysis of a policy initiative can cause exactly the wrong conclusions to be reached. More subtly, information feedback can be used to explain the observed tendency of social systems to be 'policy resistant', to react more weakly and more perversely to policy shifts than some experts predict (p. 4).

Policy resistance is indeed a major characteristic of complex social systems, which is often ignored in the analysis of public policies. Thus, while accounting for first-order effects, there is a need to ponder the n-order effects that play out over a longer time span, as the agents in the system adapt to and respond to the interventions.

Delays

Not only do many problems take a long time horizon to manifest, but also the effects of public policies often are different as time unfolds. As an example of the former case, at the time of writing, Brazil has been facing a scorpion infestation that took two decades to unfold (Carvalho, 2019). The typical example of counterintuitive long-term effects of policies is road building to alleviate traffic congestion, in particular beltways that circle big cities, which produce improvements in the short term, only to lead to more vehicles on the roads over time (Morecroft, 2015; Sterman, 2000).

Thus, delays are a major hallmark of interventions in complex systems. The root causes of a complex problem, Stroh (2015) asserts, can be found in the many interdependent and often delayed relationships among the system's parts. Indeed, as hinted above, delays are a major reason behind the failure of usual policies. First, because all interventions produce consequences beyond

the first-order effects their sponsors expect, as social agents try to adapt and resist the policies (Arthur, 2014; Sterman, 2000). Second, because the n-order effects usually take time to play out and are unanticipated. Thus, policies often produce misleading positive results in the short term (Sterman, 2000). Moreover, even when they go in the right direction, policies usually require a long-time horizon to manifest their results as material (e.g., financial resources, people) and immaterial stocks (e.g., reputation, brand image) slowly accumulate.

As a rule, the more units of time are accounted for in the analysis of a policy, the better.

Nonlinearities

Effects of policies are rarely proportional to cause (Sterman, 2012). In social systems, the interactions weaving together the different variables are typically nonlinear. For instance, the effect of the additional numbers of circulating cars on traffic ranges from mild to extreme, which means that, at some critical tipping point or threshold, adding a few cars to the streets is the recipe for monumental gridlocks. Nonlinearities thus define the existence of thresholds or tipping points in social phenomena. Worker satisfaction, sales of new products, economic development, support for political candidates, consumers' tolerance limits (Agénor, Canuto, & Jelenic, 2012; De Langue, Puntoni, & Larrick, 2017), all have clear thresholds that influence the performance of the respective systems.

Path dependence

Sterman (2000) defines path dependence as "a pattern of behavior in which the ultimate equilibrium depends on the initial conditions and random shocks occurring as the system evolves" (p. 350). In any system, decisions change the state of the world, causing further changes in the system and triggering other social actors to act. The new situation constrains the path for following courses of action. Thus, choosing a path often leads to irreversible consequences that practically seal the fate of the system, making it history-dependent. Many actions are hardly reversible: during the cold war, the great powers produced more than 250 tons of plutonium for use in weapons, an element whose half-life is about 24,000 years (Sterman, 2000).

Most policies suffer from inertia. In fact, Banerjee and Duflo (2012) refer to the triad ignorance-inertia-ideology as the major plague affecting public policies. From a practical perspective, we should look at the history of a policy, the ecosystem it creates, and the constraints emerging from the combination of inertia, embedded rules and the capabilities created by the prevailing networks of social agents.

Archetypes

Many public policies fail in predictable ways. We draw on the so-called system archetypes literature within the system dynamics field to illustrate how fitting a policy under analysis to one of the major archetypes may help in the identification of critical factors of success or failure.

Senge (1990) helped in the popularization of the concept of system archetypes, while Braun (2002) provides a helpful guide in the management context. As Senge (1990) stresses, if feedback and delays are the nouns and verbs of systems thinking, system archetypes are similar to simple stories that get retold again and again in different contexts. They are underlying generic structures that reveal the source of many management and policy problems.

It is hard to find a public policy that do not exemplify a systems archetype. Even in the case of success, the dynamics generated by a policy will inevitably match an archetype, such as limits to growth or growth and underinvestment. Often, a systems audit shows that policies once deemed successful are producing inefficacious results or simply worsening the actual problems.

Table 1 presents common system archetypes along with their basic definition and examples in the context of public policy.

Table 1

System archetypes

Archetype	Basic definition	Example
Limits to growth	All processes of growth will inevitably face barriers as the limit of the system is approached.	Environmental limits to economic growth.
Shifting the burden	Preference for symptomatic solutions that block the development of fundamental remedies.	Restrictions to the circulation of vehicles (road space rationing) versus congestion charges.
Eroding goals	Downward adjustment of goals in the face of degrading performance.	Pressure to lower the goals for educational policies.
Escalation	Escalation of threats between two parties.	Competition for market share between health providers.
Success to the successful	Good performance is rewarded with more resources, allowing one party to continue performing better than the underserved competitor.	Educational vouchers.
Tragedy of the commons	Depletion of common pool of resources as different groups compete to achieve their particular goals.	Depletion in fish stocks.
Fixes that fail	Preference for symptomatic solution that worsen the fundamental problem producing unintended consequences.	Building more roads to alleviate traffic congestion.
Seeking the wrong goal	A goal is established because it is easier to achieve or measure.	Incapacitating terrorists instead of addressing the root causes, such as poverty, corruption and despair.
Growth and underinvestment	Good performance followed by reluctance to invest in organizational capabilities.	Mismanagement of investments in the public health sector.
Accidental adversaries	A partnership that turns into bitter contentiousness.	Relationship between public and private organizations in health care settings.
Attractiveness principle	The existence of multiple barriers to growth, some more attractive to address than others.	Public agencies trying to address a barrier while neglecting other interdependent barriers.

Note. Source: Adapted from Braun, W. (2002). *The system archetypes*. Retrieved from https://www.albany.edu/faculty/gpr/PAD724/724WebArticles/sys_archetypes.pdf, Monat, J. P., & Gannon, T. F. (2017). Failures of systems thinking in U. S. foreign policy. *American Journal of Systems Science*, *5*(1), 1-12, and Senge, P. M. (1990). *The fifth discipline: The art and practice of the learning organization*. New York, NY: Doubleday.

Elements from complexity science

The literature on complexity science has been flourishing in recent years (M. Mitchell, 2009) notwithstanding the diverging definitions about what a complex system is. Perhaps the most concise definition is the one provided by Thurner, Hanel, and Klimek (2018), stating that complex systems are co-evolving multilayer networks. Indeed, networks comprise the core of most popular definitions, along with the concepts of emergence, adaptation and self-organization (M. Mitchell, 2009). Evidently, many public policies do not fit the complexity profile. Many are simple interventions whose effects do not ripple beyond their specific contexts or do not create unexpected consequences. However, in the most important contexts of modern life, these policies seem to be the exception rather than the norm. From this literature, we highlight the concepts of power laws, networks and evolving ecosystems.

Power laws

Technically, a power law is a relationship between variables so that one of them is a function of the other raised to some fixed power, such as $y = x^2$ (Miller, 2015). Power laws are ubiquitous in natural and social systems. The Pareto distribution – the idea that roughly 80% of a phenomenon depends on 20% of the agents or causes – is probably the most known example of a power law (Thurner, Hanel, & Klimek, 2018). We are interested in one major consequence of power laws: concentration of resources, problems or success in few social actors or cases. Some examples discussed in Buchanan (2000), Miller (2015) and M. Mitchell (2009) help in making the point, since all exhibit the similar profiles of concentration: number of deaths by wars in human history, distribution of size of cities or corporations, frequency of use of words in texts, scientific citations by academics, and magnitude of earthquakes. Therefore, thresholds arise naturally when a policy reaches the most accessible segments of a population, creating an often-unintended concentration.

Networks

Margaret Thatcher once said, "They are casting their problems at society. And, you know, there's no such thing as society. There are individual men and women and there are families" (Margaret Thatcher Foundation, 1987). Contrary to that assertion, which exemplifies a popular view, virtually all social phenomena comprise the existence of networks of agents organized in nodes and hubs (M. Mitchell, 2009). Like the varying number of friends per person, some nodes have few connections while others are densely connected – the hubs. The latter are major conduits for the flow in activities or information in networks (M. Mitchell, 2009).

Public policies may draw on existing networks, such as anti-tobacco organizations that help in the effort to curb cigarette consumption, or they may induce the development of new ones, such as when a policy stimulates the development of a social ecosystem for recycling. The importance of adopting network lenses resides in acknowledging the capacity of networks to store knowledge and know-how (Hidalgo, 2015) as well their potential for continuous restructuration (Thurner et

al., 2018). They can achieve much more than isolated social actors, and they are essential in the process of spreading information.

We are interested in identifying which existent or potential networks may be present in the social ecosystem under analysis. Depending on the case, it may be important also to estimate their relative power. For instance, in the case of highly contentious social issues, such as tobacco consumption or fossil fuel-induced climate change, the power of business networks often leads to distortions in the design of public policies. Hence, it may be of interest the identification of supporting and opposing networks in the social ecosystem under analysis.

Evolving ecosystems

A major tenet of complexity science is the existence of systems that evolve and adapt. In fact, we can conceive society as an agglomeration of constantly evolving social ecosystems, comprised by networks of actors in constant interaction, based on institutions, norms and broader cultural patterns. The evolution is often driven by macro forces such as technology, science and cultural trends.

Changes are increasingly faster. For instance, Wilensky and Rand (2015) assert that,

> In the current day, the world we live in has become increasingly complex, in part because, in earlier periods of history, we did not have to pay attention to complex interactions, we could get by with understanding simples systems and local effects. Yet, as technology and science have advanced, we have become more affected by complex interactions. We are now aware that changes to the rain forest in Brazil can have dramatic effects on the climate of faraway countries, that unwise financial decisions in one country can have significant economic impact on the rest of the world (p. 5).

In turn, social processes that drive change are evolutionary, path-dependent, out-of-equilibrium and context-dependent (Thurner et al., 2018). Consequently, social systems are in continuous change even when they appear to be still. Changes often do not lead to adequate adaptation. Indeed, one major force within social systems is the proneness to entropy or drift to lower performance. Worsening performance may arise out of exploitation of the system by its agents (Arthur, 2014) or by processes of decision forged under false premises of predictability and linear thinking (Forrester, 1971; Sterman, 2000).

For the purposes of our framework, we recommend sketching the history of social ecosystems under analysis and understanding what macro forces may be driving the course of events, including, as discussed above, inertia and traditional macro forces (i.e., economy, culture, technology, science, nature, and sociopolitical trends).

Elements from legitimacy literature

Finally, the third arm of the thresholds framework is legitimacy. The evaluation of public policies, typically focused on effectiveness, efficiency and performance issues, often ignores the essential aspect of legitimacy – good policies often fail by inadequate management of this dimension (Wallner, 2008). Legitimacy is the generalized assumption that the actions of an entity are desirable or appropriate within a socially constructed system of beliefs, values and norms. It is crucial for social agents (e.g., organizations) and social artifacts, such as public policies. It fosters credibility, which is essential to garner support and social resources, including symbolic ones (Suchman, 1995).

Regarding legitimacy, we can conceive two typical thresholds in the life of a public policy: in the beginning, when there is need to acquire legitimacy, and during its life course, when different threats may erode support for the policy. The management of legitimacy around both thresholds may be tricky, involving adequate engagement of existent and potentially salient stakeholders, manipulation of symbols, and the crafting of narratives that resonate with stakeholders and the broader public (Du & Vieira, 2012; Wallner, 2008).

Indeed, changes in macro environmental forces tend to challenge the legitimacy of public policies. As pointed previously, the broader environment where public policies exist is constantly changing, as cultural, technological and other forces shape and reshape its constraints and affordances. As the velocity of such changes seem to be accelerating, many speak of a VUCA world – volatile, uncertain, complex, and ambiguous (Millar, Groth, & Mahon, 2018). This new world where unknown unknowns are the rule (Thurner et al., 2018) challenges the capabilities of private and public organizations, in particular their dynamic capabilities of learning and adapting. Therefore, legitimacy of public policies, once taken for granted, may erode if not actively managed.

Perceived efficacy seems to be key to sustain a policy's legitimacy. New institutional developments, such as new alternatives to evaluate a policy cost-effectiveness, may nibble at what Suchman (1995) call pragmatic legitimacy – the policy's expected value for a particular set of stakeholders. This may be particularly true when often-ignored opportunity costs are pitted against traditional evaluations of a policy's effectiveness. On the other hand, moral legitimacy – the perception that a policy is fair, good and right (Suchman, 1995) – may suffer when a typical paradox arises in the context of public policies: the public wants better services or benefits, but the government pushes for lower costs and greater efficiency (Sonpar, Pazzaglia, & Kornijenko, 2010). Ironically, the previous existence of stakeholders who benefit from current status quo may provide legitimacy to cost-ineffective policies, while also hindering the development of more adequate policies.

Summary of research questions

The research questions enabled by the thresholds framework and the possible strategies of inquiry are presented in Table 2. The list of questions and suggested methods is non-exhaustive, as the

referenced literature is broad and multifaceted. While we have previously defended the idea that system dynamics is the most suited method to use with the framework, we acknowledge possible contributions from the other methods indicated in Table 2. The framework should be read as a set of conceptual lenses that help in seeing systemic and complexity features of a given problem, policy or social ecosystem.

Table 2

Research questions and strategies of inquiry

Element of the framework	Implied questions	Suggested methods or strategies of inquiry
Endogeneity	What are the interrelationships (feedback loops) among variables involved in the problem? What are the sources of policy resistance?	
Delays	What effects occur in the short and in the long run? Are there different effects over time?	
Nonlinearities	What thresholds exist in the system? What kind of nonlinear relationships exist in the system?	
Path dependence	What are the defining events that shaped the history of the system? What are the major constraints?	System dynamics Agent-based modelling
System archetypes	Which system archetype best fits the problem or the policy under analysis?	Network analysis Systems mapping
Power law	What kind or degree of concentration exists in the system? What are the barriers to lower the concentration?	Grounded theory Ethnography
Networks	What are the important networks in the system? Who are the opposing and supporting groups?	Case studies
Evolving ecosystems	What forces drive the changes in the particular social ecosystem under analysis? Is inertia a particular concern? What threats and opportunities arise over time?	
Legitimacy	Are there legitimacy concerns involving the policy? What are the thresholds in legitimacy (i.e., in the processes of gaining, maintaining or losing it) present?	

Applying the thresholds framework to the Brazilian WFP

There has been a long tradition of research on the topic of food programs and their effects, including the British Food Stamp Program (Hoynes & Schanzenbach, 2012; Landers, 2007), school meal programs (Afridi, 2010; Gleason, 2010) and even behavioral consequences of meals (R. J. Mitchell & Bates, 2011). Most studies adopt a nutritional or public health perspective (e.g., Veloso & Santana, 2002). We did not find any study employing a systems perspective, so a case in this context seemed a good candidate for applying our framework. Thus, we employ the thresholds framework to analyze the Brazilian WFP. Next, we provide context for the diverse worker food programs created in the second half of the last century, while also discussing the specifics of the Brazilian case.

Worker food programs and specifics of the Brazilian case

Worker food programs have a long history. The first country to create such a program was the United Kingdom during the Second World War. France, Belgium and Italy soon followed the Britannic lead (Mazzon et al., 2016). The WFP in Brazil – in Portuguese, Programa de Alimentação do Trabalhador (PAT) – was created by law in 1976 (Lei n. 6.321, 1976) and thereafter other Latin American countries followed the Brazilian pioneer initiative. Similar to in other countries, the main goal inspiring the WFP was the improvement of the nutritional status of Brazilian workers, at that time a hindrance to improve productivity in the country. Undernutrition and malnutrition were the rule among the working force. In the context of work, undernutrition and malnutrition can lead to accidents and productivity losses (Wanjek, 2005). Colares (2005) reports a study with sugar cane cutters showing increases in productivity (52%) and reduction in absenteeism (38%) as a consequence of a WFP-like program running for five years. Work accidents, in turn, are more than a matter of simple, direct economic costs. Not only do work accidents represent a loss of productivity for firms, but they also increase social security costs and can disrupt familiar structures, especially when they result in death (R. J. Mitchell & Bates, 2011). Low-income workers, with salaries ranging from one to five times the minimum wage, have been the main target since the inception of the program, comprising 85% of current beneficiaries (Mazzon et al., 2016).

Overall, WFPs throughout the world have undergone some changes regarding their structure and operational mechanisms (Colares, 2005). Nevertheless, they usually share the same goals: reduction in work accidents, increase in workers' productivity and promotion of well-being and better quality of life (Wanjek, 2005).

The networks that integrate Brazilian WFP's social ecosystem comprise government agencies, businesses, workers and their unions, and the diverse set of companies and agents that integrate complementary economic sectors. The latter includes businesses from the agro-industrial sector, restaurants, brokers, firms that manage vouchers, companies offering consulting services, etc.

A WFP-like program has attractive benefits for companies willing to provide better meals and nutrition to workers. It has also short and long-term benefits for economic sectors, such as restaurants, the food industry and the other actors that operate in the economic ecosystem. However, the generation of positive multiplicative effects from a WFP program requires some necessary conditions. First, governments must create an adequate conceptual and legal framework. Calibrated incentives and adequate coordination make possible the first transition of state – it works like a metaphorical ladder that invites the economic actors to start climbing. The most common design of WFPs shares the costs of the program among three networks of social actors: companies offering the benefit, their employees, and government.

Governments create the legal infrastructure for a WFP. They typically institute regulations that attribute legal status to the benefits. In a WFP, the benefit does not share the same status of regular salaries. This means that benefits are exempt from social security or income taxes. On the

other hand, workers share some of the costs, usually limited to a small fraction of their salaries, while businesses share the remaining costs.

In most countries, governments offer tax incentives to attract companies to the system, which means, in practice, the public sector also shoulders part of the costs, while receiving taxes generated by the program through its multiplicative effects on the economy (Mazzon et al., 2016; Wanjek, 2005). This structure is important insofar as it creates path dependence and inertia. The rules tend to be difficult to change; at the same time, constraints from strained public budgets have been preventing the offering of new tax incentives to attract small businesses to the program.

Overall, the programs in different countries have been successful. They usually decrease problems of inadequate nutrition among workers, providing them and their families with access to better and varied food. By reducing sickness and work accidents, the programs also decrease costs in the public health system. By increasing productivity at work, they generate economic gains to participant firms. Finally, by generating network effects through positive multipliers, they induce the growth and development of related economic sectors, increasing the collection of taxes over time. The effects are widespread. For instance, a study in Portugal showed that WFPs could help to distribute income in society, considering that the price of meals is proportionally higher for lower income workers. By providing meals and food vouchers, WFPs represent an actual increase in their budgets (Vassalo, 2012). Thus, the history of social ecosystems created by worker food programs typically presents several benefits spreading through different channels.

Understanding the effects through a system dynamics model

The Brazilian WFP puts in motion a complex web of effects that spreads through different sectors, creating a virtuous cycle. Firms provide better nutrition to workers, leading to increases in worker satisfaction and productivity, improved capital-work relationships, and better occupational health (i.e., lower incidence of diseases, reduction in absenteeism, and less work accidents). The federal government incurs in less costs compensating victims of work accidents. Moreover, tax incentives lead, though multipliers, to increased tax revenue over time. The expansion of economic activity in the food, meals and agribusiness sectors increases tax revenues and jobs, and stimulates the sophistication of those industries. Nevertheless, the effects are not immediate. There is a delay before entrepreneurs perceive an increase in demand for meals, for instance. Similarly, it takes time in the food and other industries to perceive a need to expand their capacity. In practice, such delays can amount to years.

Based on the general scheme displayed in Figure 2 for a WFP that accounts for the existence of delays and multipliers, we created a system dynamics model to represent the main effects of the Brazilian WFP over a time horizon of 50 years, starting in 1976, the year when the program was created. Whenever available, we used data from official sources, such as the average tax burden. Otherwise, we adopted conservative estimates. The model can be obtained from the authors.
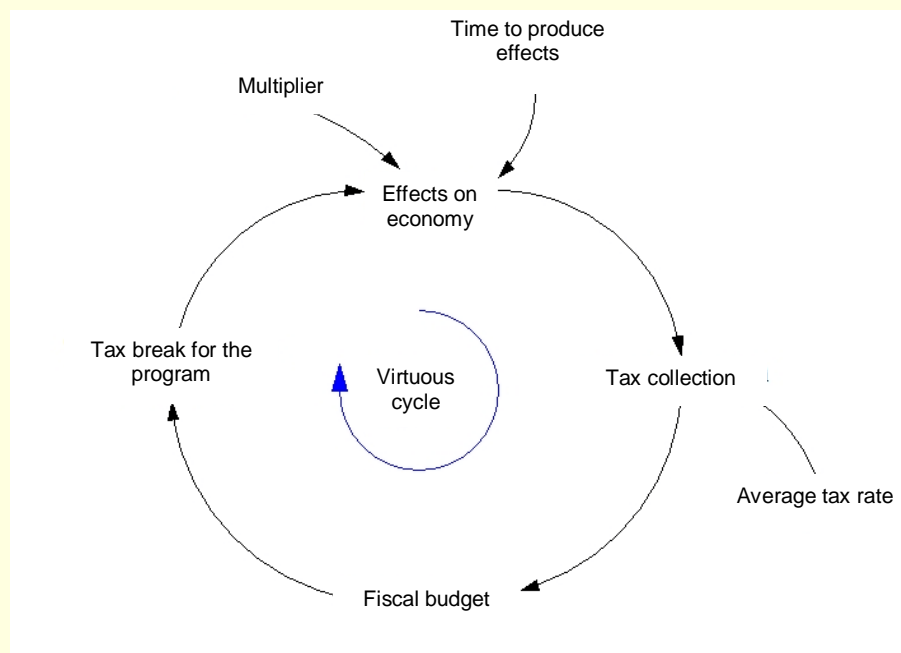
Figure 2. General scheme of a worker food program

As stated before, a major feedback loop drives the dynamics illustrated by the model. The endogeneity in the program is directly linked to taxes. Tax breaks incentivize companies to join the WFP, setting in motion several multiplier effects in the economy, which, in turn, generate new tax revenues, thus closing the cycle. Hence, the main trade-off made in the program, from a public policy perspective, is the concession of tax incentives versus the possibility of future tax revenues. Such revenues take time to manifest, especially due to delays associated with the development of new businesses in the WFP ecosystem. Another important aspect is the nonlinearity in adoption rates. They depend on the level of tax breaks, knowledge of the rules, normative pressure (e.g., perception that similar companies are doing the same) and the easiness in enrolling and complying. Similarly, it takes some years, in practice, to potential entrepreneurs realize unaddressed demands in the meals market and invest in new restaurants. The trade-off may elicit opposition to the program based on its short-term foregone taxes (in the initial years) or represent a temptation to public executives to cut tax incentives in times of constrained fiscal budgets.

Thus, regarding delays, it is important to emphasize that any governmental program offering tax incentives faces a temporal trade-off when it has positive multipliers. Losses in the short-term and gains in long-term characterize the trade-off. The size of the multiplier and the delays involved in the production of effects may make the introduction of such program sensitive to budget constraints and political pressures.

Figure 3 shows the simulation for 50 years. It depicts accumulated numbers for tax breaks and tax revenues generated by the program. It is worth noting in the simulated series that the breakeven point takes about seven years to occur. After that point, however, the accumulated

increase in tax revenues grows at a steeper rate. The payback in taxes is equivalent to $7 for each $1 invested by government (through tax incentives).
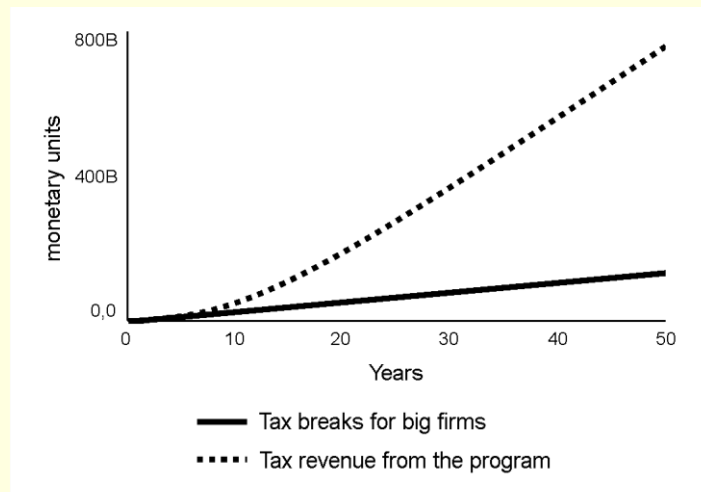

Figure 3. Simulated results for the Brazilian WFP: Accumulated tax break and accumulated tax revenue

Thresholds appeared clearly in the Brazilian WFP. After a steady expansion since its launch, it exhausted the pool of beneficiaries afforded by the rules (i.e., workers from big firms). Thus, the program fits nicely the limits to growth archetype. More than three decades after creation, the Brazilian WFP has never surpassed a crucial threshold, never reaching the most vulnerable segment represented by employees of small firms. As expected when power laws are present, there is concentration of beneficiaries in a relatively few number of big companies, while the majority of potential beneficiaries work for small businesses.

Nonetheless, the last available data shows that, in December 2015, around 20 million employees (almost 20% of the Brazilian workers), working in more than 250,000 companies, received either meals or other benefit (typically, food vouchers) from companies operating within the program (Ministério do Trabalho, 2016). On the other hand, nearly 80% of Brazilian workers do not benefit from the program, because they are not employed in big firms. In addition, according to the Brazilian statistics bureau (IBGE, 2015), only 40% of private sector workers are in formal job contracts in Brazil. Critically, employees from small companies are typically from lower social classes, have lower educational levels, work more hours and are more prone to work accidents (Mazzon et al., 2016).

The broader point illustrated by the case is that the hardest segments to reach in almost any governmental intervention tend to be the ones where such intervention is more pressing. This seems true for interventions in any field related to development of human capital, particularly education and health. This is also the case of the Brazilian WFP. While it has been successful since its introduction, around four decades ago, it has never surpassed a crucial threshold, failing to reach the most vulnerable segment of employees.

Overcoming Brazilian WFP thresholds: Nonlinearities

The Brazilian WFP led to clear nonlinear effects in the economy. The rationale for the existence of at least two thresholds in these effects is explained as follows. First, an increase in demand for meals produced by a WFP generates the minimum viable demand for new restaurants and service providers as well as the addition of new costumers to existing businesses. Threshold analysis (Deller & Ryan, 1996) suggests that this effect tends to be stronger in middle and small cities where fixed and variable costs are smaller.

Over time, the accelerated expansion in the number of restaurants and meal providers leads to an increase in economic complexity, which, given a certain threshold for scale effects, may transform the associated economic sectors. They become more sophisticated, new services flourish (such as in consulting, development and education) and there is increasing differentiation in the culinary of restaurants, among other consequences. In Brazil, an innovation in the meal industry in the 1980s was the popular pay by weight restaurant – where people choose from a diverse set of plates and pay according to the weight of the food. Sophistication has been accelerating since then. In the city of São Paulo, for instance, there have been increased competition and professionalization among restaurants, creation of undergraduate programs in gastronomy, greater availability of fresh produce and other inputs, and development of human capital (Masano, 2011).

The multiplicative and threshold effects of the WFP are favorable both to providers of inputs (tableware, silverware, food), who also become more sophisticated over time, and to the creation of special services, such as management, nutrition and gastronomy consulting. In turn, new services create positive feedback in the system, inducing the emergence of premium restaurants, new formats for meal provision, and so on. Network effects are depicted in Figure 4.
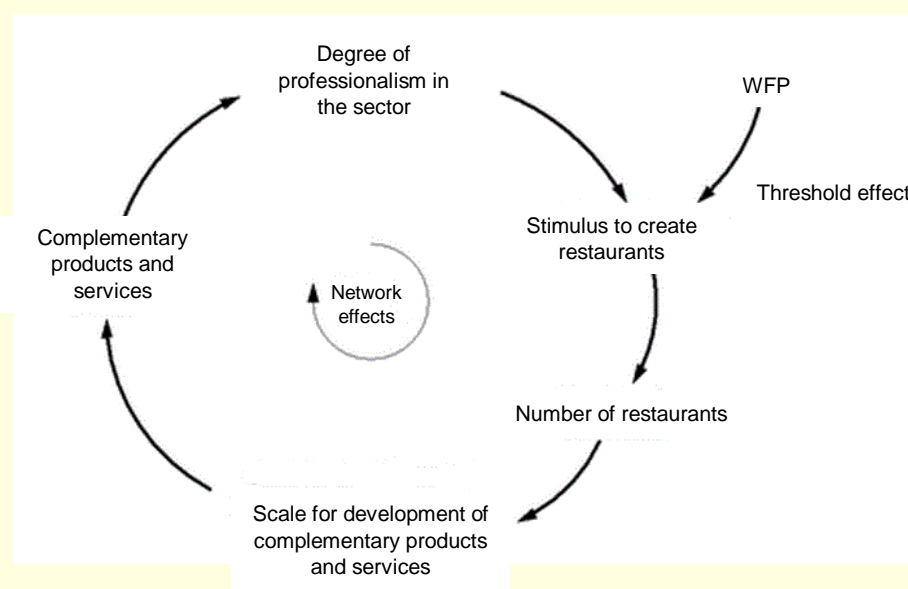

Figure 4. Network effects of a WFP

Threats to legitimacy

A major challenge to the Brazilian program comes from the increase of obesity in the population. In 1975, a staggering percentage of 22.3% of Brazilians suffered from undernutrition (Mazzon, 1981). Only in 2007, Brazil would overcome this health problem. Since then, the numbers of undernutrition in the country have been undetectable (i.e., below 5%). While undernutrition seems no longer a problem, obesity has taken the spotlight. Most recent data shows that 52.5% of Brazilians are overweight, with a corporal mass index (CMI) above 25 Kg/m^2, and 17.9% of the population are obese, with a CMI above 30 Kg/m^2 (Portal Brasil, 2015). According to Cardoso (2015), Brazil is the fifth country in the world in number of obese individuals, and the problem has become epidemic. The costs to the health system have skyrocketed, reaching 2.4% of Brazilian GDP. Like undernutrition in the past, obesity is strongly related to socio-economic status, affecting disproportionately the poor in developing countries (McLaren, 2007).

Hence, while there are several recognized benefits of WFPs, they can become ill adapted when obesity becomes the norm in the social landscape. According to the World Health Organization (WHO, 2018), overweight and obese populations represent more than 1.9 billion adults in the world. This is more than 30% of the world's adult population. Excessive consumption of industrialized food is a serious challenge to many countries, especially considering its effects on the growth of cardiovascular diseases, diabetes, musculoskeletal disorders and cancer. The growth in obesity associated with the virtual elimination of undernutrition thus may pose a serious threat to the legitimacy of WFPs.

The second threat comes from the increased strain in the public budget, which has led to overall resistance to tax incentives in Brazil (Leahy, 2016). Opportunity costs of public policies may also be a rising concern among specialists (Dunn, 2015). Thus, the socioeconomic landscape has changed but the program rules have led to path dependence, as discussed previously. In fact, social programs in general tend to face similar challenges: their rules are stickier than the dynamic reality in which they operate.

Finally, another threat to the legitimacy of the program comes from the belief that giving benefits in cash is better. In monetary terms, a benefit in cash can be even higher than in vouchers, given the elimination of administrative costs (Vassalo, 2012). However, people do not treat money as a fungible resource; instead, at least in industrialized societies, they perform mental accounting to decide how to allocate their expenses (Thaler, 1999). Thus, a benefit in cash would seem to have higher probability of being used to cover other expenses than food, since the elimination of vouchers would blur the boundaries of the (mental) account for meals. Consider that someone necessarily uses a voucher to pay for meals or food. Cash, on the other hand, goes to a general pool of financial resources. It is easier to spend what otherwise would be the price of a meal on another more pressing need or desire. People could then resort to meals of poorer nutritional quality.

Thresholds framework applied to the Brazilian case

Today's VUCA environment requires deeper understanding of the effects of public policies. Systems thinking, and particularly system dynamics, offers a valuable repertoire of tools to help in this endeavor. In this paper, we weave together systems thinking and the literature on complexity and legitimacy to propose the thresholds framework. The application of the proposed framework to the Brazilian WFP is summarized in Table 3.

Table 3

Thresholds framework applied to the Brazilian case

Element of the framework	Concrete manifestation in the case
Endogeneity	Tax incentives attract businesses, creating an entire ecosystem that leads over time to the collection of more taxes, offsetting the initial disbursement. A system dynamics model shows the program generates returns seven times greater than its costs.
Delays	As a typical public policy, it takes time to produce results. Contrary to inefficient policies, in the case of the Brazilian WFP, the short-term effects are not opposite to long-term consequences.
Nonlinearities	Nonlinearities manifest in the existence of network effects, which lead to minimum viable levels for businesses and marked increase in the level of sophistication in the market for meals provision.
Path dependence	Once the policy's rules lead to the creation of an ecosystem, it is difficult to produce radical change. The program depends on tax incentives, which are difficult to increase or even eliminate. At the same time, inertia creates a powerful barrier to adaptation by participants in the different networks associated with the program.
Archetypes	The program fits nicely the Limits to Growth archetype, having failed so far to overcome the barriers that prevent its extension to workers from small businesses.
Power laws	Big firms concentrate the bulk of beneficiaries.
Networks	Networks integrated by government agencies, restaurants, service providers, unions, employers and employees interact, while also developing markets and trying to adapt to threats and opportunities. In practice, all networks have been supporting the program.
Evolving ecosystems	Constantly changing landscapes include the rise of obesity as the number one problem in public health. On the other hand, the ecosystem has evolved in the direction of sophistication and diversification.
Legitimacy	The program was forged on strong legitimacy pillars, but it faces threats inasmuch as it does not tackle the obesity problem and tighter public budgets call into question the opportunity costs of public policies. The alternative of providing cash instead of vouchers may also threaten the structure of the program. In any case, the threshold associated with declining legitimacy may be approached in the absence of proper management.

Conclusion

The paper offers both theoretical and practical contributions. From a theoretical point of view, there has been several attempts at designing systemic frameworks to analyze or produce better policies (Stroh, 2015). However, most frameworks either ignore legitimacy and complexity issues or offer complicated recipes to incorporate systems thinking into the analysis (Cook & Tõnurist, 2016). To our knowledge, the thresholds framework is the first to incorporate both literatures along with more traditional system dynamics tools. By emphasizing the role of conceptual lenses, the framework is sufficiently flexible to allow the pursuit of different strategies of inquiry.

The framework also addresses theoretical and practical gaps that have been surfacing in the management literature, such as the so-called complexity gap and the non-linear nature of modern business challenges (Dekker, 2011; De Langue et al., 2017; Denning, 2013; Zolli & Healy, 2012). It can be used to orient the design of business programs in dynamic contexts, such as the environment of social cause marketing. For instance, responding to a perceived threat of tougher regulation, a growing number of companies are starting to measure the carbon generated by their activities (Aldy & Gianfrate, 2019). Preparing for a warming planet may require developing networks or ecosystems of new suppliers, building or repairing the legitimacy of business activities and avoiding the common traps exemplified by systems archetypes. The framework presented in this paper provides lenses to identify critical thresholds and constraints that often arise in such endeavors.

As for practical contributions, this study includes the propositions of a set of questions that can be helpful in the design of policies (presented in Table 2) and the evaluation of a current program, including the identification of threats and opportunities for expansion. Studies on the effect of worker food programs usually adopt a nutritional or public health perspective (Veloso & Santana, 2002), providing limited guidance to decision makers willing to understand broader social effects. Concerning limitations, the paper does not address the issue of opportunity costs, which is a major concern in the evaluation of public programs. Suggestion for future studies include the application of the framework to other policies or social problems, such as the scorpion infestation in Brazil or the policy of beltway construction in big cities. We also suggest the use of other methodologies, such as agent-based modelling and grounded theory, to illuminate questions not covered in this paper.

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Corrigendum

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