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The journal covers a wide range of topics relating to the manufacturing industry and industrial policy including the industrialization process; industrial development, institutions and structural policies that support economic development including the political economy aspects; tools (such as economic planning) and market structures (including monopolistically competitive markets that have a bearing on manufacturing value added and overall economic productivity) and their impact on economic development and industrialization; low and middle income traps; productivity; mechanism design and incentive structures that hinder or foster industrial and economic development; science, technology and innovation strategies and polices (at corporate and national levels) and their impact on economic development; individual and institutional learning processes, education systems, financial institutions, markets and policy, vocational training, third generation, entrepreneurial and industrial universities and their impact on economic development and industrialization; and historical and contemporaneous case studies relating to industrial development.

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Hacking Economic Development

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Abstract

This paper explores the potential use of growth hacking as a prescriptive tool in development economics from a system dynamics perspective. Growth hacking is a popular business method, and it stands as the umbrella term for attaining exponential business growth by creating and harnessing non-linear dynamics by forming virtuous cycles with creative ideas, field experimentation, and fast feedback loops. In this sense, growth hacking is inductive, non-linear, and empirical, contrasting the economic literature's deductive, linear, and abstract frameworks. Given this rationale, growth hacking can yield prescriptive and actionable insights that create virtuous cycles, avoid vicious cycles, and regulate linear economic development. Also, this perspective led to a novel definition of the quality of growth. As an extension of this definition, three development archetypes are stylized as “active,” “passive,” and “sustaining” based on reflexivity characteristics of the underlying economic subsystems.

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1. Introduction

Developing countries need realistic perspectives to tackle their economic challenges due to the ineffectiveness of mainstream economic thinking and its toolset for several reasons.

First, economics literature is primarily deductive, reductionist, and linear, often conducted from a historical perspective utilizing abstract constituents. To illustrate, constituents such as institutions, nations, states, markets, industries, and firms are abstractions. Their behavior is an emergent feature of individuals' actions and choices. Similarly, concepts such as technology, innovation, entrepreneurship, competitiveness, investment, and human capital are emergent aggregates of highly complex systems; hence they are not actionable. Therefore, ideas and models of economics literature function in unactionable aggregates and abstractions, yielding ex-post descriptive insights at best. In the words of Nobel laureate Paul Romer, “models attribute fluctuations in aggregate variables to imaginary causal forces that are not influenced by the action that any person takes” (Romer, 2016, p. 1). Additionally, the historical perspective embedded in economic thinking assumes sequential development steps, ignores future opportunities, and yields commoditized insights that are unlikely to bring faster-than-average development.

Secondly, the deductive nature of economic thinking leads to reductionist policy formulation and waterfall execution frameworks. To illustrate, unactionable aggregates in the form of monolithic abstractions, such as unemployment and inflation, are framed under vague causal chains and broken down into policies that lack the logistical clarity necessary for effective execution and impact evaluation. Such a top-down approach's coordination complexity, cost, and slowness are too hard to bear for developing countries. Moreover, this reductionist approach yields outputs that neglect the contextual affordances of individuals, especially those of the political agents, who are the real action-takers. By the same token, since the dissimilar contexts of individuals and institutions are ignored, a coordination problem arises almost to the effect of a paralyzingly complex cold-start problem that requires a magical reset.

Third, the economic development and growth literature offers consistent narratives that synthesize historical economic observations and fit models to the economic data. But developing countries often lack data. Even for developed economies, the reliability of economic data is questionable due to the analog, reactive, and survey-based approaches, which often show up as revisions after data releases and different organizations releasing contradicting data on the

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same phenomena. To illustrate, for the second quarter of 2023, St. Louis FED and Atlanta FED of the USA looked at the same US economy and forecasted diverging GDP growth rates of -0.32% and 1.95%, respectively. Given the complexity of economic phenomena and models, it is viable to intuit that data quality issues build up and exponentially reduce model reliability.

Finally, economic literature is haunted by the fixation on building models with whatever data is available, creating a form of streetlight bias, which can be summarized as searching for answers in the wrong place simply because the data is there.

2. Three Types of Economic Growth

Gross domestic product (GDP) is the standard measure of the value added created by producing goods and services in a country during a certain period (OECD, 2023). Economic growth is mostly measured in terms of GDP growth as the reference point for the health of national and global economies (Callen, 2017). In this regard, GDP originates from a macro view that does not discern sweet spots and non-linearities.

To build on the virtues of growth hacking in economics, we must first define the term "growth" from a perspective that lends itself to the virtues of growth hacking, which operates from the lenses of system dynamics and in terms of non-linear concepts such as advantage, snowball effect, leverage, sweet spot, synergy, contagion, virtuous cycle, compounding, network effects, scalability, and automation.

The growth hacking mindset is not unusual. In the real business context, strategic management seeks growth by creating advantages by performing different activities from rivals or similar activities in different ways, and repositioning the business as imitation and strategic convergence erodes advantages (Porter, 1995). In the most generic sense, strategic management is a future-looking framework that seeks future advantages and continuously adapts to the changes in the life cycle of advantages. By this token, strategic management moves businesses into new advantages while exiting the old advantages. This stipulates business strategies that actively seek, reposition, and restructure businesses by inventing, discovering, and harnessing non-linear value creation pathways by the following means.

1. Creating new markets
2. Positioning for pricing power to lift the price of outputs
3. Positioning for bargaining power to suppress the cost of inputs
4. Business model innovations to
   - scale faster at a lower capital requirement
   - minimize operating leverage
   - reduce capital requirements and cost of capital
   - minimize risk exposure and costs of managing risks
   - minimize the cost of exit
5. Exit in a timely manner.

Given the level of global competition and how fast innovations disseminate, businesses that lack these five means are certain to get commoditized rapidly. Therefore, the quality of the growth is proportional to the extent to which these five means are materialized. This proposition leads to defining three archetypes of economic growth to characterize the higher-order system dynamics driven by the quality of growth.

1. **Active GDP Growth** originates from willful acts to create new markets and disrupt existing ones with competitive advantages and exponential business models involving virtuous cycles.
2. **Sustaining GDP Growth** originates from sustaining innovations, R&D, and productivity improvements within the existing markets and for the existing activities and products.
3. **Passive GDP Growth** originates from incumbents exiting some activities by downsizing, divesting, and offshoring. The void left behind by downsizing and divesting indirectly pulls passive growth while offshoring, and foreign direct investment (FDI) directly spoon-feeds passive growth.

In the following sections, active, sustaining, and passive growth archetypes are stylized to expose their underlying non-linear and/or circular dynamics (reflexive) and their associated social, political, and environmental effects to epitomize growth from a developmental perspective.

3. The Origins and Anatomy of Passive Growth

Passive growth originates from the exhaust of the incumbents' strategy process. Incumbents move into the emerging sources of advantage and exit the declining ones. Because from the incumbent's perspective, maximizing the capital returns depends on concentrating the capital on the most sensitive levers of advantage by exiting non-core businesses, products, and activities to focus on core ones that drive competitive advantage (Prahalad, Hamel, 1990). The resulting offshoring or outsourcing trend, its cross-industry pervasiveness, and its strategic, financial, and other rationale are shown in a myriad of studies (Vagadia, 2012, p. 82).

Passive growth of an economy can be stylized as being grown. It takes place in two pathways. The first pathway of passive growth emerges from the supply void left behind when incumbents downsize or divest the economic activities of declined business advantage. From the entrant perspective, this supply void offers an established market with minimal growth risks in terms of the market, technology, and operations and comes with the features of low entry barriers such as commoditized know-how, expired intellectual property, and increased access to and abundance of necessary capital goods. The second pathway of passive growth emerges

when the incumbents directly move economic activities into other jurisdictions by outsourcing, offshoring, or direct investments to build offshore capacity. In both pathways, passive growth follows the path of least effort, does not entail business vision to obtain, and leads to the growth of economic activities with low or no competitive advantage.

In addition to their perceived constraints and deficiencies, developing economies face internal pressures to grow rapidly, create jobs, and finance infrastructure gaps as fast as possible. Given the political and social urgencies of developing economies, it typically looks super appealing to grow fast regardless of the growth's origin, path, and destination. With this bias for the speed of growth and the tendency to follow the path of least effort, passive growth economies can grow from ~$2.000 per capita GDP to ~$10.000 as fast as 13 years in the example of Romania and 14 years in the example of China.

Table 1. Fastest growth periods from $2.000 per capita GDP to $10.000

Country Name	GDP Per Capita		Years
	Between $1900-$2500	Between $10.000-$11.500	
Romania	2002	2014	13
China	2006	2019	14
Poland	1991	2007	17
Korea, Rep.	1982	1999	18
Chile	1988	2007	20
Mexico	1988	2008	21
Malaysia	1990	2011	22
Türkiye	1989	2010	22

Source: World Bank Database

In this sense, passive growth resembles feeding sugar to cancer cells and leads to a set of vicious cycles. Passive growth pulls an economy into economic activities with little or no competitive advantages and industries with low entry barriers. These industries are almost always working capital-intensive with minimal margins, so the working capital profitability is inherently low, sometimes lower than the cost of capital. Thus, any marginal economic activity destroys capital, even excluding capital expenditure. Similarly, some low-barrier industries require high operating leverage due to the technical nature of the business or the importance of economies of scale. Thus, these industries are susceptible to fluctuations in demand at multiples of their operating leverage.

When the first pains of the working capital kick in, the easiest managerial reaction is to push for more growth, which can be named as working capital ponzi. Since firms are networked with trade finance, the working capital ponzi is contagious. Preys of working capital ponzi draw their business partners to the ponzi by extending payment terms while increasing business activity. Eventually, in a few years, if not a decade, while the commodities they produce are further commoditized, passive growth participants collectively become addicted to the proceeds of future orders to finance current operations and get overleveraged, leading to their total capitulation vis-a-vis their customers.

Passive growth is often accompanied by a lack of public institutional capacity, especially in regulating the banking industry, capital markets, labor markets, and the environment. This lack of institutional capacity leads to simplistic policy responses in times of crisis. On the other hand, low-entry barrier industries have little or no competitive advantage. Thus, they can stay alive and grow only as a function of an ever-weakening local currency, efficiency of inhumane working conditions, government subsidies, and cost-avoidance of environmental ignorance, all catered by institutional incapacities. In a passive growth economy, when the situation worsens for too-big-to-fail firms, these firms are given charitable loans from state banks, which destroys banking capital. If the macro economy worsens, market forces lift inflation, or regulators commit devaluation, killing all domestic productive factors without discrimination. Making matters worse, to stay functioning, passive growth industries require imported capital goods and services, and even imported inputs, which become increasingly expensive as the local currency loses value. While firms survive by exploiting institutional incapacities, individuals of passive growth economies survive via cronyism, corruption, and nepotism, which leads to the social and political normalization of all these resorts. Ultimately, survival of the fittest replaces survival of the best, discouraging meritocracy and accelerating the brain drain. Overall, the resulting social dynamics of passive growth stretch inequality, drain the domestic talent pool, and create a small number of the super-rich and millions of people living at the threshold of capitulation, which overlays on the political populism that kicks in every five years but usually more frequently due to the inherent political instabilities.

The main factor that led so many economies to fall prey to passive growth was the low policy rates of the G7 countries in response to the 2008 financial crisis. The low-interest rates of developed countries created an interest rate differential from those of developing economies which ultimately induced massive hot money outflows toward developing economies (McKinnon & Liu, 2013). In the 2008-2015 period, the very

low world funding interest rates were associated with a rise in volatile capital flows and asset market bubbles in fast-growing emerging markets (Andreas, 2014). These financial propositions support the notion of passive growth in the sense of "being grown" by external forces. The second factor that boosted global passive growth was the rapid growth journey from ~$2000 per capita GDP to ~$10.000 seemed like the passive growth economies were achieving miracles. As the money flows financed passive GDP growth, fueled asset bubbles, and appreciated domestic currencies, a false sense of wealth emerged, alleviating the accompanying social pains, almost like a painkiller. The third factor was the reinforcing loop between the rich world's excessive consumption and the deflationary forces served to the rich world by the passive growth economies. Due to these three factors, passive growth economies have been so sure about their policies that they compete by offering more incentives and subsidies for more passive growth.

Economists study the middle-income trap with the assumption that the economies in the league of middle-income aspire to pass the middle-income tier. From the passive growth lenses, it seems reasonable to intuit that once an economy falls into the passive growth path, the system of forces evolves to be stronger at staying in the middle-income tier, which is the passive growth version of development, almost to the effect of developing to be better at staying poor. Because, just as unconsciously as they were pulled into passive growth path, economies of passive growth watch the emergence of a system of exploitation and control, which fundamentally contradicts the necessary dynamics to progress people's wealth and health.

It is tempting to frame passive growth within a cost leadership strategy relying on productivity gains by industrial engineering, automation, lean methods, and optimization. However, these productivity gains are unlikely to provide long-term profits because productivity is not an advantage. First, from the cost perspective, profits driven by cost reduction are transitory until the next best competitor adopts productivity techniques with the same cost-reduction effect. Second, productivity follows a path of diminishing returns which converge costs to a hard limit.

Third, from the pricing perspective, passive growth industries are price takers, so their productivity gains are transferred to their customers as deflation. Last but not least, if a product is a commodity now, it will get commoditized further in time and lose its market value, usually faster than the extent to which productivity gains can offset.

A combination of capital scarcity fallacy, sequential development fallacy, and political urgency drives a powerful conviction for passive growth. Since most developing economies suffer capital deficits, low-barrier industries seem more feasible due to low entry requirements regarding financial capital and technological readiness. From a political urgency perspective, the relative ease and speed of achieving passive growth are irresistible. However, passive growth traps scarce capital into unprofitable businesses, pollutes the environment, concentrates power, normalizes corruption, and wastes precious opportunities while new markets emerge.

All in all, passive growth destroys more capital than it creates. Nevertheless, even if we assume passive growth leads to some capital accumulation, it is a slight linear accumulation in an exponential world of active growth. Even if we assume passive growth leads to exponential capital accumulation, this capital is accumulated in the hands of the few, more likely to be banking offshore than domestically to hedge political risks and minimize tax burden (Alberto & Tabellini, 1989). This capital flow to foreign jurisdictions feeds foreign economies while starving the domestic economy as exemplified in the example of Russia, where the wealth held offshore by rich Russians is about three times larger than official net foreign reserves and is comparable in magnitude to total household financial assets held in Russia (Novokmet et al., 2018, p. 1). Even if we assume capital flight is prevented and kept domestically, it will likely be spent on building unproductive wonders (Al-Hathloul, 2022) and wasted by corruption and inefficiency (Jimoh et al., 2022, pp. 17-18). From this perspective, it might be viable to formulate policies that restrain passive growth.

4. Origins and Anatomy of Sustaining Growth

Sustaining growth originates from sustaining innovations, research & development, and productivity improvement within the existing markets for the existing products and activities. Sustaining growth occurs in established markets via linear business competition, often showing diminishing returns. It can be stylized as a failure to exit old markets and create new ones in a timely manner. In this sense, economies dominated by sustaining growth show strong R&D spending in old markets but weak venture capital investments in new markets. Taiwan, Japan, Italy, South Korea, and Germany can be considered economies of sustaining growth, as shown in Table 2.

Table 2. Global share of R&D and Venture Capital investments from 2013 to 2022

Countries	Share Of Global R&D Expenditure 2013-2022 (A)	Share Of Global VC Investments 2013 -2022 (B)	A / B
Taiwan	2.03%	0.14%	14.90
Japan	8.53%	0.71%	12.09
Italy	1.60%	0.19%	8.29
S. Korea	4.62%	1.57%	2.94
Germany	6.12%	2.37%	2.58
Global 25th Percentile	0.89%	0.50%	1.78

Source: World Bank, Dealroom & Statista.

Unlike developing economies, developed economies are not short of capital, technology, and infrastructure. Also, unlike developing economies, developed economies do not face the political urgency to create jobs and pull millions of people out of absolute poverty in a short time. However, developed economies such as Japan, the UK, and Germany missed major opportunities for active growth since the 1990s, such as the internet businesses, cloud technologies, electric vehicles, smartphones, and artificial intelligence, and they stuck with the markets, products, and services of the past. A sole focus on sustaining growth comes with massive opportunity costs of losing new markets. To illustrate, as of May 2023, with a market capitalization of $2.7T, Apple Inc. alone is more valuable than the entire UK stock market ($2.6T), Chinese stock market ($2.5T), Canadian stock market ($2.1T), French stock market ($1.8T) and German stock market ($1.3T) (Pisani, 2023).

For developed economies, missing new markets mainly stems from the disproportional growth in industries with high exit barriers. The establishment of too big and hard-to-disrupt industries creates a distaste and denial of emerging opportunities of a disruptive nature. Also, the social context of welfare and political stability inhibits the appetite to seek new endeavors. Aging demographics disadvantage the entrepreneurial ecosystem while fostering a shareholder profile that prefers extracting value rather than fueling growth by taking risks. The combination of a risk-averse management profile and an academic leadership style biased toward overthinking and underacting might also be a factor.

5. Origins and Anatomy of Active Growth

Active growth originates from willful acts to create new markets and disrupt existing ones with strong competitive advantages and exponential business models involving virtuous cycles. Origination of active growth only and only requires strategic intelligence, imagination, willfulness, and risk-taking. It is tempting to assume financial capital, human resources, technology, regulation, and infrastructure are prerequisites to the origination of active growth, but they are not. The factors of strategic intelligence, imagination, willfulness, and risk-taking come first; then, these factors acquire or develop missing factors and influence unfavorable ones. Therefore, active growth intrinsically drives progress and builds positive externalities in the broader economy and society.

Active growth builds exponential businesses and multiplies itself by spreading its seeds. Prominent examples of this multiplication are how Paypal paved the path for Palantir, Facebook, Tesla, SpaceX, and Linkedin, how Amazon led to Blueorigin, and how Tesla alumni, also known as Tesla-mafia, founded 11 influential companies (John, 2021). But the multiplicative effects of active growth are more sweeping than strategic entrepreneurship. The industrial policy can initiate active growth as well. Some policy-led examples of active growth are as follows,

- NASA's Appollo and Pentagon's ARPANET programs led to the emergence of the tech spree and the Silicone Valley as we know it today (Haigh, 2019)
- National Institutes of Health's Human Genome Project of 2000 led to the emergence of the biotech boom, contributing over $69 billion to the U.S. GDP each year and supporting over 7 million jobs (Gitlin, 2021).
- Danish focus on wind energy started around the 1970s leading to Vestas's emergence as the biggest wind turbine manufacturer in the world, surpassing big names such as GE of the USA and Siemens of Germany (Van Est, 2022, pp. p45-65).
- Estonia's focus on digital businesses started in 2000, acknowledging access to the internet as a fundamental human right. Estonia has more unicorns per capita than any other country ("Estonia has the most unicorns," 2022) and is the 3rd best in the world in cyber security (Vihma, 2022).
- Turkiye's focus on the defense industry led to the country's emergence as a drone superpower (Axe, 2022) and a one-stop-shop for almost anything in the defense industry (Malsin & Kivilcim, 2022).
- A more recent and exciting example is Luxembourg's focus on the space mining industry (e Selding, 2022) and El Salvador establishing Bitcoin as a legal tender (Belsie, 2022).

The exponential nature of active growth combined with its positive externalities and contagious mindset develops a system of virtuous cycles through capital accumulation, formation of venture capital, human capital, dissemination of futurist views, a winning culture, an attractive lifestyle, and progressing science & technology. This reflexivity leads to the emergence of innovation hubs such as Silicon Valley, Tel Aviv, Toronto, Melbourne, Tallinn, and Shenzhen (Gauthier, 2022).

Active growth deals with the knowledge frontier and requires talented human resources, which is always scarce due to the novel and advanced skills needed for active growth. This scarcity creates a new class of workers with high salaries complemented by equity premiums, which often exponentially increase in value. In parallel, in most major economies, real wage grows slower than asset prices; therefore, the legacy definition of middle-income jobs in the manufacturing industry needs to be questioned. It is viable to intuit that only active growth can create the compensation to afford the legacy life standards attributed to the middle income.

6. The Proposed Approach

6.1 Establish a sovereign venture fund

For an underdeveloped country, it might take a decade to develop its local active growth economy to reach a material scale. However, direct investment in active growth through a sovereign venture fund can be a shortcut to gaining exposure to active growth. This will offer a significantly higher return on investment than investments in primitive forms of local industries. To illustrate, a poor country can export wheat and invest proceeds into quantum computing stocks.

The governance and transparency of the sovereign venture fund might be challenging. But, still, it is a significantly more manageable challenge than catching up with the rest of the world through a sequential development process from farming to industrialization to the digital age.

For middle-income countries, the sovereign venture fund shall foster local innovation in selected areas of concentration for businesses qualify on the five means of competitive advantage outlined in the introduction. As a side benefit, such a sovereign fund investing in local innovation will create a sense of developmental citizenship as each citizen will have a shared stake in the country's future and innovation potential.

6.2 Develop a global market intelligence ecosystem

The essence of developmental hacking is to achieve continual pricing power and positioning for advantage by successfully exiting the declining advantages while entering the emerging advantages, which can only be guided by an effective market intelligence ecosystem that ideates, researches, and analyzes the future. This ecosystem includes market research firms, data aggregators, think tanks, consulting firms, and venture capital.

6.3 Grow a global political network of developmental citizenship

Most strategies and policies are designed deductively and represented by the waterfall methodology, which leads to a reductionist and linear perspective that sets goals and actions for governmental or private organizations. This approach is inherently reactive, slow, fragile, and prone to ineffectiveness and infeasibility.

This paper regards real actions and choices of individuals as the fundamental and only driver of progress. Therefore, a persona-based inductive framework is required to tilt everyday choices and actions of like-minded individuals in the same progressive and synergistic direction and leave the optimization of choices and actions to individuals, given their contextual affordances, implications, and tradeoffs.

The personas of this framework might involve bureaucrats, citizens, politicians & activists, thought leaders, business leaders, and investors as some of the key personas of developmental significance. Each persona shall be associated with behavioral norms and social feedback. To illustrate, the social norm for American billionaires is to fund further innovation, do philanthropy, and build infrastructure for the next generation monopolies, as exemplified by Elon Musk and Jeff Bezos, who are building the space infrastructure.

6.4 Use diplomacy, culture, and lobbying for a polished, progressive & peaceful economic brand

Competition for the new markets and monopolies of the future requires surgical execution and hygiene. There is no tolerance for even minor handicaps that negatively bias the future customers, partners, allies, and financiers. Similarly, a polished, progressive, and peaceful economic brand will positively bias future collaborators.

6.5 Evangelize a developmental culture

A culture of credibility and progress is foundational to cultivating development.

Regarding the culture of credibility, business ethics, and work discipline are foundational to flourishing a culture where trust is granted, and suspicion is earned. This type of credibility culture is exemplified by founders and venture capitalists not needing non-disclosure agreements in most cases, and investment deals initiated on a single-page term sheet with a few bullet points.

Regarding the culture of progress, as exemplified in all successful innovation hubs, imagination, hope, confidence, risk-taking, celebrating failures, and grit are vital attitudes that must be normalized. This set of attitudes, tested and proven in real life in many different geographies, should be taught and

displayed as art forms such as movies and TV series. Similarly, business leaders should accordingly exemplify and reinforce the culture of progress within their purview.

6.6 Evangelize advantage-seeking business thinking and execution

Strategy, despite being an inescapably popular term in business, is rarely understood as a process to create and sustain advantage in a competitive and comparative environment. Therefore, it is critical to evangelize the advantage-seeking hard-core strategic mentality among business leaders.

6.7 Restrain passive growth and regulate sustaining growth

Passive growth should not be the primary driver of the economy and should be kept under control at a manageable size that doesn't drive the overall characteristics of the economy, society, and politics. On the other hand, the national capital should not be trapped in sustaining mode and should not grow into a too-big-to-disrupt size.

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The Efficacy of Interest Subsidies as an Investment Incentive Instrument

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Abstract

The efficacy of investment incentives is a long-debated topic in the literature and studies mostly focused on quasi-tax incentives. Since interest subsidies have always been a crucial part of investment policy, this study dwelled on the efficacy of interest subsidies as an investment incentive with an extended literature review method. Firstly, interest rate and cash-flow sensitivity literature are explored. Then, the literature on the efficacy of both credit rates and interest subsidies has been discussed in a coherent way to shed light on investment motivation. The possible projection of literature findings on the course of investment and credit in Turkey was discussed by resorting to comparison in the research. Findings show that financial market failures stem from information asymmetry, companies' financing conditions, economic cycles affect the efficacy of interest subsidies. Second, since credit accession (especially for Turkish companies) is a major impediment, the impact capacity of credit guarantee mechanisms seems to be much higher than interest subsidies. Third, interest subsidies might only become effective when the subsidy rate is generous in financial fluctuations. Fourth, monetary and interest subsidy authorities should coordinate on financial aid policies.

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1. Introduction

Subsidies and incentives aim to motivate investors through grants, direct payments, tax reductions and exemptions. The WTO definition is more comprehensive: "A subsidy is a financial contribution by a government, that confers a benefit on its recipients" (Steenblik, 2007). Policymakers usually incentivize certain regions and productive sectors to stipulate investments to ease development. In that sense, the efficiency of incentive tools has always been a hot topic focusing on whether these transfers are meaningful or not.

Even though impact analyses are prevalent in international and domestic literature, credit and interest subsidies did not seem to grab much attention considering the level and intensity of credit subsidies under investment incentives. Credit subsidies consist of three main elements: credit guarantees to solve collateral and credibility problems, interest subsidies to reduce the company's financial cost, and direct subsidized credits via export credit agencies or development banks (Antunes et.al., 2015).

2. Methodology

The study embarks on an extended literature review method. First, the literature focusing on the interest rate and cash-flow sensitivity of investments is explored. Because the rich literature and views embedded in this domain, actually crack the door for potential effects of the interest subsidies. Then, the literature on the efficacy of both credit rates and interest subsidies has been discussed coherently to shed light on investment motivation. The probable inferences from literature findings on the course of investment and credits in Turkey were discussed by resorting to trend comparisons and up-to-date data in the research. The credit circumstances that actually affect Turkish companies' investment decisions are

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also inevitably investigated throughout the research to bring policy recommendations alternative to interest subsidies.

3. Brief Interest Subsidy History Under Investment Incentives in Turkey

The roots of investment incentive legislation date back to the Ottoman Empire in Turkey and Industry Incentive Law in 1913 was the first sprouts of it. Initial liberalization efforts led the FDI support policies in the 1950s and the Turkish Development Bank was also established to provide 'middle and long-term credits' to the manufacturing sector (Altay and Karabulut, 2017). The paradigm of the economic administration was the import substitution based on central planning before transforming into an export-based liberal approach in the 1980s. The 80s policies were a good example of how policymakers would like to use credit policies. On July 1, 1980, the government removed all controls on commercial bank interest rates and allowed them to float under market mechanism (Yalta, 2006), and rapid liberalization led to a steep increase in the real lending rates during tight monetary policy due to hasty fund gathering that banks were not able to attract in the planning period. Real interest rates were mounted to around %15 (Kandemir & Kandemir, 2019) which seemed to compel policymakers to resort to interest subsidies. However, credit constraints persisted even after the liberalization of financial markets (Günçavdı et.al., 1998).

1979-1983 Development Plan introduced the term "priority regions for development" and the government desired to relocate productive investments to priority regions, %10 higher than the rest of the cities (DPT, 1979: 294). In 1981, priority regions were also divided into two sub-groups according to the severity of underdevelopment shortages (DPT, 2000: 52). In 1984, custom duty exemptions, investment tax credits, income and corporate tax discounts, corporate tax delays and medium-term investment 'credit interest subsidies' are applied with regards to regional priorities, minimum capital and sectoral requirements. This six-legged incentive structure has continued over the years with several tunings.

Efforts on diversifying regional incentive structure continued in the 90s and the term "industry belt" was introduced to classify the underdeveloped cities to address (Official Gazette, 1995). This concept was also abolished later on, but the regional perspective was maintained (Karaca, 2004).

At the end of the 90s, the incentive system was similar to previous versions, including 'loans' from the special incentive fund, customs duty exemptions, investment tax credits and VAT exemptions (Official Gazette, 1999). In the "8th Development Plan Regional Development Expert Commission Report", high public debt, constant legislation amendments, red tape and weak organizational coordination were mentioned as hampering factors in the incentive system (DPT, 2000: 33).

At the beginning of the 2000s, the incentive structure remained the same till 2003 (Official Gazette, 2001) when the differentiated investment tax credit rate was fixed at 40% (Official Gazette, 2003), the priority regions were revised according to the socioeconomic development classification prepared by the State Planning Organization in 2004 (Official Gazette, 2004).

The year 2006 was a turning point for the incentive legislation. 40% fixed investment tax credit is repealed considering the general corporate tax reduction (Official Gazette, 2006). Hence, one of the best-known incentive instruments was ruled out. The years between 2006 and 2009 were one of a kind in incentive tools compared to other historical periods with their simplistic form. In 2006, there were only VAT and customs duty exemptions and 'credit interest subsidies' especially for SMEs. Additional energy support was solely applied to the tourism investments (Official Gazette, 2006b). Subsidized credits/interest subsidies seem to be survived even under the humblest incentive scheme between 2006-2009.

3.1 The Role of the Interest Subsidies Under Current Incentive System

The investment incentive system has been in effect since 2012 with several amendments. The general framework of the current incentive scheme will be examined in this section mostly to clarify the role of interest subsidies.

The incentive system has four main sub-schemes and all of which have similar support measures, yet the support densities depend on the sector, importance assigned by the decree. Available tools can be seen in Table.1 in each sub-scheme.

Table 1. Investment Tools

Support Measures	General Scheme	Regional Scheme	Priority Scheme	Strategic Scheme
Vat Exemption	✓	✓	✓	✓
Customs Duty Exemption	✓	✓	✓	✓
Tax Deduction		✓	✓	✓
Social Security Premium Support (Employer)		✓	✓	✓
Income Tax Withholding Support*	✓	✓	✓	✓
Social Security Premium Support (Employee)*		✓	✓	✓
Interest Subsidy**		✓	✓	✓
Land Allocation		✓	✓	✓

VAT Refund***				✓

* For investments in the 6th region.

** Only for investments in regions 3, 4, 5 or 6.

*** For Strategic Investments' construction costs only for a minimum fixed investment amount of TL 500 million

Source: Ministry of Industry and Technology – DG of Incentive Implementation and FDI

In the regional scheme, six different regions are classified according to the socioeconomic development level determined by the Strategy and Budget Department. Each investor can receive whichever instrument is available according to the regional, sectoral and minimum capital requirements (Annex-1). The support density increases gradually for the investments located in cities in underdeveloped regions. The minimum capital requirements are also lower for underdeveloped regions.

In the priority scheme, specific sectors with high socioeconomic value-added capacity enjoy the privileges of 5th region instruments and support levels although the investment took place in 1, 2, 3, or 4th regions.

In the strategic scheme, the production of certain intermediate and final products with high import dependence is addressed provided that certain criteria are met.[1]

The general scheme covers rather modest instruments and is applied to all projects falling out of the scope of the other three schemes. Only the sectors that are mentioned explicitly as unable to receive incentives are not covered. In addition, certain medium-high technology projects can benefit 4th region terms, even if they took place in 1, 2, and 3rd regions (except greenfield investments in Istanbul) (MOIT, 2020).

The regional perspective is the backbone of the incentive structure. In this regard, interest subsidies are unavailable for 1st and 2nd regions. The amount of payback is 3 points for the 3rd region, 4 points for the 4th region, 5 points for the 5th region, and 7 points for the 6th region (Annex-1). It also applies to medium-high tech investments, priority and strategic investments; thus interest subsidies are available under most of the schemes applied under the system.

Interest subsidies have been a major incentive instrument since the 80s. It is occasionally implemented as a low-cost credit while sometimes taking the shape of an interest subsidy to bear funding costs. However, although many studies focus on tax incentive efficacy in Turkey, the capability of interest subsidies has not drawn much attention to date.

4. Interest Subsidies: Theory and Concept

Interest subsidies are classified under credit subsidies in the literature. Credit subsidy is defined as a government loan with a lower interest rate than the market or making credit available with less collateral to back up the loan, repayment deference, or longer installments (Steenblik, 2007).

The interest subsidy as we called it in this study, lowers borrowing costs for companies, increases free cash flows, and is also expected to ease the credit accession for a bit (Podpiera, 2011). It might help to overcome either market failures or structural weaknesses in the financial market to induce firms to expand capital holdings in productive assets, generate employment and economic growth (Dailami and Kim, 1994), or alter allocative efficiency (Lurie, 1982). Mankiw (1986) recommends that credit subsidies - guarantees or interest subsidies - are useful countercyclical tools when financial conditions are tightened.

4.1 Theoretical Framework

Apart from tax incentives, the roots of interest subsidy literature go back to the financial market frictions that cause interest rate equilibrium to fail in clearing off markets, thus necessitating state intervention. Therefore, the effect of financial market friction is worth mentioning.

Interest rates affect investment decisions via two mechanisms. First, commercial lending rates are the cost of machines and equipment (capital factor). Second, deposit or bond rates are the major alternatives for the rate of return on investment projects. Thereby the next episode will dwell on the interest rate/investment correlation without digging deep to stay on track.

The following episode will be spared to the investment/cash flow sensitivity. The rich literature on the cash flow sensitivity of investments would help to relate the funding cost or credit accession to the investment decisions to elucidate one more layer on the interest subsidies' success probability.

4.2 Financial Market Frictions

Financial market failure literature dates back to the famous information asymmetry article of Akerlof (1978) about the market of lemons. He exemplifies a local lending relationship in India where a high level of interest rates was the leading factor in landlessness because the local lender[2] grants only to those (1) who easily enforce his contract with or (2) those he has personal knowledge of their character. The author infers that this may cause other lenders to end up doing business with "bad" debtors, thus probably making a loss due to asymmetric information. The author addresses the importance of guarantees to keep good borrowers in the market.

Arping et.al. (2010) also states that credit guarantees could alleviate market failures led credit rationing because credit guarantees alleviate entrepreneurs' insolvency risk. Lelarge et.al. (2010) found that loan guarantees are effective in helping

[1] At least 50% share of the ultimate product must be supplied through imports nationwide; the import amount of the ultimate product must be at least $50 million for the last 12 months period which is not applicable for the goods with no domestic production; minimum investment requirement is 50 million TL, production must create minimum 40% value added within the borders of the country.

[2] Who is defined as a well-known local. There are other lenders in the market who are not linked to the central lending agency.

young French firms to grow. The study of Gale (1991) specifically dwells on theoretical aspects of credit programs and infers that, when credit policy is assumed to be constant, the existence of adverse selection in financial markets can lead to an increase in lending rates which may eventually cause banks' expected return to decrease. The hike in the lending rates may cause relatively risky projects to apply for costly loans, which have a higher probability of default.

Stiglitz and Weiss (1981) argue that the credit markets eventually become rationed. Because the equilibrium interest rate (r*) cannot clear off the market since banks are not keen to open a credit line to an individual who offered to pay more than r*, such a loan is likely to be perceived as risky. The expected return of loans at an interest rate above r* is actually lower than the loans the bank is presently lending, due to lower reimbursement possibility. Hence, r* affects the loan quality perception of the bank, so whenever lending rates increase, interest subsidies hypothetically would help desired projects to be successfully completed or induce banks to produce an optimal credit quantity (Minelli and Modeca, 2009). Information asymmetry puts more pressure on small firms (Myers, 1984). Entrepreneurs with high ability but low initial wealth have higher marginal products of capital relative to those with low ability but high initial wealth. This picture has a high probability of misallocating credits (Antunes et.al., 2015). In times of a negative shock to internal funds, leverage and lending rates increase. The interest subsidy can step in and compensate for the margin distortions (Correia et.al., 2016). Because, as credit conditions deteriorate, investment spending contracts and exacerbates the downturn through distortions on net worth and collateral values (Gilchrist and Himmelberg, 1995).

Contrary to Stiglitz and Weiss (1981); De Meza and Webb (1987) argue that credit market equilibrium may be characterized by overinvestment means that companies can be overly leveraged in the financial market even if it does not reflect market equilibrium. Thereby, the authors recommend additional investment tax for rebalancing which is not deemed to be valid in the Turkish context since the economy is floundering in the middle-income trap, which translates into a lack of investment quality and volume (Duran, 2019).

Financial market literature more or less agreed on market failures stemming from informational asymmetry which legitimizes the credit subsidies. However, the subsidy becomes efficient when the lending rates mount, financial conditions mount and surely where the social benefit from the last increment of subsidy equals the social cost associated with it (Shoup, 1972) in practice, designing a frequent Pareto efficient subsidy is impossible due to uncertainty about the response to the subsidy and other difficulties in estimating its benefits and costs (Lurie, 1982).

The information asymmetry literature seems to emphasize the market mechanism facilitator feature of the interest subsidies to back risky, high-interest-charged projects, yet findings that will be mentioned later on in this article will show that interest subsidies may have no impact on credit accession of so-called *risky* projects in the Turkish context.

4.3 Interest Rates vs Investment Expenditure

The interest rate sensitivity of investment decisions is rooted in the very first definitions of investment function. Bernanke (1983) indicates that high-interest rates are so depressing that even the tax reliefs are not able to offset the negative effect. Lawrence and Siow (1985) confirm the common thought stressing that higher nominal interest rates have persistent negative dynamic effects on investment spending even if the real interest rates remained constant, due to the elevating pessimism.

On the other hand, an early contribution has been made by Modigliani and Miller (1958) indicating that there are ample grounds to doubt that interest rates directly influence the investment expenditure. Krainer (1966) states that external finance mechanisms might not have been as valid as common thought presumes. The author seemed hesitant to draw bold conclusions contrary to the well-agreed literature but he adds that the link between interest rates and investment decisions might be overrated a bit.

Kohli (2001) states empirical evidence shows no significant response of private investment to interest rates or the cost of capital in India. The interest rates remained unchanged for years and investment was determined, besides demand variables, by credit availability. Even after the financial liberalization, interestingly, investments peaked when real interest rates were very high in 1996-1997, which means credit accessibility matters rather than the cost of financing. Study results differ depending on the context and time frame they have been applied, yet there may be no sound link between interest rate and investment expenditures. Günay, H., & Kılınç, (2015) argue that the credit volume is an essential factor for business cycles in Turkey as they also underlined the fact that historical investment expenditure swings are a lot higher than the consumption, thus investment volatility is an important source of GDP fluctuations in Turkey. The interest sensitivity of investment expenditure studies implies that the credit volume could be a vital determinant besides the level of the market interest rates.

4.4 The Corporate Finance and Investment Decisions

There is remarkable literature on whether corporate finance/cash flows influence investment behavior. These studies are motivated by explaining the business cycle fluctuations without relying on large production shocks. The neoclassical view of perfect capital markets suggests that investment and finance are treated separately. Because in perfect financial markets, external and internal finance become perfect substitutes under perfect information.

According to Modigliani and Miller's theorem (1958), a firm's value is independent of how it is financed; the planning for optimal financial strategy is not trivial, but it should have no bearing on the basic decision to invest which would take place wherever the rate of return exceeds the capital cost. On the other hand, a post-Keynesian, Kalecki (1937) claims that profits, a good proxy for available internal cash flows, have a

significant effect on capital accumulation because it is less risky than an external fund for two reasons; firstly, a large amount of investment endangers entrepreneur in case of a failure. Secondly, machines and equipment often act illiquid and probably would be sold for less than their real value in times of urgent liquidity.

According to the pool of funds view, several projects are available in a specific time frame for any company to invest, and a certain amount of funding has been made before an investment decision (Ferrara, 1966). Clark et.al. (2009) supports the view that companies have a desired debt ratio beforehand.

Besides, many studies emphasize the importance of financial constraints[3] especially for those in developing countries (Cull et al., 2015). Financial constraints are considered one of the major obstacles to investment according to developing country business leaders (Dethier et al. 2011). Moreover, due to weaker market mechanisms, developing country governments tend to play a larger role in channeling financial resources (Ayyagari et al. 2012). The corporate finance/investment relation seems to depend on the context, location and methodology of the studies, therefore the cash flow/investment literature is divided into two fractions. Empirical evidence will be mentioned below in two sub-sections.

4.4.1 Findings on Cash Flow are Important for Investment Decision

Gilchrist and Himmelberg (1995) tried to set up a model taking Tobin's q as a proxy of cash flows[4]. They introduced a term of fundamental Q[5] instead to incorporate investment opportunity and found that there is very little residual correlation between investment and cash flow for unconstrained firms, but there is a high degree of residual correlation for constrained firms. In addition, the authors found no excess sensitivity of investment to cash flow for firms with easy access to finance, as measured by the presence of either a debt or commercial paper rating. For firms without a bond or commercial paper rating, roughly 50% of the investment response to cash flow is potentially attributable to financial factors.

One of the most referred articles in the field, Fazzari et.al. (1987) emphasizes the fact that investment is highly correlated with cash flows or other measures of internal funds. This correlation arises in models of capital market imperfections because investment is directly linked to available internal funds when the company is credit rationed. In other words, the influence power of the cash flow is much higher for financially constrained firms[6]. Fazzari and Mott (1986-1987) examined firm-level attitudes between 1970 and 1982 in the US and they found that internal finance has a significant importance on investment decisions. Fazzari and Petersen (1993) focused on the role of working capital as a smoothening tool for companies' investment sensitivity during cash flow shocks in the US between 1970 and 1979. They find that investment sensitivity to cash flow is higher than in earlier studies when working capital is included in the model. In the regression model they applied, the coefficient of the working capital[7] variable was found to be negative on affecting investments which means cash flows are important for investment decisions of constrained companies.

According to Gross (1995), firms invest until they reach the desired capital stock level if they are non-constrained. Financially constrained firms prefer to borrow to prevent their capital stock level from falling further. He infers that firms borrow when internal resources are low and financial resources are closely related to investment behaviour. Small firms have a higher sensitivity to cash flows due to the volatile distribution of financial flows.

Hoshi et.al. (1991) also present evidence from two different sets of Japanese manufacturers; the first group has close ties with large banks and thus has less information asymmetry while the second group of companies has weaker relations with the bank. Study indicates that investments are more sensitive to liquidity when companies have more fragile relationships with the banks. Similarly, Shin and Park (1999) stated that investments of Korean group companies -Chaebols - have less sensitivity to cash-flows than other companies based on an observation of 629 companies. The study of Mulier et.al. (2016) examines SMEs in Europe those are not quoted on a stock exchange. The findings imply that constrained companies pay higher interest rates. They also iterate that financial shocks crash credit volume and constrained companies display the highest investment-cash flow sensitivity. The findings especially indicate the importance of financing for those having constraints.

[3] Financial constraints defined as inability of a company to acquire sufficient funds when there is a plausible funding cost reflecting real risk of a company or projects is possible to deliver (Maeseneire and Claeys, 2006).

[4] Author admits that it might be exclusionary for certain sub samples in the model.

[5] 'Fundamental Q' is computed by estimating a set of VAR forecasting equations for a subset of information available to the firm, and then evaluating a linear expectation of the present discounted stream of marginal profits to obtain the investment fundamental, thus reflects an attempt to include profit expectations to address signalling deficiency might have stemmed from Tobin's q. For instance, the firms identified as financially constrained are typically newer, smaller, and faster growing than other firms in the sample, the stock market is less likely to have accumulated the usual stock of knowledge that arises through detailed evaluation and monitoring of firms over time. Thus, Tobin's Q might contain less information about investment opportunities for 'new' companies than the companies have been defined as unconstrained.

[6] Constrained firms are generally identified by using a priori information such as size, dividend behaviour, and capital structure in the model.

[7] Working capital, also known as net working capital (NWC), is the difference between a company's current assets—such as cash, accounts receivable/customers' unpaid bills, and inventories of raw materials and finished goods—and its current liabilities, such as accounts payable and debts. It's a commonly used measurement to gauge the short-term health of an organization.

4.4.2 Studies Argue Cash Flow Does Not Affect Not Effective on Investment Decision

Rather than denying its effect, these studies seem to argue that cash flows might not be as effective as expected. They also indicate some methodological drawbacks. Mauer and Triantis (1994) emphasize the time lag effect of financing decisions for prospective investors and conclude that debt financing has a negligible impact on the firm's investment and operating policies. Gomes (2001) finds that there is a much lower correlation between Tobin's q and investment decision compared to the neoclassical model.

The study of Kaplan and Zingales (1997) is also one of the most contested and referred one. In light of the annual financial reports and executive statements of the companies previously declared as 'constrained', authors find that 85% of the constrained companies could have increased their investment — in many cases, substantially — if they had chosen so.

Becchetti et.al. (2010) indicate occasionally self-declared credit-rationed firms have excessive investment-cash flow sensitivity while admitting that only the credit-rationing status may overcome the nonmonotonicity critics brought forward by Kaplan and Zingales (1997). Becchetti et.al. (2010) acted as a mediator between the two opposing views underlining the constraint company definition.

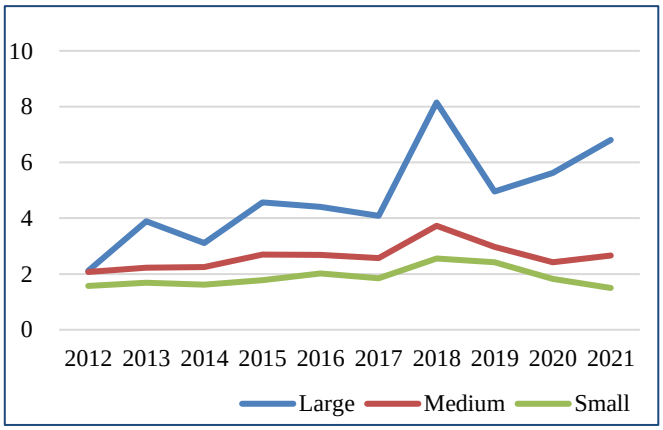
Shapiro (1986) provides a different angle addressing a common statistical methodology pitfall. When the underlying shocks to output and cash flows are autocorrelated, it is possible to obtain solid but spurious correlations between the variables. The study of Almeida and Campello (2010) contributes via the premise of the standard pecking order[8]. They state companies' investment choices might become endogenous to external financing decisions. Because in the study, companies facing higher external financing costs do not show a preference for internal funds. While it is still the case that such firms place a high value on internal funds, reducing external financing is not necessarily the best use of funds for them. In other words, internal funds and external financing can become complements rather than substitutes even when external financing costs are high. Authors also criticize the constrained firm definition focusing on companies that pay little or no dividends, small-scale and whose debt instruments are not rated because they claim that constrained companies can still have access to external finance. Studies on the negative side emphasize the constraint definition and some other colliding mechanisms and present external financing as a complement to internal funds.

4.5 Observations on Theoretical Aspects of Credit Subsidies

The financial frictions literature can provide mindful insights into current incentive legislation. Policymakers need to remember that financial market mechanisms might fall short to deliver an equilibrium interest rate to clear off the market. Suppose a credit market is unable to perform properly when lending rates are higher. In that case, then interest subsidy instruments become crucial to reduce funding costs and alleviate adverse selection, especially in times of credit crunches. Otherwise, credit guarantee type supports to enhance credit accession could be considerable. Inferences on guarantees are not perfect but partial substitutes to interest subsidies, because both instruments -supposedly- increase the chance of repayment and assure banks.

Relatively, higher funding needs of SMEs or start-ups are widely accepted phenomena that might also shed light on better interest subsidy practices for start-ups. Besides, at present, applying interest subsidies for only the 3rd, 4th, 5th and 6th regions (relatively underdeveloped) seems plausible; considering the probability of hesitant attitude of the lenders in these regions.

Figure 1. Share of financing cost in net sales (%)



Source: CBRT Aggregated Sectoral Balance Sheets

The mixed empirical evidence on the relationship between interest rates and investment expenditures made us think about the relative importance of the funding cost of the Turkish manufacturing companies among other balance sheet items. The share of financing costs in net sales is shown for the years between 2012 and 2021 with a breakdown on a scale of each company group in Figure.1[9]. The financing costs of the manufacturing companies are between 2% and 8% which is relatively low for all company groups compared with the other

[8] There are two mainstream funding decision theory. First one is the trade-off financing theory implies that decision on financing through equity or debt relies on the equilibrium between the advantage and disadvantage of the external finance. The second one is pecking order view dwells on the informational asymmetry in the financial sector which lead company to seek for internal resources before searching for an external finance due to its inevitably higher cost (Okuyan and Taşci, 2010).

[9] Company scale is determined according to the Bank for the Accounts of Companies Harmonized operating under the European Committee of Central Balance Sheet Data Offices. Companies with net sales amount lower than 10 million Euros are defined as small, companies with net sales amount between 10 million and 50 million Euros are defined as medium scale while companies with net sales amount higher than 50 million Euros are defined as large companies (CBRT, 2023).

cost types. The relatively low share of the financing cost might well indicate a limitation for interest subsidy tools to influence companies' investment decisions since the support would be unable to draw as much attention as other cost items in the balance sheet. The share of financing of larger scale companies is higher than medium and smaller scale companies, probably due to higher credit accession.

Studies claiming investments are sensitive to the cash flows are in line with market friction literature and necessitate an intervention to alleviate the adverse effects. It is obvious that the definition of financial constraints inevitably influences the study results, however almost in all studies, investment decisions of constrained companies have a certain degree of potential to be affected by cash flows. Returning to our core subject, we can infer that interest subsidies have a great probability of supporting constrained companies, assuming the interest subsidy would increase the fund transfer and facilitate companies to access credits. A certain amount of selectivity addressing the company's financial condition might be plausible. However, addressing informational asymmetry with guarantees would be easier and cheaper.

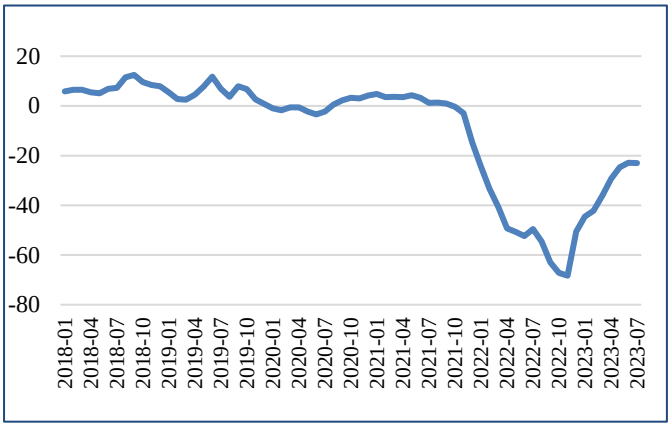
5. Are Interest Subsidies Matter for Investment Behaviour?

In this section empirical study results will be mentioned focusing on interest subsidies whether they are a determinant factor for investment decisions. Since not many studies focus on interest subsidies as we framed in this study, we decided to extend the analysis horizon to other studies exploring the effects of financial parameters under investment determinants. Financial parameter-based studies are picked from the studies analyzing the Turkish business environment.

5.1 Interest Subsidies vs. Investment Expenditure

In this section, the studies directly investigating the efficacy of credit subsidies for investment behavior will be examined in comparison with the Turkish context. Some studies analyzed credit subsidies as an umbrella term covering guarantees while others differentiated the type of subsidies.
Correia et.al. (2016) discussed credit subsidies as an alternative monetary policy instrument. Their study states high and volatile credit spreads should be corrected when financial intermediation is costly. Credit rationing occurs when banks charge higher interest rates, which drive some borrowers out of the market. Since interest subsidy bears the additional cost of credit, banks do not tend to increase the lending rate further, due to the risk of losing clients (Janda, 2011).

Figure 2. Real commercial lending rates (Weighted Average, %)



Source: CBRT Data Central

In Figure 2 real commercial credit lending rates in Turkey are shown for 2018-2023/July and the recent downward trend is crystal clear. Considering the recent steep decline in real commercial lending rates in Turkey, one can say that there is no coordination and mutual harmonization between the monetary and incentive policy tools since the interest subsidies persisted during the extremely low lending rate period.

This view is also reflected in the study of Podpiera (2011) which provides valuable insights from Serbia where interest subsidies were implemented as a substantial policy response to the global recession. It performed well according to the author, because several convenient pre-conditions were in place. First, the Serbian government has had fiscal resources available for the subsidies. Second, the government reacted swiftly during the crisis to counteract delinquent debtor blockages (defined as a specific feature of Serbia by the author). Third, the central bank allowed banks to deduct subsidized credit from the reserve requirement base. Fourth, a less concentrated feature of the Serbian Banking System enabled competition among commercial banks to keep their clients. According to the calculations by the author, the 2009 GDP contraction would have been 1-2% higher in Serbia if interest subsidies had not taken place. It is also calculated that the loan rejection rate decreased by 1% because of the interest subsidy scheme. It resembles the Turkish interest subsidy tool but there are certain differences. First, the Turkish scheme is always in place whether the economy is in a downturn or not. Second, the Serbian subsidy amount consisted of around 50% of all credit costs but in Turkey, the subsidy base points are fixed. Third, there is no coordination between the monetary policy and interest subsidy instrument and the two policy purposes are likely to contradict or overlap in certain occasions.

De Bruyne and Van Rompuy (1982) conducted an econometric analysis for Belgium and evidence shows that regional interest rate subsidies have a redistributive effect on investment. This result relates to the Turkish context because

interest subsidies are applied with a regional perspective (MOIT, 2023).

In the model designed by Antunes et.al (2015), banks handle everything and the government provides subsidies at the end as in the Turkish model. Presumably, interest subsidies reduced the lending rates to the level of deposit rates. Still, they turned out to be inefficient overall due to distortive distributional effects stemming from required austerity in payroll taxes because of the deficit it caused in the general budget. Authors concluded that countries should focus on financial reforms that improve the functioning of credit markets such as reforms that solve creditor protection, asymmetric information and intermediation costs, considering the bearings on the taxpayers.

Several studies examined credit subsidies in Brazil. Pazarbasioglu et.al. (2017: 20) analyzed 25 public companies between 2004 and 2012, and there was no significant relationship between companies' investment rate and the proportion of subsidized loans[10] which only helped companies to lower their financial expenses. These findings are also parallel with the inferences of Lazzarini et al. (2014) who indicate that subsidized credits finance large and profitable firms in general with no effect on their investments. With respect, Jo and Senga (2019) point out that the credit subsidies' results hinge on the companies' financial status. It can be helpful for SMEs to alleviate financial constraints to achieve an efficient and larger scale of production.

Lage de Sousa and Ottaviano (2014) also show that companies getting subsidized credits are not able to outperform non-subsidized companies. However, Cardoso et.al. (2011) examined subsidized credits for rural farmers in Brazil and found that the GDP contribution of the program exceeds the cost of the interest subsidies provided by the government[11]. Regional effects of interest subsidies seem more optimistic than overall influence.

Janda (2005) indicated that untargeted interest rate subsidies are powerless and become meaningful when channeled to high-risk recipients. However, uniform non-targeted credit guarantees improve welfare. The author also claims that the estimated amount of the fund transfer from the government is lower for credit guarantees when project diversity is high while budget cost goes down for interest subsidies when project diversity is low. Because, the participation cost of low-risk companies becomes the same as the participation cost of high-risk companies in the case of uniform interest subsidies (Janda, 2011).

A simple estimation might help to compare project diversity for the Turkish incentive system on guarantees and subsidies. Between 2010 and 2023[12], annually, an average of 6.758 incentive certificates for 158 sub-sectors have been delivered by the DG of Investment Incentives which implies a diversified project structure for the Turkish incentive system.

Gale (1991) examined all types of credit subsidies for the US and found that subsidies lead to major changes in the allocation of credit, but little effect on aggregate investment. According to Dinh et.al (2013), subsidies worked in Vietnam in the first half of 2009 (the global recession) but after that, some of the subsidized loans leaked into irrelevant activities (i.e. real estate or stock market speculation). Interestingly and undesirably, leakage elevates when economic growth perspectives are rather pessimistic, thus, interest subsidies are unable to counteract economic downturns under the boom-bust cycles[13].

According to neoclassical economics, without a loan subsidy, firms will determine production level where MRR is equal to the MCC, which determines their optimal total investment in productive assets, I*. When the credit subsidy is implemented, firms still won't change their investment in productive assets whatever the subsidy level is, because the loan subsidy has no influence on the MCC at I* and the remaining subsidized capital will be invested in speculative assets, which promises a better MRR under the subsidy. It also makes sense if we assume the current economic environment resembles a monopolistic competition market model with a decreasing MRR. When a company decides on one unit of increase in production, it would result in lesser revenue, thus a company can easily resort to speculative fields (Dinh et.al, 2013) as Demir (2009) finds the same tendency for Turkish investors in times of uncertainty. The authors infer that interest subsidies should be used for a limited timeframe and closely monitored. Turkish interest subsidies are also limited to the investment period but not monitored after the subsidy payment is provided.

Bosworth et al. (1987) also state that subsidized credit may simply induce borrowers to substitute debt for equity or capital instead of labor. The borrower may also use the funds for some entirely unrelated purpose.

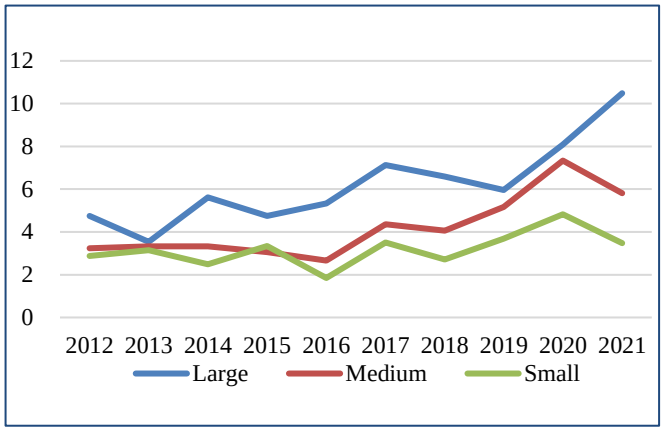
[10] Subsidized loans are given via Brazilian Development Bank (BDB) and the benchmark rate for BDB loans is set well below the monetary policy rate and often below the inflation rate (Pazarbasioglu et.al., (2017: 8).

[11] Interest subsidies or lower credit lending is a widespread tool in the agriculture sector in different forms. Li and Shen (2012) state that interest subsidies can be successful to keep labor in rural areas while Li et.al. (2013) states that interest subsidies able to increase factor employment and investment in advanced agriculture applications although admitting that wage and land subsidies are superior to interest subsidies. In terms of incentivised projects for all types of investment schemes, only 1.3% of the total incentivised projects took place in the agriculture sector between 2001-2020/March in Turkey while 53% took place in manufacturing and 25% took place in the services sector. Hence, interest subsidies focusing on the agricultural sector are just mentioned slightly. There are other types of special agricultural credit programs in Turkey as well (Cevik and Zeren, 2014).

[12] The period yearly incentive certificate data was available for the new incentive scheme.

[13] The years 1986-1988 is defined as *three low era* (low oil price, low inflation, low FX rate) which leaded to an investment boom in Korea.

Figure 3. Profitability rate in manufacturing (%)



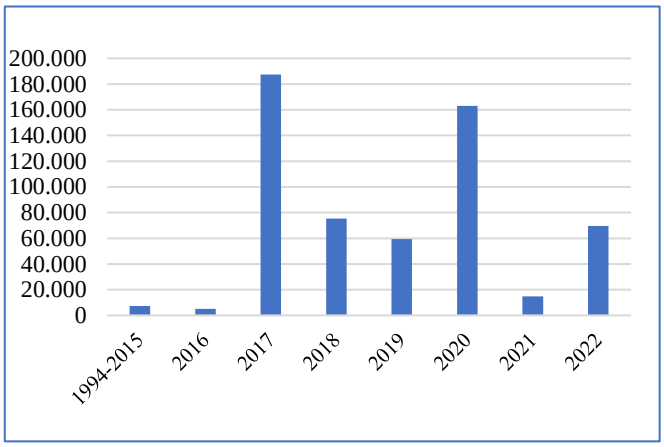
Source: CBRT Aggregated Sectoral Balance Sheets

Lapar et.al. (1995) examined a microenterprise credit program in the US and empirical results suggest that there might be no need for subsidized interest rates because there are strong indications that microentrepreneurs are capable of gaining high rates of return on capital thus they are capable of paying market rates of interest. The Figure.3 shows the profitability ratio for the company groups by scale in the manufacturing sector. Smaller-scale companies work with lower profitability in comparison with others, which might indicate a need for further action for lower-scale companies. Another study in Turkey infers that profitability eases credit accessibility for SMEs (Demirgüneş, 2016) who represent 78% of the total employment, 50% of private investment and 59% of exports in Turkey (Başkan and Benli, 2019). Hence any discriminative approach in favor of SMEs might well pay off in the Turkish context.

Rapisarda and Patacchini (2003) analyzed the credit subsidies in Italy between 1995/3 – 1999/2 and found evidence that subsidized loans tend to replace pre-existing loans, with minimal effect on investment. In addition, the substitution effect is pronounced for borrowers who seem to be financially unconstrained, reinforcing the argument that subsidies tend to reach firms that would have access to finance anyway. These results again address selectivity in credit subsidy design.

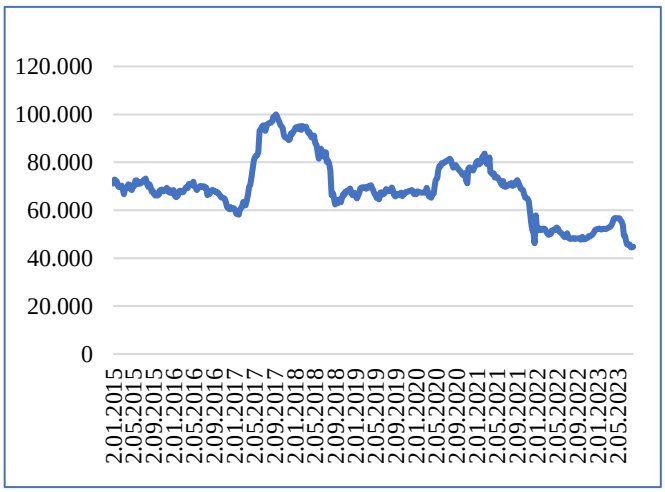
Wang (2013) has developed a model assuming some borrowers are rationed under separated equilibrium due to asymmetric information. Study results show that interest subsidies, loan guarantees, and monitoring cost subsidies are able to alleviate the problem of credit rationing in various degrees. Loan guarantees were found to be the most efficient, yet the interest subsidies entail higher distortionary taxation.

Figure 4. Total guarantee amount (Million TL)



Source: Credit Guarantee Fund

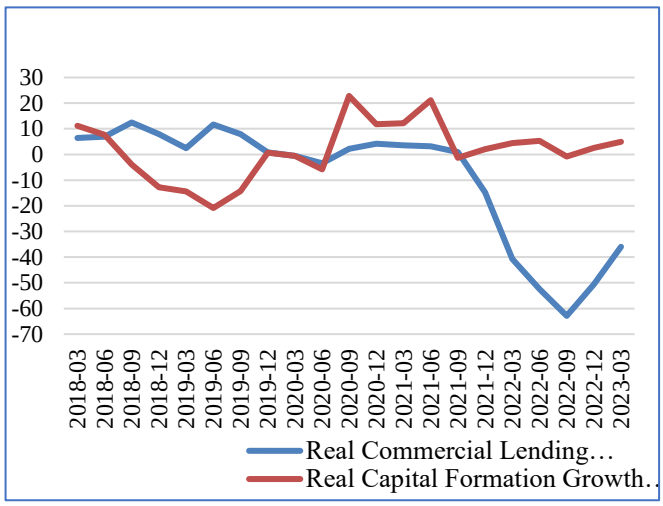
Figure 5. Commercial Credits (Million $)



Source: CBRT Data Central

In Figure 4, the amounts of the guarantees given by the Turkish Treasury Credit Guarantee Fund (CGF) are illustrated between 1994-2002. The Turkish Treasury pledged 25 billion TL in 2017 as collateral to the state-backed CGF and the guarantee amount surged quite steeply compared to previous years. (KGF, 2022: 50). Credit volume expanded substantially with the help of the CGF mechanism (Akcay and Güngen, 2019) as can be seen in Figure.5 which confirms the significant effect of the guarantees in the Turkish economy. According to anonymous expert views, CGF credit expansion contributed economic growth rate by 1,5-2 points per se in 2017 (BloombergHT, 2018). However, between 1994 and 2017, only 12% of the CGF guarantees were made available for underdeveloped regions of Turkey, most probably because of a lesser extent of economic activity in those regions. However, 45 CGF beneficiary companies stated that guarantees solved their funding constraints (Başkan and Benli, 2019).

Figure 6. Weighted Real Commercial Lending Rate vs. Real Capital Formation Growth (%)



Source: CBRT Data Central

In Figure.6, there is no significant correlation between real commercial lending rates and real capital formation, even after the extremely low-interest period we observed after 3rd quarter of 2021.

We can conservatively infer from all of the studies above that, interest subsidies may turn into null fund transfers from one group to another. The impact of interest rates and lending rates is rather limited especially compared to cash flow conditions and credit boom-bust cycles. The lesser share of financing cost in the balance sheets and much more importance attributed to the credit accession on investment decisions also rules out interest subsidies.

However, most of the studies point out the relative need for finance in smaller or constrained companies compared to non-constrained companies. Interest subsidies could be more efficient in times of credit crunch and downturns even if there is evidence on the contrary in Vietnam. Last but not least, empirical evidence mostly prefers guarantees over interest subsidies. The inferences seemed in compliance with the theoretical aspects underlining market frictions.

5.2 Interest Subsidies vs. Investment Expenditure

The rest of the studies focusing on financing-related investment determinants will be examined in this episode to broaden the scope of interpretation.

Post-Keynesians assume that profit rates are the main source of investment finance due to the degree of the confidence argument (Arestis, 1996) while later on Marquetti et al. (2010), Basu and Das (2017) use the profit rate to reflect the expectations of the entrepreneurs in the investment function.

Doruk (2017) studied the determinants of investments in the Turkish manufacturing sector and inferred that profit rates and cash flows positively affect investments. Yeldan et.al. (2002) found that profit margins and real wages have a significant positive effect on investments which underlines the demand side. Çonkar et.al. (2018) ran a Granger and the Toda-Yamamoto causality analysis and found that credit volume (including Islamic finance) is one of the determinants of investments. Rittenberg (1991) analyzed the impact of interest rate policy on investment spending in Turkey throughout both financial repression and liberalization and found that investments are encouraged by below-equilibrium interest rates while hampered by higher interest rates. Günçavdi and Küçük (2013) indicate that the credit policy and accommodative monetary policy with lower rates of interest could be the essential elements of economic policies that revive investments in Turkey. However, the authors examined the period of 1987:1–2007:4, considered the inflation rate as a proxy of uncertainty before the 2000s, and inferred that the decreasing interest rates played an essential role. But in the 2000s, other remarkable developments are not included in the regression as a former minister now at the Brookings Institution Kemal Dervis admits that the buoyant global economy in the 2000s was a big boon for Turkey's recovery (Wigglesworth, 2015) as well as political stability. Atiyas and Bakis (2014) also claimed that TFP growth was remarkable between 2002 and 2006 in agriculture, industry and services as a result of the relocation of the hidden unemployment from agriculture to other production fields. Jensen (2009) states financial and political uncertainty is found to be detrimental to investments in Turkey.

Based on interviews with 33 executives in the Turkish manufacturing sector, 60% of respondents state that future demand conditions and market share growth are their major investment determinants as suggested by Keynesian theories. Interestingly, no firm ever mentioned investment incentives as a determinant of investment. 95% of companies reported that uncertainties in demand or cost conditions are major impediments, while only 20% of firms mentioned 'cost of finance' as the most important problem. Besides, none of the holding companies cited the funding cost or loan accessibility as a source of impediment, which is another evidence of the adverse effects of informational asymmetry (Gezici, 2007).

Günay and Kılınç (2015) state that in Turkey, investment expenditure fluctuates substantially when divergence from the HP trend is calculated between 1990-2004. 1994 and 2001 economic crises (the latter was a twin crisis that hit banking and current account balance together) took place in this period and calculations showed that investment expenditure deviations from the HP trend were quite larger than GDP, whose swings reached up to +25% and down to -30%. They concluded that the credit cycles are an important component of the boom-bust cycles in investment expenditures while the non-tradable sector is more sensitive to the credit swings because of harder financial constraints as depicted by Tornell and Westermann (2005). Cyclicality inference is compatible with Post Keynesian framework and implies that when volatility is high, risk-averse executives perceive a crisis of confidence and cut investments even more than they would do in lower volatility. This is also the major motivation of internal fund preference which is deemed cheaper and safer (Gezici, 2007). Günçavdı and McKay (2003) also underline the

importance of macroeconomic instabilities and the availability of credit for Turkish manufacturing investments.

Kaya (2011) investigated the determinants of investment by looking at the squeezed financial conditions during the global recession and found that companies' investment decisions are positively affected by their cash holding and sales revenues. Yet there is no robust finding to claim a different attitude in different company groups. Including the global recession in the time frame might have blurred the possible discrimination among company groups since the global recession hit every economic agent hard enough. Egimbaeva (2013) analyzed investment cash-flow sensitivity in Turkey for 135 manufacturing companies listed in ISE and found that companies' investment decision is affected by cash flow, while the sensitivity is higher in constrained firms[14]. Özen and Erdem (2016) followed a similar path. They analyzed 125 manufacturing companies listed in ISE for the 1998-2010 period and stated that financial conditions affect investment decisions and its implications are more severe in constrained companies as Fazzari et.al. (1987) depicted. Yesiltas (2009) contributed in the same vein examining 9.400 manufacturing companies which account for almost 75% of total manufacturing employment under the CBRT data system and found a significant positive relationship between firms' investment and their cash flow. While the investment cash flow sensitivity differs across size and age groups, divergence is not statistically significant for the main sample. She states that Turkish manufacturing companies are constrained overall.

Okuyan and Taşci (2010) analyzed the 1000 biggest industrial companies in Turkey and found that both scale and profitability are negatively correlated to the tendency to borrow which indicates companies favor internal funds first, in line with the pecking order approach even if they are expected to suffer less from the informational asymmetry. Cetenak and Vural (2015) analyze 164 manufacturing companies between 2004-2012 and indicate that information asymmetry hits smaller and independent companies harder than other firms and their investment expenditures are more sensitive to cash flows.

The regression analysis of Vithessonthi et.al. (2017) provides useful insight for the financial determinants of investments. They find that the lending rate has a negative, and acquired credits have a positive effect on investment as expected with a nuance that the lending rate coefficient is significant only at the 10% level, thus authors infer that credit accession is a more important determinant than the lending rate. Another salient evidence is on investment opportunities which are measured via market-to-book-ratio and equity return[15]. The investment opportunity coefficient is positive and significant in all models computed, and more importantly, neither the lending rate nor the credit usage abates the sensitivity of opportunities. This implies market opportunities and values dominate the credit conditions. For constrained firms in the model, the effect of the supply of bank loans is evident while the lending rate is not. For constrained companies, the supply of loans matters more as expected.

Islam and Begum (2004) argued that investment expenditure is weakly responsive (-0.36%) to lending rates. The observation of Ahmed and Islam (2005) is also consistent with the general empirical evidence which states that investment spending is weakly sensitive to lending rates[16].

6. Conclusion and Policy Implications

Investment incentives have always been a major topic in the literature. Any public transfer from one group to another brings efficiency debates along and it is also controversial whether incentives spur investments or not. Incentive analysis mostly focused on quasi-tax incentives by nature since incentives mostly consist of quasi-tax instruments. However, even though interest subsidies have always been a crucial part of Turkish incentive history, efficacy studies did not pay great attention to interest subsidies.

The marginal value of any public fund is undoubtedly higher for developing countries and it becomes more important when it comes to a country like Turkey with a chronical saving deficit. It compels policymakers to find optimum incentive methods and levels to utilize public funds in the best way.

Interest subsidies differ from other types of incentives since conditions of the financial market, companies' financing preferences and accessibility are also important side factors that affect the outcome of the interest subsidy policy. First, financial markets have a great probability to suffer from informational asymmetry which holds companies back from accessing the credits and sometimes leads to overcharged lending rates. This type of friction is the major reason for government intervention in the financial system, which is also absolutely valid for Turkish financial markets as depicted in the CGF pledge impact above.

According to most studies in the field, there is also a strong correlation between cash flows and investment decisions although the constrained company definition is still contested. Constrained companies have a great probability of cutting their investments if they are unable to reach credits. In times of credit crunch or financial crisis; credit accession and

[14] Constraint criterias selected as dividends of previous period, small by size and younger by age. Hence sample is exposed to the criticisms of Kaplan and Zingales (1997). Besides, companies listed on ISE might not differ from each other in terms of informational asymmetry since all of them required to have certain equity, capital deliver accounts by independent audit agency and age depending on their main sector and structure. Criterias can be found on: https://www.borsaistanbul.com/en/companies/public-offering-and-listing-in-borsa-istanbul/equity-market/public-offering/bist-stars-and-bist-main/listing-requirements

[15] Equity return measured as the first difference in the natural logarithm of stock price at the end of the year.

[16] Lending rates are estimated from quarterly weighted average interest rates of all scheduled banks and adjusted by CPI.

investment confidence deteriorates, interest spreads widen and intervention becomes necessary, sometimes inevitable.

The need for financial support policies differs according to the scale of the companies. Smaller scale companies are more exposed to financial pressure due to the information asymmetry; thus market equilibrium interest rates are unable to clear off the market. Considering public finance, providing interest subsidies only for SMEs would pay off and relieve the pressure on the budget although it has a limited effect. Preferring guarantees could be even better for all.

The recent developments on the interest rates of the commercial credits, and enhanced CGF guarantee facility also reveal three important aspects of Turkish financial markets. First, Turkish companies suffer from financial market frictions and guarantees helped them a lot. Second, recent below-inflation commercial credit interest rates already provide a fund transfer to the companies and there is no coordination between incentive and monetary authorities. Third and most importantly, there is no meaningful correlation between real commercial lending rates and investments, even after the extremely low-interest period we observed after 3rd quarter of 2021.

Credit subsidies mostly seem more efficient or allocate resources towards underdeveloped regions. In Turkey, the interest subsidy tool is only available for relatively underdeveloped regions, which is an accurate step. However, the credit guarantee mechanism unfortunately fails to exert effort on underdeveloped regions, opening the door for a contingent set of policy combinations covering guarantee and interest subsidies for these regions.

A subsidy/guarantee combination can encourage investors and provide solutions for the financial oppression they are facing. However, most studies focusing on interest subsidies and financial determinants of investments imply that companies care about loan accessibility way more than the cost of the credit. Considering the findings altogether, as a better alternative, credit guarantees could well replace interest subsidies, especially for those companies that are constrained, smaller, or newer would be a good policy revision for the current scheme. Interest subsidies could be considered for mega projects with sound development goals, since the share of the financing cost is higher in large scale companies.

Annex - 1

REGIONAL INVESTMENTS INCENTIVE SCHEME MEASURES

INCENTIVE MEASURES			REGIONS					
			I	II	III	IV	V	VI
VAT Exemption			YES	YES	YES	YES	YES	YES
Customs Duty Exemption			YES	YES	YES	YES	YES	YES
Tax Deduction*	Rate of Contribution to Investment* (%)	Out of OIZ or IZ	15	20	25	30	40	50
		Within OIZ or IZ	20	25	30	40	50	55
Social Security Premium Support (Employer's Share)	Support Period	Out of OIZ or IZ	2 years	3 years	5 years	6 years	7 years	10 years
		Within OIZ or IZ	3 years	5 years	6 years	7 years	10 years	12 years
Land Allocation			YES	YES	YES	YES	YES	YES
Interest/ Profit Share Support	Local Loans		-	-	3 Points	4 Points	5 Points	7 Points
	Foreign Exchange/ FX|denominated loans				1 Point	1 Point	2 Points	2 Points
Social Security Premium Support (Employee's Share)			-	-	-	-	-	10 years
Income Tax Withholding Support			-	-	-	-	-	10 years

OIZ: Organized Industrial Zones
IZ: Manufacturing Investments in Specialized Industrial Zones
*Within the scope of incentive certificates issued for manufacturing sector (US-97 Code: 15-37); Rate of contribution to investment for each region shall get 15 points additionaly and tax deduction rate for each region shall be applied as 100 per cent for the investment expenditures that would be realized between the dates of 1/1/2017 and 31/12/2019.

Source: MOIT (2023)

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Enhancing Labor Productivity via Local Agro-Governance of Nepal

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Abstract

Agriculture is vital for Nepal's livelihoods and economy, contributing approximately 27% to the national gross domestic product and acting as a buffer during economic downturns. Nepalese agriculture, with a rich history, faces challenges of declining profitability, causing farming abandonment, especially among the youth, despite local policy efforts. Addressing issues of unprofitability, land degradation, input inadequacy, and low productivity requires targeted agricultural research and policy reforms. Sustainable agro-practices, resilience, and achieving socio-economic indices are current community demands. This quantitative research design includes various constructs of agro-production and local agro-governance, estimating labor productivity through multiple regression. The research results revealed the importance of agro-policies focusing on farm inputs, agriculture extension, and governance enrichment. Minimizing policy shocks and executing labor-extensive short-term and long-term strategies are crucial for comprehensive agro-development.

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1. Introduction

The Nepalese agrarian economy supports the livelihoods of 29,164,578 (males 48.9% and females 51.1%), among them approximately 18.7% are still under the poverty line (NSO, 2023). In the Himalayan foothills and rural areas, agriculture remains a key sector providing employment for approximately 65% of the population. Although agriculture is a major economic pillar, its productivity has not been enhanced yet. Stagnant and disjointed governance throughout the pre-and post-farming activities leads to diminished benefits for the people. In this instance, local governance may create an institutional bricolage among agriculture productivity, socio-economic indices of people, and environmental sustainability. Despite of rich agricultural potential, it faces numerous challenges in its pursuit of agricultural sustainability (Gurung, 2012). The poor governance, low productivity, limited access to farm inputs and resources, and global warming and changing climate, have hindered progress in this sector (MoALD, 2020).

It is evident that agro-growth is the precursor to an unprecedented reduction in poverty and a major engine of pro-poor growth (Gauchan, 2008). Agro-rural accommodating policies and successful local governance are crucial for rural development in Nepal (Chaudhary, 2018). These contexts are closely aligned with the prevailing constitutional provisions, legal frameworks, and systems in place. As the existing unitary governance transformed into three tiers (the federation, provinces, and local levels) after the promulgation of the new constitution in 2015; the restructuring of the state provided opportunities to ensure sustainable and resilient practices for improving agro-governance even from local levels (FIARCC, 2016). Thus, local governance structures have emerged as promising avenues for addressing the issues of overall agro-development.

In the realm of agricultural development, for decades, it has emphasized the formulation and implementation of agriculture policies to enhance agriculture productivity and growth (Abro et al., 2014; Mueller & Mueller, 2016), agriculture diversification and commercialization (Pradhanang et al., 2015), poverty reduction through agricultural development (World Bank, 2016; Corral et al.,

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2017; Ivanic & Martin, 2018), agriculture development to resolve conflicts (Singh, 2012; Tanentzap et al., 2015; Milczarek Andrzejewska et al., 2018), efficient governance for agricultural development (Cumming, 2016; Saint et al., 2017; Sidibé et al., 2018), and environment-friendly and climate change-resilient agriculture (Blanco et al., 2017; Mittenzwei et al., 2017; Babu et al., 2018; Cortignani & Dono, 2018).

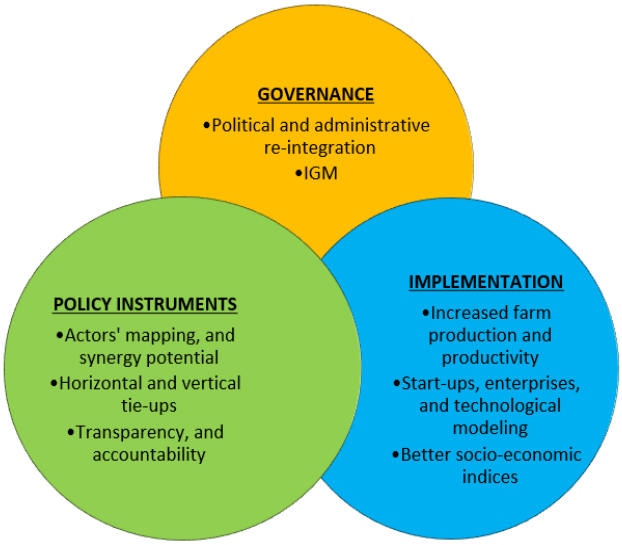
Likewise, numerous researchers have made significant contributions to the study of various perspectives on agricultural development in Nepal: Devkota and Upadhyay (2013) studied agricultural productivity and poverty reduction, and GC et al. (2019) analyzed the determinants of farm mechanization. Basnet (2010a & 2010b); Upreti (2010); Bedari et al., (2020); and Thapa et al. (2020) focused their study on multiple facets of rice production and productivity in Nepal. Likewise, Bhandari et al. (2017) reviewed the policies of paddy production, while Sigdel et al. (2022a & 2022b) analyzed the use of ICT tools and mechanization in paddy production. Khanal et al. (2020); Tamang et al. (2020); and Bishwakarma, et al. (2021) reviewed the agricultural functions, institutions, and policies in the context of sectoral restructuring. Such endeavors have proven to be notably beneficial for advancing agricultural development in Nepal.

Agriculture development is multi-dimensional and multi-sectoral (Swinnen, 2018), including production (crops, livestock, and horticulture) and value addition and trading (processing, distribution, and trading of agricultural goods) (MoALD, 2021). As agriculture plays a crucial role in national development; Nepal began planned development efforts after a democratic government was established in 1951 (Khanal et al., 2020). Nepal's policies often followed a top-down; supply-driven model: emphasizing technology's input-output linkage rather than involving local communities and stakeholders through a bottom-up approach. Thus, changes in the policy provisions (ADB, 2013), limited capacity for implementation (GoN/FAO, 2013), overlapping policies causing conflict in ownership and accountability, incomplete policy design, and supporting laws are some governance constraints.

The decentralized agricultural research and extension service, community-based Agriculture Service Center (ASC), efficient and sustainable land use (tenacity right, fragmentation, and haphazard use), expansion, and improvement of irrigation and access to improved farm inputs and labor force shortage are major issues. Due to the subsistence farming approach and involvement of farmers with small holdings, productivity is significantly low: the significant gap in the sectors compared to current and potential agro-production demands productivity enhancement, and structural reforms (MoALD, 2020). The whole agroecological mapping of the country is yet to be done (Khanal et al., 2020). Despite multi-fold efforts, the result we are getting is the stagnation of agricultural development (Devkota & Upadhyay, 2013). Although the efforts made for the overall development of agriculture seem appreciable, several facets need to be improved.

Agro-governance is a holistic approach involving economic benefits, environmental preservation, and sustainable agriculture practices; prioritized policy execution, public-private partnerships, entrepreneurship and investment climate, farm inputs, subsidies and extension services are essential for its enhancement. Similarly, sustainable agriculture gives equal weight to environmental, and socio-economic concerns (Brodt et al., 2011). The juxtaposition of agriculture development, sustainability, and agro-governance seems more challenging in Nepal. Thus, horizontal and vertical tie-up and collaboration among various agencies are inevitable. The intergovernmental management (IGM), policy instruments, and program implementation in the Nepalese milieu can be visually represented through a symbolic schema (Figure 1). This illustrates an inclusive framework for understanding how these elements interact and work together toward achieving common goals in the newly federalized context.

Figure 1. Optimal Coherence for Output



Source: Authors' depiction based on the enacted laws, and pertinent literature

The general necessity of food grains (rice, maize, wheat, millet, buckwheat, barley) per year is 181 kg per person in Nepal, but the average consumption is approximately 137 kg (MoALD, 2022). The current data also shows that rice holds a major proportion of consumption (approximately 121 kg per person per year); and, there is a significant deficit. Due to rice being the predominant staple food, its consumption deficits underscore the urgent need to enhance its productivity. The government enacted various policies that have given impetus to the promotion of paddy production and productivity (Bhandari et al., 2017). Despite the planned development

efforts in agriculture for decades, tangible achievements in paddy production and productivity have not been achieved. The rice production system has been facing serious constraints including declining yields, resource depletion, limited crop diversity, conversion of food to fuel (bio-diesel), urbanization, climate change, labor shortages, gender conflicts, institutional constraints, high food prices, reduced research and development investment, and environmental pollution. (Basnet, 2010b). Thus, studying labor productivity in the case of paddy production holds significant importance in agricultural sustainability and improving livelihoods in ecologically diverse rural mid-hills of Nepal.

However, the potential benefits of local governance in enhancing agriculture productivity are widely acknowledged, and there remains a paucity of empirical research on the new local governance structure in Nepal. This research seeks to fill this critical gap by examining the specific ways in which local governance can influence and enhance labor productivity. It employs a quantitative approach to examine the multiple facets of agro-production and local agro-governance, with a specific focus on enhancing labor productivity in paddy production. Also, assessing the perception and satisfaction levels of farmers regarding the functional delivery by the local government holds paramount significance. On the other hand, it bridges research gaps and provides pragmatic solutions for policymakers, local communities, and stakeholders in shaping the local agricultural landscape of Nepal.

To achieve these objectives, this paper is organized as follows: In the next section, materials, data collection, and research methodology are explained. Following that, a description of variables and coding details for the quantitative study is presented. In the subsequent sections, the findings are presented, and their implications are discussed. Finally, key findings are concluded with their broader implications.

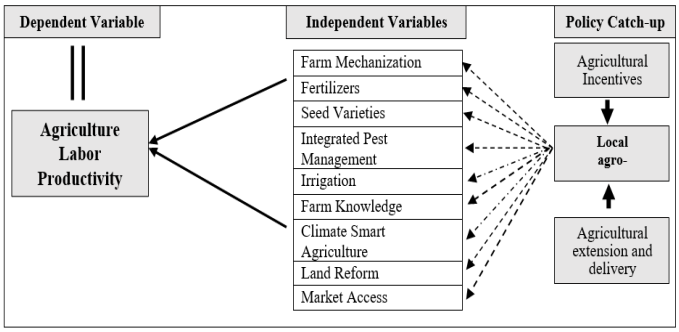
2. Materials and Methods

Tamakoshi Rural Municipality in Dolakha, a rural mid-hill region of Nepal with a temperate and humid subtropical climate, having the main occupation of subsistence farming; was selected as the study location. The primary data was collected by distributing the structured questionnaire; 285 samples were collected (20th February to 25th March 2023) with a response rate of 87.7%. The samples were selected randomly from all seven wards among the roster of farmers provided by the rural municipality. This research employs a quantitative design to investigate the impact of local governance on labor productivity in paddy production, incorporating variables related to agro-production and agro-governance in Tamakoshi Rural Municipality, Dolakha (Fiscal Year 2022/23) by multiple regression analysis.

2.1 Analytical Framework of the Study

The framework for the political economy determinants of agricultural public spending, as outlined by Mogues and Erman (2016) in the context of Africa (cited by Goyal & Nash, 2017, p. 271), with some improvisation in the Nepalese context; serves as the basis for the current study. The analytical framework consists of eleven independent variables such as farm mechanization, fertilizers, seed varieties, integrated pest management, and irrigation, farm knowledge, climate-smart agriculture, land reform, market access, agricultural incentives, and, agricultural extension and delivery; and labor productivity a dependent variable. The analytical framework of the study is presented in Figure 2.

Figure 2. Analytical Framework of Study



2.2 Variables Description

Independent variables were selected based on their expected direct and indirect impacts, following an extensive review of pertinent literature and legal provisions. Variables related to paddy production were derived from literature, while those related to local agro-governance were extracted from the Unbundling/Detailing of List of Exclusive and Concurrent Powers of the Federation, the State (Province), and the Local Level Provisioned in the Schedule-5, 6, 7, 8, and 9 of the Constitution of Nepal (FIARCC, 2016). Among various agro-constitutional rights at the local level, agriculture development was analyzed, with the livestock sector left for future studies.

2.2.1 Agriculture Productivity

Productivity is commonly defined as a ratio of a volume measure of output to a volume measure of inputs (OECD, 2001). Agricultural productivity refers to the output produced by a given level of inputs in the agricultural sector of a given economy (Amire, 2016). Abro et al. (2014) studied different policies for agricultural productivity growth and poverty reduction in rural Ethiopia and examined family income, extension services, land-labor ratio, and land/labor productivity. Kaur (2013); Awoyemi et al. (2017); and Ivanic and Martin (2018) studied the importance of agricultural productivity to the overall growth of people. Similarly,

Devkota and Upadhyay (2013) analyzed multiple dimensions of agriculture productivity and poverty reduction and identified the constraints in Nepalese contexts.

In this study, labor productivity is studied by a regression model (Abro et al., 2014; Kapri & Ghimire, 2020) and is defined as the production of paddy in Quintals divided by the total working hours on the rice farm. The cumulative working hours are constructed by using total family labor (working males and females), average working hours (per day per person), and average working days (per year) on rice farms. The smaller agricultural tasks performed by minors are excluded. A distinct gender-based division of labor is evident in wholesome agricultural activities: including the rice production cycle. Consequently, both males and females are regarded as equivalent participants in this study; acknowledging their respective roles and contributions. Thus, agriculture productivity can be explained as the ratio of the value of total farm outputs to the value of total inputs used in farm production (Sam, 2013).

2.2.2 Farm Mechanization

Farm mechanization can be defined as the application of implements, tools, and other machinery to achieve agricultural production (Houmy et al., 2013), which can be a panacea for decreasing labor scarcity (Upreti, 2010; GC et al., 2019; and Devkota & Upadhyay, 2013). Due to increasing population demand and dis-oriented land policies, the farm area is degrading gradually; there is less possibility of bringing more land into agriculture production (Basnet, 2012). Thus, the process of mechanization in farming cycles has greater significance. The National Agriculture Policy (2004) in Nepal focused on the uses of machinery such as heavy machines/tractors, mini-power tillers, threshers/seeders, motorized pumps, and sprayers as farm mechanization, which also included the mechanization in the production of major cereal crops.

2.2.3 Fertilizers

CBS (2013) classified fertilizer use patterns in Nepal as local/organic fertilizers (Farm Yard Manure (FYM), Compost) and minerals/chemical/inorganic fertilizers (Di-ammonium Phosphate (DAP), Urea, Potash). The availability of chemical fertilizers on time, whether due to unavailability or inadequacy, is a major challenge in Nepalese agriculture.

2.2.4 Irrigation

CBS (2013) defined irrigation as intentionally providing land with water, excluding natural flooding from rainfall or river overflow, but including the controlled collection and use of rainwater or uncontrolled flooding for improving pastures or crop production. The major sources of irrigation in Nepal are rivers/lakes/ponds (by gravity or by pumping), dams/reservoirs, tube wells/boring, and others (wells and springs). Mixed sources refer to the combination of two or more of the above sources, which are essential for agricultural production.

2.2.5 Seed Varieties

Seeds are a major part of farming; without them, agriculture cannot be imagined. CBS (2013) considered the seed use pattern as high-yield and/or local seeds at the time of sowing. Many literatures specified the importance of seeds; as seed varieties are central to agricultural produce (Goyal & Nash, 2017, pp. 189-191; Jones et al., 2017; Abro et al., 2014; Kaur, 2013). Rice production and productivity are influenced by seed varieties and cultivars (Bedari et al., 2020). Similarly, Basnet (2012) quotes the importance of seeds for rice production as "healthy seedlings are responsible at least for half of the yields."

2.2.6 Integrated Pest Management (IPM)

Pesticides/insecticides also include fungicides, fumigants, herbicides, rodenticides, and other materials for controlling pests and diseases (CBS, 2013). Pests and diseases directly affect and ultimately decrease the yield of agricultural produce. Thus, protecting harvests from pests, diseases, and weeds is very essential.

2.2.7 Farm Knowledge

National Agricultural Policy (2004) highlighted the importance of human resources in agricultural development in Nepal. Total years of farming experience, farming techniques, methods of increasing agricultural profits, etc. are equally important in agriculture (Abro et al., 2014; Upreti, 2010). The level of agricultural literacy of farmers is a crucial factor that impacts their ability to make decisions and carry out effective farm practices.

2.2.8 Climate-Smart Agriculture (CSA)

Climate change in the years is a risk and a multiplier that threatens water, agriculture, and food security (Basnet, 2012). Environment-resilient technology and investment in CSA must be the frontier of today's climate change regime in agriculture (Babu et al., 2018; Cortignani & Dono, 2018; Blanco et al., 2017; Basnet, 2012). Kaur (2013) argued the importance of weather insurance over crop insurance due to the dismal results of the latter across the world. As a better management tool, the government should promote weather insurance primarily due to its transparency, objectivity, and ease of administration. However, it is crucial to prioritize environmental friendliness and sustainability when pursuing increased production and productivity (Basnet, 2010a).

2.2.9 Land Reform

CBS (2013) defined agricultural holdings (Chalan gareko jagga, which means land being used) and land parcels. Choudhary et al. (2022) studied the effects of land fragmentation and the number of parcels in paddy production. Similarly, Devkota and Upadhyay (2013) found a positive output of land reform on productivity. The studies conducted by Upreti (2010) demonstrated that improving soil fertility in paddy production led to positive yield outcomes; Basnet (2012) also critically states "Grow paddy with soil fertility, wheat with fertilizers."

2.2.10 Market Access

CBS (2013) reported one-way travel time (10 min to > 3 hr) and modes of transport (on foot, bicycle/rickshaw, motorcycle/tempo, car/bus, mixed; foot and vehicle) to the nearest agriculture markets at the time of Agriculture Census in Nepal in 2011. Access to the market is essential for enhancing agriculture production and productivity and ultimately annual farm income of families.

2.2.11 Agricultural Incentives

Providing agricultural incentives to farmers is quite essential in developing countries (Kaur, 2013). Bishwakarma et al. (2021); Khanal et al. (2020); Sidibé et al., (2018), and Barkley and Barkley (2020, pp. 12-15) also highlighted the necessity of either monetary assistance or material subsidy to farmers. Mogues and Erman (2016); Jones et al. (2017); and Goyal and Nash (2017, p. 271) argued the requirement of effective public spending in agriculture. Similarly, Swinnen (2018) described the importance of a wholesome political economy of agriculture and food policies in livelihoods.

The government of Nepal also enacted numerous policies and programs to support farmers in agriculture development. According to the new constitutional jurisdiction (Schedule-8, Schedule SN. 15 & 18); agricultural incentives (monetary assistance or material subsidies) provided by state or non-state institutions are channeled through local levels. Thus, most of the agricultural incentives have significant outcomes in agriculture production and a positive impact on agro-governance.

2.2.12 Agricultural Extension and Delivery

Unbundling/Detailing of the list of exclusive and concurrent powers of the federation, the state (province), and the local level provisioned in the Schedule-5, 6, 7, 8, and 9 of the constitution of Nepal outlined agriculture extension services (outreach, training, farming techniques, awareness, and support) in the jurisdiction of local governments (FIARCC, 2016). As local levels are governments in the vicinity: they better understand the necessity and deliver effective services to the people with appropriate governance set-up. Agriculture extensions and delivery are one of the most important parts of local agro-governance in Nepal.

The definition and coding of the variables used in this study primarily adhere to the guidelines of CBS (2013) and are further mentioned by relevant literature in the field as summarized in Table 1.

Table 1. Description of Variables

Variables	Description and coding details
Socio-demographics	Ward Number, gender, marital status, age, and cast
	Second occupation other than agriculture (1: Yes, and 0: Not at all)
Dependent	
Agriculture Productivity	Labor productivity (rice production): Quantity of rice produced divided by the total working hours on the rice farm (Abro et al., 2014; Kapri & Ghimire, 2020)
Independent	
Farm Mechanization	At least a machine (Tractors, Mini-Power Tillers, Seeders, Motorized Pumps, and Others-if) used in farming (1: Yes, 0: No/Just Animal-based Power)
	Number of machines (farm capital: Abro et al., 2014) used assuming farm assets are not heterogenous among households
	Years of using at least one machine on the farm
Fertilizers	Uses of chemical fertilizers in kg (1: Yes, 0: Just FYM)
	Uses of organic and inorganic fertilizers (both) in kg (Urea: NH_2CONH_2), DAP: $(NH4)_2HPO_4$, FYM, and Others-if)
Seed Varieties	Uses of high-yield seeds (also both types) (1: Yes, 0: Local Seeds)
Integrated Pest Management (IPM)	Prioritization and implementation of IPM initiatives by RM (1: Yes, 0: Otherwise)
	Total expenditure (NPR) on pests and disease control (per year)
Irrigation	Water purposively provided other than rain (canal systems/other methods) (1: Yes, 0: Rainfed farming)
Farm Knowledge	Total years of schooling of the HoH (No schooling: 0; non-formal: 3 (Abro et al., 2014); Primary: 5; SLC/SEE: 10; and Higher Secondary and/or above: 12)
	Total farming experience (Years)
Climate-smart agriculture (CSA)	Natural calamities and climate risks (drought, heavy rainfall, flood, snowfall, hailstorm, soil erosion, and storm) that destroy the farmland and/or damage the agricultural harvest as a whole or in parts (1: Yes, 0: Not at all)

	The number of harvest/s per year (Once-1, Twice-2)
Land Reform	Land consolidation (also partial) (1: Yes, 0: Otherwise)
	Number of parcels within the cropped area
	At least an activity used to improve the soil fertility (other than tillage) (1: Yes, 0: No/Just Tillage)
Market Access	Distance of the nearest agriculture market (km)
Variables related to policy catch-up and local agro-governance	
Agricultural Incentives	Either monetary assistance or material subsidy received (provided by the local government themselves or as delivery units) (1: Yes, 0: Not at all)
Agriculture Extension (Outreach, Training, Farming techniques, Awareness, and Support) and delivery	At least a method known (Value chain, Value addition, Productivity, and others-if) to make more agriculture profits (1: Yes, 0: Not at all)
	At least an agro-service received (Outreach, Agro-technician field inspection, and others-if) (1: Yes, 0: Not at all)
	Commercial crop/s harvests (1: Yes, 0: Not at all)
	Annual budget approval by RM on stipulated time (1: Yes, 0: Otherwise)
	The perception and satisfaction level of farmers in the agro-governance and delivery at the local level (Five-point Likert scale)
	Quality of agriculture extension service received (1: *Excellent*; 2: *Good*; 3: *Rather Average*; 4: *Bad*; 5: *Very Bad*)
	Adequacy of agricultural incentives (1: *Adequate*; 2: *Good*; 3: *Rather Average*; 4: *Inadequate*; 5: *Very Less*)
	Rural Municipal willingness to institutional restructuring (actions) for integrated (co-ordination with stakeholders) agro-movements (1: *Very Satisfactory*; 2: *Satisfactory*; 3: *Rather Average*; 4: *Dis-satisfactory*; 5: *Disappointing*)
	Rural Municipal Preparedness for agricultural transformation and its Sustainability (1: *Very Satisfactory*; 2: *Satisfactory*; 3: *Rather Average*; 4: *Dis-satisfactory*; 5: *Disappointing*)
	Incorporating the findings of agro-research into policy formulation and policy revision by RM (1: *Adequate*; 2: *Good*; 3: *Rather Average*; 4: *Inadequate*; 5: *Very Less*)
	Enabling local agro-governance (1: *Excellent*; 2: *Good*; 3: *Rather Average*; 4: *Bad*; 5: *Very Bad*)
	Change in the socio-economic status of farmers (1: *Strongly Agree*; 2: *Agree*; 3: *Rather Average*; 4: *Dis-agree*; 5: *Strongly Disagree*)

3. Results

A total of 285 respondents from all the wards (1-7) consisted of 236 (83%) males and 49 (17%) females. The education level of respondents varies significantly across the communities, most of the respondents completed primary education. Farming experience varies from 5 to 35, with an average of 17.6 years. Only 18% of the respondents had a second occupation in addition to agriculture, while 82% primarily relied on agriculture as their main occupation. Most of the respondents 270 (95%) used at least a machine in farming and 15 (5%) were still using only animal-based power. Most of the farmers used high-yield seeds with local ones, also, inorganic/chemical fertilizers were mixed with organic fertilizers. Overall, 112 respondents, accounting for 39% of the total, participated in harvesting commercial crops alongside their paddy harvests. The average distance to the nearest agriculture market in the rural municipality is 6.2 km, ranging from 3 to 9 km. The average number of working days on a rice farm per year is 122.4, with a range between 115 to 130 days.

The rural municipality provided agricultural incentives to the farmers as much as possible, although they appear to be inadequate. The frequency analysis, mean (M), and standard deviation (SD) for all the five-point Likert scale questions showed that the overall rating for the quality of agriculture extension services was the lowest (M = 2.24, SD = 1.16), while respondents' perception with agro-research and policy incorporation of findings was the highest (M = 3.67, SD = 0.99).

Multiple linear regression analysis (IBM SPSS V25) was used to assess the ability of independent variables to predict the dependent variable. The preliminary analysis was conducted to ensure non-violation of the assumptions of normality, multi-collinearity, and homoscedasticity. The significant impact and prediction of the independent variables on labor productivity indicate an overall strong goodness of fit for the model, the adjusted R2 = .79 depicts that the model explains 79% of the variance in the dependent variable. The results of multiple regression analysis are presented in Table 2.

Table 2. Summary of Multiple Linear Regression Findings

Coefficients[a]							
Variables	**Beta**	***SE***	**β**	***t***	***p***	**CS**	
						T	**VIF**
(Constant)	0.126	0.104		1.209	0.228		
Mechanization Status	0.065	0.027	0.094	2.416	0.016**	0.478	2.093
No. of Tractors	0.058	0.020	0.095	2.911	0.004**	0.673	1.485
No. of Mini-Power Tillers	0.031	0.007	0.138	4.139	0.000***	0.651	1.536
No. of Motorized Pumps	0.027	0.005	0.193	4.836	0.000***	0.452	2.212
No. of Seeders	0.043	0.007	0.258	6.066	0.000***	0.400	2.501
Organic and Inorganic Fertilizers (both)	0.413	0.025	0.663	16.242	0.000***	0.221	4.532
Expenses for controlling pests/diseases (NPR)	3,82E-02	0.000	0.239	5.828	0.000***	0.429	2.334
Farming experiences (Years)	0.003	0.001	0.107	2.637	0.009**	0.441	2.266
No. of parcels within the cropped area	0.026	0.004	0.282	6.334	0.000***	0.365	2.741
Annual budget approval by the rural municipality on time	0.040	0.015	0.103	2.673	0.008**	0.482	2.074
Agro-services received	0.033	0.017	0.080	1.986	0.049*	0.405	2.469
Preparedness of rural municipality (perception)	0.012	0.006	0.094	2.032	0.043*	0.337	2.971
Varieties of seeds	0.017	0.015	0.046	1.144	0.254	0.453	2.206
Years of mechanization	0.002	0.004	0.022	0.498	0.619	0.372	2.687
Status of land consolidation	-0.002	0.015	-0.005	-0.132	0.895	0.605	1.654
Chemical fertilizers (Inorganic)	0.014	0.029	0.015	0.483	0.629	0.744	1.345
Methods for improving soil fertility	-0.004	0.020	-0.008	-0.198	0.843	0.423	2.363
IMP initiatives by RM	-0.032	0.038	-0.027	-0.842	0.401	0.690	1.449
Irrigation Method	-0.025	0.017	-0.051	-1.514	0.131	0.627	1.596
Number of harvests (Per Year)	0.075	0.075	0.029	1.005	0.316	0.887	1.127
Harvesting commercial crops	-0.004	0.010	-0.011	-0.354	0.723	0.708	1.412
Distance to nearest agriculture market (km)	0.002	0.004	0.018	0.551	0.582	0.696	1.437
Damage of crops by natural calamities or climatic chaos	-0.001	0.011	-0.004	-0.115	0.908	0.621	1.610
Destroy of land by natural calamities or climatic chaos	-0.015	0.012	-0.044	-1.308	0.192	0.630	1.588
Agricultural Incentives received	-0.010	0.016	-0.031	-0.655	0.513	0.333	3.003
Familiar with agricultural profit-making methods	-0.026	0.018	-0.065	-1.480	0.140	0.377	2.652
Quality of agriculture extension services (satisfaction)	-0.008	0.007	-0.057	-1.049	0.295	0.242	4.140
Adequacy of agricultural incentives (satisfaction)	-0.006	0.006	-0.036	-0.987	0.325	0.550	1.817
The willingness of RM to agro-development (perception)	-0.009	0.007	-0.063	-1.308	0.192	0.310	3.228
Agro-research by RM (satisfaction)	-0.003	0.006	-0.016	-0.415	0.679	0.490	2.040
Change in the socioeconomic status of farmers	0.000	0.004	0.002	0.062	0.951	0.874	1.144
a. Dependent Variable: Labor Productivity							

Note: *p < 0.05, ** < 0.01, and, ***< 0.001 (the first 12 variables were significant and explained), Unstandardized coefficients (Beta and Standard Error, SE), Standardized coefficient (β), Significance (p), Collinearity Statistics (CS), Tolerance (T), and Variance Inflation Factor (VIF).

Thus, the prediction equation can be written as follows:

Labor Productivity = 0.126 + 0.06 (Mechanization Status) + 0.05 (Tractors) + 0.03 (Mini-Power Tillers) + 0.027 (Motorized Pumps) + 0.04 (Seeders) + 16.24 (Organic and Inorganic Fertilizers) + 3.821E-05 (Expenses on pest/disease control) + 0.003 (Farming Experiences) + 0.026 (No. of Parcels) + 0.03 (Agro-services received) + 0.04 (Annual budget approval on stipulated time) + 0.01 (Rural Municipal preparedness for agricultural transformation and its sustainability).

4. Discussion

The minor engagement of women in agriculture may represent pre-specified roles (socio-cultural) and more involvement in household stuff. The level of education (formal, non-formal) briefly entails the socio-economic status of the family, also related to farming experiences, and is important for better farm decisions. Similarly, average farming experience (17.6 years) shows majority have been engaged in farming for a long. Despite favorable weather and climatic conditions harvesting paddy once a year represents crop diversification and labor shift. Timely availability and adequacy of high-yield seeds and chemical fertilizers are unresolved issues in Nepalese agriculture. Thus, fertilizers (organic and inorganic) and seeds (high-yield and local) were mixed for farming activities.

Almost all of the respondents used at least one machine in farming, while a minority are still using animal-based power. This entails the need for a policy departure through in-depth studies based on landscape and crop-specific mechanization policies. Farmers' engagement in paddy farms (average 122.4 days per year) illustrates how labor productivity and engagement in farming connect to the larger interface. In contrast, the negative relationship between market access and labor productivity in this study can be attributed to the relatively long average distance (6.2 km) to the nearest agricultural market in the study location. The absence of significant and consistent means of public transport likely encourages farmers to seek alternative marketing channels and rely on community market mechanisms.

The assessment of farmers' feedback (M and SD) on agro-services and programs delivered by the rural municipality indicates notable variations among respondents in terms of their perceptions and satisfaction levels concerning agro-services and delivery. That highlights the pressing need for significant improvements in various aspects of local agro-governance, which is crucial for meeting the needs of farmers and promoting sustainable agriculture by collaborative efforts among governments, policymakers, farmers, and stakeholders to formulate better agro-policies, thus, enhancing the institutional capacity.

In this study, various constructs of agro-production and agro-governance were designed and regressed. Conducting a comprehensive statistical analysis that encompasses various facets of agriculture development and predicts their relationship with labor productivity provides valuable insights into key production factors: policy design, resource mapping and allocation, performance evaluation, decision-making, and effective monitoring and evaluation approaches.

Mechanization contributes to increased productivity by enhancing efficiency, improving precision and quality, and reducing labor dependency. By embracing mechanization, farmers can optimize their operations, save time and resources, and achieve higher yields and profitability. Farm mechanization had significant impacts on labor productivity. The Tractors, mini-power tillers, motorized pumps, and seeders used on rice farms; all were significant in the study. These findings align with previous research exploring various aspects of farm mechanization across multiple dimensions documented in Takeshima and Liu (2018); GC et al. (2019); and Sigdel et al. (2022b).

On the other hand, adequate expenses (cost of pesticides, insecticides, traps, biological control agents, controlling weeds, or any other appropriate methods) to control pests/diseases ensure optimized uptake and utilization of nutrients by the harvests promoting healthier growth and maximizing productivity had a positive relationship. The obtained results also show acquaintance with some previous studies including those conducted by Devkota and Upadhyay (2013); and Choudhary et al. (2022).

Farming experience plays a crucial role in better crop selection, and rotation, optimizing resource management, continuous learning and innovation, appropriate farm decisions, adaptability, and resilience. The results showed that farming experience played a significant role in agriculture productivity in the study area. The result is also supported by works performed by some researchers. The perception of mechanization, use of extensions, and farm decisions are related to farming experiences, which ultimately impact production (Sigdel et al., 2022a, 2022b). Experienced farmers have an edge over fledgling farmers who may benefit from some agricultural training to catch up on efficiency (Devkota & Upadhyay, 2013).

Well-defined land parcels enable farmers' efficient farm management to optimize the use of resources such as water, fertilizers, labor forces, and machinery and to maximize productivity. The appropriate number of parcels within the cropped area had a significant impact (coefficient 0.026). This observation is further supported by previous studies by Devkota and Upadhyay (2013), and Choudhary et al. (2022). In addition, excessive fragmentation and parceling can lead to operational inefficiencies, making it more challenging to effectively apply farm inputs, ultimately resulting in a reduction of the overall agricultural output potential. Therefore, it is essential to consider a saturation point by

carefully understanding and acknowledging all the ground realities and factors at play.

The lack of timely availability of high-yield seeds for most of the farmers could explain the absence of a significant relationship on labor productivity. Similarly, limited irrigation infrastructure and insufficient knowledge of irrigation methods among the study area's respondents may not significantly impact productivity. Conversely, the study did not reveal a significant link between climate-smart agriculture and productivity in the area, possibly due to the absence of significant crop damage and farmland destruction during the fiscal year 2022/23, attributable to favorable weather and climatic conditions. Despite these favorable conditions, most farmers chose to harvest paddy once a year, potentially due to diversification into other commercial crops during the second term and the structural shift of the labor force into other occupations.

In addition to the previously most discussed variables, the study has identified some novel factors that exhibit a significant impact on labor productivity such as the organic and inorganic fertilizers, the rural municipality's annual budget approval within a specified timeframe, agro-services received and the rural municipal preparedness for agricultural transformation and its sustainability.

The timely unavailability of chemical fertilizers is a dominant perennial issue in Nepal. In the absence of adequate chemical fertilizers (Inorganic), farmers choose alternative options such as mixing organic and inorganic fertilizers and tend to rely on FYM, compost, and other fertilizers. Therefore, organic and inorganic fertilizers (both together) used on rice farms emerge as the significant factor influencing productivity outcomes (coefficient 16.24). These findings also align with prior research conducted by Timsina et al. (2012); and Devkota and Upadhyay (2013).

Appreciably, annual budget approval by the rural municipal assembly on a designated timeframe had a positive impact (coefficient 0.04) on productivity. Local Government Operation Act (2017) explicitly outlines the SOP of annual budget approval; the fruitful implementation of enacted laws and regulations drives better governance and delivery outcomes. Narrowing the gap between planned and actual spending involves numerous partners in budget management, and so will need consensual agendas to make real progress (Goyal & Nash, 2017, p. 232). The successful execution of policies and policy outcomes is primarily based on information symmetry, the assembly's timely approval of a detailed budget, and fruitful implementation of the program of action.

On the other hand, the agro-services received and the rural municipal preparedness for the agricultural transformation and its sustainability were significant; thus, had a significant impact on labor productivity. Factors affecting land productivity often require long-term investments, extensive research, large-scale interventions, and broader collaborations based on farm inputs, soil chemistry, weather and climatic conditions, and other external factors. The huge agricultural incentives for farmers, specialized targeted programs and expertise may be beyond the scope of the rural municipality alone. Alternatively, labor-intensive programs include training, capacity enhancement, access to information, improvement in farming techniques, and short-term programs yielding instant results. The influence of rural municipal agro-services may be limited on land productivity due to the focus on labor-intensive programs, the inherent characteristics of land, resource constraints, external factors, and time lag effects. Thus, the agricultural extension and agro-services received by respondents might be significant in enhancing labor productivity.

The enforcement of rules and laws designated at the national level remains a prominent institutional mechanism for ensuring effective multiscale governance (Sidibé et al., 2018). Most of the time, such blanket regulations are not only unable to meet practical needs at local levels, but they may conflict with local institutional judgment, thereby creating new challenges (Sidibé et al., 2018). In the newly federalized structure of Nepal, many laws are still to be formulated. In addition, following the promulgation of laws, there is often a significant delay in formulating supportive regulations, and directives (Bishwakarma et al., 2021).

On the other hand, the land-labor ratio calculated by dividing the total cropped area by available labor (Abro et al., 2014) is 4.01. This implies the relative abundance of land resources. However, an increase in this ratio is primarily driven by a decrease in family labor resulting from factors such as abandoning homes, marriage, changing livelihoods, migration, and others. In reality, government land use policies and the partition and inheritance of land within families contribute to a gradual scarcity of land, as the average share of land per adult diminishes. In response, it becomes crucial to focus on enhancing the productivity of production factors to make the most efficient use of the available land and other resources.

In a nutshell, the values of the Beta coefficients reveal that a one-unit increase in the independent variables corresponds to a one-unit increase in productivity, assuming other factors remain constant. Moreover, the presence of significant t-values indicates that the relationship between these factors and productivity is highly unlikely to have occurred by chance. Furthermore, p-values < 0.05 provide a strong level of statistical significance, further supporting the validity of the obtained results.

5. Conclusion

This quantitative research study employed multiple regression analysis to investigate the impact of integrated variables related to agro-production and local agro-governance on labor productivity. The mechanization status of farmers, use of tractors, mini-power tillers, motorized pumps, seeders, organic and inorganic fertilizers (both), expenses for controlling pests/diseases, farming experiences (years), number of parcels within the cropped area, annual budget approval on time, agro-services received by the respondents, and preparedness of rural municipality for agriculture development showed a statistically significant relationship to predict labor productivity in the study area. The study findings supported our hypothesis regarding the significant influence of local agro-governance on labor productivity. Hence, local agro-policies should focus on farm mechanization (agriculture machinery and implements), use of organic and inorganic fertilizers, integrated pest management, farm engagements of farmers, land reform techniques, and agriculture extension and delivery programs for the enhancement of labor productivity on paddy production. Wider understanding and effectively managing those factors are crucial for optimizing labor productivity and promoting sustainable agricultural practices.

One notable limitation of this study is the limited sample size, along with the underlying assumptions of homogeneity in socio-economic status among farmers, uniformity in farm assets and practices, and consistent environmental and climatic conditions within the study area. In spite of that, detailed analysis of farm mechanization, the role of farm inputs, and post-harvest activities are left for future studies. However, the findings of this study have major implications for local agriculture development, policy input for the stakeholders, and open avenues for future researchers. Thus, to achieve comprehensive agro-development, and sustainable outcomes, after minimizing the policy shocks: it is essential to create and execute distinct short-term and long-term labor-intensive approaches.

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R&D Expenditures and Economic Growth: A Panel Data Analysis for Selected Developing Economies

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Abstract

Growth theory suggests that technological development is the primary determinant of long-term economic growth, and research and development (R&D) activities are considered the driving force of technological development. This study aims to investigate the relationship between economic growth and R&D spending. To this end, we study the relationship between gross domestic product (GDP) per capita and the ratio of R&D expenditures to GDP in a group of developing and newly developed economies (namely, Brazil, Chile, Colombia, Indonesia, India, Peru, Republic of Korea, Russian Federation, Singapore, Thailand, and Türkiye) using annual data from 2000 to 2020. Using the fixed effects model, a panel data analysis is estimated, where gross domestic product (GDP) per capita is used as the dependent variable; R&D expenditures as a ratio of GDP, number of technicians in the R&D sector, and number of researchers in the R&D sector are used as independent variables. We also utilized gross fixed capital formation, labor force, and aggregate government expenditures as a ratio of GDP as control variables. The results indicate a significant and positive relation between economic growth and R&D-related explanatory variables. We also find that the model's control variables have positive and significant effects on economic growth. Given its favorable impact on economic growth, especially developing countries may be advised to allocate more resources to R&D activities.

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1. Introduction

Emerging market economies have become more significant to the global economy over the past few decades. About 80% of the output of all emerging markets comes from the seven biggest emerging economies - China, Russia, India, Brazil, Türkiye, Mexico, and Indonesia. Similar to the G7 (the Group of Seven major advanced economies), this group, which is commonly referred to as EM7, has also been the primary driver of growth in emerging markets and their integration into the global economy. Particularly with those in their respective neighborhoods, the EM7 economies have strong trade and financial ties with other emerging markets (EM) and frontier markets (FM). Egypt, Indonesia, Mexico, South Korea, Saudi Arabia, Taiwan, and Türkiye round out the top ten emerging and developing economies by nominal or PPP-adjusted GDP, along with the other four BRICS nations (Brazil, Russia, India, China, and South Africa) growth in the EM7 could have significant global economic spillovers due to their size and integration.

Emerging markets are characterized economically by low-income, high-growth economies that rely heavily on market liberalization. Undoubtedly, emerging economies can progress past this stage and move into the post-emerging stage. Emerging markets become developed economies once they graduate from that economic status. Israel, Poland, South Korea, Taiwan, the Czech Republic, and city-states like Singapore have made the transition from emerging to

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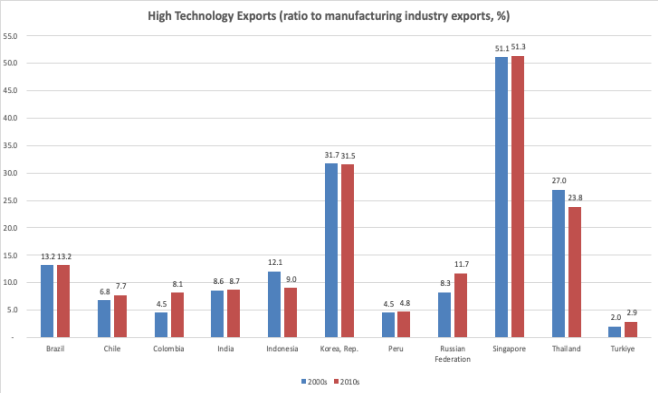
developed economies. Compared to those classified as emerging markets, these markets tend to have higher incomes and more stable political systems.

A common problem that most EM encounter is high trade and current account deficits and, in return, their dependence on international liquidity and foreign capital inflows. In order to mitigate their macroeconomic vulnerability in this respect, EM may decrease their foreign dependency by means of decreasing their trade deficit. While many EMs are part of the global value chain, some of them largely produce and export low-value-added products. For instance, while Türkiye's ratio of medium and high technology products exports to total industrial exports has been around 30%, its high technology product ratio to total industrial exports is only about 3% (Figure 1).

Figure 1. Exports of high technological products (ratio to manufacturing industry exports, %)



Source: World Bank; World Development Indicators

Among industrial goods, high-value-added products are typically high-technology products. Countries that need to import such high-value-added products or that cannot produce, and export high-value-added products commonly give trade deficits. In order to mitigate their trade deficit, and thereby their reliance on foreign capital, EM should be increasing the share of high-technology productions and exports. The high value-added nature of high-technology products also contributes to the growth of countries. Since economic growth is particularly important for the welfare of households in EM, producing high-technology products is critical for EM. Since an important determinant of producing high-technology products is research and development (R&D) activities, we assert that policymakers should be allocating enough resources for product development and innovation. Against this background, this paper investigates the eleven countries Singapore, Russia, Thailand, South Korea, Peru, Chile, Brazil, Türkiye, Indonesia, and India in terms of their economic infrastructure, economic features, and the impact of R&D expenditures on economic growth via empirical analysis.

2. Literature Review

One of the most fascinating and exciting fields of economics is still economic growth. This interest is undoubtedly related to issues that economic growth addresses. In its simplest form, the idea of economic growth can be defined as the gradual increase in a nation's economic output. Both developed, and developing nations have serious concerns about the phenomenon of economic growth. Nevertheless, while developed countries typically emphasize increases in GDP, developing countries typically attach more importance to economic development, including economic growth, ensuring income equality in the nation, increasing employment, and decreasing inflation.

There are two contemporary growth theories: exogenous and endogenous growth. The Harrod-Domar model and the Neo-Classical Growth model are well-known exogenous growth theories. In exogenous growth models, while production is made with capital and labor by using appropriate technologies, technological development is not explained in these models.

In endogenous growth models, the works of Romer (1986) and Lucas (1988) stand out. In these theories, growth is provided by human capital, technical and technological knowledge, and R&D expenditures. Through its impact on innovation and total factor productivity, R&D spending is likely to promote economic growth. When a company invests in R&D, it is anticipated that new concepts, intermediate products, cost-cutting techniques, and finished consumer goods will be created, enhancing the company's productivity and profitability. R&D has public benefits as well as positive spillovers within and between businesses, industries, and geographical areas. Due to the non-rival nature of knowledge created through R&D, businesses can profit from the R&D expenditure of other businesses, even if they are located in different industries or geographical areas (Arrow, 1962; Aghion and Howitt, 1992).

Using panel data analysis, Lichtenberg (1992) investigated the relationship between R&D expenditures financed by the public and private sectors and economic growth in a study of 74 countries spanning the years 1964–1989. The study's conclusions are as follows: When R&D expenditures are financed by the public sector, there is no effect on economic growth and, in rare circumstances, an adverse effect; when private sector financing is used, it has been observed that there is a positive and significant relationship between growth and productivity.

Park (1995) also examined the relationship between R&D investments and growth in production in 10 OECD countries, for the years 1970–1987. The author finds that local private sector R&D investments were a more significant determinant for the rise in both local and foreign factor productivity than public sector R&D investments. Furthermore, it was discovered in the study that public spending had a secondary

impact on productivity growth by encouraging private sector investments in foreign public R&D projects.

Samimi and Alerasoul (2009) examined the impact of R&D expenditures in 30 developing countries for the period 2000-2006. They did not find a significant relationship between R&D spending and economic growth. The authors contend that this is due to low R&D expenditures in the subject countries, and they suggest developing countries increase their R&D expenditures.

Examining the relationship between innovation performance as measured by per capita R&D expenditure and the Global Competitiveness Index in 11 Central and Eastern European nations, Kiselakova et al. (2018) find that raising R&D spending can significantly help countries become more competitive, which will lead to growth. In a similar vein, Simionescu et al. (2017) R&D spending has a positive impact on the competitiveness of Romania, Hungary, and the Czech Republic.

R&D encompasses systematic efforts aimed at utilizing all forms of knowledge to design new applications. In the context of a continuously evolving global process, mankind has transformed into an entity that learns, adapts, adopts innovative approaches, and integrates economic activities into this evolution. Consequently, macroeconomic goals have shifted from labor-intensive production to technology-based R&D and innovation-dependent economic growth and development. This transition represents a shift towards "R&D-based innovative production processes" beyond traditional capital and labor production. Countries that grasp the significance of R&D-based technological advancements that positively impact their economy and industrial structure treat science and technology policies as a system and prioritize R&D significantly. Within the framework of innovation policies, developed countries aim to increase their competitive advantages by gradually enhancing R&D spending and the number of technical personnel and researchers employed in R&D activities. This study delves into R&D data, recognized worldwide as the most critical key to international competitive advantage and development. It examines various indicators such as the ratio of R&D spending to Gross Domestic Product (GDP), the distribution of R&D expenditures across sectors, the distribution of R&D spending by source of finance, the number of personnel engaged in R&D activities, and the sectoral distribution of the labor force employed in R&D activities for the European Union (EU) and Turkey. A comparative analysis of these R&D indicators provides insights into Turkey's position concerning its technological, sectoral, economic structure, and level of development compared to EU countries (Göze Kaya, D, 2019).

The study conducted by Ayyıldız and Demirci (2022) sheds light on the pivotal role of research and development (R&D) spending in Turkey's economic development and growth trajectory. Highlighting the surge in R&D expenditures globally since 1980, the research reflects Turkiye's intensified interest and commitment in this domain. Notably, the allocation of funds to R&D, catapulting from 0.53% of the Gross Domestic Product (GDP) in 2001 to 1.09% in 2020, stands as a testament to this enthusiasm. In this context, public support for R&D activities emerges as a crucial driver, invigorating endeavors in this sphere. Analyzing the socio-economic goals of Turkey, the study explores the correlation between R&D budget allocations and expenditures from the central government budget and economic growth within the 2008–2035 timeframe. Utilizing artificial neural networks for predictive modeling and employing the Autoregressive Distributed Lag Bound Test (ARDL) analysis, the research identifies the energy sector as the category of R&D spending with the most pronounced positive impact on economic growth, while expenditures related to the health sector exert the least influence. These findings underscore the significance of R&D funding allocation and its sectoral distribution in shaping Turkey's economic development and growth landscape.

3. Data and Methodology

This study aims to analyze the relationship between economic growth and R&D spending in a total of 11 countries (Brazil, Chile, Colombia, Indonesia, India, Republic of Korea, Peru, Russian Federation, Singapore, Thailand, and Türkiye). We utilize the real gross domestic product (GDP) per capita as the dependent variable. The precise expression of the level of innovation activities is an important factor in empirical research on the impact of economic growth rate. The most commonly used data on innovative activities are the share of research and development expenditure in GDP. This approach is highly acceptable because it is suitable for quantitative and qualitative analysis. Hence, we also utilize R&D expenditures as a ratio of GDP as a dependent variable. Gross capital formation (representing domestic investments), labor force, number of researchers and technicians working on research, and government spending are used as control variables. We use annual data and the data spans from 2000 to 2020.

We employ a multiple regression model with fixed effect (FE) in our study. This strategy is chosen because we decided to examine the impact of a few variables that change over time. The fixed effect model examines the relationship between a dependent variable and independent and control variables within each individual entity (in our case, the countries that were observed). Each individual determines how independent and control variables will affect the dependent variable (in this case, real gross domestic product (GDP) per capita) based on their unique characteristics.

When using FE, we assume that a factor present in the countries may have an effect on the predictor or outcome variables, and we must take measures to mitigate this. Another crucial premise of the FE model is that the entity's time-

invariant characteristics are specific to it and shouldn't be correlated with those of other entities. Since each entity is unique, its error term and constant (which captures its unique characteristics) shouldn't be correlated with those of the other entities (Wooldridge, 2002).

3.1 The model

For 11 countries (i = 1, ..., 11) and multiple time periods (t = 1, …, 21), a multiple regression model was developed

$$y_{it} = \alpha + x_{it}\beta + c_i + u_{it} \quad (3.1)$$

where c_i is the country-specific effect, y_{it} is the dependent variable, is the intercept, x_{it} is the K-dimensional row vector of explanatory variables, β is the K-dimensional column vector of parameters, and u_{it} it is the error overall term. The matrices below summarize the T (T = 21) observations for each nation: dependent variable y_i is symbolized as follows:

$$y_i = \begin{bmatrix} y_{i1} \\ . \\ . \\ y_{i5} \\ . \\ . \\ y_{i21} \end{bmatrix}, y_i = [21X1]$$

For independent variable X_i, it is represented by:

$$X_i = \begin{bmatrix} X'_{i1} \\ . \\ . \\ X'_{i5} \\ . \\ . \\ X'_{i21} \end{bmatrix}$$

Given that regression involves four independent variables, $X_i = [21 \times 6]$, The general error term matrix is as follows:

$$u_i = \begin{bmatrix} u_{i1} \\ . \\ . \\ u_{i5} \\ . \\ . \\ u_{i21} \end{bmatrix}, u_i = [21X1]$$

Since $E(u_{it})=0$ and $E(c_t)=0$, the data generation process can be described as linear:

$y_{it} = \alpha + x_{it}\beta + c_i + u_{it}$

The model is linear in parameters α and β, individual effect c_i, and overall error u_{it}

Independence: $\{Xi, yi\}_{i=1}^{N}$ (independent and identically distributed).

The observations are independent between people but perhaps not across time. The random selection of nations ensures this.

Strict exogenicity: $E = (u_{it} \mid X_i, c_i)$

The explanatory variables for all past, present, and future time periods of the same person are assumed to be uncorrelated with the overall error term, or u_{it}. This strong premise, for instance, disqualifies lagged dependent variables. Additionally, it is presupposed that the overall error is unrelated to the effect that is unique to each person. We can distinguish between the fixed effects model and the random effects model using additional presumptions (Schmidheiny, 2013).

3.2 Random effects versus fixed effects models

The individual-specific effect in the random effect model is a random variable that is unrelated to the explanatory variables.

Unrelated effect: $E = (c_i \mid Xi_i) = 0$

According to this supposition, the individual-specific effect is a random variable that is not related to the explanatory variables for any of the individual's past, present, or future time periods. Typically, economists do not like such a strong assumption. We can infer from this that the random effect model would not be applied in this study. Later, we used the proper test to demonstrate this.

The individual-specific effect in the fixed effects model is a random variable that is permitted to be correlated with the explanatory variables.

Related effect: $E = (c_i \mid X_i) \neq 0$

Variance effect: $V = (c_i \mid X_i) = \sigma^2 < \infty$; $V=(c_i \mid Xi) = c_{i,t}^2(X_i) < \infty$

This assumes constant variance of the individual-specific effect.

Identifiability rank $(\ddot{X})=K < NT$ and $E(X_i\ddot{X})$ where typical element $x_{it} \doteq x_{it} - \bar{x}$ and $\bar{x} = \frac{1}{T}\sum x_{it}$

This is based on the assumption that all regressors have non-zero within-variance and that the explanatory variables are not perfectly collinear. As a result, neither a constant nor any other time-invariant variables can be included in X_{it} (Schmidheiny, 2013).

4. Empirical Results

4.1 Serial correlation and heteroskedasticity

We must address the possibility of serial correlation in the error term and homoskedasticity for time series data. With the Breusch-Godfrey test and the Breusch-Pagan test, we will check for serial correlation and homoskedasticity, respectively, and provide solutions for correction if necessary (Stock & Watson, 2003).

Table 1. Results of breusch-godfrey/wooldridge test for serial correlation in panel models

chisq = 137.14,	df = 6	p-value < 2.2e-16
alternative hypothesis	serial correlation in idiosyncratic errors	

Table 2. Results of breusch-pagan test

BP = 47.888	df = 6	p-value = 9.96e-10
Null Hypothesis (H0):	Homoscedasticity is present (the residuals are distributed with equal variance)	

The absence of serial correlation is the null hypothesis for the Breusch-Godfrey test. The test's p-value indicates that we can rule out the null hypothesis and verifies that our error term contains serial correlation.

Just as we addressed heteroscedastic errors, we can apply computes the corresponding Wald confidence intervals to rectify serial correlation. To ensure a covariance matrix that accommodates heteroskedasticity and simultaneously considers autocorrelation, we will utilize the HC sandwich estimators with the method Arellano, encompassing both aspects (Stock & Watson, 2003).

To check for cross-sectional dependence, we use the Pesaran cross-sectional dependence test.

4.2 Cross sectional dependence

Table 3. Pesaran CD test for cross-sectional dependence in panels

z = 10.841	p-value < 2.2e-16
alternative hypothesis	cross-sectional dependence

The null hypothesis is that there is no cross-sectional dependence, as we've seen with other tests. However, the p-value indicates that there is cross-sectional dependence and that we must correct it. In general, there are two methods for addressing cross-sectional dependence.

The cross-sectional and serial correlation (SCC) method by Driscoll and Kraay (1998) is preferred for obtaining heteroskedasticity and autocorrelation consistent errors that are also robust to cross-sectional dependence because it addresses the drawbacks of Beck and Katz's PCSE method. We can obtain the SCC-corrected covariance matrix (Stock & Watson, 2003).

We will decide which model to choose before determining the mods on the outputs. Then we will make the modifications and reach the result.

4.3 Simple linear regression

Introducing independent variables into the model sequentially, the model results are presented in Table 7.

We begin our analysis with a summary of descriptive statistics in Table 4 and Table 5.

Table 4. Descriptive statistics and names of variable

Variable	Mean	Std dev	**Min**	**Max**
GDPPC	11597	13081	442	66859
RDEXP	1.02	0.97	0.05	4.81
INVGDP	0.25	0.06	0.15	0.42
LABOR	0.48	0.07	0.33	0.62
GGCE	14.31	3.25	6.53	20.79
TECHN	398	299	16	1311
RES	2207	2369	57	8713

Table 5. Average of variables by country between 2000-2020

Country	GDPCC	INVGDP	GGCE	RDEXP	TECHN	RES	LABOR
Brazil	7854	0.18	19.32	1.12	599	580	0.48
Chile	11087	0.24	12.83	0.36	275	406	0.45
Colombia	5275	0.21	14.78	0.22	49	73	0.49
India	1218	0.34	10.82	0.75	89	174	0.37
Indonesia	2560	0.3	8.68	0.17	23	237	0.48
Korea, Rep.	23655	0.32	14.18	3.36	872	5422	0.52
Peru	4655	0.21	11.86	0.12	476	701	0.52
Russia	8908	0.22	17.9	1.1	505	3119	0.52
Singapore	44735	0.26	10.24	2.05	459	5946	0.51
Thailand	4637	0.25	15.22	0.46	206	830	0.57
Türkiye	8755	0.27	13.76	0.75	139	935	0.36

The standard deviation exceeds the mean real GDP per capita of 11597. Significant deviation was also present in the explanatory variables (dependent variable and control variables). This might serve as one of the indicators to use the fixed effect model in this paper's upcoming regressions. We assume that each nation has some unique characteristics that have an impact on real GDP growth in various ways.

Table 6 represents a correlation matrix between independent variables and predictors. The simple correlation with GDPPC and other predictors is modest. There is not a strong correlation between independent variables, which is good for our future regressions.

Table 6. Correlation matrix

	GDPPC	RDEXP	INVGDP	LABOR	GGCE	TECHN	RES
GDPPC	1						
RDEXP	0.54	1					
INVGDP	0.17	0.28	1				
LABOR	0.45	0.26	-0.06	1			
GGCE	-0.15	0.1	-0.59	0.008	1		
TECHN	0.08	0.05	0.07	-0.03	0.05	1	
RES	0.008	-0.05	0.06	-0.06	0.18	0.57	1

We start by performing a simple linear regression. The real GDP growth rate is the dependent variable we use. Government final consumption spending, gross fixed capital formation, R&D as a percentage of GDP, labor force, and number of technicians and researchers are the independent variables. In Table 7, the regression result is presented.

Table 7. Results of OLS

	Estimate	Std. Error	t value	Pr(>|t|)
Intercept	6.8	0.63	18.33	< 2e-16 ***
log(RDEXP)	-0.15	0.05	9.58	< 2e-16 ***
log(INVGDP)	-0.25	0.29	-1.24	0.197
log(GGCE)	-1.33	0.29	-1.23	0.218
log(LABOR)	-0.43	0.31	8.909	2.44e-16 ***
log(TECHN)	0.33	0.12	2.73	0.007062 **
log(RES)	0.47	0.09	4.824	3.96e-06 ***

The R-squared value, which represents 50.46% of the variance in real GDP per capita, is explained by our regression model. Our regression model's number of variables is taken into account, but adjusted R-Squared has a similar interpretation. The evidence between our independent variable and a dependent variable that accounts for all other variables is essentially what we are looking for. Real GDP growth rate has no relationship with final government consumption expenditures as a percentage of GDP, gross fixed capital formation as a percentage of GDP.

Ceteris paribus applies to the interpretation of the multiple regression coefficients. The p-values for final government consumption expenditures as a percentage of GDP and gross fixed capital formation as a percentage of GDP are particularly high and indicate no significant effect from them. This is the first indication of the regression that we found.

We draw the conclusion that an OLS regression model is ineffective on the basis of two main arguments. The first is that neither the p values of our independent variables, nor the p values of either of the two control variables, are significant. Accordingly, we prefer either the Fixed Effect or Random Effect regression model for our analysis.

4.4 Results for fixed effect regression model

Firstly, the independent variables were entered into the model differently. Table 8 shows that R&D expenditures are significant and positive. The analysis was continued using model 10 as the final model.

Table 8. The relationship between R&D expenditures and economic growth

The Relationship between R&D Expenditures and Economic Growth

Variable / target variable = GDPPC	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
log(RDEXP)	0.71***	0.6***	0.25***	0.57*	0.25**	0.36***	0.13*	0.1*	0.25**	0.27***
log(INVGDP)		1.71***			1.1***	1.88***	1.24**	1.42**	1.51**	1.47***
log(LABOR)			2.73***		2.3***		2.16***	1.9**	1.21**	1.07***
log(GGCE)				0.86*		1.42***	0.82*	1.5**	1.05	3.11***
log(TECHN)								0.1*		0.33**
Rlog(ES)									0.28*	0.11***
No of Observation	231	231	231	231	231	231	231	231	231	231
No of Country	11	11	11	11	11	11	11	11	11	11
Serial Correlation Problem	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cross Sectional Dependence Problem	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note:*** p<0.01, ** p<0.05, * p<0.10

The following table represents the results, where all the independent variables are included into the regression.

Table 9. Multiple regression using fixed effect model

	Estimate	Std. Error	t value	Pr(>|t|)
log(RDEXP)	0.27	0.09	2.83	0.005***
log(INVGDP)	1.47	0.208	7.08	2.329e-110 ***
log(GGCE)	1.07	0.315	3.39	0.0008328 ***
log(LABOR)	3.11	0.54	5.86	1.865e-08 ***
log(TECHN)	0.33	0.12	2.73	0.07062 **
log(RES)	0.11	0.09	4.824	3.96e-06 ***
R-Squared	0.51901			
F-statistic:	53.9524	p-value	< 2.22e-16	

Note:*** p<0.01, ** p<0.05, * p<0.10

All predictors have statistically significant p values, as shown in Table 9. The inference drawn from Table 9 is that ceteris paribus, a 1% increase in R&D spending as a percentage of GDP will have an effect on real GDP growth rates in the observed economies by 0.27 percentage points over the course of the observation period. 51.9% is the coefficient of determination.

In the model, it was discovered that the R&D expenditures variable's coefficient was both positive and statistically significant. Panel data tests were run in this main model, and the conclusion was made. This model predicts that an increase of 1% in R&D expenditures as a percentage of GDP will lead

to an increase of 0.27 percent in GDP per capita in a select group of countries.

The analysis' findings indicate that the model's labor control variables and domestic investment controls have a favorable impact on economic growth. According to the model, a 1% increase in the share of gross fixed capital investments in GDP causes an increase in economic growth of 1.47% in these countries; a 1% increase in employment causes an increase in economic growth of 3.11%.; increase in the share of Government Expenditures in GDP causes an increase in economic growth of 1.07% in these countries.

4.5 Hausman test for endogeneity of the model

We perform a Hausman test to determine whether to use fixed or random effects, with the null hypothesis being that random effects are preferred over fixed effects. The main test is whether the regressors and the unique errors (ui) are correlated; the null hypothesis is that they are not.

We will compare the fixed effects and random effects model results with the hausman test and determine which result to choose. Table 10 displays the Hausman test results.

Table 10. Results of hausman test

chisq = 115.41	df = 6	p-value < 2.2e-16
alternative hypothesis	one model is inconsistent	

The Hausman test tests the null hypothesis that the coefficients calculated with the efficient random effects estimator are the same as those estimated with consistent fixed effects. According to the Hausman test result, fixed effects is a more effective model.

4.6 Results

We know from the test results in Section 4.1 and 4.2 that although the results are statistically significant, we rejected the null hypothesis in the serial correlation, homoskedasticity and cross-sectional dependence tests and will be corrected accordingly. In this section, besides the significance of the variables, we will use some modified functions to test whether we can use them in the final model or not.

We will start with the HAC function that we will use for Serial Correlation and Homoskedasticity. After this step, we will continue with SCC and our model will take its final form.

Table 11. Results of HAC

	Coefficient
log(RDEXP)	0.27***
log(TECHN)	0.33
log(RES)	0.11**
log(INVGDP)	1.48***
log(GGCE)	1.07**
log(LABOR)	3.17**

Note: *** p<0.01, ** p<0.05, * p<0.10

We can see that with heteroskedasticity and autocorrelation consistent (HAC) standard errors, the number of technicians is no longer a significant predictor in our model.

Table 12. Comparison of coefficients and significance

Variable	FE	FE after HAC	**SCC**
log(RDEXP)	0.27***	0.27***	0.27**
log(TECHN)	0.33**	0.33	0.33
log(RES)	0.11***	0.11**	0.11
log(INVGDP)	1.48***	1.48***	1.47***
log(GGCE)	1.07**	1.07**	1.07**
log(LABOR)	3.17**	3.17**	3.11**

Note: *** p<0.01, ** p<0.05, * p<0.10

We can see that with SCC, the number of researchers is no longer a significant predictor in our model. We see the modified model in the equation 1.

$$\text{Log(GDPPC)} = 0.27\text{Log (RDEXP)} + 1.47\text{Log(INVGDP)} + 1{,}07\text{Log(GGCE)} + 3.11\text{Log(LABOR)} \quad (1)$$

Although R&D expenditures' significance declines in the final case, the final coefficients have been reached within the bounds of statistical significance for all four variables using the SSC method.

In the model, it was discovered that the R&D expenditures variable's coefficient was both positive and statistically significant. Panel data tests were run in this main model, and the conclusion was made. This model predicts that an increase of 1% in R&D expenditures as a percentage of GDP will lead to an increase of 0.27 percent in GDP per capita in a select group of countries.

The analysis' findings indicate that the model's labor control variables and domestic investment controls have a favorable impact on economic growth. According to the model, a 1% increase in the share of gross fixed capital investments in GDP causes an increase in economic growth of 1.47% in these countries; a 1% increase in employment causes an increase in economic growth of 3.11%.; increase in the share of Government Expenditures in GDP causes an increase in economic growth of 1.07% in these countries.

5. Conclusion

Technology advancement, physical and human capital, natural resources, and an increase in population-based labor are some of the factors that contribute to growth. According to studies and models developed to date, R&D activities that are produced using knowledge are among the most significant production resources that influence the welfare level and development of nations. The amount of physical and human capital that nations possess determines the production of new technologies required for new products and methods of production. R&D initiatives by nations, the number of patents, the number of R&D employees, and the number of resources allocated to R&D expenditures as a ratio to GDP can all be used to gauge the country's R&D activities.

Productivity and the competitiveness of the nations will rise as a result of R&D activities brought on by the effective and correct application of technology and high-rate production. It is clear that the R&D sector has evolved into the foundation of the nation's economy as a result of R&D activities. New technologies are created as a result of R&D activities, and these activities take on increasing importance as new products are developed. Investments in knowledge, research, and development will lead to the development of new technologies, which will improve national welfare and permit significant increases in national income levels.

In this study, we analyzed the effect of R&D activities on the economic growth of 11 countries that are considered to be fragile due to their reliance on foreign capital. Specifically, the effect of R&D expenditure as a ratio of GDP on the growth of GDP per capita in Brazil, Chile, Colombia, Indonesia, India, Peru, Russian Federation, Singapore, Thailand, Republic of Korea, and Türkiye for the years 2000–2020 is analyzed in this study.

The findings indicate that the share of R&D expenditures in GDP, fixed capital formation, and labor force are all found to be statistically significant and have a positive impact on economic growth. Control variables such as the labor force and fixed capital formation also have a statistically significant and favorable impact on economic growth. The variable with the greatest impact on economic growth is found to be the labor force, followed by gross capital investments, government expenditures, and R&D expenditures, respectively, according to the size of the coefficients. Hence, our results are in line with most of the studies cited in the literature review part that demonstrate that R&D expenditures have a positive and significant impact on economic growth.

Particularly the countries that run current account deficits should increase the value of their exports and should rely less on importing high-value-added products. Because higher R&D expenditures typically enable countries to produce high-technology, so high-value-added products, it is especially important for developing and fragile economies to increase their R&D activities.

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