

ESSAYS ON ECONOMIC PLANNING, INFORMATION AND COMPUTERS

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A todos os que dedicaram a sua vida a abrir para o mundo novas possibilidades.

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Introduction

This thesis was born from a need to better understand methods and theories of resource allocation. While spending a significant part of my life studying through courses in the economics curricula, from bachelor's to the PhD, I was taught a lot about markets, general equilibrium theory, game theory, or information economics, but close to nothing about how planned economies work. Except for some general remarks in economic history classes about five-year plans and the impressive rates of Soviet or Chinese GDP growth, it was never clear to me how these systems functioned. This absence of planning from the curricula struck me even more as I gradually realized that the market system does not adequately, or sufficiently, describe the economies of countries such as China, India, the Soviet Union and many African countries during the 20th century, where a vast majority of the world population lived.

To fill this gap, I started to look for works on economic planning and planned economies, having to overcome the lack of recent introductory literature on the topic. My point of departure was the socialist calculation debate, which will be the main topic of Chapter 1. Initiated with von Mises (1920) and later developed with arguments by Hayek (1935, 1937, 1945), this debate focused on the issue of whether a planned economy could 'rationally' allocate resources in the same way a market economy does. That question, after Hayek's writings, quickly turned into a discussion on how market economies deal with information and how planned systems have problems in efficiently using it. Central to the discussion was the notion of Hayek's "knowledge problem". The Austrians argued that economic knowledge is inherently dispersed across all individuals and firms populating the market system. Not only is this knowledge highly dispersed but it is in part tacit – corresponding to information and skills possessed by people. A planner who wishes to create an economic plan for a country cannot possibly use as much knowledge or information, as that mobilized by the market in generating its resource allocation 'plan' (Hayek, 1945). To answer Hayek, neoclassical Marxist authors (Lange, 1936; Dickinson, 1939) argued that 'rational' planning could be achieved through the application of the general equilibrium model, where prices and quantities are determined mathematically rather than through markets, in what became known as the model of market socialism. For Lange, for instance, the planner could mimic the mythological Walrasian auctioneer and adjust prices accordingly whenever demand and supply would be out of balance for any market. Later on, Hayek and other Austrians reassessing the debate (Lavoie, 1985), turned the discussion into the question of efficient discovery of information, incentives and adaptability of the economic system. The main question was not only about whether a one-time solution to the resource allocation problem

would be found, but whether this solution would be practical, in an economic system faced with constant change. Hayek (1968) was not concerned with the static analysis of equilibrium points, but rather with the dynamics. In his view the market system is the best method to generate innovation in the economy, over time, because it creates incentives for people to mobilize their tacit knowledge, in the hope of making profit. These incentives, he believed, would be absent in a planned economy.

While the calculation debate generated a significant amount of literature from the 1920s to the 1940s and later in the 1980s and 1990s, it does not refer to the economic practice of planned economies, except for some sparse remarks about the Soviet Union. However, the debate raises important questions about knowledge and information, which led my research into question such as: were economic planners aware of the arguments raised by Hayek and Austrians, such as the knowledge problem? How did real world planned economies address information problems?

These questions drew me into the study of planned economies, and particularly the Soviet economy, for which there is a considerably larger amount of literature, compared to other planned systems. My research on planned economies is at the origin of chapter 2 of this thesis. A complete understanding of the challenges faced by planned economies in managing information requires an examination of its institutional structure and the historical context from which it emerged. For that reason, the next step was to study how the USSR – the type of planned economy Hayek seemed to be targeting – came into being and set up its economic model.

At the same time that scholars and academics involved in the socialist calculation debate argued on whether an efficient planned economy would be possible, in Russia, the new Bolshevik government was trying to erect a new economic system free from market forces. This process of constructing a new economic system raised different kinds of debates, such as the Soviet industrialization debate (Erlich, 1967) in which questions over what sectors to prioritize in the beginning of the industrialization process were fiercely discussed. After a period of political turmoil, with the revolution, followed by war communism and the need to restore market mechanisms with a New Economic Policy (NEP), the Soviet Union finally entered its central planning phase with approval of the first plan in 1928 (Ellman, 2014). With time, the Soviet planning system will mature into what came to be called the ‘traditional model’ of planning. In broad terms, this model was operationalized with five-year plans, specifying a comprehensive list of quantitative production targets to be achieved – reflecting social goals determined by the ruling communist party (Kornai, 1992). The usual teleological drive of these plans was to bring about a rapid industrialization of the country – deemed a

necessary condition for modernization, but also national survival in a hostile world. With the study of the Soviet case we see thus a system built towards securing practical needs - industrialization and national defense - which contrast with the discussion on rationality debated by scholars of the calculation debate.

Beyond the Soviet Union, various models of planning emerged throughout the world, reflecting different historical and institutional conditions. Yugoslavia, for example, pioneered a different type of model, usually labeled as workers' self-management, or market socialism (Horvat, 2016). In this system the guiding role of authorities was much weaker, compared to the Soviet case, since enterprises - run collectively by employees – could decide on how much to produce and what prices to charge. In such a framework planning meant an exercise in harmonizing the whole system, through the control of investments, regional distribution and monetary policy (ibid). At the same time, in post-war Europe, the so-called 'indicative' planning model was being implemented throughout the continent in countries such as Italy, France, Norway or the Netherlands. France probably represents the most paradigmatic case of this system where the State had a guiding role in industrial macroeconomic strategy without fully replacing market mechanisms (Sapir, 2022). Through what the French call *concertation* – a large communication exercise involving representatives of sectors, industries, workers, government and relevant associations – it was possible to achieve a harmonization of common social goals and reduce uncertainty about the future of the economy (Masse, 1962, 1965). In the southern hemisphere, post-colonial India set up a planned economy aimed at rapid development through import-substitution industrialization, following the Soviet case, but in a context of political democracy and a mixed economy (Menon, 2022). Through planning India hoped to consolidate the State apparatus and inaugurate a different kind of State policy, requiring the involvement of citizens in providing data and demonstrating enthusiasm towards the plan (ibid).

From this general study of how planning came about and what it historically meant in different contexts, my focus turned into information problems in these planned economies, particularly in the Soviet case. While during the first 25 years of the planned economy set up by Stalin it is hard to find a discussion on information problems, after the mid-1950s these issues came to the surface, in the context of reform debates. The analysis of some of the proposals presented in those reform discussions will be the topic of the third chapter.

Although explicit references to Hayek or other Austrian authors by Soviet authors writing in the 1950s and 60s are very rare – perhaps impossible to find - the Soviet Union was aware of how information issues affected the efficiency of its system. Indeed, the Soviet Union provides a particularly rich case study in the intersection of the topics of planning and

information. While the Soviet economy was built on a foundational belief in the possibility of rational economic management through planning, throughout its history, it faced persistent difficulties in collecting and processing the vast amounts of data required for effective social coordination. From the early use of material balances and national income accounting (Ellman, 1973) to the later attempts at automating economic management through projects such as the OGAS (Gerovitch, 2008; Peters, 2016), Soviet policymakers continuously grappled with the challenge of information processing. Solution attempts such as the one led by Viktor Glushkov, in the 1960s, with the OGAS project, aimed to create a nationwide computer network to optimize economic planning through improving communication flows, data gathering and mathematical methods (Glushkov et al., 1964). However, this and similar projects never fully materialized, with explanations for their failure focusing on institutional resistance, technical constraints and an excessive influence of bureaucratic power (Gerovitch, 2008; Peters, 2016; Safronov, 2022). The story of the failure to reform the Soviet economy reflects both the ambitions and the limitations of planned economies of the Soviet type: the ambition to achieve optimal allocation of resources, through a hyper-rationalization of the economy and society, and the reality of bureaucratic and institutional constraints anchoring the system to its foundations (Nove, 1993).

The study of the main theoretical debate on planning and the study of the experience of planned economies - including planning problems in the Soviet Union - led me to formulate the research questions which guided my research in this thesis. The first and main question concerns the importance of information for economic planning and the attempts to address information shortcomings in planned systems – both theoretical and practical. The second is how planning historically emerged and what it meant in different time periods and geographies across the world. The third, more directly connected to the first one is to understand how computers promised to solve information problems in the planned economy and, more generally how they impacted economics in general. These three questions roughly correspond with the three chapters of this thesis, where I review the main literature on these topics and attempt an answer to them in the chapter conclusions.

In chapter 1, I begin from an examination of Hayek's main arguments in the socialist calculation debate and the replies they received, in an attempt to know if - and how - they are still relevant today. After Lange and the market socialists, and the turn of the debate into the question of discovery of information and dynamics, new models of socialism were put forth to face Hayek's challenges (Adaman & Devine, 1996; W. P. Cockshott & Cottrell, 1993, 1997; Devine, 1988; Hahnel, 2021). Some of these models question Hayek's subjective epistemology, arguing that what is relevant for economic planning is objective information

such as the one contained in documents, forms and statistics (Cockshott & Cottrell 1997). With this information at hand planners can formulate economic plans and simulate different outcomes in computer systems allowing for a choice of the policies most suitable for the plan's objectives (Cockshott & Cottrell 1993). Other proposals, such as those of Devine (1988) and Hahnel (2021) propose a type of decentralized planning where there is no planner who has to aggregate information and elaborate a plan based on it. In their models, plans are formulated through a large participation of people at the level of their communities or workplaces (in the case of Hahnel), or in the negotiation processes involving all those affected by an enterprise's activity (in the case of Devine). With these more recent models we see two important underlying ideas. First, that the question of what type of knowledge is important for planning deserves more attention. Historically, planned economies have relied on objective information to formulate their plans. While the question is not whether plans are feasible - but whether they are efficient - Hayek just assumes that in a planned economy there will be no room for individual plans that are intrinsically based on their subjective knowledge¹. Second, while Hayek's argument is target at central planning, decentralized plans, by not having to aggregate information and mobilizing people in their formulation – contributing to knowledge discovery, escape Hayek's critique. Thus, we conclude the chapter by affirming that Hayek's knowledge problem is still central for discussions on economic planning, although not enough to prove that planned systems are, *per se*, inefficient.

Chapter 2 moves the study of planning to practical experiences that emerged throughout the world in the 20th century. It describes in what circumstances the planned systems of the USSR, Yugoslavia, France and India came about and attempts to present a non-exhaustive description of the system in its mature phase, highlighting some particular characteristics for each of these planned economies. It concludes with a reflection on the importance of these historical experiences. Their study shows planning as a method of organizing society that emerged after a difficult period in the history of those countries. Far from being the same system, everywhere, the chapter attempts to present the nuances of planning – by focusing on 4 different models: Central planning; Self-management; Indicative planning; Development planning corresponding to the four countries in analysis. Regarding information, we can see from these planning experiences that planning was since its onset connected with the need to gather data and statistics, at an unprecedented scale and process it in models and calculations.

¹ The existence of *blat* – a Russian word describing a system of informal networks, black markets, corruption and exchange of services – indeed proves that subjective knowledge is mobilized in a planned system. Although *blat* was aimed at private benefit - probably with negative effects on global efficiency - other movements, such as voluntary participation or *Stakhanovism*, also mobilized subjective knowledge, in this case for the goal of increasing global efficiency.

Furthermore, as we see from the French case (Massé, 1965), planning as mechanism for coordinating individuals' future expectations was argued precisely due to the information benefits it provided, by harmonizing the goals of many economic agents.

Chapter 3 moves the discussion on planning to the reform of planned economies through the use of computers, focusing on the Soviet Union as a case study. After discussing the economic problems faced by the Soviet Union (Ellman, 1969, 1973), it discusses the context in which computers appeared in the USSR – associated with the rise of cybernetics (Gerovitch, 2002) – and the first proposals to use computers for economic planning. The chapter presents a literature review of the main narratives for the failure of the OGAS project (Gerovitch, 2008; Leeds, 2016; Peters, 2016), presenting for the first time in English, to my knowledge, the arguments of Safronov (2019, 2020, 2022) published in Russian economic history journals, in Russian language. After that the chapter moves to the analysis of primary sources – the project draft of the OGAS, from 1964, (Glushkov et al., 1964) and the draft for project ASPR – the computer system of Gosplan (Gosplan USSR, 1969) with the goal of presenting more detail on how Soviet cyberneticians and planners projected the application of computers to their planning system. In a final section before the conclusions, the chapter compares the implementation of computers in Western economies with their implementation in the Soviet Union, contributing to the literature on the computerization of economics. It concludes, by tracing parallels and differences between Soviet and Western computerization of economics and reflecting on the role of users in appropriating and shaping the implementation of technological systems, that can be relevant for today's discussions on new technological innovations.

Besides its historical importance, I believe the research done in this thesis can also inform current and future challenges of our societies. Particularly, in light of the recent developments in computer science, big data, and artificial intelligence (AI), interest in economic planning is re-emerging. These technologies are increasingly applied in economic and managerial domains, with today's multinational corporations using algorithms to optimize supply chains and global networks (Phillips & Rozworski, 2019). Inspired by these technological applications some authors suggest that similar computational methods could also be used for public sector or non-profit planning (Cockshott & Cottrell, 1993; Morozov, 2019). Beyond the economic world, contemporary global challenges, such as the COVID-19 pandemic and the climate crisis, highlight the need for coordinated, large-scale economic interventions that go beyond market mechanisms (Durand & Keucheyan, 2024; Sapir, 2022; Groos, 2021). These crises have revived debates on the role of economic planning, as markets alone have struggled to effectively allocate resources in times of emergency and foster an energetic

transition in time to meet climate goals. The study of the variations in models of economic planning reveals that planning is not a rigid, monolithic system but rather a flexible set of tools that can be adapted to different political, economic, and technological challenges. Examining the historical experiences of how different countries historically shaped their societies reveals different methods and solutions and provides valuable lessons for contemporary discussions on state-led economic coordination in the era of AI and big data.

Chapter 1: Is Hayek's knowledge problem still relevant for economic planning?

1. Introduction

In recent years the topic of economic planning is re-flourishing. Current developments in computer science, big data and artificial intelligence, and their application to the economic and managerial domain, have led to a renewed interest in the topic of planning (Boettke & Candela, 2023; Morozov, 2019), as well as to new proposals for non-market methods of resource allocation (P. Cockshott, 2019; Dapprich & Cockshott, 2023; Saros, 2014). The fact that large multinational corporations are already using algorithms to plan their global networks and supply chains, serves as a reference for applying the same methods to non-profit oriented plans (Phillips & Rozworski, 2019). The Covid-19 pandemic, the climate crisis and the consequent need for a swift transition to a green economy, also raise interest in planning as a solution for the failure of market mechanisms to act appropriately in these domains (Groos, 2021; Sapir, 2022). The promotion of democratic planning is a central feature of the eco-socialist current, which advocates the need for a system oriented towards the production of use-values, where production and investment decision are not circumscribed to the owners of capital, but are rather the fruit of a general public debate (Borgnäs et al., 2015; Löwy, 2007). To these recent reasons for interest in planning we can add the hopes of all those who long criticize the organization of society under the whims of market forces and who have been proposing concrete alternatives for a more democratic economic system (Cockshott & Cottrell, 1993; Devine, 1988; Hahnel, 2021; Saros, 2014).

However, economic planning is not a recent matter. It was a central topic in most of 20th century's discussions on economics, politics and development. It left its footprint in the history of economic thought by being the main subject of a theoretical debate between Austrian, Neoclassical and Marxist scholars. The so-called "socialist calculation debate"² centered around the question of whether a planned economy could be as efficient as a market economy. Started in the 1920s, with a paper by von Mises (1920), in reply to earlier writings by O.Neurath (1919) on socialism and the "natural economy"³, it originated a prolific discussion which lasts until today. From the 1930s onwards, the contribution of F.A. Hayek

² In the following pages we will use the terms "socialist calculation debate", "calculation debate" and "planning debate" interchangeably.

³ An economy without the use of money, where calculations would be based on physical quantities, inspired by economic planning done during the first world war.

to the debate centered the discussion on planning around the topics of knowledge and information, which became the foundations of his comparative analysis of different economic systems. In response to Mises and Hayek, who argued for the impossibility/infeasibility of planning, neoclassical Marxist authors proposed the first model of market socialism. This proposal advocated that rational decisions on the allocation of resources within society could be arrived at through solving a general equilibrium model, to obtain equilibrium prices and quantities for goods to be produced. This Walrasian inspired solution, was enough to convince most economists of the theoretical feasibility of planning. Despite some critiques to market socialism by Hayek and others, the discussion settled down, until the 1980s, when D. Lavoie(1985) and other Austrian writers, sought to re-opened the debate, by claiming that market socialists had misinterpreted the original arguments against planning provided by Mises and developed by Hayek. From then on, a new phase of the debate started, which lasts until today, and involves new topics such as AI and environment.

Outside the debate, Hayek's ideas had a significant impact in economic science by being crucial for its turn into information and incentive related issues, with the emergence of the subfields of information economics and mechanism design (Mirowski & Nik-Khah, 2017). Nonetheless, neo-Austrian authors still consider this influence in economics far from satisfactory and maintain that Hayek's arguments are still misunderstood and oversimplified by most neoclassical economists and their models (Boettke, 2018). Beyond the Austrian school, authors such as Hodgson (2019), still argue for the infeasibility of socialist planning on the same basis as Hayek, while others consider that economics could benefit from better appropriating Hayek's insights on market equilibrium (Bowles et al., 2017)

The present paper will focus on the question whether Hayek's arguments are still relevant for economic planning. While planning, to a lesser or greater degree, is ubiquitous in any economy: in firm's plans, consumer plans, government plans, etc.; our main object of inquiry here will be planning at a macro level, in theoretical models which propose plans as the main method for allocation of resources within society⁴. We start, in the following two sections, by revisiting a sample of Hayek's original writings in which the topic of knowledge and its implications for planning are developed. Our main sources for this will be a part of the Hayekian corpus consisting in articles published in the context of the calculation debate (Hayek, 1935, 1937, 1940, 1945) and some posterior texts on competition (1948, 1968), complemented by secondary literature from scholars who engaged with Hayek's work. In

⁴ Thus, we explicitly leave out of our analysis models coming from Information Economics, Mechanism Design; and planning methods adopted throughout the 20th century in socialist and mixed economies. The latter will be the object of Chapter 2 and part of Chapter 3 of this thesis.

Section 4 we look at how proponents of new models of planning interpret Hayek and propose to deal with his knowledge related objections. To that end we analyze a sample of the literature on planning written by economists who propose new concrete models for a planned economy and whose writings directly engage with the calculation debate. Section 5 summarizes the main arguments from the previous sections and develops the argument that decentralized planned systems are able to escape the knowledge problem. Finally, we conclude by elaborating on the relevance of the knowledge problem for the current discussion on planning.

2. Hayek and the Knowledge Problem

It is generally claimed (Boettke, 2018; Caldwell, 1997) that Hayek's ideas on knowledge stem from his engagement in the socialist calculation debate, when elaborating on Mises' argument against the possibility of "rational calculation" in a planned economy. In a nutshell, Mises' (1920) main point is that in a socialist planned economy "calculation" of the amount of goods to produce, and their prices, is impossible, due to the absence of markets for capital goods. Since the socialist government's program implies nationalizing productive forces, market trade for those goods disappears, becoming impossible to know the right prices of capital goods, and – consequently - the correct prices of all other goods in the economy. Without adequate prices, socialists would have no way to properly allocate goods and would only be operating an irrational economic system. This argument, known as the calculation problem, was important for Hayek, who still at times referred to it, but soon started to focus on the role of knowledge in the economy, as the main issue with planned economies.

Hayek's first piece specifically on the role of knowledge in economics was his 1937 paper entitled *Economics and Knowledge*. Aiming his critique at neoclassical economics, Hayek states that propositions of traditional equilibrium analysis can only have meaning for the real world when accompanied with statements about how knowledge is acquired and communicated. The point was that changes in knowledge create disruptions in equilibria, by changing the basis from which individuals take their decisions. For Hayek this basis goes much beyond the knowledge of current prices and price expectations:

"The wider aspect of the problem of knowledge with which I am concerned is the knowledge of the basic fact of how the different commodities can be obtained and used, and under what conditions they are actually obtained and used, that is, the general question of why the subjective data to the different persons correspond to the objective facts." (Hayek, 1937, p.50)

Hayek's notion of knowledge relevant for economics encompasses what he calls, in a later article (1945), the knowledge of local conditions of time and place: a body of unorganized, non-scientific and private knowledge with which each individual has some advantage respective to others. This includes things such as the know-how involved in doing a particular job, the knowledge of people, local conditions and special circumstances - such as knowing how to use local infrastructures of transport and communication, for instance. However, although each individual is endowed with its different unique subjective knowledge, somehow there appears to be a tendency towards an equilibrium and agreement of intentions among all members of society (1937, p.44). But, although we can empirically observe this tendency to equilibrium, for Hayek, we are in the dark about the conditions under which this tendency is supposed to exist and the nature of the process by which individual knowledge changes (ibid.). By 'we' he means economists relying on the traditional theory which, in his view, lacked answers to these questions. For Hayek, neoclassical theory focused too much on the conditions of competitive equilibrium - where it is assumed that the data for different individuals are fully adjusted to each other - and ignores the nature of the process, the dynamics, by which this adjustment occurs (1948, p.362). Precisely, the key point is to explain the dynamics: how knowledge is acquired and how it changes over time. To assume that participants in the market possess complete knowledge of the relevant factors - as is assumed in the theory of perfect competition - is simply to beg the question. Hayek states:

"the tendency towards equilibrium, which we have reason to believe to exist on empirical grounds, is only towards an equilibrium relative to that knowledge which people will acquire in the course of their economic activity, and if any other change of knowledge must be regarded as a "change in the data" in the usual sense of the term, which falls outside the sphere of equilibrium analysis, this would mean that equilibrium analysis can really tell us nothing about the significance of such changes in knowledge." (1937, p.53)

In this passage Hayek underlines the irrelevance of an "equilibrium analysis" which excludes changes in data. In his view, equilibrium is contingent on the knowledge that individuals have and constantly acquire as they try to realize their plans. As people get new information and update their previous plans, they also change the equilibrium point towards which the economy is converging. Since these changes are continuously happening, only a dynamic equilibrium framework - without fixed equilibria - can be relevant.

In *The Use of Knowledge in Society*, one of the most cited articles in economics, Hayek (1945) elaborates on the topic of coordination of individual plans in society. He defines what he calls the "knowledge problem" and explains how it relates to a society's "economic problem". In

the beginning of the article, after arguing that the data are never given for the whole society, but rather dispersed and incomplete, Hayek formulates the problem of any economy as:

“a problem of how to secure the best use of resources known to any of the members of society, for ends whose relative importance only these individuals know. Or, to put it briefly, it is a problem of the utilization of knowledge not given to anyone in its totality. (...) The various ways in which the knowledge on which people base their plans is communicated to them is the crucial problem for any theory explaining the economic process. And the problem of what is the best way of utilizing knowledge initially dispersed among all the people is at least one of the main problems of economic policy or of designing an efficient economic system.” (1945, p.520)

Thus, the main problem of a rational economic order - the problem of best utilizing resources⁵ - is the problem of how knowledge is communicated to individuals, and how this knowledge, which is dispersed, is used globally in the best possible way. As Boettke (2018, p.83) sums it, for Hayek the central problem of economics is the “coordination problem” that arises from the problem of the “division of knowledge” in society. As we will see in section 3, this is the framework that Hayek will use to answer the question of whether planning⁶ should be done centrally, or in a market system.

For now, let us focus on the communication of knowledge. The social coordination of different plans made by dispersed individuals, each having incomplete and private bits of information requires the use of some communication mechanism. For Hayek, this mechanism is the price system, which he analogises to a telecom system constantly communicating changes in the relative scarcity of products through variations in prices. These variations provide enough information to make people adapt their decisions concerning their use of resources. They do not need to know the underlying causes behind any price change, or why some good became more or less scarce. Indeed, this system has as its main virtue the “economy of knowledge” it provides, by making individuals adapt without being ordered to do so or having to know the reasons behind any change. For Hayek, the soundness of such a price system depends on an institutional context of competition which generates changes that will later be reflected in price variations.⁷

⁵ In Hayek (1948, p.369) the “economic problem” is also defined as: “(...) a problem of making the best use of what resources we have, and not one of what we should do if the situation were different from what it actually is.”

⁶ Hayek defines “planning” as: “the complex of interrelated decisions about the allocation of our available resources.” (1945, p.520).

⁷ See for instance (Hayek, 2002, p.19): “(...) competition not only shows how things can be improved, but also forces all those whose income depends on the market to imitate the improvements (...) Competition represents a kind of impersonal coercion that will cause many individuals to change their behaviour in a way that could not be brought about by any kind of instructions or commands.”

In a later article, Hayek (1948) elaborates on these ideas precisely by analysing how competition relates to knowledge. He again criticizes neoclassical economics' lack of proper concern for knowledge and expands on how knowledge is actually obtained in society. The key factor is the process of competition through which people learn about new solutions and opportunities for solving their problems. In Hayek's own words:

“Competition is essentially a process of the formation of opinion: by spreading information, it creates that unity and coherence of the economic system which we presuppose when we think of it as one market. It creates the views people have about what is best and cheapest, and it is because of it that people know at least as much about possibilities and opportunities as they in fact do. It is thus a process which involves a continuous change in the data and whose significance must therefore be completely missed by any theory which treats these data as constant.” (1948, p.371)

For Hayek it is by competing that individuals discover objective facts about things that complement their subjective knowledge. They discover the lowest price at which a commodity can be produced; they are informed about consumers' wishes, desires and their willingness to pay; they discover which alternative goods are available; they form judgements about the trustworthiness of a product seller or supplier. It is in this ecosystem of competition that the price system can better perform its function of communicating knowledge and ultimately lead to global plan coordination. Let us remark here that for Hayek, and Austrians in general, this competition framework is dependent on an institutional context of private property, a price system allowing for profit-loss calculation, and a broader set of liberal institutions (Boettke, 2018, p.87) - a topic which we will come back to in section 5.

In a later article on competition, when criticizing neoclassical assumptions of constant data and given quantities of resources for not allowing a true understanding of competition, Hayek (1968, p.13) states that competition is the process through which, “which things are goods, or how scarce or valuable they are” is discovered. In the same paragraph, he goes on to describe important aspects of his concept of knowledge:

“(...) each individual's particular combination of skills and abilities which in many regards is always unique—will not only (and not even primarily) be skills that the person in question can recite in detail or report to a government agency. Rather, the knowledge of which I am speaking consists to a great extent of the ability to detect certain conditions—an ability that individuals can use effectively only when the market tells them what kinds of goods and services are demanded, and how urgently.” (ibid.)

These unreportable skills and abilities emerging and being used in market contexts are what some authors classify as tacit knowledge⁸. Unfortunately, Hayek does not elaborate much more on why exactly the rather vague “ability to detect certain conditions” can only be used effectively in a market context. Nevertheless, Hayek is cautious about the merits of competition. So much as competition is a discovery process of facts that cannot be known in advance – otherwise we could not speak of actual discovery – he states: “we are also unable to determine how effectively competition leads to the discovery of all the relevant circumstances that could have been discovered.” (1968, p.10). But, although we cannot be sure how effective a method competition is, Hayek claims that we should stick to it since, historically, societies relying on competition have performed better than societies that did not rely on it (ibid.).

Following Hayek, other Austrian authors provided additional insights on knowledge and planning. A classical paper on the topic is the one by Kirzner (1984). In it, he presents the knowledge problem as that “of making the most effective use of the available dispersed knowledge existing in society at a given moment” constrained by communication and search costs (p.408). Knowledge itself is a scarce resource, which is costly to obtain, due to being dispersed and - in part - tacit. But, for Kirzner, the problem of obtaining knowledge cannot be subsumed under an overall economic problem. The fact is that, in order to formulate a plan seeking to achieve any social or individual objective, we require some background knowledge. Before elaborating such a plan, we could eventually formulate a preliminary plan, what Kirzner calls a “plan B”, to search for the knowledge required for our main plan (plan A). But, rather than solving things, this “plan B” expands the problem. Kirzner (ibid., p.411-412) argues that even if such a plan B is successful, the planner will most likely miss something. After plan B is finished, the planner may realize he missed more information than he had thought beforehand; he may be mistaken about the items of information he believes to be missing or about the most efficient methods for searching this information. The problem is that one cannot know beforehand which information is necessary, and consequently, whether the costs of searching for some piece of information are worth the benefit it may provide for the attainment of plan A. “We are not aware of the degree of our ignorance”, as Kirzner (ibid) puts it. Thus, the question is not only about the difficulty of gathering information, but that we cannot know *a priori* how relevant for a plan is the information that we have and the one that we lack⁹. This ‘radical ignorance’ - a concept dear to Austrians -

⁸ For instance, Lavoie (1985).

⁹ In Hayek (1937, p.51) a similar formulation is hinted at, when discussing how in the execution of the original plan a planner may find the fact to be different from expected: “*he [the planner] may have no knowledge of things, which, if he possessed it, would certainly affect his plan.*”

produces a difficulty in making the “most effective use of knowledge”, since we cannot know in advance what we need to find and how to find it¹⁰.

From the identification of the knowledge problem with this degree of fundamental ignorance, Kirzner (ibid) departs to an explanation of how the market system solves this problem through an “entrepreneurial-competitive discovery procedure”. The author starts by clarifying what he considers a common misinterpretation of Hayek: the idea that the price system avoids the dispersed knowledge problem by efficiently conveying all the necessary information to relevant decision makers:

“The importance of prices for coping with the Hayekian knowledge problem does not lie in the accuracy of the information which equilibrium prices convey concerning the actions of others who are similarly informed. Rather, its importance lies in the ability of disequilibrium prices to offer pure profit opportunities that can attract the notice of alert, profit-seeking entrepreneurs.” (1984, 415)

The difference between equilibrium and disequilibrium prices is important here. For Kirzner, it is when individual’s activities lack coordination, that profit opportunities will be revealed by disequilibrium prices, i.e., the discovery process starts. The lure for profit is the catalyzer of an “entrepreneurial-competitive discovery procedure”, which ultimately will reveal information and ensure a tendency towards coordination of individual plans. This “entrepreneurial-competitive discovery procedure” can, possibly, be interpreted as an aggregate of what Hayek calls the “ability to detect certain conditions” in market contexts – that we saw previously. Unfortunately, Kirzner does not go much further than Hayek in explaining exactly how this procedure works and how it overcomes the knowledge problem¹¹, despite claiming that central planning, precisely by impeding it, has no way of dealing with the knowledge problem.

Summing up, we can state Hayek’s knowledge problem as the problem of best utilizing knowledge in society, which is the crucial problem involved in designing an efficient system for the allocation of resources (economic problem). The problem is a problem precisely due to some fundamental characteristics of knowledge: it is dispersed among society; some of it is unreportable, tacit and thus, impossible to be gathered; it is not static, but rather constantly generated, discovered and changing. This problem is also one of coordination of individuals plans which are based on inevitably different background knowledge. This requires an

¹⁰ This ‘radical ignorance’ is also pointed by Austrians as a reason for making Hayek’s theory difficult to formalize in the framework of neoclassical economics, see Boettke (2018, p.104-11).

¹¹ He only adds the following: “*We know very little about the precise way in which pure profit opportunities attract entrepreneurial attention. But there can be little doubt about the powerful magnetism which such opportunities exert.*” (p.415). He further states, without arguing, that this ‘attraction of attention’ is different from costly search. On the whole section we find Kirzner to be very vague on this matter.

efficient system of communication, which for Austrians, is the price system operating in a competition framework. This system, through price variations, allows for an inexpensive and fast spreading of information about the use of resources, and for the discovery of new knowledge and opportunities, through competition. The knowledge problem comes also in a context of a critique of neoclassical economics which disregarded it under its assumptions of complete knowledge by the agents, its focus on statics, and markets of perfect competition. We are now in a position to move on and see more specifically the implications of the knowledge problem in the context of planning an economy.

3. Knowledge as a challenge to planning: the socialist calculation debate

Throughout the history of the calculation debate different interpretations were made about the relevance and centrality of some of its points. While in an initial phase of the debate Mises' problem of calculation appeared as the central one, in the main stages, according to neo-Austrian interpretations (Boettke, 2018; Lavoie, 1985), the main issue was considered to be the knowledge problem and the (im)possibility of formulating an efficient plan. Still nowadays, these issues are said to have been misunderstood and not properly answered¹². On the following, we will focus on the knowledge problem as a challenge to the possibility of efficiently planning an economy.

The previous section presented the major economic problem of any society as involving a knowledge problem. While discussing this problem, Hayek also points out how market economies solve it: through the workings of the price system in a context of competition. Thus, in this view, any alternative economic system that considerably modifies these two mechanisms – prices and competition - is expected to hinder the possibility of rationally allocating resources.

Hayek's initial arguments against planning were first stated in his introductory and concluding essays to a volume that he edited, collecting English translations of articles on planning. Hayek (1935, p.3) starts framing the discussion by affirming that a collectivist society, i.e. one under socialist planning, will have to solve the same economic problems that are solved in a market society, a point taken from Mises (1920). Hayek lauds the market systems' ability to achieve some sort of solution to the problem of distributing resources in society for different uses, without anyone being deliberately concerned about it. In the market

¹² Boettke (2018, p.77): *“For economists and scholars who have studied Hayek’s work seriously, there is a persistent sense that Hayek is cited but not understood by many of the mainstream formalist economists who so often claim to have grappled with Hayek’s ideas.”*

the decisions of price-taking individuals and a price system operating in a framework of competition suffice to solve the problem in a decentralized way.

Hayek is careful to state that his discussion on planning is not about the ends that socialism tries to achieve, but rather about the quality of the method. His is thus a discussion on efficiency - whether a central board could carry its plan “with a reasonable degree of accuracy, with a degree of success equalling or approaching the results of competitive capitalism” (1935, p.16-17). As he states when discussing the Soviet experiment with planning, what is to be judged are “the goods which the system actually delivers to the consumer, and the rationality or irrationality of the decisions of the central authority.” (1935, p.205)¹³

The first targets of Hayek’s critique were the proponents of the so-called “mathematical solution” to the economic problem, such as F. Taylor, W. Roper, and H. Dickinson. The latter held that the same apparatus with which theoretical economics explains the formation of prices and the direction of production in a competitive system might be used to determine the values and quantities of different commodities to be produced in socialism¹⁴. In practice, this would mean that the task for socialists in organizing production would consist in formulating and solving the equations of a general equilibrium model for their economy. For Hayek, this proposal lacked any practical relevance, due to “the nature and amount of concrete information required if a numerical solution is to be attempted and the magnitude of the task which this numerical solution must involve” (1935, p.208). The socialist central board would require a huge amount of information that is simply not obtainable. Not only due to the problem of its sheer quantity, but also because this knowledge is not always “in existence in a ready-made form” and might be difficult to quantify into some statistical measure or even impossible to “discover” by the central authorities (1935, p.210). Moreover, planners would also need to gather data on consumer demand and, somehow, to predict future changes in demand while planning production. Only with all this information would be possible to properly formulate all the equations and solve them to get equilibrium prices. But Hayek further claims that, even if we concede that all this is feasible and equilibrium prices are found, the essential point is how adaptive this system would be to changes:

¹³ In the calculation debate, the focus on questions of efficiency - understood as rational allocation of resources - led to a disregard for other questions such as income and wealth inequality, which a body of more recent literature shows to have a significant impact on efficiency (Stiglitz, 2013) . This also led to a disregard for views such as that of M. Dobb, who was willing to accept a less efficient system as a fair price to pay for socialism.

¹⁴ For simplicity, I follow Hayek’s imprecise use of the word “socialism” to mean “planning”.

“We should not expect equilibrium to exist unless all external change had ceased. The essential thing about the present economic system is that it does react to some extent to all those small changes and differences which would have to be deliberately disregarded under the system we are discussing if the calculations were to be manageable.” (1935, 212-13)

Hayek’s interest here is in how dynamic adjustments come about. To have the central planners recalculate all the equations once there is a change in some relevant factor, and then, each time, communicate the new prices to individuals is - in his words - an “absurd idea” (1935, p.214).

In response to such arguments against the possibility of planning, some neoclassical economists developed a model which later came to be known as the model of ‘market socialism’. Most prominent among them were Dickinson (1939) and Lange’s (1936) proposals. Instead of a ‘mathematical solution’ to the problem of planning, they proposed that equilibrium prices would be found through a ‘trial and error’ method, mimicking the market system. In these models, central authorities start by setting an initial ‘accounting’ price for all goods - which can be based on historical prices, or set at random - and after that agents make their decisions taking these prices as given. In case imbalances between supply and demand emerge, the authorities simply adjust prices - in order to reduce excess demand or supply - and communicate them again, replicating the *tâtonnements* of the Walrasian auctioneer (Lange, 1936, p.66). Through this method, planners would avoid the problem of having to gather the information and formulate the equations. In addition, in Lange’s model, the traditional conditions of optimality for the general equilibrium model would still apply. Public firm managers would be instructed to produce not for profit, but to sell at a price equal to marginal cost and industry managers would be responsible to check whether firms were producing at the minimum possible average costs.

Hayek could not fathom how these ‘trial and error’ proposals differed from the mathematical solution on the crucial aspect of dealing with changes. For him the question was not whether a certain method would eventually lead to an equilibrium, but which method is the fastest and provides more complete adjustments to daily changing conditions (Hayek, 1940, p.131). As Caldwell (1997, p.1864) comments, Hayek believed that Lange’s focus on equilibrium “had misled him into thinking that the movement toward some final equilibrium set of accounting prices would be a one-time adjustment, whereas in reality it would be a never-ending process”. The real issue is that in a planned economy prices no longer adjust automatically to changes, because they are set by central authorities. In a world of constant change, authorities would have to be constantly gathering information about market imbalances and after communicating price changes. Such a complex process, would require a constant exchange

of information in a huge array of communication channels. Even if it were feasible, it could never be more efficient, for Hayek, than the competitive system.

On the criterion of selling at prices equal to marginal costs, Hayek critically replies that cost phenomena of real life are not so precise and definite as economists suppose when concerned with the conditions of a static equilibrium (Hayek 1935, p.226). Under dynamic conditions, and without a normal context of competition, it would be impossible to know what the costs are. For Hayek, as we have seen in section 2, the forces of price competition reveal what are the lowest costs:

“The force which in a competitive society brings about the reduction of price to the lowest (...) is the opportunity for anybody who knows a cheaper method to come in at his own risk and to attract customers by underbidding the other producers. But if prices are fixed by the authority this method is excluded.” (1940, p.139)

In a planned system, the process of finding a cheapest method of production, would be much slower than in the competitive case, since individuals no longer controlling the means of production could only test new innovations and methods after approval by central authorities. Additionally, here a knowledge problem would also emerge. When central authorities have to decide where to allocate capital, they have much less subjective knowledge and knowledge of local conditions, in general, than individuals directly involved in the production of goods, who could invest in their own business (Caldwell, 1997, p.1865-66). Lacking this knowledge, it would be impossible for planners to make good capital allocation decisions. Alongside knowledge problems, incentive problems would also play a part. For Hayek, in the absence of private property, public managers would have no incentive to risk and try new things in their companies. In case of failure they would be penalized and in case of success they would not receive any significant personal (material) reward. Overall, this would lead to a tendency to prefer conservative practices over risky innovations, impairing the economy’s ability to progress and “discover” knowledge¹⁵. Thus, for Hayek and Austrians in general, in a context where the discovery mechanism of competition is inoperative, due to the absence of private property of capital, ‘rational’ resource allocation decisions are impossible¹⁶.

¹⁵ Hayek also raises other questions regarding the difficulty in judging managers’ performance and the overall use and allocation of resources within industries (1940, 139-145). For sake of brevity we will skip these matters since they are not essential to the argument’s main point.

¹⁶ Let us remark that capitalists in the market system also fail in their investment decisions, and that the requirement of an extra scrutiny of decisions by central authorities might mean that many of these decisions could be avoided, particularly the ones with high private benefit and costs for social welfare. Additionally, even when private investment decisions are successful that does not mean that overall the social benefit resulting from them will be positive.

Although the debate on planning spans over many other different issues, we are now able to sum up the main points of Hayek's critique. In general, the problem of gathering the necessary knowledge for a central plan is simply insurmountable, because the nature of the knowledge relevant for the plan frustrates the possibility of its collection by a planner. A transition to socialism would imply a disruption of the price system and competition, which Hayek considers essential to discover and spread knowledge throughout the economy. As D. Lavoie (1985) argues, Hayek's main point is about the impossibility of obtaining the relevant information under socialism, and not about calculating with it, if it were available. Another point to be highlighted is the focus on dynamics. Hayek points out several times that neoclassicals' overconcern with static equilibrium and its assumptions, led to the belief that a 'mathematical' or 'trial and error' solution would be possible, disregarding the key issue of how well an economy can adapt to constant changes.

We thus conclude that Hayek's main argument against planning can be summarized in the idea that planning is less efficient than markets in obtaining and utilizing the knowledge necessary to solve the economic problem. Markets communicate this information much faster and effortlessly, allow for the discovery of new information, through the process of competition, and adapt organically to changes. On the other hand, planning, by requiring additional controls from planners – in price setting or investments decisions - renders the communication sluggish and blocks the mechanisms of information discovery. Planners lack an important amount of knowledge, that, due to its dispersal and subjective character, they cannot obtain. In a word, planning fails in communicating, generating and processing knowledge, and quickly adapting to change.

4. Recent literature on planning and the knowledge problem

In the previous two sections we have looked at Hayek's knowledge problem and his critique of planning based mostly on Hayek's original writings in the context of the calculation debate - most of them written in the 1930s and 1940s. From the 1950s onwards, the production of new literature on the debate receded. In that period, most economists were convinced that despite Hayek's critiques, Lange and the market socialists had been able to demonstrate the feasibility of a planned economy¹⁷. A contrary opinion only emerges in the 1980s, when Austrian authors re-assessed the debate and argue that Hayek's points were never properly

¹⁷According to Backhouse (2002, p. 285) market socialists were perceived as the victors of the debate. Their market socialism model used the framework of neoclassical economics and was accepted by most economists of this tradition. This acceptance is one of Lavoie's targets of critique in the Introduction of his book (1985).

addressed by market socialists (Lavoie, 1985). They consider that Hayek's original arguments still suffice to discredit any belief in the possibility of efficient planning, a position they maintain until today. The re-opening of the discussion originated, in reply, new literature on the hermeneutics of the planning debate and its arguments, as well as new proposals and models. In the following we will discuss a sample of that literature and its implications for the understanding of the difficulties of planning.

With the neo-Austrian interpretation (Boettke, 2002; Kirzner, 1984; Lavoie, 1985), the focus of the debate became the question of discovery. Different institutional arrangements are compared based on their ability to discover knowledge. They argue that Mises' argument - focused on the impossibility of calculation - and Hayek's arguments - regarding knowledge - are not separate arguments, but rather different elaborations of the same. The 'calculation' issue coming from the problem of not having the right prices for capital goods in the absence of markets, as formulated by Mises, is also due to a blockage of the processes of discovery, that the transition to socialism implies, rendering price information incorrect. In this interpretation, Hayek's case for the market system is restated and the role of entrepreneurs as fundamental actors for bringing about discovery in the market is praised.

A set of different answers appeared in response to the new Austrian challenge. Some of them accept the Austrian critique about the inevitability of the market, some revise their market socialism models, while others proposed alternative planning methods in response. In the following, we will look at how new planning models, coming after the Austrian reappraisal of the debate, approach knowledge related issues. For this we select a sample of literature written by economists, who frame their discussion in the context of the calculation debate and who are still active in writing and spreading their ideas about planning at a macro level, such as Cockshott and Cottrell (1993), Devine (1988) and Hahnel (2021).

In their paper *Information and Economics*, Cockshott and Cottrell (1997) directly address the knowledge problem. The authors start by questioning Hayek's epistemology that considers the relevant knowledge for the social sciences as subjective. They claim that Hayek bases his views on a notion of a rational subject, which is not in accordance with recent literature in psychological and sociological research. For Cockshott and Cottrell the relevant subjects in economics are juridical entities, like firms, and its actions cannot be reconducted to the subjective life of any single person. In Hayek, the idea that information is personal, or subjective, is fundamental to his concept of knowledge as being dispersed and tacit. Such a conception diverts attention from the "technical supports for information" and makes it "impossible to see the production and manipulation of information as both a technology and a labor process in its own right, whose development acts as a constraint upon the possibility

of economic relations.” (1997, p.7). Instead, for these authors, economic processes depend on a material and technological basis. As an example, the price system itself historically relied upon the technology of counting and calculation, which demanded a material support such as coins, or stones. Adopting an objective point of view on information, Cockshott and Cottrell reach different conclusions. They consider the task of socialist planning as that of replacing market information processing by the processing of information within a planning organization – not an individual planer (1997, p.8). In this organization the information is not concentrated in any single mind - as Hayek sometimes states in his writings- nor even in the mind of its workers, but rather in their written records, forms and accounting systems. With this information, in Cockshott and Cottrell’s model of socialism (1993), the planning bureau has the task of deriving a target net-output vector to satisfy social needs, revealed by a combination of democratic political decisions (voting, referenda) - for public goods and investment - and aggregates of actual consumer purchases. This general macro plan is subsequently broken down into output targets for different enterprises, who perform a similar task to that of enterprises in a capitalist business conglomerate, who get their production plans from the main company¹⁸. The authors claim thus, that the management problem of socialist enterprises is similar to the one of capitalist corporate groups.

Regarding the knowledge of local conditions and opportunities, Cockshott and Cottrell (1997, p.9-10) argue that some of the knowledge that Hayek might have considered at the time he was writing, is now possible to transmit through computer technology¹⁹. Moreover, this kind of knowledge, even when not codifiable, may still be used locally, without prejudice to the operation of a central plan - something that Hayek seems to overlook. They argue that in a planned economy not all processes are centrally planned and that there would still be room for enterprises, and their managers, to decide on how to meet their output targets.

In section 2, we mentioned Hayek’s (1945) analogy between the price system and a telecom system, which - by communicating to individuals changes in prices - provides them enough information to adapt their economic decisions. Cockshott and Cottrell consider the price system to be a limited processor of information, because its rate of information transmission is bounded by the rate of change in prices. The latter depends on the real movement of goods, or new production facilities being brought on line, rendering the speed of adjustment dependent on how fast the real economy can move. Assuming one could gather all the relevant information concentrated in a small volume of computers and instruct them to look

¹⁸ The cases of Amazon or Walmart are good examples (Phillips & Rozworski, 2019).

¹⁹ They mention the SABRE system for computerized booking of flights, which rendered unnecessary the knowledge, from the part of travel agents, of where flights are available from any point A to B across the world. The nowadays widespread use of the Internet could provide many more examples.

for optima within the possible states of the economy, then “the evolution from one simulated state to another could proceed as fast as the computers could exchange information regarding their own current state” (1997, p.11). That is, a computer simulation of all the economy could search much faster and explore a bigger set of possible price/quantity solutions to the resource allocation problem than the price system does. Additionally, the authors argue that the observation of price changes does not provide all the necessary information for a rational decision. Only observing price variations is not enough to know if a change in prices is permanent, or temporary, which has a different impact on decisions. Furthermore, current expectations of future prices - which are also essential for profit calculation before the production process starts - depend on more objective information than just the one provided by price changes.

As we previously discussed, one of Hayek’s points, later emphasized by neo-Austrians, was that the market competitive system is a discovery mechanism, enabled by the entrepreneur’s ability to detect profit opportunities in out-of-equilibrium contexts, that leads ultimately to the discovery of least-cost methods. Cockshott and Cottrell do not elaborate much on the topic of innovation, but they consider that convergence upon least-cost methods of production could be faster in socialism than in capitalism, because without patents or commercial secrecy, it would be possible to share best practices with less efficient enterprises (1997, p.13). Finally, Cockshott and Cottrell develop a model for comparing the communication costs implicit in a market system and a planned system and claim to demonstrate in their analysis that the “the centralized gathering of information is less onerous than the commercial correspondence required by the market” and has a faster convergence time, implying a superiority in adapting to change (ibid., p.19).

A different approach to planning is found in the work of Robin Hahnel, whose proposals started to come out in the 1990s in collaboration with Michael Albert. In his latest book, Hahnel (2021) gives a detailed description of his model. His model of socialism is described as a participatory economy²⁰ without a central authority, guided by the principle of self-management, in which councils of consumers and workers, respectively, are responsible for making their own consumption and production plans. These councils are integrated in federations of consumers and workers, respectively, which are responsible for coordinating plans and for deciding on the provision of public goods. An Iteration Facilitation Board (IFB) is responsible for announcing estimates of opportunity costs, at the beginning of a planning round. After worker and consumer councils propose their plans, based on the initial opportunity costs supplied by the IFB, the latter are updated in order to adjust for excess

²⁰ Designated sometimes by the ‘PARECON’ acronym.

demand or supply. Consumers and workers are then asked to update their plans based on these new opportunity costs. The process is then repeated until there is no longer excess demand or supply for any good²¹.

Hahnel (2021) dedicates some pages of his book to the problem of tacit knowledge and to commenting on the socialist calculation debate. While discussing the problems inherent to central planning, he addresses the “tacit knowledge problem”. He believes that the strongest argument for not having central planning is not because of the difficulty in overcoming information issues – as Hayek claimed - but because it goes against the possibility of worker self-management. He conceives the tacit knowledge problem as the problem of “how the CPB [central planning board] can discover all the different productive technologies available to different production units to produce their goods” (2021, p.62) and believes this problem to be already answered by the literature on central planning, published since the late 1960s, on the methods of material balances and other iterative procedures like trial prices, trial quantities and gradient search. These methods are based on Lange’s (1936) theory of market socialism and define a set of procedures for the interaction between planning authorities and production units. Their general idea is that, in a first phase of the plan, the CPB provides the sectors with either a level of final demand, resource prices or quantities of resources – depending on the method they choose to apply – and the sectors reply to the CPB with a level of input, profit-maximizing quantities, or shadow prices, respectively. These processes go through a number of iterations between the CPB and the sectors, which adjust the initial values, until finally equilibrium prices/quantities are found, resulting in a plan. Hahnel believes that these techniques are enough for the planning bureau to get the information it needs. He mentions, however, that there might be “incentive compatibility” problems between the central board and firm managers, which can make the latter not report truthful information.

In what regards his own proposal for socialism Hahnel considers the socialist calculation debate to be largely irrelevant (2021, p.295). His model of participatory planning claims to follow the philosophy of early socialists who proposed to replace the “anarchy” of markets with a control over economic decisions by associated producers. “The socialist calculation debate was always about whether it was reasonable to expect *a decider* would be capable of calculating an efficient comprehensive plan for the economy” (2021, p.294), thus, for Hahnel,

²¹ Hahnel’s model of self-management comes from a tradition of socialist thought influenced by Yugoslavia’s planning model, which will feature in Chapter 2 – section 3 of this thesis. Through the works of authors such as Branko Horvath, Jaroslav Vanek, or Benjamin Ward, the Yugoslav planning experience was theorized, in the 1970s and 80s, and popularized in western countries.

by not relying on a central authority, models of participatory economics escape the knowledge problem.

Among the ranks of those who propose a participatory model for socialism is also Pat Devine with his model of negotiated coordination (1988). His proposal for participatory planning comes from an attempt to design a model addressing Hayek's knowledge problem and M.Dobb's case for planning (Adaman & Devine, 1996). Dobb criticised the market system's short-sightedness, i.e. the fact that firms make their production plans uncertain about what others will do, or how the economy will be like in the future, which results in resource wasting. For Dobb, replacing market *ex-post* coordination for (*ex-ante*) planning would mean that some decisions would be easier to coordinate and some uncertainties overcome, resulting in increased economic efficiency (Adaman & Devine, 1996, p.527-8)²². Adaman and Devine subscribe Dobb's view on planning, but also recognize the importance of Hayek's insights on knowledge. Their model, thus, tries to reconcile planning with the "articulation of tacit knowledge" through a model of participatory planning. It is based on two prerequisites: generalised participation in the social process of discovery - by allowing people access to the necessary resources for it; and that decision making at all levels involves all those affected by a decision in a participatory process. These prerequisites are delivered by the concept of "social ownership" which means "ownership by those who are affected by the use of the assets involved". Hence ownership, or control, over assets would be granted to all those of are affected by the use of those assets. At the enterprise level, for instance, this would mean that workers, costumers, communities, regions, and other groups affected by its activity would be represented at the governing board of the enterprise. This more generalized participation would guarantee a wider mobilization of social knowledge that, through negotiation, would enable a generalized process of knowledge discovery. Similarly, the expansion or contraction of enterprises would not be decided by market forces, but by a negotiated coordination process at the industry level involving all those affected. Devine's model of participatory planning replaces thus market forces by a process of negotiated coordination, although retaining market exchanges in consumer transactions.

In this way, Adaman and Devine claim to reconcile Dobb's *ex ante* coordination through planning with a wider social involvement in the process of knowledge discovery and mobilization. Similarly to Hahnel (2021), this model by not relying on a central planner and

²² Pierre Massé (1965), chairman of the French planning commission in the 1960s, presents a similar argument in favor of planning. In Massé's view the market failed in the long-run allocation of investments, due to the uncertainties involved in long periods. Planning, by coordinating economic agents would reduce the uncertainty in the economy and allow for more rational allocations of capital in the long-run. In chapter 2, section 3, the French model of planning will be analyzed.

allowing a widespread use of subjective knowledge claims to avoid the Austrian critique of planning. In their article, the authors directly criticize the narrowness of the Austrian view on discovery and mobilization of knowledge, which praises the role of the entrepreneurs, but excludes from the process non-entrepreneurial subjective knowledge. They point out that, if one considers the discovery of knowledge as the criterion to compare different institutional arrangements - as the Austrians propose - it is paradoxical to restrict this activity to entrepreneurs, when an alternative system generalizing “access to the social process of discovery would not only be more democratic and more just but also more efficient” (1996, p.532).

5. Escaping the knowledge problem

In this section we elaborate on the conditions that allow an economy to escape the knowledge problem. We saw in section 2, that Hayek backs his support for the market competitive system with the argument that, historically, societies relying on it have performed better, although we cannot really know if competition discovers all the relevant circumstances that can possibly be discovered. Kirzner concept of radical ignorance identically points out that we cannot know *a priori* what the relevant information for a plan is. Thus, we assume that Hayek is not making an absolute claim for competition as the most efficient method of discovering and dealing with information, but rather a historical-contingent argument, meaning that an alternative method, at least as efficient as competition, may exist²³.

Before we discuss alternative methods to deal with knowledge, we have to be clear about what the knowledge problem implies. From our previous discussion, we conclude that the knowledge problem involves three problems:

- Knowledge gathering: Some of the knowledge regards conditions of time and place, has an inarticulate and tacit nature, is subjective and constantly changing. These features make its aggregation very difficult.
- Knowledge discovery: Interactions in the economy generate knowledge. Hayek, and Austrians, believe that competition, by enabling entrepreneurial activity, is the most effective method of generating knowledge.
- Knowledge processing: Assuming we possess some knowledge, or information, its usefulness depends on the ability to process it. This involves a capacity to interpret it and calculate values fast-enough, so that the decisions taken can be up to date with real changes in underlying factors.

²³ Additionally, we might question the meaning of ‘performing better’, which Hayek does not clarify. How would one compare the performance of a planned economy with a market one, isolating from other relevant factors such as culture, level of development, international integration, war, among others?

For Hayek the market-competitive system is efficient in solving these problems. Markets are places where holders of knowledge come together and directly use it, without the need for anyone to worry about its aggregation (gathering). They generate the incentives for entrepreneurial activity, which is the catalyst for discovery. They make use of the price system, which adapts spontaneously to relevant changes in underlying factors and efficiently communicates those changes throughout the whole economy (processing).

An answer to the knowledge problem needs to take into account these factors. In particular, it has to provide a description of how an alternative method would solve those issues, and/or challenge the idea that the market-competitive system is efficient in solving them.

In Cockshott and Cottrell (1997), we see a mix of these two strategies. They start by countering Hayek's subjective conception of knowledge, which is the core of the aggregation problem. For these authors the knowledge relevant for planning is objective, expressed in statistics, documents and forms. Thus, for them, the problem of gathering objective information is reduced to the problem of designing a communication system: a computer network - to transfer statistics and data from firms - and voting and referenda for information on preferences for public goods and investment demand, involving a type of direct democracy. It is beyond our goal to argue here about which type of economic knowledge (objective vs subjective) is more relevant for a macroeconomic plan but let us remark that a process which involves transfer of information should also address the question of designing procedures to guarantee that that information is trustworthy, which is not much developed by Cockshott and Cottrell. Regarding discovery, the authors do not directly discuss how it would be generated or incentivized, but they argue that subjective knowledge would still be used by individuals, since not every aspect of the economy would be determined by a plan. Nevertheless, they point out that innovations, when occurring, would be more beneficial than in the market system, because in the absence of commercial secrecy they would spread much faster, a point resonating to Lange (1936). In terms of processing, Cockshott and Cotrell argue that computer calculation is much faster than the price system. The latter depends on the rate of change of the real economy which is slower than the time needed by computers to arrive at optimal prices for different scenarios. Furthermore, they criticize Hayek's apology of the market as a provider of information, since it leaves out an account of how expectations influence individual decisions, which require more information than that provided by prices changes alone.

Although Hahnel and Devine do not make an extensive critique to Hayek - from what we exposed in section 4 we can conclude that their main argument against the knowledge problem is that without a central authority trying to aggregate information for a plan,

individual knowledge can still be used in the same way (or better) as in a market system. Therefore, in their models, aggregation is not a problem, since there is no central planner or anyone that needs to gather information. Regarding discovery, it happens through the interactions of individuals as they actively participate in the directive boards of their firms, or through their involvement in negotiations at the industry or higher levels. This participation would be accessible to all workers and consumers, in Hahnel's model, or to all the 'social owners' in Devine's. It would enable a more considerable number of people to be involved in the discovery process than in the market system, where that activity is mostly limited to owners of capital and managers. Regarding processing, in Hahnel's model it would occur through the interaction of councils, federations and the IFB, as they adapt their plans until an equilibrium between supply and demand is reached, in a similar fashion to Lange's Walrasian auctioneer. In Devine's, model processing would happen through the interactions of production plans - derived from the negotiated coordination process of social owners - with market demand expressed by consumers. Hence, in both Hahnel and Devine, we see models that do not totally reject the market system – the same way Lange did not - but just its ability to alone coordinate plans and provide socially desirable outcomes.

We saw thus, two different approaches to knowledge and its problems. On the one hand, there is the claim that the relevant knowledge for planning is not subjective, but objective and the task is just one of designing a fast communication system to transfer information and have computers calculate equilibrium prices. In it, lies an epistemological question that we deem worthy of a deeper discussion than the one we could provide here. On the other hand, there is the claim that a decentralized planning system escapes the knowledge problem. A question on which we will expand in the following.

In Hayek's writings, the equalization of planning with centralization is quite clear, for instance in Hayek (1945, p.521):

“Planning in the specific sense in which the term is used in contemporary controversy necessarily means central planning (...) Competition, on the other hand, means decentralized planning by many separate persons.”

In his papers Hayek often refers to the problem of a central board gathering knowledge, and the impossibility of having 'one mind' process all information. In his introductory piece to *Collectivist Economic Planning* (1935) he explicitly avoids discussing other types of socialism: *“The earlier systems of more decentralized socialism like guild-socialism or syndicalism need not concern us here since it seems now to be fairly generally admitted that they provide no mechanism whatever for a rational direction of economic activity”* (1935, p.19), a discussion that, to our knowledge, he does not retake in later writings.

Thus, from our reading of Hayek, it seems that Hahnel and Devine have a point when claiming that a decentralized system avoids knowledge problems. However, even if Hayek's arguments are targeted at centralization, there may be other ways in which they raise problems for decentralized models. One of those ways may be through the Austrian argument that without private property economic calculation is impossible. For instance, Boettke & Candela, in a recent article (2023, p.47-48), write:

“Indeed, the commercial society is predicated on private property rights to provide incentives to decision makers to husband resources efficiently, but it is the contextual knowledge embodied in relative prices, as well as profit and loss signals, that guide them in their efforts. Regardless of how well-motivated central planners may be, absent private property rights, decision makers are left without prices, and without prices, profit and loss statements are rendered economically meaningless. They would not know how best to utilize resources and how best to act to coordinate their activities (...) prices without property are the grand illusion.”

The main idea, as we understand it, is that without private property there are not enough incentives to ignite the entrepreneurial discovery process which reveals information to agents, resulting in a society unable to properly use and discover economic knowledge. However, this argument has been demonstrated by Denis (2015, 2017) to be an Austrian misinterpretation of their own theory. It is not private property, but rather ‘several’ property which is relevant for the argument. Several property, as Denis (2015, p.9) defines it, “is divided property with a single legal owner, property which is no longer held in common or jointly, with plural owners, but has been severed (...) it is thus opposed to the common property of a community, but – and this is key – there is no particular requirement for it to be private (...) rather than public divided property”. Hayek himself, in his last book, *The Fatal Conceit*, privileges the term ‘several property’ to private property (1991, p.110) and mentions it explicitly when discussing planning: “decentralized control over resources, control through several property, leads to the generation and use of more information than is possible under central direction.” (1991, p.86). Denis argues further that by property usually Austrians have in mind the notion of ‘de facto control’ over resources, i.e., not the legal right *per se*, but real control and decision capacity. Thus, he concludes, a more correct of interpretation of Austrian theory should have as a pre-condition for calculation the notion of ‘several control’ rather than private property²⁴.

²⁴ Denis (2015) original argument originated a debate with Bylund and Manish (2017), in the Review of Political Economy, to which Denis replied (2017). Bylund and Manish criticize Denis (2015) for neglecting the fact that in a public ownership with several control regime public managers will be less risk-averse in their decisions, as they would benefit from the profits of their decisions but would not be penalized from losses – since they would not be risking their own capital. Over time, this would lead to an unsustainable production structure. In a rejoinder, Denis (2017) replies that it is unreasonable to assume that the public

From our understanding of Hahnel and Devine's models, we believe the type of property regime they propose to be consistent with the notion of 'several control'. In Hahnel (2021) people, as workers, have control over the assets and resources necessary for the operation of their firms. In Devine (1988) the control over resources is spread through all people affected by their use, the social owners. Therefore, following Denis interpretation of Austrian theory, we believe that their models, besides the tacit knowledge critique, also escape the argument for the impossibility of calculation in the absence of private property.

6. Conclusion: On the relevance of the knowledge problem

The aim of our paper was to depart from an analysis of Hayek's writings on knowledge and planning, a topic often claimed to be misunderstood, to build our interpretation of the subject. In a further step we confronted Hayek's and more recent Austrian arguments, with the critiques coming from some of the proponents of planning models. We now conclude by elaborating on the relevance of the knowledge problem for current discussions on planning.

Hayek's critique of planning is not a global critique of all types of planning but targeted at a specific type of planning: centralized planning. A more accurate formulation would be then to define it as a critique of centralization. This critique is based on an epistemological background that sees the knowledge relevant for economic planning as subjective, tacit and dispersed. Cockshott and Cottrell contrast this epistemological view with one grounded on objective knowledge and based on the last decades' developments of information theory. Any model based on an objective conception of knowledge will thus fail to accommodate Hayek's critiques, simply because the type of knowledge with which it is concerned is not the same. Hence, we believe that a prior step to any discussion on planning should be to provide arguments in support of the epistemological view adopted since, I believe, a definite position on this matter has not yet been reached and deserves more attention.

Proposals, such as those of Hahnel and Devine accept a main role of subjective knowledge in planning and propose to address it in a decentralized way. Their planning models are decentralized ones, in which the institutional framework of property and control over resources is constructed to allow for an effective participation of holders of subjective knowledge. Their models rely on active participation of people in the decisions taken at the firm, industry and national level. This participation guarantees a wide mobilization of

owners of capital, in a several control regime – the community, would be simply less diligent and vigilant in their defense of property than capitalists of today. Regulatory institutions could actively analyze the actions of public managers and penalize them for losses.

subjective knowledge and its discovery, through negotiation procedures. Thus, the question of guaranteeing an efficient use of knowledge in society becomes contingent on the issue of assuring that people engage and participate as much as possible in the planning procedures.

Contrary to what Austrians still argue today, private property is not a necessary condition for economic calculation as Denis (2015) showed. Any model based on an institutional framework of several control, such as those of Devine and Hahnel, escapes this type of critique. Restraining our discussion to efficiency matters, a new interesting question emerges with these new models of decentralized planning: whether a system that allows more people to participate in the discovery procedure can generate and mobilize more knowledge than a system where discovery is concentrated on entrepreneurs. While a generalized discovery mechanism gets everyone involved a problem for this type of models can come from low rates of participation, since each person faces smaller incentives than an entrepreneur in a market system - who has the chance of appropriating huge profits. And here a paradox of the Austrian position emerges. While they criticize central planning for concentrating the planning process in a central board, they propose to centralize the process of discovery in a class of entrepreneurs. In contrast, Hahnel and Devine propose a widespread discovery procedure – not dependent on owning or being able to borrow capital. Since the debate has been shifted to the question of discovery, its main question shifted as well. The question of centralization versus decentralization entered a new dimension, in which the roles have been inverted: it no longer is about who should do the planning, but who should control the process of discovery and mobilization of knowledge. In this phase the main advocates of centralization are no longer socialists, but rather Austrians.

To conclude, we believe Hayek's knowledge problem is still relevant for discussions on planning models – future and past. The question of which methods for gathering, processing and discovering information in society lead to better outcomes are still relevant today and central in the discussion of new planning models. However, the present-day calculation debate gives too much emphasis to these questions. As we will see in the next chapter, planned economies emerged from the need to guide society towards specific social goals, often imposing sacrifices in the name of future benefits. While information was important for the definition of targets to be achieved, the reasons why authorities opted for planning had less to do with a concern for global efficiency, but more about the very possibility of directing society towards those goals.

Chapter 2: The emergence of 20th century economic planning

1. Introduction

The 20th century marked a turning point in the search for methods for resource allocation, alternative to the market system. While some experiments, in the 19th century, had been made - particularly by socialists and other critics of the market-system - in the 20th century attempts to develop non-market methods for the allocation of resources exponentially increased, in quantity, scale and across different geographies and cultures. One crucial reason for the global spread of these attempts was the development of the theory and practice of economic planning in the Soviet Union. The Soviet model showcased to the world a radical and fast transformation into a 'modern' society, guided by five-year plans. As the country spread its influence worldwide, planning increased its number of admirers inspiring similar solutions to economic development problems.

Before Soviet planning - at the start of the 20th century - the biggest attempts at comprehensive planning had been the management of the war economy, during WWI. Germany, France and Tsarist Russia both adopted planning at a macro scale to concentrate their economies on providing supplies and equipment to troops on the combat front (Sapir, 2022). Although aimed at facing the problems of war and not spanning for a long time, these experiences also revealed the possibilities of planning (Milward, 1980).

However, it is after WW2 and during the decolonization period that most countries will opt for some kind of planning. With the world divided in blocs, both the Americans and the Soviets try to expand their influence and export their economic model. In the global south, when most of the post-colonial countries got their independence the Soviet planning was particularly influent. But by then already non-Soviet models of planning had been implemented and were showing good results. In Yugoslavia - the first country to reform the traditional model of planning - growth rates were among the highest in Europe, in the 1960s (Horvat, 1976). Elsewhere in Europe, countries such as France had set up planning mechanisms to decide on economic and social priorities and coordinate the actions of economic agents. (Sapir, 2022). In the decolonizing world of the 1960s and 70s, independence came to be strongly associated with the setting up of economic planning. According to Menon (2022, p.14) by 1965, thirty-five African nations had development plans.

In the following of this chapter, an attempt will be made to trace the historical and socio-economical conditions leading to the implementation of planning systems. To ease our task, we will focus on four main models of planning. First the Soviet, which was the first long-lasting comprehensive planning model and raised important discussions and concepts that will be relevant to other planning attempts – such as what sectors to prioritize in national industrialization, or whether plans should follow a ‘genetic’ or ‘teleological’ principle. After focusing on Soviet planning in Section 2, in Section 3 other models will be discussed, such as Yugoslavia’s which came to be known as a self-management, or market socialism model, France’s post-war ‘indicative’ model, and finally India’s development planning model. Our aim is not to present an evaluation of these models or their economic results, but rather to show in what circumstances and for what purposes, according to their founders, they were set up. Far from presenting a thorough discussion on the respective models, our goal is to trace the main steps – conceptual and chronological - that occurred since the origins of a certain model of planning to its mature phase.

A study such as the one attempted in this chapter is an exercise in concision and risks inevitably to be incomplete, due to the vast amount of planning experiences throughout the world in the 20th century and their conceptual variations. In face of this inevitable incompleteness our presentation reflects the choice of four models that can be considered representative of other countries’ planning models²⁵.

Before we start with our analysis of the emergence of the planning models it is important to roughly define what is meant by planning, in general. Following Hare’s (2001), we can define planning as comprehensive management by the state beyond creating and securing conditions for markets to operate well. In line with Kornai (1971), we believe framing the debate as planning versus market is misleading. Instead, the focus should be on how these two systems of control can complement one another. Believing in the possibility of a ‘pure planned’ or a ‘pure market’ economy represents an extreme faith in rational abstraction, at odds with reality. Proponents of a pure market system usually assume that individuals, as ‘homo economicus’ dominate at the micro level, with market mechanisms and ‘optimal’ prices providing all the necessary information to control the distribution and allocation of resources. On the other hand, advocates of a purely planned economy assume that planners possess an extraordinary level of rationality, enabling them to create exact and reliable high standard plans. Both of these pure theories, however, neglect the inherent conflicts and uncertainties

²⁵ Perhaps two of the most important absences in this chapter are China and Japan. Japan can be considered a variation of the ‘indicative’ planning model (such as the one appearing in France) in which the Central Bank and a strict control of investments were crucial. China, after a Maoist period of central planning, evolved into a mix between a centrally planned economy and a regulated market economy.

present in a real economy and oversimplify in their abstract models the real sphere of the economy (ibid).

As we will see in the following, in planning market elements can be strongly present, as well as planning elements can be crucial in market systems. The cases of Yugoslavia and France as we will see in chapter 3, are paradigmatic of the former and the latter, respectively.

In the following section we will start our journey by looking at the historical roots of the most influential planning model of the 20th century, the Soviet planned economy.

2. The emergence of the ‘traditional model’ of Soviet planning

After seizing power in Russia, on November 1917, the Bolshevik party establishes a national government aiming for the construction of a socialist society. However, concrete ideas on how such society would be managed were scarce, as assumed by Lenin on a report in 1918, shortly after the revolution:

“We know about socialism, but knowledge of organisation on a scale of millions, knowledge of the organisation and distribution of goods, etc., – this we do not have. The old Bolshevik leaders did not teach us this . . . there has not been anything about it yet in Bolshevik pamphlets, and nothing is said about it in Menshevik pamphlets either.” (as cited in Ellman (2014:2))

Beyond the Bolshevik or Menshevik tradition, Marxist references would not provide considerable help too. As was implied in Marx’s distinction between scientific and utopian socialism - and his critique of the latter - all those who tried to devise blueprints of a future socialist society were labeled as ‘utopians’. Besides some broad ideas - that in socialism private ownership of the means of production is abolished; exploitation of labor ended; production oriented towards use-value and not exchange-value – and a general principle of distribution - according to work, under socialism, and according to need, in communism – not much more could serve as a guideline. Thus, a solution for the problem of organizing a socialist state would have to be worked out according to real conditions, for each particular case.

Peace was also one of the main goals of the Bolshevik revolution. In 1918, with the treaty of Brest-Litovsk, the new government reaches an agreement for the withdrawal of Russia from

the First World War (WWI). However, peace does not last long and later the same year conflicts against internal and external opponents emerge, which will last until 1920. During this period, designated as 'War Communism', policy was dominated by wartime confusion and the need to guarantee the survival of the new regime²⁶. All countries involved in WWI had, to some extent, renounced to the market mechanism and centralized their control over the allocation and distribution of resources (Malle, 1985, p.298). During 'War Communism' that trend continued in Russia. Land was nationalized and the right of its use given to peasants. Rationing and food requisitions were implemented. Through a series of decrees firms and factories were nationalized and a Supreme Council of National Economy (VSNKh) was established to manage them. The banking system was nationalized and combined into a single People's Bank (Allen, 2003). In this context the first attempts at planning appear, with VSNKh and its branches elaborating the first drafts of economic plans, for specific projects and industries, which ended up not being fulfilled due to war circumstances. Only in 1920, the first long-term nation-wide plan is formulated and approved. By Lenin's initiative, the State Commission for the Electrification of Russia (GOELRO) was set up and a team of two hundred engineers and scientists were assigned the task of drawing up a plan for the electrification of the country (Bor, 1967, p.22).

By the end of the civil war, the economy was devastated and agriculture and industrial levels of output were considerably below pre-WWI levels. To address the situation a New Economic Policy (NEP) is introduced, which inverted the war time trend of economic centralization. Food requisitions ended and were replaced by moderate taxation. Factory industries were organized according to commercial and profit-maximizing principles. Private trade was legalized and market transactions resumed. Nevertheless, the institutional background of planning continued to develop. In 1921, the State Planning Commission (Gosplan) is founded. Taking as a basis for its work the GOELRO plan, in its early years, Gosplan draws up a food plan, an agriculture plan, sectoral plans for some industries and annual control figures for the development of the entire economy (Bor, 1967, p.24).

During NEP the Soviet economy was fundamentally a mixed economy, where the state exerted his influence through the budget and credit system. Two of the main objectives of the Bolshevik revolution were socialism and industrialization. While NEP was important for post-war economic recovery, it fell short of both of these objectives. First, under NEP, the Soviet economy was, in the main, a market economy, implying that the allocation and distribution of resources was dictated by market forces and not according to a work or needs

²⁶ A comprehensive study of economic policies taken during War Communism is the one by Malle (1985).

criteria, more consonant with socialism. Second, while industry was state-owned, it operated in a capitalist manner, with the allocation of investment being directed towards the maximization of firm's profit, not taking into account the effects of that investment for society as a whole.

In the early days of the revolution the Bolsheviks had hoped that communist movements would be successful elsewhere and would later come in support of the Russian revolution (Traverso, 2021). In the 1920s, after the failure of other European proletarian revolutions, the hopes of cooperating with other countries for the construction of socialism start to fade away. The Soviet Union turns into the doctrine of "Socialism in One Country", where the priority becomes guaranteeing the survival of the only socialist country in a geopolitical context of increasing tensions and a new eminence of war. For survival, thus, economic self-sufficiency and the building up of military might became two of the central goals. To achieve them industrialization would be paramount.

By the mid-1920s, when pre-war levels of output had been restored, a growing consensus started to emerge on the need to overcome the limitations of NEP and pave the way to socialism. Yet, views on how to do that differed considerably and a debate ensued about the appropriate strategy for industrialization²⁷. Which sectors of the economy to prioritize, what should be the tempo of their development and the character of the plan were topics of intense discussion. On these matters the Bolshevik party split into a left and a right wing with opposing ideas. On the left, Preobrazhensky held that maximum priority in the allocation of investment should be given to industry, in order to expand industrial capacity faster. In his theory of 'primitive socialist accumulation' the peasants should be constrained to finance the costs of industrialization, through high taxation and price controls on agriculture products. In contrast, the right-wing advocated a bigger focus on agriculture. Shanin and Sokol'nikov, for instance, advocated an increase in investment in agriculture in order to allow farmers to develop agricultural capacity and save enough to later finance investment in the industry sector. Based on the principle of comparative advantage, trade with capitalist countries of agricultural goods for industrial equipment would be pursued (Erlich, 1967, p.24-31). Still on the right, Bukharin, argued for a more moderate over time balance between investment in agriculture and industry. The State should set prices to incentivize production in agriculture and peasants should finance capital accumulation in the industry voluntarily. Similarly to Shanin and Sokol'nikov, Bukharin believed in the strategy of trading agricultural goods for

²⁷ The main reference for the Soviet Industrialization debate is Erlich (1967).

industrial equipment. Until the grain crisis of 1927 Stalin shared Bukharin's views on industrialization and the left opposition was gradually discredited until defeat.

Despite the different opinions on how to approach the task of industrializing a primarily peasant country, such a transformation as the one envisaged by the Soviets required political deliberation from above. The operationalizing instrument for that deliberation was the plan²⁸ and intense discussion went on over what should be its guiding principles. Following Nove (1993, p.129), "all planning, in the sense of deliberate decision-making affecting the use of resources, must represent some sort of compromise between two principles": 'genetic' and 'teleological'. The genetic principle, emphasized as the starting point of the plan the current conditions of the economy and extrapolated from the current trend a future path of development. On the other hand, the teleological principle emphasized starting from a strategy for development and set goals to achieve the strategy, instead of adapting to current circumstances of the economy. Some authors, such as Bazarov, thought both principles convenient for a proper plan, but as the debate went on, positions diverged. Gradually 'teleology' became a term for those that wanted to go beyond the market and 'genetic' for those that did not (Carr & Davies, 1969, p.842). As the left strategy of rapid industrialization was getting more and more supporters within the party, the 'teleological' desire to shape the economy became the dominant one. Pyatakov represents well the spirit of those who supported the 'teleological' principle:

"We are setting ourselves a task, we deliberately depict a model of industry to ourselves as we want it, so that it may be brought into existence; in other words, we set ourselves a definite purpose and a task dictated by our will (volevaya zadacha); we free ourselves to a considerable extent in the given circumstances from the clutches of what is given by history; we break the old bounds and gain a considerably greater creative freedom. But not every task can be accomplished; and we must set ourselves only tasks which can be accomplished." (in Carr & Davies, 1969, p.840)

The idea of pioneering a new way of economic management, was also present in Kuibyshev, who contrasts this new type of planning with what was being done elsewhere:

"In America and elsewhere plans are usually an attempt to foresee how the further development of the economy is blindly forming itself as a result of the business management

²⁸ As Carr & Davies (1969, p.873) put it: "The cardinal purpose of planning was to direct resources into industry and to mould its development".

of economic units which are not interconnected by a unified will and leadership. With us it is a quite different matter. We can construct plans based not only on foreseeing what will happen, but also on a definite will to achieve specific tasks and purposes.” (ibid.)

In the mid-1920s the general concept of planning in Gosplan involved a general plan, usually covering a period of 10 or 15 years, a 5-year perspective plan, plans for concrete investment projects and annual control figures. In all its lifespan the USSR never managed to approve a general plan and until the approval of the first 5-year plan, economic policy was directed mostly through annual control figures. The control figures were aggregates of the ‘operational plans’ elaborated by the different commissariats, republics and regions, and worked as guidelines for the year.

In April 1927, the 4th Congress of the Soviets instructed the Government to draw up a five-year national development plan. After many corrections and adjustments, the plan was finally approved, in 1929. The first five-year plan adopted higher growth tempos and investments than what the previously defeated left-opposition had been proposing, which merited criticism and opposition from the right-wing. In and after 1928, Stalin discredited and pushed aside any voices claiming for caution and more balanced targets, including some of his previous right-wing allies (Nove, 1993, p.146). By then, the teleological drive had completely captured planners and policy makers. Galvanized by the slogan “There are no fortresses that the Bolsheviks cannot take” the plan relied on worker’s motivation and enthusiasm to go beyond what would normally be considered achievable targets. Thus, the first version of the plan expected in only five years²⁹ the level of all investments to triple; national income to almost double; the level of producer’s goods to almost triple; and an overall industrial production increase of 108%. The targets for electricity were a three-fold increase in produced KWhs; and iron ore, pig iron, steel and machinery were to have above two-fold increases in production (ibid, p.145). A posterior optimal version of the first plan established even higher targets. Regarding agriculture, collectivization was to be advanced gradually being predicted to have by 1933 only over 15 per cent of total agricultural output produced by state and collective farms³⁰ (ibid, p.154). This would mean that a very vast majority of peasants would remain in the private sector. However, after late 1929, a ‘great turn’ happens and a nationwide campaign to immediately and forcedly collectivize the peasantry is launched, which resulted in one of darkest periods of Soviet history with massive shifts of population across distant

²⁹ In a later Congress in December 1929, ‘shock brigades’ adopted a call to fulfil the five-year plan in four years (Nove, 1993, p.189). A famous propaganda poster from the period presents the formula “2+2=5” where the enthusiasm of the workers would allow a 5-year plan to be fulfilled in just 4.

³⁰ In 1928, the level of sown area by state and collective farms was less than 3% of total sown area.

regions in the USSR, deportations and killings, to which was added a major famine, in Ukraine and other Soviet republics, with lasting economic consequences (Naumenko, 2024).

The first five-year plan was the first comprehensive plan, specifying assignments for all sectors of the economy and a calendar with a breakdown of production and construction targets for each year. Ellman (2014, p.10-11) refers to the period of the first five-year plan (1929-33) as prelude to socialist planning, in which the chaos originated by collectivization made it “impossible to speak of a viable economic system”. Only after 1933, with the second five-year plan, the model of the planned economy matures in a form which will remain virtually unchanged until 1965 Kossygin’s reforms. In general, across all five-year plans during Stalin the main goals remained rapid industrialization, economic development, to ensure national survival and to surpass capitalist countries.

In what follows, we adopt Ellman (2014) and Kornai’s (1992) characterizations of the ‘traditional’, or ‘classic’, model of planning, which describes the Soviet economy under Stalin and subsequent models based on it. According to these authors, the model included the following main features:

- State ownership of the means of production: The state owned all the land and productive resources, with private and collective property existing only in a small scale and temporarily before eventual nationalization. This approach was justified on three grounds: it was essential for effective national economic planning; it was considered the highest form of social ownership; and it facilitated the allocation of consumer goods according to a “deserts” principle. State ownership enabled the mobilization of resources toward strategic sectors—essentially heavy industry and defense—while also considered important to mitigate class conflicts inherent in capitalist societies by ensuring that resource distribution reflected individual contributions to society.
- Political dictatorship: The ruling group controls power and deals with opposition by repression. In the case of the Soviet Union the Communist Party held power in the name of the proletariat. This had important economic consequences: Censorship and control allowed for disastrous policies to be pursued, since the consequences could be covered. By restricting feedback mechanisms, it could generate some forms of waste. The party controlled appointments in the economic apparatus and all decisions had to conform to ‘party mindedness’, which also led to distortions in statistics, false data and suppression of sensitive information.

- Mono-hierarchical system: All economic hierarchies are ultimately subordinate to the Party leadership. Vertical relations of hierarchy dominated horizontal relations of contract and exchange, leading to an environment devoid of competition and characterized by the rigid fulfillment of centrally imposed criteria.
- Imperative planning: Planning takes the form of binding orders and instructions, instead of forecasts, as in other planning systems. Resources are allocated bureaucratically, with plans usually consisting of extensive lists of output targets, operationalized by listing the corresponding investment projects to be completed, continued or initiated. Plans had to be broken down, disaggregated by ministries and departments to provide targets for individual enterprises.
- Subordinate role for money, profit, prices and banks: In this model, monetary mechanisms and market signals played a secondary role. Instead of being allocated through market transactions, many goods were distributed directly by the state, thereby reducing the centrality of profit motives, market prices, and banking institutions.

The traditional model, achieved considerable results. Particularly, in the military sector, it allowed for the development of an industry which allowed the USSR to withstand the Nazi invasion in WW2 and become a world power. It generated a profound transformation of the economy from a mainly agrarian country to an industrialized one, with some highly technologically complex sectors such as the space industry. It greatly increased levels of social capital, comparing well in levels of education, with the most developed countries. (Allen, 2003). However, it also had fundamental shortcomings, which led to prolonged discussion and struggles on how to reform it. Some of these shortcomings and discussions on reform will be the subject of the next chapter.

One of the hopes of socialists around the world, throughout the 20th century, was the idea that socialism would lead to a more rational management of society, one in which the constant economic fluctuations typical of the market system, would be eliminated. To achieve that goal, an alternative method of resource allocation would have to be operationalized. The plan, besides stating targets and goals, provided that alternative through a method of balances: a set of accounts or budgets stating receipts and outgoings for each of the national industries, usually expressed in physical or monetary terms. Balances were meant to facilitate coordination between different parts of the economy and reduce disequilibria or disproportions. However, they also demanded a great deal of information that was not available at the time. In order to operationalize this method, an immense effort in classifying

many thousands of branches, production units and products and integrating them into a standardized national accounting system had to be done and frequently revised (Kornai, 1992). The Soviet planning system, took thus the application of national accounting and classification systems to an unprecedented scale.

In practice, much of the planning process consisted in accounting for the amount of available inputs for each sector of the economy and then balancing those resources according to aggregate output targets specified by authorities. The ministry or department responsible for a sector of the economy received an output target for its sector and would have to disaggregate the plan, into targets for each directorate (controlling several firms), and finally the directorate would disaggregate it into targets for each firm. In turn, firms could make comments and counterproposals for output targets, or require more inputs to achieve the designated target. The same could happen at the ministerial level, as the ministry could require changes in plan targets and inputs. This enormous process involved many thousands of public employees and factory managers, negotiating, calculating, and renegotiating planning figures until final planning commands emerged, in what Kornai (1992, p.114) called a “monumental piece of bureaucratic coordination”.

The Soviet economic model, increasingly more after WW2, had a strong global impact in giving credibility to other planning attempts. It served as a role model for post-colonial developing countries, trying to transition to an industrialized economy, as we will see in the next section. In Europe, it was influential for the creation of institutions and social policies in western capitalist countries that led to the formation of social welfare states. (Rasmussen & Knutsen, 2023). Reconstruction efforts in post-WW2 Europe were often determined in planning commissions, in many countries throughout the continent (Milward, 1984). Additionally, the studies developed by Gosplan were very significant for contributions to economic theory in the areas of input-output modeling, popularized by Leontief (Clark, 1984), growth models, with the pioneering contribution of Feldman (Hagemann, 2022), and linear programming, by the Economics Nobel-prize winner Kantorovich (1939).

As we will see in the next section, the traditional model of planning that emerged in the USSR to answer specific needs of Soviet society and its leaders was not simply replicated by other countries. On the contrary, its principles were selectively adapted and reformed to align with different historical circumstances and local conditions. More than concrete techniques or configurations, countries extracted from the Soviet model the teleological idea, that it is possible to guide the economy – and society- towards specific social goals, over a medium, or long-term perspective.

3. Later developments and variations of planning

Particularly after WW2 planning starts to appear in different shades. This section will give a brief overview of some of the most influential types of planning, in the post war period, which had an impact at a global scale. In the following we will focus on the cases of self-management planning in Yugoslavia, indicative planning in France, and development planning in India.

Self-Management in Yugoslavia

The ‘traditional model’ of planning, in virtually every country in which it was adopted, soon or later went through a process of reform. From the 1950s onwards, socialist countries will start implementing decentralization measures, which usually involved the reintroduction of markets in some sectors and granting more autonomy to non-state economic agents.

The first country to pioneer this reform process was the Socialist Federal Republic of Yugoslavia (SFRY)³¹ having set up what was considered as an example of a “self-managed, participatory, labor-managed or socialist market economy” (Mencinger, 1986, p.31). Coming out of WWII with very significant casualties in terms of people, infrastructures and industrial capacity, the natural solution for the new Yugoslav communist government was to follow the Soviet example and push for rapid industrialization and reconstruction. For that end, a 5-year plan (1947-51) was designed, in which land and private capital were to be nationalized. The plan reached the goal of quickly restoring the economy to pre-war levels of output, through a big increase in investments directed at industry. Collectivization of agriculture was gradually attempted, however resulting in a decline in agrarian output. Already in 1948, a major political turn occurs and Yugoslavia is accused by Stalin of revisionism and ‘anti-Sovietism’ in its policies (Horvat, 1976). Disagreements about Yugoslavia’s foreign policy, the role of the Communist party in society and the process of collectivization were the pretext for a dispute with the USSR which ultimately led to SFRY’s expulsion from Cominform³² (Drulovic, 1973). This event had a sharp and immediate economic impact. By 1949, development loans and trade with eastern partners – which represented more than 50% of total exports and imports – were reduced to zero. Isolated from the communist world and with a general feeling of disappointment about the outcomes of the centralized model, an internal

³¹ Hereafter Yugoslavia. It was a federation of six republics – Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, Slovenia and Serbia with two autonomous regions (Vojvodina and Kosovo).

³²The Cominform (Communist information bureau) was an international organization constituted by European communist parties, which operated from 1946 to 1957.

debate about the appropriate Yugoslav path to socialism unfolds. From 1950 onwards, politicians and social scientists engage in a reappraisal of the concept and strategy of socialism, by re-reading the works of Marx, Engels and the classical socialist corpus³³. In this period, two figures emerge as the main theoreticians of Yugoslav socialism: Boris Kidrič - president of the economic council and chairman of the planning commission - and Edvard Kardelj - one of the leaders of the Yugoslav Communist party, later renamed the League of Communists. Both were critical of Soviet socialism, particularly opposing the idea that the state should control the means of production and that a bureaucratic class should decide in the name of the proletariat (Boffito, 1968, p. 15). In an article written in 1950, Kidrič (as cited in Horvat, 2016, p. 10-11) stresses the importance of moving away from state socialism and bureaucracy to build a socialist democracy:

“State socialism represents... only the first and the shortest step of socialist revolution... Persisting in state (bureaucratic) socialism... unavoidably leads to an increase and strengthening of privileged bureaucracy as a social parasite, to a suppression... of socialist democracy and to a general degeneration of the system into... state capitalism... The building of socialism categorically requires the development of socialist democracy and a bold transformation of state socialism into a free association of direct producers.”

Kidrič's, who suffered an early death in 1953, still saw his ideas spread rapidly among Yugoslav social scientists and inspire a new constitution that came into effect that year. Curiously, that same year was marked by the death of Stalin. This event, and the consequent change in the Soviet leadership, will gradually result in an easing in military tensions and the re-establishment of Yugoslavia's political and economic relations with its eastern neighbors. In Kardelj (1955, p.9), we can see a continuation of Kidrič's idea of socialist democracy into a direct democracy based on self-government:

“(...) with the development of socialist relationships, the organizing mechanism of the classical bourgeois democracy will also gradually transform itself into a system of direct democracy which will be based on broad self-government of men in all fields of social life, that is to say, into a system wherein men will not be acting as the adherents of this or that party but as conscious social workers adopting their attitudes to concrete

³³ For a complete overview of the ideological sources see Horvat et al (1975).

social problems independently (...) Such a development of direct democracy will simultaneously mark the process of the withering away of the state as an instrument of class consciousness as well.”

Thus, the development of socialist democracy will gradually originate from the development of socialist relationships, which will result in a system of direct democracy that is ultimately a process of withering away of the state, resonating back to the Marxist tradition and the writings of Engels (1880). At the heart of this democracy lies the principle of self-government, or self-management³⁴. According to Kardelj (1976, p.3), this principle dates back to the time of the Nazi occupation, when it emerged as a way of partisan organization of liberated territories and production units³⁵. It generally meant the direct participation of citizens on issues at the level of their local commune or, in the economic realm, the control of decisions directly by workers participating in the activity of an enterprise. Both the communes and the enterprises were to be organized in councils of citizens and workers, respectively, who elected delegates to form managing boards and take decisions.

From the 1950s onwards, the Yugoslav state initiated a reform process. In law, it approved a new constitution, in 1953, in which the principles of socialist ownership and self-government were central. The Communist Party was transformed from a political party to what Horvat (*ibid.*, p.13) called a “political activist’s organization” - the League of Communists. In this reform process, the state pushed for a decentralization of decisions, transferring power to citizen and worker’s councils. The role of the state, prior to its withering away, was centered around the promotion of self-government and decentralized decision making, guaranteeing social property, promoting worker’s consciousness and education, coordinating local interests with federal and republic goals and conducting foreign policy (Kardelj, 1955, 1976).

In this new political system economic planning greatly differed from the Soviet-type of plan implemented in the 1947-51 period. A new type of planning emerged, in which the plan no longer binds the enterprises to a pre-established target. The determination of what and how much to produce was directly decided by labor-managed enterprises, and prices determined,

³⁴ The original term *samoupravljanie*, or *samouprava*, in serbo-croatian and other slavic languages admits both translations. Some authors, such as Horvat use the term self-management to denote self-government applied to business firms,

³⁵ Kardelj goes even further in claiming that self-management was still present and important during the post-war years and the first central plan, becoming one of the causes of the conflict with Stalin. However, Mencinger (1986, p.34) classifies this as not accurate ‘official rhetoric’ and points out that in Kidric’s writings before 1950, state control was still considered the highest form of property. Only after the conflict with Stalin self-management emerges a central concept to economic practice.

in general, through free market forces³⁶. Planning, in this framework, besides its psychological (or moral) impact, fulfills three basic roles, according to Vanek (1967, p. 381): minimize misallocations of resources and disequilibria of all types; transferring decisions concerning the rate of capital formation and savings from the sphere of consumers' to the sphere of social (or political) sovereignty; regional, and in some cases, sectoral, equalization of income distribution. In this system, the central authorities still kept an important role in guaranteeing market stability, limiting market concentration, monopolistic practices and inflationary influences, as well as promoting economic growth, by guiding investments and harmonizing development across very different regions. To that end, a combination of fiscal, credit, price, wage and foreign trade instruments was at the planners' disposal, through which individuals and economic organizations were indirectly induced to take actions leading to the fulfillment of planned targets (Horvat, 1976; Waterson, 1962).

In Yugoslavia, in contrast with the Soviet Union, in the official discourse markets were not seen as opposed to the construction of socialism, but rather as an essential mechanism for the promotion of enterprise efficiency:

“Enterprises compete with one another, for the market is a free one. Qualitative production and lower prices are what decides their market success. This pressure of market competition in respect to more favourable prices and superior quality, together with a certain dependence of the material status of the whole working collective, and of the whole community even, upon the market success provides a stronger stimulant for quality production than could any administrative control whatever.” (Kardelj, 1955, p.19)

Markets in the Yugoslav context performed a double role. On the one hand they were seen as mechanisms for the improvement of economic efficiency through competition, bringing about “favourable prices and superior quality” and providing incentives for worker motivation and effort, since worker earnings – set by worker’s councils – and contributions to the local commune were dependent on enterprise performance. On the other hand, markets were important for the policy shift towards the promotion of personal consumption. Starting in the mid-1950s, policy makers focused on creating a consumer society and increasing standards of living. In contrast, with shops in the Eastern Bloc, shops in Yugoslavia displayed a great variety of domestic and foreign products. Authorities expected that feeding consumer

³⁶ Exceptions to this are prices regulated by the authorities to prevent extreme inefficiencies in resource allocation or income distribution (Vanek, 1967, p.380).

dreams of the Yugoslav worker would result in increased effort and motivation and overall benefit economic growth (Le Normand, 2014).

Far from static, the Yugoslav economic system evolved and changed over time, through the approval of several laws and constitutional changes. In the previous paragraphs a general overview of the system and its main principles was attempted for the period from 1953 to 1990, at the cost of simplifying sometimes ambiguous processes of decentralization and recentralization that occurred until the end of SFRY³⁷.

In the field of international relations, an outgrowth of the idea of self-government was the non-aligned movement, which Yugoslavia was one of the leaders. Having been formally established in 1961, in Belgrade, the non-aligned movement rejected the division of the world in 2 blocks of countries - one under the influence of the USSR and the Warsaw Pact, the other under the influence of the USA and NATO. The movement sought to promote “peaceful coexistence, national equality and democratic unification of peoples through active cooperation rather than through the creation of hegemonic systems” (Kardelj, 1976, p.86) a message that appealed to many newly independent post-colonial countries. Through this movement Yugoslavia spread its political influence and exported its economic model across the globe. The good diplomatic relations that Yugoslavia held with numerous countries allowed for economic opportunities for Yugoslav companies, which were present in many countries, particularly in the global South.

Finally, but not least important, the Yugoslav model, and particularly the idea of worker’s self-management had a considerable influence in industrial debates and labor movements in Western Europe (Zaccaria, 2018) and inspired works on the theory of participatory labor-managed economics such as those of Jaroslav Vanek, Branko Horvath, or Benjamin Ward well into the 1980s. It is from this tradition that some contemporary planning models, such as those of Robin Hahnel and Pat Devine – among others - that we have seen in the previous chapter, come from.

Planning Capitalism

Besides socialist countries, in capitalist countries, at different periods, to different degrees, planning was an important resort during the 20th century. In countries such as the Netherlands,

³⁷ An account of these changes can be found in the work of Mencinger (1986, 2022), who analyzing these changes identifies 4 main distinct periods in Yugoslav economic history: 1945-1952 – administrative socialism; 1953-1962 mixed administrative self-managed market economy; 1963-1973 – labour-managed market economy; 1974-1990 – contractual socialism.

France, Italy, Norway, or in the East, Japan and South Korea some type of planning was implemented for economic recovery and development after the Second World War (WW2).

However, planning in the capitalist world does not start in the post-war period. Its roots go back to the beginning of the century to the first world conflict. According to Jacques Sapir (2022), in the industrial era success in war has become increasingly dependent on logistics and organization than ever before. Since the XIX century, wars became industrial challenges in the same way that factory management started to resemble army organization. With the beginning of WWI belligerent countries were faced with an enormous challenge of producing weapons, ammunition and all kinds of supplies at an unprecedented scale and creating new supply chains to support the military, sometimes fighting thousands of miles away. To face these challenges, countries such as Germany, France, the USA and Russia restructured their economic institutions and activities and imposed restrictions on the market mechanism, opting for a centralized allocation of resources. Thirty years later, during WW2, similar reconfigurations happened with the war endeavors being organized through centralized measures. According to Isabella Weber (2021, p. 65) during WW2 “all major powers, with the exception of China, implemented price and wage controls that were far more comprehensive than those of the First World War”.

The USA, a country usually associated with free markets, presents an interesting experience in economic planning during WW2 which will later influence other experiences. After a short experience in economic mobilization during WWI, with the War Industries Board controlling the allocation of steel in the economy, and New Deal politics of state intervention, in the interwar period, the WW2 will mark the most comprehensive exercise in economic mobilization of American history (Sapir, 2022, p.59-68). Mark Wilson’s (2016) book tells the story of how “public investment, public management of industrial supply chains, and robust regulation” were crucial to turn American military-industry into what Roosevelt called the world’s “arsenal of democracy”. During this period, “the government paid for, and owned, acres of new industrial plant; it managed complex supply chains. It collected huge amounts of information about its contractors’ costs and business operations, which helped it to strictly control prices and profits. It even seized the facilities of several dozen companies, including those led by executives who flouted federal labor law.” (ibid., 4)

One of the main protagonists of American war planning was J.K. Galbraith³⁸. At the helm of the Office of Price Administration (OPA) he introduced price controls, price freezes,

³⁸ Despite being sacked from the OPA, in 1942, the measures introduced by him stayed in place until the end of the war.

rationing and wage controls in several agricultural and industrial companies to control inflation in a period in which the labor force reached full employment (Weber, 2021, Ch.2). Despite critiques by Hayek and von Mises (ibid., p.86), Galbraith's measures revealed effective in keeping prices down while increasing GNP at the same time.³⁹ After being gradually lifted, in the post-war period, prices controls were reintroduced again during the Korean War (1950-53) and in the years 1971-73 by Nixon in the context of the Vietnam War (ibid., p.87), with then Milton Friedman joining the critics.

Despite have used strong state intervention to influence production and control prices, during war periods, we cannot talk about an American lasting planning model. In contrast, across the Atlantic, France felt a need to direct its economy in the post-war period, setting up an economic planning system that will last until 1992.

France

Before setting up its main planning institution, the *Commissariat Général du Plan (CGP)*, France had already some experience of state interventionism. The most relevant was the experience in WWI in which a system of coordination between the State, enterprises and workers was put into practice to manage production and distribution efforts (Sapir, 2022, p.38-42). During WW2, the Vichy regime had put forth the first planning instruments and among the French resistance planning the future of the country was a common topic of debate, involving figures such as Pierre Mendès France and George Boris. Despite coming to occupy important political offices, in the post-war period, both Mendès France and Boris will not be able to see their planning proposals approved. It was instead an initiative by Jean Monnet, at the end of 1945, that got the approval of general de Gaulle, then prime minister of the provisional government. Monnet proposed a national plan for the reconstruction and modernization of France, searching for a balance between incentives and discipline:

“From liberalism, the 1st Plan rejects profit as the only guide to the economy, but resorts to it as a stimulus. From bureaucracy, the Plan rejects intrusive and finicky interventions. But, from interventionism he retains the need to discipline reconstruction in the name of the sole criterion of the general interest”. (Monnet, as cited in Sapir, 2022, p.165)

The fact that Monnet was responsible for the first plan, introduced an important American influence in French planning. Monnet had close connections with American planners during his official missions to the United States, including contacts with members of the War

³⁹ Galbraith reflects on his experience with price controls in his book *A Theory of Price Control* (1980) from 1952, with price control recommendations to control peacetime inflation.

Production Board, which helped him define the general lines of his plan (Mioche, 1984). Following Monnet's initiative, in 1946 the CGP is set up with the objective of presenting a plan in the following six months. The goals to prioritize were the increase in national production and foreign trade; increase in labor efficiency to the level of the most developed countries; achieve full employment; increase the standard of living of the population and reconstruct production facilities and equipment lost during the war. As a means for the plan, the official decree establishing the *Commissariat* provided planners the authority to access a wide range of statistics and information, both from public and private sources.

The first plan established ambitious targets for six key industries: coal, electricity, steel, cement, agricultural machinery and transport, with fuel and nitrogen being added later. During the period of the plan, France also benefited from investment funds from the US Marshall Aid program, which was integrated with the plan and led to an extension of its deadline to six years (1947-53) (Masse, 1962, p. 6). The first plan goals were set from the need to recover the country from a difficult post-war situation. The focus on supplies, machinery and equipment was meant to quickly restart industrial activity, not only to rebuild the country, but also to materially guarantee national security in case of an eventual conflict (Sapir; 2022, p.179-83).

Regarding the planning process, the plan started from an estimation of a global macroeconomic rate of growth established by the CGP and the Treasury (*Trésor*). Subsequently, the government would submit a directive expressing its goals for aggregate areas – such as balance of payments, regional balance, education, housing, etc. Then the *commissariat* proceeded with discussions and meetings among sectoral/industry sub commissions to disaggregate the targets into detailed objectives. These commissions could create workgroups to discuss specific problems in their respective fields of the economy⁴⁰. The work of the sub commissions not only allowed to identify local priorities and reach some consensus, but, more importantly, to harmonize - consciously, or unconsciously - points of view and anticipations, something that Hayek had argued was the main intrinsic force of the market system. Finally, the plan was submitted to a number of consulting organs, connected to ministries and interest groups, before ultimately being submitted to parliament for approval (ibid., p.168-9). In this big iterative coordination exercise estimations of income-elasticity and input-output tables, as well as forecasting methods, were important to arrive at coherent targets. Thus, French planning appears as a big communication exercise, aiming to provide

⁴⁰ The number of commissions was not fixed and neither the workgroups set by them, but they could involve up to thousands of people. For instance, while preparing the fourth plan 3000 people were involved in the workgroups, while the CGP only had around 40 permanent workers at the time.

information and coordinate economic agents' intentions and expectations, to achieve specific economic and social targets. Looking back at Hayek's arguments, in chapter 1, in claiming that the market system is the most efficient because of the information it processes and generates, it is curious to see that for French planners the crucial reason to plan was precisely to provide a communication infrastructure able to deliver information to economic agents in order to coordinate their actions. While in a non-planned market system each individual agent is very interested in obtaining as much information as it can, often they will not be interested in disclosing information about their actions to others, restring public information on their future actions. Similar to a prisoners' dilemma situation, where it is in each one's best interest not to cooperate, society ends up in a suboptimal (non-Pareto) equilibrium, do to non-disclosure of information. To transition to the Pareto equilibrium, society needs an agent concerned with global efficiency who can introduce (and enforce) a mechanism for information disclosure. That agent is the State and its mechanism is planning.

From the 5th plan (1966-70) onwards the methods of planning start to incorporate more refined mathematical techniques, culminating in the Fifi (Physico-Financial) model introduced in the 6th plan. The Fifi was computer model of the whole economy comprising its interdependencies and allowing to simulate the impact of different economic policies to the overall result (Aglietta & Courbis, 1969). This model, expressing the relations between physical and financial variables, attracted attentions across the iron curtain, particular that of Hungarian planners who were in contact with French planners during the 1970s (Gouarné, 2018).

In his book, *Le plan ou l'anti hasard*, Pierre Massé (1965), head of the CGP during the period of the fourth plan (1962-65), presents his view on the general goals and characteristics of French planning. According to Massé, above other things, the plan is characterized by its spirit (*esprit*) of coordinating all social and economic powers of the country (ibid., p.152). For him planning is a symbol of a development conscience, representing an active will to put effort and ideas in the service of stable and balanced progress (ibid., p.164-5). Furthermore, the plan increases the coherence and rationality of State decisions by situating them in a common framework, liberating also the market from useless or unfavorable interventions. Far from being an instrument of dirigisme, the plan brings transparency to the economy, by simplifying it (ibid., p.166-7). For Massé, the market systems' ineptness in correctly guiding firms' decisions regarding a distant and uncertain future, legitimizes the activity of the CGP (p.168). Overall, for Massé the plan is seen as a powerful instrument to reduce uncertainty (*anti-hasard*) in the economy.

The French model of planning is usually called an example, or even the prototype, of ‘indicative planning’. However, authors such as Sapir (2022) disagree with this taxonomy. While ‘indicative’ relates to the fact that plan targets were not binding, the authorities could however use many instruments - such as legal, fiscal or credit - to make enterprises adhere to the plan, making it in their best interest to comply. For Sapir thus, French planning is wrongly called indicative and should be better called *concertation* (coordinative), not excluding a coercive element when necessary (ibid., 196).

In total planning guided France from the post-war period until the financialization of its economy, happening in parallel with the European integration. This experience spanned from 1946 until 1992, with a total of 10 plans approved. After progressively losing its influence, in 1992 planning was abandoned and the role of the CGP transformed into a prospective studies institution, allegedly due to an increase in global economic uncertainty, but also due to political options (ibid, 212-13).

The period from 1950 to 1970 marks the high point of French planning, with the French economy achieving steady annual rates of growth around 5%⁴¹, despite the constraints imposed by the colonial war in Algeria (1954-62). The good economic results inspired other countries such as Belgium and the United Kingdom to adopt planning institutions and similar methods to those used in the CGP.

After 1970, planning became less effective. The oil shocks of the 1970s, the increasing international competition, the constraints imposed by European integration and the financialization of the economy, all introduced uncertainty and constraints in the planning process, which contributed, according to Sapir (ibid., p.200-1), to its gradual dissolution. Realizing the constraints on planning imposed by the European integration, advocates of French planning, more prominently Robert Marjolin, encouraged the attempt to push through the idea of planning among European partners. This attempt, however, faced the resistance of German officials, who rejected any long, or medium-term planning attempts - being only favorable to short-term forecasts - leading to the failure of the French proposal to establish planning at a European scale (Caldari, 2019).

Planning for development

At the time when France and Yugoslavia were institutionalizing their planning systems, a wave of decolonization movements was swiping out the old-world political borders.

⁴¹ These rates compare favorably with those of the UK and the USA, in the same period and are similar to those of Italy – which also resorted to a form of economic planning.

Particularly in Africa and Southeast Asia, many recently independent countries were facing the challenges of setting up new States and economic institutions able to secure independence and development. At the height of the cold war and bloc division, many countries chose to follow the Soviet model, which ideologically and materially supported anti-colonial movements abroad, while others opted for a third way, between capitalism and Soviet socialism, inspired by the non-aligned movement. Among the co-founders of this movement, alongside Yugoslavia, was Jawaharlal Nehru's India. Gaining independence shortly after the end of WW2, in 1947, India's experience in building a democratic government and a planned economy served as a beacon for post-colonial countries in the global South. As the title of Nikhil Menon's (2022) book summarizes, "Planning Democracy", in India the political and the economic realm were seen as highly interdependent. In the following, we will delve into the history and specificities of Indian planning and its worldwide influence.

The origins of Planning in India predate its independence, by roughly a decade. Already in 1938, a National Planning Committee (NPC) is set up by Congress president Subhas Chandra Bose. By then, planning gathered a wide consensus throughout the country, being backed not only by socialists, but also by nationalists and capitalist supporters of industrialization. Even businessmen such as Ghanshyam Das Birla⁴², argued for planning of major public works, import-substitution – which would protect them from foreign competition - and the reduction of inequalities as a way to avoid social tensions that might lead to a communist revolution (Menon 2022, p.6). At the helm of the Planning Committee was designated Nehru, future prime minister of independent India and one of the fiercest advocates of planning. For Nehru planning was seen as the only effective way of transforming India from a "civilization of classical antiquity into a modern nation-state" (Chakrabarty, 1992, pp. 276–277). Inspired by the economic achievements of the Soviet Union - which he attributed to planning - Nehru pushed in Congress for heavy industrialization reforms facing the resistance of more conservative parties and figures such as Mahatma Gandhi. Despite the strong opposition, the support from Chandra Bose and the British ruling elite were enough for the establishment of the Planning Committee. Nevertheless, the conflict between Nehru and Gandhi over the need to industrialize greatly constrained the activity of the Committee and accentuated divisions in the nationalist movement, until in 1940, during WW2, the NPC is suspended.

⁴² The Birla group is to this day a big multinational conglomerate group, headquartered in Mumbai, India. In 1944-5, Birla and other seven influent industrial businessmen proposed a post-independence economic plan - the Bombay plan – focused on import-substitution industrialization. The plan was never accepted by Nehru, but its influence conquered a place in Indian plan mythology (Sapir, 2022, p.79-82).

During the colonial period, one of the main arguments in favor of India's independence was that the exploitative nature of colonial rule impeded the country's economic development (Menon, 2022, p.5). After India got independent, in 1947 - and the country stabilized after a period of civil war and the partition of Pakistan - the time was ripe to finally steer India's economic policy and open the way for development.

An important theoretician and planning advisor to many governments in the underdeveloped world - including India - was Charles Bettelheim. Originally from France, Bettelheim (1971) described the economic challenges of post-colonial countries and argued in favor of strong state intervention as a pre-condition for economic development in post-colonial countries:

*"The experience of all underdeveloped countries shows that economic laissez-faire leads to a growing gap between the level of underdeveloped countries and that of industrialized countries. Therefore, only a policy led by the State itself - provided, of course, that it is carried out properly, boldly, and courageously - can gradually put an end to underdevelopment."*⁴³(*ibid.*, 47)

Already in the 1950s, the same insights, could be found in the debates on Indian planning and development. The plan seemed the best – and for many the only - way to start a rapid modernization process and improve material conditions for the most needed part of the population. Indeed, the eradication of poverty was seen as a precondition for the effective use of civil liberties, creating a knot between economic development and the construction of a democracy (Menon, 2022:16). Planning, thus not only answered the ambitions for rapid economic growth but also the need to legitimate the new State apparatus. At the head of the new State was prime minister Nehru, who will hold the office for 16 years (1947-64) and leave its imprint in the configuration of the Indian state. Sympathetic to socialist ideas, Nehru considered socialism “after all not only a way of life but a certain *scientific approach* to social and economic problems” (as cited in Chakravarty, 1989, p. 103). Central to this ‘scientific approach’ was the idea of organizing the economy through plans, which, he believed would allow to resolve conflict and overcome divisions in a large and heterogenous subcontinent (Chakravarty, 1987, p. 3).

In 1950, the Planning Commission is created by a cabinet resolution, technically as an advisory organ. The president of the Commission was the prime minister himself who

⁴³ Translated from the original: “L'expérience de tous les pays sous-développés montre que le laisser-faire en matière économique conduit à un écart croissant entre le niveau des pays sous-développés et celui des pays industrialisés. Aussi, seule une politique menée par l'État lui-même, à condition bien sûr d'être menée correctement, d'être audacieuse et courageuse, est capable de mettre fin progressivement au sous-développement.”

nominated the vice-president. The Commission was comprised by experts for topics such as economy, industry, science and administration and some of the government ministers also made part of the organ (Sapir, 2022, p.82-3). This *sui generis* configuration of the commission meant that planning was not to become independent from the government - which contrasts with French planning, where the plan was developed in an independent organization and ultimately had to be approved in parliament. Indian planning reflected Nehru's development priority which he believed would be better advanced by shielding planning from political ideologies and conflicts (Menon, 2022, p.11). Instead of political plan approval, authorities focused on increasing 'plan consciousness' and 'democratic planning' with mass popular campaigns. These campaigns were seen not only as an instrument to legitimize the plan, but also the new State and democracy itself (ibid., p.17). Bollywood films, public exhibitions, magazines and media campaigns about the plan all contributed to kindle popular plan enthusiasm, grant popular approval to a technocratic process and more easily obtain essential information for the plans from statistical surveys – which played a crucial role (ibid., p. 119-65).

Indeed, according to Menon (ibid., p.25-52), the development of national statistics will be closely tied to the development of economic planning. At the beginning of the works of the Planning Commission the lack of good statistics was a constant complaint. An essential tool for the planning process is the availability of data, not only to get a correct picture of the state of the country, but also to define what is important to measure and later evaluate the outcomes of the policy taken. Nehru, already from his experience as head of the NPC, acknowledged this interdependency between statistics and planning and soon started a collaboration with the 'father' of Indian Statistics: professor Mahalanobis. Mahalanobis, a polymath physics professor, who was internationally recognized for his pioneering work in statistics⁴⁴, was at the helm of the country's main statistics think tank in the 1950s - India's Statistics Institute. Already in the 1930s the Institute had built its reputation by conducting innovative work on random data sample surveys, an area in which it achieved worldwide recognition. Within months of the creation of the Planning Commission, a Central Statistical Organization was established with the objective of providing the data that central planners were lacking. Mahalanobis and his Institute, through statistical expertise, will play a strong role in the discussion of economic plans. Already in 1950, the first country wide periodic exercise in data gathering - the National Sample Survey – is approved, becoming the first worldwide to

⁴⁴ This recognition led him to be voted Chairman of the UN Statistical Commission, multiple times, during the 1950s (Menon, 2022, p.37).

apply random sampling to household surveys. At the same time under the coordination of the Statistical Organization, India starts to regularly calculate national income.

With time, through his expertise in statistics, Mahalanobis becomes such a prominent figure in the discussions of the Planning Commission that he is considered the mastermind behind the second Five-year Plan, which set the planning principles that were followed by planners until the market reforms in the 1990s. While a first five-year plan was put in place, from 1951-56, it emerged in a very difficult context after the partition between India and Pakistan, which caused millions of casualties and refugees. Its focus was on agriculture – to face food shortages and the refugee crisis - and transport and electricity infrastructures. Its targets for economic growth were largely surpassed, due to good agricultural years (Sapir 2022, p.85).

With the second five-year plan, launched in 1956, the objectives and methods of planning changed to what will become the future standard planning framework. Focused on heavy industry, machine production and the creation of a vast public sector, the second plan predicted the doubling of public investment. The goal was to create a national industry able to substitute overtime capital and goods imports, appealing to the patriotic and nationalist values of the newly independent country. This strategy was focused on the long-term development of the country and asked Indian citizens to forgo present consumption for the benefit of a future national industry (Chakravarty 1987, p.7-18). The phrase “You can’t build the future on Coca-Cola” pronounced in parliament a few years later by prime minister Nehru summarizes this strategy (as cited in Menon, 2022, p.72). Regarding methods, while the first plan was based on a Harrod-Domar growth model, the second plan used the Harrod-Domar model to predict the development of agriculture and the Mahalanobis model - a new multisector mathematical model - to determine investment allocations in the other sectors of the economy (Chakravarty 1987, p.7-18). The second plan laid the foundation for successive Indian planning models, which continued to follow the strategy of prioritizing the capital goods sector. With time and through planning India instituted a mixed economy, with a strong public sector controlling investment and resource allocation and a private sector, heavily regulated by controls and licenses.

Over time and particularly after the 1960s the consensus over the idea of planning started to erode. War with China and Pakistan, political instability and the influence of old business elites complicated the work of planners and raised public disbelief in their strategy for economic development. Finally, in 2014, by order of prime minister Narendra Modi, the Planning Commission ended. However, as Menon argues (2022) Indian planning remains important in the history of twentieth century, by its international influence and achievements

in statistical methods, protagonized by Mahalanobis. Countries such as the United States and the UK closely looked at the Indian National Survey methods to inspire their domestic statistical operations, which remains an incredible achievement for a post-colonial country in its early years of independence.

4. Concluding remarks

With the advent of the 20th century came an unprecedented in history wave of attempts to shape and control the destiny of whole societies. Born from the necessity of guiding a country's production and distribution efforts during war periods, these attempts gradually spread – geographically and in time - to encompass the whole of society during peace periods. The first world war, and later the second, marked a paradigm in these attempts. The relative success in shaping their economies to the needs of war showed to western countries, from then onwards, that they did have to follow blindly market forces and could control the running of their economies (Milward, 1980, p.100).

Besides western countries, the success of planning spread throughout the world also due to the prestige achieved by one of the victors of WW2 - the Soviet Union. Having transformed a mainly rural country into an industrialized society capable of defeating Nazi Germany, popularized the Soviet economic model throughout the world. In Section 2, we traced the origins of the Soviet planned economy and how the latter was constrained by the need to assure the survival of the revolution amid numerous military threats. Planning was necessary to kickstart the industrialization of society, that would guarantee the country's defense efforts in case of war. More than a 'genetic' evolution from the conditions of the time, planning was meant to make possible an unachievably fast transition, by galvanizing all the citizens to participate wholeheartedly in the plan tasks. This teleological drive of planning, in higher or lower degrees, was present in all the planning experiences discussed in this chapter. Both Yugoslavia, France and India explicitly backed their plans with the idea of guiding their societies towards a desirable progress expressed in goals set by the authorities. In a way, this represented a kind of technocratic control set by experts through the establishment of targets to be achieved. Dichotomies such as the one between the 'left' and the 'right' in the Soviet industrialization debate were also felt in other countries, with most following the Soviet example of rapid industrialization due to the perceived success of its model. This was the case in India (Chakravarty, 1987), and Yugoslavia (Horvat, 1976) before 1950.

A common trace to the four planning systems analyzed is the need to legitimize the State and start something new through planning after a difficult period of its history (Menon, 2022). The USSR wanted to break with the tsarist State tradition; Yugoslavia to do away with the monarchy of the interwar period; France to overcome the trauma of the Nazi occupation; India to build an independent state after colonial rule. As we saw in section 3, for Yugoslavia planning was associated with the goal of building an economic democracy (Kardelj, 1955) as well as in India, where development was essential to reduce poverty and allow for effective participation of its citizens (Menon 2022).

While these countries adopted some type of planning, the way they shaped their system and their economies showed considerable nuances and differences. In the Soviet Union planning was imperative, providing specific targets for producers and prioritized heavy industry, in detriment of consumer goods (Ellman, 2014). In Yugoslavia, after the second plan, it prioritized consumer goods industries and producers were free to determine how much to produce and at what prices, with the planning authorities trying to harmonize global outcomes (Vanek, 1967). In France, planning was an exercise in ‘uncertainty reduction’ through the coordination of economic agents to achieve pre-determined goals (Masse, 1965). In India, it focused on import-substitution industrialization led by heavy state investments and it hoped to be the main instrument for development (Menon, 2022). From these diverse– and still very incomplete on a global scale – analyzes we see planning as a flexible system, able to adapt to particular historical circumstances and different societal challenges.

In what regards planning and the importance of information I believe two important lessons can be taken from this chapter. First, as we saw more explicitly in the French case, planning can be conceived as a mechanism to coordinate economic agents’ actions by reducing uncertainty about the future. Through a big communication exercise – involving meetings, work groups and stakeholder discussions, as was French planning - information is disclosed that can be relevant to harmonize individual actions and lead to a better social outcome. Second, we saw also how planning was an important driver in the development of statistic institutions, national accounts and statistical measures. Planners’ need for information led to the development of new methods for gathering (objective) information and new techniques to process it. This contributed greatly to the use of more quantitative models and methods in economics, which later computerization greatly enhanced. Related to the USRR, many important contributions to economic theory, from Leontief, Feldman, or Kantorovich – to name some of the most famous ones - were created taking into account methods developed for the planned economy, or to answer its needs. In India too, figures such as Mahalanobis

and his random data survey sampling methods presented important contributions to world statistics and national accounting. These methods aimed to provide planners with the necessary information for establishing their plans and measure success. As the economy grew more complex and interdependent, along with the models representing it, new challenges emerged related to how to handle these informational and computational requirements. As we will see in the next chapter, an important tool will emerge in the mid-century which will open new possibilities and shape the discussions on the promises and limits of planning systems: the computer.

Chapter 3: Computers and Economic Planning in the Soviet Union

1. Introduction

The relationship between information, computation, and economic planning has been a central theme in economic thought for over a century. As we saw in chapter 1, in the early 20th century the socialist calculation debate opposed advocates of central planning against proponents of market economies, with figures such as Ludwig von Mises and Friedrich Hayek arguing that the absence of decentralized price signals would render socialist planning ineffective. They contended that rational economic coordination required vast amounts of dispersed knowledge, which only market mechanisms could efficiently process. In response, thinkers like Oskar Lange and Abba Lerner proposed that a socialist economy could, in principle, simulate the price system through trial and error methods, in what they presented as a market socialism system. However, these debates remained largely theoretical and had little practical relevance in shaping how real planned economies worked. Nonetheless, debates on how to organize, process and control information were central for the discussion of reform of post-war central planned economies, not so much because of theoretical critiques by Austrian scholars, but because of manifest inefficiencies in the planning system and the advent of a new promising machine, the computer.

The Soviet experience with the computerization of economic planning represents one of the most ambitious attempts to resolve the informational challenges of a centrally planned economy. Projects like the OGAS⁴⁵ and ASPR⁴⁶ were designed to direct the power of computation to improve economic coordination, automate data collection, and introduce mathematical optimization of planning decisions. One of the main architects of OGAS, Viktor Glushkov (Glushkov et al., 1964; Glushkov & Dalas, 1981), projected a nationwide network of computing centers that would enable real-time economic management, bypassing the inefficiencies of bureaucratic information flows. This vision, if realized, would anticipate in some years, the appearance of the first prototype for the internet - the US ARPANET system - as well as more recent trends in cloud computing. Its ambition was to radically automate the processes of economic planning and offer a Soviet counterpoint to the computational developments occurring in the West (Peters, 2016).

⁴⁵ OGAS is the russian acronym for *Obshchegosudarstvennaya avtomatizirovannaya sistema ucheta i obrabotki informatsii* – All-State automatic system for information records and processing.

⁴⁶ ASPR is the russian acronym for *Avtomatizirovannaya sistema planovykh raschyotov* – Automatic system of planning accounts.

Today, as digital technologies increasingly mediate economic processes, the themes of the socialist calculation debate remain more relevant than ever. The rise of big data, artificial intelligence, and algorithmic decision-making has reopened discussions on the feasibility of planned economies in a digital age (Boettke & Candela, 2023; Morozov, 2019). Some scholars and technologists argue that modern computing capabilities—far beyond what was available in the Soviet era—could enable real-time economic coordination at a scale previously unimaginable, challenging Hayekian arguments about the superiority of market-based information processing. The growing influence of digital platforms, predictive analytics, and centralized data infrastructures has even led some to describe contemporary developments as a form of "digital planned economy" emerging within capitalist frameworks. By revisiting the Soviet experience with computerization, this article contributes to a broader understanding of how technology interacts with economic organization. While the OGAS and ASPR projects ultimately failed to create a fully automated planning system, their trajectory offers critical insights into the institutional, technical, and political challenges of large-scale economic computing. In this chapter we compare these Soviet computer experiments with the parallel development of computer-based economic management in the West. Our study highlights not only the technical limitations of the time – 1960s-70s – regarding the lack of qualified personnel, machine reliability, programming, etc.; but also, the different ways in which computing was framed within socialist and capitalist economic systems.

The study done in this chapter, therefore, serves a dual purpose. First, it reconstructs and contextualizes the experience of the computerization of Soviet economics and the information problems its planned economy faced. Second, it aims to put in contrast the experiences of Soviet and Western countries in the development of computing for economic applications.

2. The OGAS project: lost opportunity or gradual development?

2.1. Economic problems in the USSR

On the eve of the September 1965 Plenum of the Central Committee of the Communist Party, the Soviet economic system remained largely unchanged from the one established under Stalin to replace the New Economic Policy (NEP). While this system achieved significant accomplishments — such as transforming a backward economy into an industrialized powerhouse capable of sustaining a military industry able to defeat the Nazi invasion and become a global superpower (Allen, 2003) —it also generated a series of deep-rooted economic problems.

Following closely Ellman (1969, pp. 285–288), these issues were primarily rooted in the planning system. Enterprises received plan targets too late, and these plans were often revised or contained conflicting directives. The central allocation of capital goods frequently failed to deliver the necessary resources, and enterprises had little concern for the quality or usefulness of their output. Production distortions arose due to poorly specified targets, while enterprises deliberately concealed their true production capacities to secure easier targets. Innovation was widely neglected, and enterprises resorted to last-minute ‘storming’ at the end of the planning period to meet targets. Further, planning ‘subjectivity’ undermined economic efficiency, since managers prioritized securing achievable targets – easy plans – over increasing actual performance. Additionally, enterprises applied and received fixed capital without an assessment of prospective returns, which led to inefficiencies and misallocations.

With time, these structural flaws started to reflect in economic indicators. By the 1950s, economic growth and returns on investment declined. The new needs of Soviet society, now considering agriculture, personal consumption, and housing as priority sectors – when previously it had been focused on heavy industry and the military - constrained the system’s capacity of response in resource allocation. As the economy grew more complex, existing planning methods struggled to keep pace. The core challenges, as summarized by Ellman (ibid), were fourfold: collecting the necessary data; managing plan aggregation and disaggregation across commodities, enterprises, and time units; performing calculations within the available time frame; and effectively coordinating administrators. Since planners were not able to resolve these issues, enterprises received inconsistent plans, often too late, with frequent last-minute alterations, further disrupting economic efficiency.

While most of these economic problems were already manifest during Stalin’s time, an open and wide discussion on them had to wait for his death and the subsequent period of political thaw (Ellman, 1973). Khrushchev, Stalin’s successor, recognizing these issues, attempted to promote economic reform and encourage open discussion. In 1957, as part of this effort, he implemented the *Sovnarkhoz* reform, aimed at decentralizing the Soviet economy. This involved organizing the economy regionally, with regional councils (*sovnarkhozy*) taking the place of central ministries in decision-making. The objective was to foster local initiative, promote efficient regional development, and reduce transportation costs by encouraging regional specializations. However, this attempt at reform did not structurally change the function of the Soviet planning system and led to increased inefficiencies. It disrupted previous supply chains between regions, led to the priority of local needs over the plan,

increased bureaucracy and was met with resistance by many party officials. The failure of this reform, together with its consequences and other political issues, contributed to Khrushchev's removal from power. In 1965, the new administration headed by Brezhnev immediately recentralized economic control to a ministerial basis, abolishing the *sovnarkhozy*. During Brezhnev the focus moved from decentralization to improving planning and management methods, promoting thus the stability of the system, without significant structural changes.

While Khrushchev's did not dismiss the importance of automation and computers for the improvement of the Soviet economy, during Brezhnev - and particularly after the Prague spring, when discussions on wider reforms became harder - the promises of computer improvements to the economy became considerably more attractive, seen as a technical solution to the problem of reform. As Gerovitch (2008, p.340) puts it: "the Soviet leaders readily accepted the idea that economic problems could be solved merely by improving information flows and management techniques, without any radical reform". During this period a series of ministerial resolutions for the increase of efforts in computer development and computers methods were passed.

While Brezhnev's support for the computerization of the economy did not come from a firm belief in the powers of technology to solve economic problems - rather from a more conservative orientation towards reform - the fact is that many of these problems were connected to problems in handling data and calculations and could thus benefit from computational solutions. Before exploring the key proposals for computerizing the Soviet economy and planning system, we will first examine how computers and the cybernetic movement associated with them emerged in the USSR.

2.2 The rise of (economic) Cybernetics

For a nationwide discussion on the use of computers in economics to arise, according to Martin Cave (1980), a series of preconditions had to be met. The first of them was the acceptance of cybernetics and the theoretical effort to make it compatible with dialectical and historical materialism. Another precondition was the development of a Soviet computer industry. Initially, the USSR kept pace with the computer developments of the USA, but in the mid-1950s the Soviets were already lagging behind (Gerovitch, 2002). In the 1960s, an important breakthrough was made into second generation computers, which greatly increased operating speeds and reliability of the machines allowing for more ambitious computer applications. Finally, at the same time, the revival of mathematical economics, under the label

of economic cybernetics, played an important role in the discussion⁴⁷. Rather than limiting computers to production automation and data processing, Soviet mathematical economists envisioned the introduction of a system of optimal planning and management. At institutions like CEMI (Central Economic Mathematical Institute), formed in 1963, mathematical economists worked on the design of a state network of computer centers, serving as a technical base to optimal planning systems. In the following paragraphs we will explore the development of these preconditions into a nationwide discussion of computer networks for planning, in general, and the OGAS project, in particular.

The term *cybernetics* was first put in, with the publication of Norbert Wiener's *Cybernetics: or Control and Communication in the Animal and the Machine* (1948), and it was meant to denote the interdisciplinary field of control and communication theory. This field comprised ideas and concepts from many different disciplinary sources, from philosophy, mathematics, engineering, biology to literary and social criticism. It aimed at becoming a general science of control and communication, about the ways in which information systems organize life, the world and the cosmos. In its theory, parallels between animal neural pathways, electromechanical circuits and information flows in larger social systems were frequently drawn (Gerovitch, 2002).

A number of studies highlight the cold war military origins of cybernetics which framed its development and discourse on the topics of control and communication (Edwards, 1997; Galison, 1994; Pickering, 1995). Wiener himself came to the principles of cybernetics through his work on an antiaircraft motion predictor project, for the military. From the beginning, cyberneticians saw these principles as applicable beyond the military and engineering, extending into sociology and economics (Mirowski, 2001).

In the Soviet Union, cybernetics went through the same trajectory, from the military to the civil sector, though not without some turbulence along the way. Since the late 1940s, it proved essential to the military, in particular for the development of the nuclear program as well as ballistic missile and anti-missile systems, which required heavy calculations. However, on the ideological front, cybernetics faced strong public criticism. Until the mid-1950s, it was dismissed in the USSR as a *bourgeois* pseudo-science and heavily criticized. This critique stemmed more from its American (capitalist) origins – despite Wiener being critical of

⁴⁷ During Stalin's rule, mathematical economics methods were considered anti-Marxist. The discipline was dismissed and some of its practitioners purged. By the 1950s political economists dominated Soviet economic studies (Gerovitch, 2002, p.270). Only after the political thaw mathematical economist start to recover a place in the economic discussions in the Soviet Union. A comprehensive study on the history of Russian mathematical economics is the one authored by Belykh (1990).

capitalism - than from any of its concrete aspects or theories (Gerovitch, 2002; Peters, 2016). While American computers quickly spread from the military to the business world, in the USSR, the secrecy of military projects and the public condemnation of cybernetics resulted in a “monopoly of the defense sector over computer access” which delayed the development of a domestic computer industry (Gerovitch, 2002, p.141).

During the political thaw that followed Stalin’s death, in 1953, cybernetics was gradually reevaluated and gained public acceptance. As scientists were allowed to travel abroad and access foreign literature, cybernetics spread as a new language of science, objectivity and truth, sharply contrasting with the typical discourse of the Stalin era (ibid.). The computer gained popularity as an “all powerful magical tool for solving all kinds of problems” and the previous ideological critiques were quickly forgotten (Gerovitch, 2002, p.160). While the military continued to be the main driving force in cybernetic research—applying it to automated control systems, missile guidance, and air defense—there was also growing interest in using cybernetic principles for economic planning (Malinovsky, 2010). Figures such as Anatoly Kitov, Alexei Liapunov, Sergei Sobolev, who participated in the first military applications of Soviet computers, started to legitimize cybernetics in academic and scientific circles, by publishing books, papers and promoting seminars and talks. Together, these authors were central in shaping specific characteristics of Russian cybernetics, as Malinovsky shows in his book on the history of Russian computing (ibid).

During this period, the first attempts to apply cybernetics to economic planning emerged (Peter, 2016; Gerovitch 2002, Leeds, 2016). In 1956, Isaak Bruk proposed the use of military computers to process economic data. In the late 1950s and early 1960s, Kitov suggested using military computer networks to manage the national economy—an idea that, despite resistance from party officials, opened discussions on the role of automation in governance. Subsequently, Kharkevich and Kovalev proposed nationwide communication networks as a technical base for transitioning to a cybernetic model of economic planning and control. According to Peters (ibid), these proposals faced strong resistance from key planning institutions such as Gosplan (State planning committee), Gossnab (State supply committee), and the TSU, fearing to lose control over economic information in the centralized command system.

In parallel with these proposals, a cybernetic vision of the (communist) economy began to emerge from the writings of military cyberneticians. Kitov, (as cited in Gerovitch 2002, p.264), exemplified this vision when he wrote in 1961:

“the national economy as a whole may be regarded as a complex cybernetic system, which incorporates an enormous number of various interconnected control loops with various levels of subordination.”

As Gerovitch (ibid) explains, Kitov argued that only the application of cybernetic methods—mathematical modeling and computer simulation—could place economics on a solid scientific foundation: *“Computer modeling makes it possible to forecast economic processes and to conduct mathematical experiments in economics. Thereby economics turns into an exact experimental science.”*

With the generalization of these ideas, a growing interest arises in the application of mathematical methods to economics, paralleling similar trends in the United States. As Mirowski (2002) argues, the postwar rise of mathematical economics in the U.S. was deeply intertwined with Cold War concerns, with models from cybernetics, systems analysis, and game theory, spilling over from the military to civil domains. A comparable development took place in the USSR, where cyberneticians and planners sought to apply cybernetic methods—such as optimization algorithms, linear programming, and input-output analysis—to economic planning and beyond it, into new concepts of governmentality (Rindzevičiūtė, 2016). These methods mark a sharp contrast with those of Stalin’s era political economy and introduced a radical change in Soviet economic science (Leeds, 2016).

As cybernetics gained traction in the USSR, it secured increasing government support, leading to the establishment of specialized scientific institutions dedicated to its application across a wide range of fields, from industrial automation to economic planning. This institutional backing also spurred efforts to develop a domestic computer industry, though not without significant shortcomings. Unlike in the United States, where market forces drove rapid innovation, the Soviet industry struggled with bureaucratic inefficiencies, resource shortages, and lack of coordination between ministries developing computer projects (Gerovitch, 2002; Malinovsky, 2010). Nevertheless, this period saw the proliferation of Soviet-built computers, such as the BESM and MINSK series, which played a crucial role in advancing cybernetic research and economic modeling efforts.

Thus, by the early 1960s, a series of preconditions had been fulfilled, which propelled the discussion on the computerization of Soviet economics to a nationwide scale. These developments set the stage for one of the most ambitious attempts at creating a cybernetic system: the OGAS project, which aimed to create a nationwide computer network for planning.

2.3 Narratives on the OGAS

In the early 1960s, in a context of widespread discussions on political and economic reform, cybernetic visions of the economy promising increased efficiency through computerization drew the attention of Soviet policymakers. Although Kitov's earlier proposal for a double use of military computers for economic calculations faced little support, the government eventually recognized the potential of computing in economic management. In 1962, being familiar with Kitov's proposal Viktor Glushkov, director of Kiev's Institute of Cybernetics, presents a new proposal to build an automated system for economic planning and management on the basis of a nationwide computer network (Gerovitch, 2008). This proposal was generally supported by Kosygin, chairman of the Soviet Council of Ministers. Soon after, Glushkov was nominated to lead a commission responsible for preparing a detailed proposal. In this commission he sought to integrate economists in the project, including Nikolai Fedorenko, the head of CEMI, with whom he closely collaborated (ibid). In 1964, they publish a joint proposal for the system, which became known as the Nationwide Automated System for Computation and Information Processing (OGAS).

The OGAS consisted in a three-tiered computer network, connecting production units, regional computer centers, and a top-level computer center, serving the government. It was conceived as a communication system, collecting primary data from production units, on available inputs, resources, production capacities, and general statistical information - transmitting to a chief computer center in Moscow, with regional centers serving as intermediaries (Glushkov & Dalas, 1981). It sought to replace the cumbersome paper bureaucracy and the inefficient duplication of information gathering channels, consolidating everything into a single infrastructure where digital data could circulate and be accessible from different points within the network. As Peters (2016, p.109) puts it, "the OGAS Project might be seen as preceding, although not precipitating, the current trends in so-called cloud computing. The national network was to provide 'collective access,' 'remote access,' and 'distance access' on a massive scale to civilian users who could 'access,' 'input,' 'receive,' and 'process' data related to the command economy (...). The decentralized network was designed so that information for economic planning could be transmitted, modified, and managed in relative real time up, down, and laterally across the networked administrative pyramid". In this cloud *avant la lettre*, workers would be able to input their own information, reports and even contribute with recommendations on how to improve the workflow, at the factory level (ibid). Beyond information gathering, computer centers in OGAS would also run algorithms for planning calculations, based on the data received. One of CEMI's main

research directives, in 1964, along with the development of a unified system of planned economic information, was precisely the development of these algorithms (Peters 2006, p.140). Glushkov and his team of cyberneticians, saw in the implementation of OGAS the opportunity to apply new mathematical techniques, namely optimal planning techniques, to the whole Soviet economy.

In the past 20 years, the OGAS project attracted the attention of some scholars (Gerovitch, 2008; Kutejnikov, 2011; Peters, 2016; Zhabin, 2020), mainly focusing on the figure of Glushkov and the causes for the project's failure. This literature presents a 'lost-opportunity' narrative, blaming mostly the Soviet institutional framework and lack of cooperation for its demise. More recently, this narrative has been questioned by a series of articles by A. Safronov published in Russian academic journals (Safronov, 2019, 2020, 2022).

According to the main narrative on OGAS, the project was never realized and the computerization of planning was independently implemented in certain ministries, departments and industries, which resulted in incompatible systems. Institutional disputes were at the hearth of the failure in implementing the nationwide information network, meant to serve the purposes of planning. As Gerovitch (2008, p.342) points out, Glushkov's proposal was opposed from two sides: "Industrial managers and government bureaucrats opposed the computerization of economic planning and management because it exposed their inefficiency, reduced their power and control of information, and ultimately threatened to make them redundant. On the other hand, liberal economic reformers viewed Glushkov's proposal as a conservative attempt to further centralize the control of the economy and to suppress the autonomy of small economic units". Institutions such as the Central Statistics Administration (TSU) and Gosplan, who were in charge of collecting statistical information and formulating economic plans, respectively, also opposed Glushkov's proposal - seeing it as a threat to their control over information and decisions. Although approved by the Central Committee of the Communist Party, the project was constantly submitted for revisions to TSU and Gosplan, who were purposively raising obstacles and delaying it into oblivion. According to Gerovitch (ibid), since no consensus was found, ministries and other government bodies, started independently to adopt their own local computer networks, making them incompatible with other existing systems, and thus guaranteeing that they would not lose their control over information.

Costs were also a problem with the OGAS project⁴⁸, but for both Gerovitch and Peters, this was not a decisive factor, since other programs such as the nuclear and space programs, with which Glushkov compared the OGAS, were able to overcome similar technical and cost barriers. Thus, for Gerovitch, the main reason for failure of the OGAS lies in the fact that “the network threatened to upset the existing hierarchy of power in the economic sphere” (2008, p.343) in which control over information meant power. The end result of the cybernetic ambition to transform the Soviet economy into an optimal system of control and communication was that computers and networks were molded by their users (ministries, institutions) to reinforce existing power hierarchies and maintain control over information, reinforcing the original *status quo* (Gerovitch, 2002, 2008; Peters, 2016).

In his book on OGAS, Ben Peters (2016) proposes the concept of “heterarchy”, as a third way alternative model, between market and hierarchy, that helps to understand the function of the Soviet economy at the time. The concept is inspired by a cybernetic term coined by McCulloch, in 1945, to describe regimes of multiple orders. According to Peters (ibid), Soviet ministries operated within an heterarchical power structure – or a context of multiple hierarchies – in which they were, to some extent, free to ignore the orders of the Politburo⁴⁹ - in particular influential ministries such as defense - and to not cooperate and shut out peer-competitor institutions. In his proposal, Glushkov considered the Soviet economy as a hierarchical system, according to the official description of the system itself, and not as an heterarchical system, as it worked in practice. Thus, although claiming that OGAS would not considerably change the structure of the system, this was only true in theory, but clashed with the practical functioning of the Soviet political and economic organization. An important reason for this (and previous) project’s failure was thus the inability to analyze the system as it actually functioned, rather than as it was officially represented:

“The Soviet socialism that the Project sought to reform never worked as it planned in part because of the economic administration’s mismanagement of its own conflicting internal egotisms and mutinous ministers. Its political economic tragedy lies in the flooding of the gray economy with the informal self-interests that the planned interests of the command economy—especially a technologically rationalized one—could never accommodate. It was not the absence but the presence of vibrant unregulated markets of conflicting forces driven

⁴⁸ Gerovitch mentions that the OGAS would cost 20 billion rubles (2008, p.343), over 15 years, while Peters (2016, p.114) mentions that costs could go up to 160 billion rubles, according to varying estimates. Simpler versions of the network were also proposed with more reduced price tags, but always in the order of billions of rubles.

⁴⁹ Central Committee of the Communist party.

by self-interested administrators that kept the Soviets from networking their nation and command economy. In another sense, the Soviet networked command economy fell apart not because it resisted the superior practices of competitive free markets but because it was consumed by the unregulated conflicts among institutional and individual self-interests(...)" (2017, p.187)

The development of Soviet history was also not favorable for such an ambitious project. As the Soviet Union transitioned from Khrushchev's leadership to Brezhnev's era, particularly following the 1968 Prague Spring, the Soviet government focused more on guaranteeing stability than on radical social reforms. Subsequent plans for computerization focused on particular subsystems of planning, according to branch, regional and national planning interests, and lost the nationwide overarching character of OGAS.

In a series of more recent articles, Safronov (2019, 2020, 2022) focuses on the computerization of Soviet planning and present a different story. Contrasting with what he calls the "lost-opportunity" narrative, this author argues that the main motive for the non-implementation of OGAS, in its original version, was its technical unfeasibility and organizational problems. Glushkov's project required a global transition of the whole economic planning system into a computer network. This required a great number of computers and technical specialists to operate those systems, which were simply not available. During the 1960s and 1970s the national planned targets for computer production were constantly under fulfilled, resulting in a generalized shortage of these machines, as well as their peripherals (Cave, 1980). On top of that, the space and defense sectors had priority over the allocation of existing computers. Problems with programming also persisted: often it would take years for planners to program by themselves the computers that arrived without installed software (2022, p.129). Safronov (2020) claims that one of the main reasons for the lack of interest in the original version OGAS was that it did not solve any of the problems of then existing institutions. The OGAS was concerned with raising economic efficiency of the Soviet economy as whole. Institutions such as TSU, Gosplan, or even the Politburo had different priorities, in what regarded computerization. None of them were interested in the increase of global economic efficiency, *per se*, but rather in more practical tasks, such as a decrease in time spent performing calculations, less risk of calculation mistakes, data reliability, elimination of information duplication and redundancies, or the possibility of calculating alternative plans. Although OGAS would also allow for the fulfillment of some of these interests, they could be much more easily - and cheaply - met with the adoption of local, smaller scale, systems. Instead of OGAS, a feasible and gradual version of a planning

network started to be implemented in the 1970s in Gosplan, with the ASPR project, which according to Safronov (ibid) is neglect in the analysis of both Gerovitch and Peters on the topic. The ASPR (Automatic system of planning accounts) system was the local computer network of Gosplan conceived to be the nucleus of a future nationwide network, that would be gradually achieved by connecting other ministerial and sectorial computer networks to it (ibid.). In the methodological documents regarding the implementation of ASPR it is clearly stated that the final goal of the network is to build the OGAS (Safronov, 2022). Gosplan, recognizing the political and technical limitations evolved in computer networks, saw in this step by step construction of the system the only possible way of implementing and securing control over the OGAS project. In order to avoid confrontation with TSU over the control of the system, Gosplan started to develop its own network (ASPR) as an internal departmental system. Focusing on achieving practical results, Gosplan hoped to obtain tangible benefits with the adoption of ASPR that could serve as good publicity for its network. The system addressed the need for faster and more accurate calculations, improved plan coordination, and allowed for the evaluation of different planning scenarios, providing significant savings in operational costs. Being able to demonstrate the advantages of its system, Gosplan could more easily claim primacy over the control of the network, and later invite other ministries and departments to integrate their local networks with ASPR. By using this tactical maneuver, Gosplan managed to navigate the complex political and bureaucratic landscape of the Soviet Union and create a system that aimed at fulfilling what was possible of the OGAS and represented a significant step in the computerization of economic planning. Although it never reached the OGAS final stage - scheduled for the year 2000 - ASPR, operated until 1989 and involved 140 scientific institutes and organizations and more than a 1000 people participated in its works (Safronov, 2022).

In the next section, we will look at the original draft projects of OGAS and ASPR to explore the evolution of these proposals and the reasoning behind their details.

3. Computers and proposals for planning systems: OGAS and ASPR

In this section, we examine two draft projects that served as the technical foundation for nationwide computer planning systems⁵⁰. Our aim is to compare these drafts from different time periods to trace the evolution of their proposals. These documents serve as important

⁵⁰ Both drafts are publicly available and easy to find online, at the time of writing this thesis.

primary sources, offering insights into the ambitions for integrating computers into the Soviet economy and planning and their evolution over time. The first draft (Glushkov et al., 1964) relates to the OGAS project and present the EGSVTs infrastructure that was meant to be the infrastructure on which the OGAS would operate. The second draft, written five years later in a stalemate period in the discussion of OGAS, present the methodology of the ASPR system (Gosplan USSR, 1969), meant to be Gosplan's computer system, but also to gradually grow to a nationwide dimension.

3.1 The OGAS – EGSVTs draft

In 1964, the Central Committee of the Soviet Communist Party and the Councils of Ministers passed a resolution identifying the improvement of economic planning—through a unified system of planning, accounting, and operational management—as a critical priority (TsK KPSS & Sovet Ministrov SSSR, 1964). Following this resolution, a commission was created to develop a proposal for such a system. This commission included representatives from Gosplan, the Kiev Institute of Cybernetics, TSU, and other institutions.

In an annotation to the report it is stated that the draft “contains the technical needs, the structure and circuits of decision, criteria for location of support computing centers, organization of tasks in the network, the main orientations and steps for the development and creation of a national automatic system of planning and management of the economy, as well as an estimation of costs for the creation and operation of EGSVTs” (Glushkov et al., 1964:5).

In the introduction to their report, Glushkov et al. (ibid., 9) emphasized that improving the efficiency of economic planning necessarily required the integration of more mathematical and computational methods. However, these methods necessitated more precise data about technical and economic characteristics of the units to be managed, which the then existing planning system was unable to provide. To address this limitation, they proposed the creation of a Unique State Network of Computing Centers (EGSVTs, in Russian). This network would serve as the technical base for a new planning system, making possible the use of optimal planning methods which would provide a boost in economic efficiency to the country.

Glushkov and his colleagues (ibid) envisioned EGSVTs as a three-tiered network of computing centers, structured according to territorial and sectoral principles. The lowest tier would serve enterprises or groups of enterprises within specific regions, collecting economic and technical information from them and transmitting it to a mid-tier network. The mid-tier network, composed of regional computing centers aligned with the *sovnarkhoz* economic structure implemented by Khrushchev, would then connect to the

main computing center in Moscow. The system aimed to ensure real-time access to reliable data, automate the collection, processing, and distribution of information, and function as a unified computing network (ibid., 11-14). Additionally, the system would accumulate statistical data for periodic control, assess plan fulfillment and tendencies, and identify deviations in real time. When not engaged in planning tasks the network was proposed to provide computational power for solving engineering problems at the factory level, something that would be important in a context of scarcity of computers.

In terms of the flux of information, it was described in the follow way: at the lowest tier, computing centers near enterprises would be responsible for automatically gathering and pre-processing data before forwarding it to the mid-tier, or support, centers. These centers would also handle enterprise accounting and maintain electronic duplicates of documents – to ensure information safety. On their turn, support centers, would complete statistics and supply them to planning organs participating in national accounting. In the opposite direction, they would carry dispatching of information to lower centers and also engage in scientific research work in mathematical methods for planning and management, to prepare for a transition to optimal planning (ibid.,13-14). Regarding the main computing center, it was to provide - involving the computing power of the support computing centers - the solution for the problems of long-term and current optimal planning and operational management at the level of state bodies, as well as the dispatching control⁵¹ of the EGSVTs. Among the main benefits from the computerization of the Soviet planning structure through EGSVTs, the authors identified (ibid.,18-19):

- Centralized accumulation of primary data.
- Automated data input and document printing.
- Simplification of data processing.
- Decision-making with optimization algorithms.
- Improved short (current) and long-term planning.
- Reduced data leaks and distortions by encoding information and bypassing unnecessary intermediaries, assuring better data protection.
- Real-time access to data, from any point in the network.
- The use of tables and graphics to support decision-making.

It was estimated that the tasks of optimal planning – current and prospective - would be responsible for up to 80% of the load of the network (ibid.,18). For the operation of the

⁵¹ Dispatching control meant generally giving orders and monitoring on their execution.

network, the authors deemed essential 30-50 support center, with computers able to perform 1-2 million operations per second⁵² (ibid.,19). For primary information collection 6000 centers were thought to be necessary.

Organs such as Gosplan, the Council of National Economy, Supreme Council of the National Economy, Gosstroy, the State Committee for the Coordination of Scientific Research, and the Central Statistics Institute were to be connected to network, as well as ministries, departments and sectorial committees, Soviets (councils) and party organs (ibid.,14).

In terms of costs, the draft report presents a table with the types and quantities of computers, perforation machines, equipment for introducing information, converting devices, storage devices, copying and microfilm equipment and supporting ventilation material necessary for each of the three tiers of the system. The cost of all these technical instruments was estimated in 3862 billion rubles (ibid., 28-29)

As stated in the draft (ibid), the system was to provide the algorithmization of 4 main tasks:

1. Storage of primary economic information.
2. Simple processing of data (re-writing, sorting, grouping, arithmetic operations, comparison of large datasets, printing).
3. Decision making with special algorithms (solutions to multivariate optimization tasks).
4. Optimal, long-term and operational planning (dynamic models).

Overall, the logic of the system was to ensure that local centers only occupy themselves with the gathering of primary economic information, accompanying the ongoing production process. The treatment of this information was to be done at upper levels, based on this primary input. In this way the interaction of enterprises with EGSVTs was first the input of information, and later, the receipt of necessary information for their activities. The authors stress the importance of this type of system organization in eliminating leaks and distortions of information, by bypassing intermediate steps⁵³. An exchange of information between any

⁵² At the time of writing the draft – 1964 – the USSR was producing computers such as the M-4M in hundreds of units (Malinovsky, ch.4) that could perform up to 220 000 operations, or the UM2 (ibid., Ch.6) up to 40 000 operations – both would be clearly insufficient for the supports centers, but eventually would be enough for the low-tier centers. However, the SOK was produced since 1957 only for the military air defense system and could perform up to 1.25 million operations (ibid., Ch.5). Only after 1967 second-generation computers, such as the BESM-6 – performing up to 1 million operations – start to be consistently produced (ibid., Ch.4).

⁵³ At the time of the report, the gathering of information for the plan was done through 4 different channels.

link of the system would become possible, allowing for a comparison of costs and analysis of related processes and normatives.

The EGSVTs system was designed to be implemented gradually over a ten-year period, starting from the lower-tier centers and expanding upwards. The head of the network, located in Moscow, was intended to be Gosplan's main computer center (ibid., p.38). The number of people predicted to be involved in the operation of the network – at all levels - was estimated to be 300 000 people.

3.2 ASPR avant project draft

Similarly to EGSVTs draft, the ASPR project draft (Gosplan USSR, 1969), produced five years later, considers the improvement of the planning system as an important condition for economic growth. Instead of focusing on the structure and technical part of the system - as the EGSVTs draft had done - its main goal was to plan the implementation of mathematical-economic and computer methods, automatic systems of management and optimal planning. The five year interval between the two drafts is relevant, because this period gave Gosplan material to support a reflection on the problems of previous computerization attempts.

ASPR was intended to fully cover the whole structure of Soviet planning, from the factories and farms to higher organs. Its implementation was seen as a gradual process starting from Gosplan USSR and Gosplan departments in each of the Soviet republics, and later on spreading to lower planning organs. Hence, we see an inverse of the logic of implementation of the OGAS, which was to start from the lower levels and proceed upwards. The ASPR draft (p.8) clearly states:

“The ASPR should ultimately cover the entire function of national economic planning, regardless of the level of management under which it is applied to—that is, from enterprises, construction sites, and collective farms to the highest bodies of state administration. It is entirely clear that creating the ASPR on such a scale cannot be done immediately. (...) Based on this, it is appropriate to define the object of the ASPR design as nationwide and republican-level planning—that is, to design the ASPR primarily as the system of Gosplan USSR and the Gosplans of the Union republics, taking into account their interaction with the automated systems of ministries and departments in the area of national economic planning.
"54

⁵⁴ Translated from Russian by the author.

ASPR was meant to tackle the problems which persisted until the late 1960s with the implementation of computer/mathematical techniques, such as the lack of qualified personnel, lack of equipment and its poor reliability, but above all, the absence of a systemic approach to solving these problems (ibid.,p.10-11). Reflecting on the previous attempts at computerization, Gosplan criticizes previous proposals for disregarding existing economic and technological conditions. Although some computerization exercises managed to gather all data necessary to solve a model, generate one or more solutions, and deliver them to the planning authorities, they involved a big waste of time and resources. Other previous attempts, had however just tried to mechanize planning accounts, which was inefficient and led to more work. Instead, ASPR was meant to overcome these limitations and be an integrated system, based on a systemic approach. The authors emphasize its character as a man-machine system - automated but not automatic - in which planners take decisions. It was designed to guarantee a complete formulation of national plans, through its three main components: Software - including planning accounts, models, algorithms, programs, documents and instructions; Hardware - comprising the computers, technical equipment and connections between them; and specialized cadres who would operate and coordinate the system (ibid.,12).

The draft goes into a high degree of the detail on the methodological tasks to be done, regarding accounting methods, lists of type of resources to consider in intersectoral planning, classification systems, which data to consider for planning, and mathematical methods (ibid., p.19-57)

The goal of ASPR was not only to formulate plans but also to improve their quality and control over their execution and fulfillment (ibid., 69). The system was intended to serve for all levels of planning—short-term (1 year), mid-term (5 years), and long-term (10 years). It was meant to generate relevant indicators to support decision-making and assist in setting objectives for those decisions. The systemic character of the project was reflected in its structure comprising many different subsystems. In the automatic subsystem planning tasks were to be solved with the use of economic-mathematical methods and computing means. To ensure a normal functioning of the system other subsystems were proposed such as the system of personnel; methods; organization/law; information; mathematics; technical; and management of operations and improvement of ASPR. An important factor for the success of ASPR was to ensure the coordination – and the use of the same methodologies - between all the Republic Gosplans and the central Gosplan USSR.

The ultimate goal of ASPR was to ensure the development of optimal economic plans (ibid, p.76), which at the time of writing the ASPR draft, was impossible. Computers were to be mainly used for calculations, but before that, ASPR developers had to provide a complete description of the work of each planning worker, the flows of information among them and tasks to be done in each planning phase, in each planning organ. ASPR was supposed to allow to repeat the plan iteration process - from central authorities to companies and back - several times, instead of only one, as was done at the time. The project should also be able to provide other balanced plan alternatives. With ASPR the order and processes of plan formulations would change, as well as the organization of work and communication between organizations.

The authors of the ASPR draft, criticize the shortcomings in the ongoing work to implement OASUs (State Automatic Systems of Management)⁵⁵ by not ensuring compatibility between systems (ibid., 92-95). To ensure compatibility, Gosplan was to become the authority responsible for plan methodology and instructions. In its tasks was the need to develop an information language for economics which was easy to learn and implement. Computers played the role of ordering the logic of plan development. It was necessary to overcome the insufficient number of plan indicators and statistics, which did not allow for the use of economic-mathematical methods; as well as the low level of analytical work and relatively low quality of statistical information, providing often incomparable data in terms of volume and calculation methodology. The systems of the time suffered also from low operability: some statistical data took too long to gather, often arriving too late to be considered in the plan. The authors recommended a standardization of data and deadlines, in all Gosplans, central and republic level and ministries.

The main goal of ASPR after implemented, as stated in the draft, was to develop and release a project for a plan of economic development and its calculations. The whole system was seen as a system taking input data and outputting other data after a transformation process - with the quality of the system depending on the quality of this transformation. To increase the quality of the system planners considered two approaches: one was to work on the organization of the system and describe the functions of each worker and information flows up to the final indicators and improve them (*ot zadachi* approach)⁵⁶. Another was to automate existing procedures with computers and auxiliary technology (*ot fotografii*)⁵⁷. The idea was to start gradually implementing ASPR from the latter approach - that is, to improve from the existing conditions - which should provide benefits - such as less errors in calculation, more

⁵⁵ These 'automatic' management systems were applied in departments or factory conglomerates.

⁵⁶ *Ot zadachi* – from the task, in English.

⁵⁷ *Ot fotografii* – from the photography, in English.

time for workers to analyze data and results, the possibility of formulating variations to the plan and less time spent in the process of storing, searching and retrieving information.

The implementation of ASPR was intended as a long gradual process, to be developed by improving already existing processes and highly coordinated and tied with the overall changes to the national planning system. In contrast, Glushkov et al. (1964) followed a type of approach that sought to completely change the existing procedures and be itself the driver of change. In the final section of this chapter, we will look at how the literature on the computerization of economics describes the impacts of computers on the discipline – mainly focusing on western economies - to form a parallel with what we wrote so far on the proposals for the use of computers in the USSR.

4. The Computerization of Economics and the Soviet case

One of the main goals of this chapter is to explore the context and consequences of the introduction of computers in the Soviet economy. To gain a broader perspective, it is also important to contextualize and compare this process with the broader experience of computerization in other parts of the World. The impact of computers on economics is still a relatively recent and understudied topic in the history of economic thought. Most existing literature focuses on Western Europe and the United States. Examining these regions, Backhouse & Cherrier (2017) highlight several key transformations brought about by computerization in economics. These include enhanced speed and accuracy of calculations, the ability to tackle new problems and experiment with innovative techniques, the facilitation of simulations and experiments that generate new evidence, improved storage, retrieval, and graphical analysis of large datasets, the development of new empirical methods, and the relaxation of constraints on theoretical modeling. Additionally, computers have contributed to automated theorem proving and the emergence of new markets requiring algorithmic analysis. Although computers redefined boundaries between applied and theoretical work, the authors claim, computerization, *per se*, is not enough to explain the post-war turn towards applied economics, an argument made by other economists (ibid.,p.2)

More recently Boumans et al. (2023), argue that computers should be understood not merely as a technological innovation but as an institution that both brings opportunities and constraints to economics. Computerization reshaped the discipline at multiple levels—altering disciplinary boundaries, research questions, modeling strategies, methodologies, and

even the role of the economic profession. Rather than being an exogenous force that transformed economics, computers were actively shaped and adapted by economists to serve their own purposes. They were not merely tools for improved efficiency but also revolutionized the discipline's methodology and epistemology by enabling the study of new phenomena and fundamentally changing its ontology—how economists conceptualize their subject matter and the objects perceived to exist in the economic world.

Beyond increasing computational efficiency, computerization introduced new forms of inquiry, novel types of computations, and alternative ways of manipulating statistical information. It also changed the circulation of information and redefined the division of labor within economics, shifting the allocation of credit and prestige to different activities. For example, human computers and programmers, who once played a critical role in the discipline, lost relevance after the 1980s as economists began to interact directly with the machines. Furthermore, computers contributed to both the boom and bust of various techniques, depending on how they were appropriated by economists to solve their specific tasks. Ultimately, Boumans et al. (2023) present computers as an endogenous driver of change in economics—one that was not merely adopted but continuously reshaped to meet the needs of the discipline.

In a different approach to the topic, Phil Mirowski (2001) explores how economists' conceptions of human agency have been shaped by a notion of rationality heavily influenced by 'cyborg sciences' and computer science, particularly those emerging from military research centers. Mainstream modern economics conceptualizes the economic agent as an information processor, reflecting a broader intellectual shift driven by military rationality—rooted in cybernetic principles of command, control, communications, and information (C3I). This influence made its way to economics through institutions such as RAND and the Cowles Commission, where the close ties between the military and economic research centers facilitated the spread of computational approaches.

Mirowski & Nik-Khah (2017) further examine how computers played a crucial role in the development of disciplinary subfields, such as the economics of information and market design. Cyborg sciences not only introduced probability theory and advanced mathematics into neoclassical economics but also significantly contributed to the rise of mathematical economics as a dominant paradigm. The increasing formalization of economic theory, influenced by computational methods, changed how economists understood markets, strategic interactions, and decision-making under uncertainty, reiterating a technocratic approach to economic analysis.

Regarding the Soviet experience with the computerization of economics, Martin Cave remains one of the few scholars to have written on the topic. His 1980 book, *Computers and Economic Planning: The Soviet Experience*, focuses primarily on the computer methods and organizational systems in use at the time but at times sparsely mentions some of the impacts of computers on the Soviet economy and management. One of the main effects Cave highlights is that the need to issue explicit, objective instructions to computers forced management systems to become more precise and structured. The simplifications required to translate commands into machine-readable language also brought greater clarity to the sequencing of economic processes. When computers communicate to reach decisions on management processes the whole process as to be made more clear and unambiguous, than when done by humans managers. However, the computerization of planning introduced significant challenges, particularly regarding the formulation and implementation of goals. Planners grappled with prioritizing different economic goals and determining how to encode them within the system. This was one of the main reasons why attempting to translate the Soviet planning system into an algorithm proved problematic, as it oversimplified a structure that functioned differently at various levels—five-year plans, annual plans, and operational plans—each with distinct objectives and roles. The sheer complexity of the system posed many obstacles to full automation. Cave also noticed that computers change management hierarchies and reduce the number of agents in the planning process. Besides that, computers reduced costs of information exchange, not only by doing it faster, but also by promoting a discussion on the number of relevant indicators to be reported by production units. Computerization also brought new challenges: should factories have their own computer centers or rely on shared computer facilities? Moreover, unpredictability in institutional arrangements, during Khrushchev's reform period, strongly put a premium on the design of more flexible techniques and systems.

With Cave (1980) we see a first-hand account, for the Soviet experience, that not only the computer changes the organization of processes and personnel, but also its implementation is shaped by institutional and social contexts. Computers brought about new questions and challenges. In such a context of institutional uncertainty and very limited availability of computers for economic applications, Cave positively saw the multiplication of different departmental computer systems as a way of experimenting and finding different solutions.

5. Concluding Remarks

In the preceding pages we have seen how the post-Stalin era, initiated with broad discussion on political and social reform, inspired by the affirmation of cybernetics as a science capable of providing solutions in all spheres of Soviet life. In this process of affirmation, cybernetics spread into Soviet science frameworks of thought imbedded in military concepts of control, communication and information. As others have pointed out before, particularly Mirowski (2001) and Mirowski & Nik-Khah (2017), similar trends shaped the American society at the same time and highly influenced economic science. However, the very different culture, and political and institutional forms present in Soviet society led to different cybernetic ambitions and proposals. While in the western experience of computerization, after a first phase of high state funding for military projects, computers spread to civil society through decentralized channels and market incentives, the Soviet approach was deeply embedded in the command economy's bureaucratic structure. To tell and contextualize this story was the main focus of this chapter.

An obvious similarity between the Soviet and Western computerizations was the recognition that these machines and techniques could enhance economic efficiency by improving data processing, facilitating complex calculations, and enabling new forms of decision-making. Just as in the West, where computers transformed the discipline of economics by enabling large-scale simulations, optimization models, and advanced statistical techniques, Soviet cyberneticians sought to apply similar methods to central planning. Both the OGAS and ASPR projects aimed to introduce optimal planning techniques, reduce information bottlenecks, and automate economic coordination—goals that paralleled the increasing use of computers in market economies for forecasting, supply chains, logistic improvements, and policy analysis (Backhouse & Cherrier, 2017).

However, and more interestingly, the fundamental differences in political and institutional contexts led to divergent outcomes. In the West, computerization was shaped by the needs of users, who, besides the military, were scientists, academics, and business enterprises, in a context of market-driven competition. In contrast, the Soviet experience was marked by the rigid structures of central planning, bureaucrats with competing institutional interests, and political resistance to reforms that threatened prior established hierarchies. While in the West, computerization facilitated the rise of applied economics and new market-based models, in the USSR, the attempt to implement a nationwide planning network faced obstacles rooted in

bureaucratic inertia, power struggles among ministries, and very considerable technical limitations.

Moreover, while Western economists adapted computers to fit evolving methodologies and needs, Soviet planners initially attempted to design computing systems that would transform economic management from the top down. The OGAS project, with its vision of a fully integrated nationwide network, proved too ambitious given the limited availability of computing resources, the lack of trained personnel, and the resistance of the key institutions supposed to benefit from it, like Gosplan and TSU. Instead, the gradualist approach of ASPR, which sought to computerize planning incrementally from a Gosplan departmental network, reflected a more pragmatic adaptation to existing conditions (Safronov, 2020). The fact that the OGAS was never implemented and the gradual approach of ASPR was, echoes a broader contrast between the failure of Soviet all-encompassing projects and the success of Western adaptive developments in computing.

Another important divergence was in the ideological framing of computerization. While Western economists and policymakers saw computers as tools to refine economic models and improve business efficiency, Soviet cyberneticians framed them as instruments for achieving an optimized grand-scale command economy. In practice, the Soviet experience revealed that the introduction of computers would not simply automate existing processes but would also have to reshape the economic management of the time, exposing contradictions within the planning system itself.

While Gerovitch, Peters and Safronov present different opinions on what were the major factors contributing to the bust of the original version of OGAS, in their writings they emphasize the central role of users in appropriating new technologies and conferring them totally different objectives and shapes than initially thought so. The failure of the original version of OGAS reveals thus a lesson on the failure of trying to implement radical technological changes without accounting for the needs and interests of its users. As Peters (2016) emphasizes, information reform – that Glushkov presented as a pure technical improvement – is also a social and political reform. The apparent neutral nature of technological improvements is only apparent. Information reform is always social reform.

Ultimately, the history of Soviet economic computerization reflects broader themes in the history of technology: the interplay between innovation and institutional constraints, the tension between centralized and decentralized approaches to system design, and the ways in which technological aspirations are shaped by social and political realities. While the Soviet Union did not achieve its vision of a fully automated planning system, the computerization

efforts from the 1960s to the 1980s anticipated many of the debates surrounding digital governance and information control that continue to be relevant today. The Soviet case, therefore, provides an important historical complement to Western narratives on computerization, illustrating how different political and economic structures shape the adoption and impact of technological change.

Conclusion

The development of information methods, particularly with the rise of artificial intelligence, and its application to virtually all spheres of society is one of the most debated and concern rising subjects of our times. While public discussions go much beyond economics, or economic methods - highly focusing on ethical, political, warfare and national security challenges - this study attempts to contribute to it, by looking at the historical debates on information and computers in economics, more particularly in planned economies. Since the beginning, the attempt to plan an economy was connected to questions of gathering information, processing and ‘discovering’ it, both in theory and in practice, as chapter 1 and 2, respectively, highlighted. The need to exert a more direct and oriented control of the economy, led to the search for new methods and the creation of new institutions to organize and process information. With the rise of computers, in the post WW2 era, the promise of greatly expanding those methods, in scale, and efficiency, led to ambitious attempts at macroeconomic planning, which were described in chapter 3.

While gathering and processing of information might have been the primary concerns of planners and theoreticians on planning, in the 1920s to 1940s, with Hayek and more recent assessments of his work, the focus of the theoretical discussion shifted to the process of information discovery. For Austrians, a planned system highly constraints the discovery procedure performed by entrepreneurs, by removing their access to property and incentives for engaging in discovery. Answers to Hayek, particularly those proposing participatory planning systems, have argued that discovery can be performed by citizens and workers involved in collective participatory processes, engaging a much higher number of people than entrepreneurial processes. Thus, I argue in chapter 1 that besides more work being necessary on epistemological clarity about how each type of knowledge (subjective/objective) is relevant to economic efficiency; the main question turns to who should control discovery processes. Should it be centralized in entrepreneurial activity – incentivized by the lure for profit - or decentralized in widespread citizen participation – providing little material benefits? The question seems to depend on how important and necessary material incentives are for people’s participation in information discovery. While there are considerable studies on entrepreneurship, I believe, an important contribution to answer this question would be to enlarge the study of historical concrete cases and practices of worker and citizen participation, and its results.

An important trend in contemporary market theory is the incorporation of planning elements, in what is called mechanism design, pioneered with the work of Hurwicz (1973), himself

addressing the discussion of the calculation debate. Through institutional tweaks and incentives it is possible to design markets to achieve pre-determined social goals (Maskin, 2008). While our goal in this thesis focused on central planning systems and decentralized planning, a relevant extension of this research would be also to study the history of this type of planned through design markets.

Chapters 2 has presented real planning systems as systems built to answer concrete practical needs, in different historical contexts and periods. In the same way that there is not a homogeneous market system, the same holds true for planning. Preceding, and during, the implementation of planning methods and systems, many theoretical debates reflected on important topics such as economic growth, economic organization, mathematical methods and political economy, and were significant for the development of economic science and statistics. The variety of planning experiences and debates throughout the 20th century originated a rich body of literature, still mostly unexplored or forgotten. Thus, a natural development of the presentation done in this chapter, would be to tell the story of these debates, institutions and practices of planning, integrating them in a global history of planning. Such a history, besides contributing to the modern debate on planning, would be very significant in providing a key to understand 20th century economics and economic development.

The history of planning also intersects the history of computer technology. As previous studies have already shown (Beniger, 1997; Ceruzzi, 2003) economics and business applications were important for the development of computer hardware and software, but also shaped the discipline in considerable ways (Backhouse & Cherrier, 2017; Boumans et al., 2023; Mirowski, 2001). A missing section in the story of the entanglement between computers and economics is the development of Soviet computing for economic purposes. Chapter 3 is an attempt to fill this gap, by showing how after WW2, computer development in the USSR greatly impacted visions on economic planning and was central to the debates on economic reform. The history of Soviet computer shows the role of users in appropriating technology to their needs, resulting in situations greatly diverging from initial aims. Institutions such as Gosplan, adapted computers to their needs, according to bureaucratic and institutional constraints, but also technical limitations. The end product was a department scale system (ASPR), planned to expand gradually through improving existing conditions, instead of a nationwide network proposing a radical change in planning processes (OGAS). The story of computer planning in the USSR puts in evidence the complex interaction between technology and society: technology is not a neutral exogenous force, and its impact is always mediated by political, economic, and institutional factors. The case of

computerization in the Soviet Union shows that technology can be shaped to reinforce existing power structures, or that power structures can shape how technology is implemented. A lesson bearing relevance for future technological implementations, particularly for the future of artificial intelligence.

A further step in the work of this study is to analyze how AI may impact the future of economic planning, both in theory and practice. Already new proposals, such as OGAS 2.0 (Kopanev, 2020) - inspired by the writings of Glushkov and Gosplan's implementation of computer planning - are being worked by independent developers and feed the dream of accomplishing Glushkov's initial aim with modern technology.

Despite the latest technological advancements, the fundamental challenges of gathering, discovering, and processing knowledge for economic planning remain relevant. The debate about the nature of knowledge, whether subjective or objective, is still important.

An aim of this thesis was to contribute to a more solid historical background in the discussion of contemporary challenges. An overall general conclusion to this research is that the discussion on planning is still relevant as current societal challenges facing humanity demand global, coordinated and oriented solutions, which historically, planning has provided through a guiding visible hand that other economic agents could follow.

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