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The Tractor Industry in the Turkish Economy: An Endogenous Growth Analysis in the Context of Monetary and Fiscal Policy Coordination



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Abstract

This study investigates the asymmetric effects of coordination between monetary and fiscal policies on agricultural productivity in the Turkish economy, focusing on the tractor industry as a core component of agricultural capital formation. While monetary policy primarily affects the quantity of tractors through interest rate channels, fiscal policy determines the technological quality of this capital through R&D incentives and technology-oriented subsidies. The central argument of the study is that increases in tractor demand driven solely by lower financing costs lead to quantitative capital accumulation without productivity gains unless accompanied by technologically selective fiscal support. To test this hypothesis, an endogenous growth framework incorporating technological risk and qualitative – quantitative capital complementarity is developed. The model highlights how insufficient policy coordination causes farmers to favour low-technology tractors as a “safe haven,” even under expansionary monetary conditions, thereby generating structural X-inefficiency and a persistent productivity trap. The findings demonstrate that agricultural modernisation cannot be achieved through credit expansion alone and that the accumulation of technologically advanced capital is essential for sustaining total factor productivity growth. The study concludes that effective coordination between monetary and fiscal policies is a necessary condition for avoiding low-productivity equilibria in agriculture. Policies focused exclusively on financing costs risk reinforcing inefficient capital structures, whereas coordinated policy design enables technological deepening, risk mitigation, and long-term productivity gains in the agricultural sector.

Keywords

Innovation and Invention · Agricultural Technology · Policy Coordination

Jel Codes

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The Tractor Industry in the Turkish Economy: An Endogenous Growth Analysis in the Context of Monetary and Fiscal Policy Coordination

Agricultural modernisation refers to the implementation of production using advanced technological infrastructure based on data analytics and precision engineering techniques. It differs from traditional agricultural production not only through an increase in the number of machines but also through the “smart” transformation of production tools, thereby shaping total factor productivity (TFP). This process, shaped around geometric optimisation in production, digital integration of capital, and cyber-physical farming practices, encompasses high value-added activities such as smart irrigation systems and variable-rate fertilisation equipped with sensor technologies. Providing significant advantages in global competition, agricultural modernisation also accelerates learning by doing processes. Thus, by obtaining higher yields per unit area and minimising input costs, farmers can achieve their profit maximisation goals. In economic development policies aimed at improving the agricultural sector, the technological content of production factors and their capacity to accumulate knowledge are of central importance. Achieving success in this context necessitates effective coordination between monetary and fiscal policies. Lowering interest rates can increase access of farmers to financing by reducing agricultural credit costs. However, unless monetary and fiscal policies are aligned, this will only lead to quantitative accumulation. Thus, the acquisition of low-technology tractors, facilitated by improved financing, will hinder agricultural modernisation, leaving agricultural productivity at an insufficient level. The inadequacy of total factor productivity (TFP) in the agricultural sector will prevent qualitative transformations, such as data-driven agriculture, autonomous steering, or fuel-efficient engine technologies. A quantitative accumulation of capital (tractor fleet) will be used, resulting in production that falls short of potential production capacity through traditional methods and high levels of resource waste. This situation is defined in the literature as “X Economic Inefficiency.” In this situation, fiscal policy needs to integrate with monetary policy and implement instruments to encourage agricultural modernisation activities (R&D support, tax exemptions, and subsidies). During periods of expansionary monetary policy, the technological selectivity of fiscal policy should also increase. Similarly, when the government promotes high technology, the implementation of monetary authority of contractionary policies may restrict access of farmers to advanced technology (Binici, 2021; Castillo, 2025; Merdan, 2024 and Çetin and Karadaş, 2018).

Despite a 27% increase in the tractor fleet in the Turkish economy over the last decade, reaching 1.6M units, technological advancement has not been achieved. The average age of these tractors is over 25 years, and a significant portion of them have low horsepower, impacting the overall factor productivity of the agricultural sector. As a result, agricultural modernisation has not been realised, and production continues with significant economic inefficiency. Due to the ineffective coordination between monetary and fiscal policies, agricultural loans have not been supported by technological filtering. Equipping the agricultural sector with low-technology production tools has led to the economy falling into a productivity trap (Akat *et al.*, 2020; Aysan *et al.*, 2019 and Nas and Odekon, 1988).

The fundamental approaches developed to examine the interaction between the disciplines of economics, politics, and law are Institutional Economics, Public Choice Theory, and the Economic Analysis of Law. The most important common point of these approaches is their focus on revealing the impact of the rules of the game on determining welfare. The Economic Analysis of Law focuses on analysing the legal

system from a productivity perspective. Ronald Coase and Richard Posner, in particular, made significant contributions to the development of this approach. The incentive and deterrent effects of the legal system on rational individual behaviour can be analysed using this approach. Minimising transaction costs is a primary goal. Legal rules should be organised to ensure not only justice but also the efficient allocation of resources. Institutional Economics, stating that the economy develops within a historical, social, and institutional dynamism, demonstrates that institutions are the factors that determine the rules of the game. Strong institutions (rule of law, security of property rights, etc.) reduce uncertainty, encouraging investment and endogenous growth, whereas weak institutions are the main cause of economic stagnation. Finally, Public Choice Theory applies economic rationality to political science. This approach posits that politicians, bureaucrats, and voters, much like actors in a market, aim to maximise their own self-interest. In this arena, often called the “political market,” it is analysed how state intervention tools (subsidies, regulations) sometimes benefit specific interest groups rather than general social welfare (Berger *et al.*, 2025; Spiess, 2025; Zdybel, 2025 and Zehir and Allaham, 2025).

In the Turkish economy, the tractor industry is not only a machine manufacturer but also a major carrier of agricultural idea generation (R&D Capital). While monetary policy affects the quantity of tractors, fiscal policy affects the technological capacity of these tractors. If these two policies are not coordinated, the accumulation of R&D capital will be insufficient, and the agricultural sector will face the risk of secular stagnation. The main objective of this study is to test this hypothesis. The tractor industry is selected as the focal point of the analysis because tractors constitute the dominant component of agricultural fixed capital formation and serve as the primary carrier of technological diffusion in Turkish agriculture. To this end, the following part of the study is designed to consist of four sections. The first is a literature review. The second contains methodological information. The third section introduces the model and performs the analysis. In the fourth section, the findings are evaluated and the study is concluded.

Literature Review

The literature review of this study focuses on three main points. Firstly, it concerns studies evaluating the Turkish tractor market. Secondly, it relates to game-theoretic modelling of coordination between monetary and fiscal policy. Third, it identifies studies examining the effects of economic activity *X* on the production process using game theory. In the tractor market, coordination between monetary and fiscal policies is of central importance in increasing total factor productivity. Based on this premise, well-established studies in the literature that utilise game-theoretic modelling of coordination between monetary and fiscal policies are evaluated from the perspective of the tractor market (Nordhaus, 1994; Sargent and Wallace, 1981; Dixit and Lambertini, 2003 and Alesina and Tabellini, 1987). Studies on the tractor market in Turkey show that consumer behaviour has evolved from traditional economic criteria to advanced technological expectations throughout its historical development process. The literature review proves that the tractor market has permanently transformed from a mechanical efficiency-focused approach to a knowledge-intensive and technology-focused market structure (Aksoy *et al.*, 2019; Baybaş and Aksoy, 2021; and Bayramoğlu *et al.*, 2025). Çetin [2010] examines the effects of economic activity *X* on the production process using game theory analysis. This study, which is related to the economy in general, provides a general theoretical framework for our model (Table-1).

Table 1*Literature Review.*

THE STUDY	THE SAMPLE	THE PERIOD	THE METHOD	THE FINDINGS
Çetin, T. (2010).	-	-	Game Theory	Examines the concept of X-efficiency through a game-theoretic framework and analyses how organizational and behavioral factors may cause production outcomes to deviate from potential efficiency levels.
Nordhaus [1994]	-	-	Game Theory	Examines the coordination problem between monetary and fiscal authorities and shows how policy conflicts may generate macroeconomic inefficiencies and suboptimal economic outcomes.
Sargent & Wallace [1981]	-	-	Game Theory	Demonstrates that persistent fiscal imbalances may undermine monetary policy effectiveness and create adverse macroeconomic consequences for economic stability.
Dixit and Lambertini [2003].	-	-	Game Theory	Analyzes the interaction between monetary and fiscal authorities and highlights the importance of policy coordination for achieving macroeconomic objectives.
Alesina and Tabellini [1987]	-	-	Game Theory	Investigates strategic interactions between policymakers and shows that noncoordinated policy actions may lead to welfare losses and inefficiencies.
Bayramoğlu et al.(2025)	Konya	2024	Questionnaire	Examines the role of technological characteristics in tractor preferences and demonstrates the growing importance of technology-oriented attributes in farmers' purchasing decisions.
Baybaş, S.& Aksoy, A. [2021].	Erzurum	2020	Questionnaire	Fuel consumption, price, spare-parts availability, and service network are among the most influential determinants of tractor brand selection, while farmer education and maintenance costs also affect purchasing decisions.
Aksoy et al. (2019).	Erzurum	2017	Questionnaire	The study shows that fuel consumption, price, spare parts, and service network are the most influential factors in brand selection. It also proves that education level and the annual maintenance costs of the tractor are influential.

Methodology

Endogenous growth models represent a revolutionary approach in modern macroeconomic literature by attributing the source of economic growth not to random exogenous technological shocks but to the decisions and policies within the economic system itself. While traditional Solow-Swan models accept technological progress as an “exogenous” and uncontrollable variable, the Endogenous Growth Theory posits that technology is a direct result of conscious investments, R&D activities, and a highly skilled workforce. Knowledge, unlike physical goods, possesses “nonrival” and “spillover” characteristics. A new production technique or tractor engine technology developed by a single firm eventually spreads to other firms and sectors, thereby increasing total productivity. In this process, Paul Romer emphasises that technological innovations emerge through the conscious R&D efforts of profit-oriented firms, while Robert Lucas states that investments in human capital (education and skills) trigger growth by enhancing labour productivity.

Endogenous growth dynamics operate through “qualified capital accumulation”. Merely increasing the number of tractors constitutes physical capital accumulation and is destined to succumb to the law of diminishing returns at some point. However, integrating precision farming technologies, autonomous driving software, and fuel-efficient engine designs onto tractors increases the sectoral knowledge base. This increase in technological quality creates an endogenous leap, allowing for the generation of much higher value-added with the same amount of land and labour. Since the market mechanism cannot fully price the positive externalities created by knowledge spillovers, the private sector may underinvest in R&D. This situation necessitates state intervention through fiscal policy instruments (incentives and supports) to foster technological quality. Consequently, endogenous growth models prove that economic development is possible not merely by borrowing at low interest rates to increase the quantity of machinery but also through the coordinated increase in knowledge production, technological depth, and human capital quality. The “leap” that Türkiye will experience in agricultural productivity depends more on the technological knowledge intensity of its tractor fleet than on the age or quantity of the fleet itself (Acemoglu and Azar, 2020; Kopytov et al., 2024 and Peters, 2020).

Model and Analysis

This study uses the Epstein-Zin type utility function to analyze the behavioral dynamics of farmers (economic decision-makers), providing a mathematical basis for the quantitative-qualitative distinction in agricultural investment decisions. Unlike traditional intertemporal utility models, the most fundamental advantage of this function is that it separates the farmer’s intertemporal substitution elasticity from their risk aversion coefficient. According to the hypothesis of the study, the technological quality of the tractor carries a high degree of uncertainty and risk. The risk aversion coefficient in the Epstein-Zin function represents the farmer’s sensitivity to this technological risk. If fiscal policy (incentives and R&D support) does not subsidise this technological risk and balance the farmer’s risk perception, the rational farmer will invest his money in low-technology standard machines that he considers “safe,” even in a low-interest rate environment, rather than in advanced technology (Grossman and Helpman, 2018; Epstein and Zin, 1989 and Epstein and Zin, 1991). In conclusion, this defined utility function explains why the lack of coordination between monetary and fiscal policies in the Turkish economy leads to a productivity trap: Although farmers are motivated to invest in quantity (by monetary policy), the inability to manage technological risk (lack of fiscal policy) results in growth that lacks the quality of a “best choice.” Farmers face two fundamental decisions when investing in tractors: “How much of their current consumption should they give up to invest?” and “Should they keep their investment in traditional technology or in risky but highly efficient advanced technology?” In the Epstein-Zin structure, monetary policy (interest rates) directly impacts the IES channel. When interest rates fall, farmers, who have high intertemporal substitution elasticity, tend to increase their tractor numbers by reducing their current consumption to increase future production capacity. However, this only explains the physical size (quantity) of the tractor fleet:

$$V_t = \left[(1 - \beta)C_t^{1-\rho} + \beta \left[E_t \left(V_{t+1}^{1-\mu} \right) \right]^{\frac{1-\rho}{1-\mu}} \right]^{\frac{1}{1-\rho}} \quad (1)$$

V_t : The Recurrent Utility (This is the sum of all the farmer’s present and expected future satisfactions. This value includes both present consumption and future return on investment (tractor)).

V_{t+1} : The Continuation Value (This variable is the present-discounted value of the expected benefits for all future periods from time $t + 1$ to infinity. When a farmer makes a decision to invest in a tractor today,



they consider how this decision will affect their production capacity at $t + 1$ and beyond, and therefore their future prosperity (V_{t+1})).

β : The Subjective Discount Factor (This is the weight the farmer places on the future. If β is high, the farmer is patient; he is more willing to give up his current consumption and invest in a tractor (capital accumulation)).

C_t : The Current Consumption (This is the portion of the farmer spending on their current needs. It is the opportunity cost of the investment (tractor purchase)).

μ : Relative Risk Aversion Coefficient measures how much farmers are wary of the uncertainty created by technological innovation (precision agriculture, digitalisation, etc.). Fiscal policy (incentives) impacts this channel. Technological tractors (quality) carry high risks. If incentives do not compensate for this risk, farmers will turn to the low-tech tractor they are familiar with due to the high cost of the tractor.

ρ : Intertemporal Substitution Elasticity (This refers to a farmer's willingness to spread their consumption over time depending on changes in interest rates. Monetary policy (interest rates) exerts its influence through this channel. When interest rates fall, farmers reduce their current consumption through elasticities and turn to credit to increase the number of tractors.)

$E(.)$: The Expected Utility Function Operator

Production is realised by combining the physical number of tractors (K_n) and R&D capital (R_q), which represents the technological capacity of the tractor. Capital grows through deepening and expansion. Expansion is related to more tractors and, according to the law of diminishing returns, loses its positive effect on production after a certain level. Deepening, which is not subject to the law of diminishing returns, refers to the more efficient use of tractors and constitutes the main engine of growth. The most important theoretical assumption in the mathematical structure of the function is that the quantity of tractors (K_n) and their technological quality (R_q) complement each other. If you've very advanced software (R_q) but no tractors (K_n) to run it, you cannot produce anything. Conversely, if you have hundreds of tractors (K_n) but they are outdated technology, productivity will stagnate. This situation is theoretical proof of the need for "Policy Coordination" in your study. Monetary policy (K_n) controls fiscal policy (R_q). Without coordination, an input is missing, and the production function cannot reach its full potential:

$$Y_t = A_t (K_{n,t})^\alpha (R_{q,t})^{1-\alpha} \quad (2)$$

Y_t : Agricultural Production Quantity

A_t : Total Factor Productivity (It is an external factor representing human capital and institutional effectiveness.)

$K_{n,t}$: Quantitative Capital (It represents the number of tractors in the field. This variable is stimulated by monetary policy (interest rates). When interest rates fall, the budget constraint of farmers eases and their physical machinery expands.

$R_{q,t}$: Qualitative R&D Capital (This represents the technological depth of the tractors (smart farming, productivity, and software). This variable is determined by fiscal policy (incentives)).

α : The Production Flexibility

The increase in the number of tractors is realised as follows:

$$K_{n,t+1} = (1 - \delta)K_{n,t} + I_{n,t} \quad (3)$$

δ : The Depreciation/Wear Rate

$I_{n,t}$: The Gross Quantitative Investment (Number of new tractors purchased.)

The future tractor stock is formed by subtracting the worn-out portion from the current stock and adding the newly acquired ones. If new purchases ($I_{n,t}$) are lower than wear and tear $(1 - \delta)K_{n,t}$, it means the tractor fleet is physically shrinking (Equation (3)). Deepening refers to the more efficient use of tractors and constitutes the main engine of growth realised in this way:

$$R_{q,t+1} = (1 - \delta)R_{q,t} + \varphi(s_t)I_{q,t} \quad (4)$$

$I_{q,t}$: Qualitative Investment (This refers to expenditures made to improve technology or resources allocated for purchasing technologically advanced tractors.)

The fundamental difference separating the equation, in Equation (4), from physical capital accumulation is the coefficient ($\varphi(s_t)$) that precedes investment. This coefficient is related to two key situations in the R&D and technology-driven growth literature. The first is the leverage effect of incentives. According to endogenous growth models, technology investments are risky and create positive externalities (one farmer learns technology and another uses it). Therefore, the market alone does not produce enough technology. The ($\varphi(s_t)$) function shows how government R&D support or technology incentives (s_t) transform each unit of investment ($I_{q,t}$) into a “technological leap.” The second is the need for coordination. Even if monetary policy increases the number of tractors (K_n), if fiscal policy does not make technological investment attractive through ($\varphi(s_t)$) accumulation (R_q) will remain slow. So, a farmer buys a new tractor (I_n), but whether that tractor is “smart” or “efficient” (R_q) depends entirely on the efficiency coefficient offered by fiscal policy. Theoretically, $R_{q,t}$ represents “knowledge capital” that is not subject to the law of diminishing returns. Even if the number of physical tractors (K_n) increases, it is this $R_{q,t}$ stock that provides the real leap in production. Once technology is produced, it permanently increases efficiency in the production function. When farmers allocate their investment between quantity and quality, they look at the following marginal rate of substitution:

$$\frac{\frac{\partial Y}{\partial K_n}}{Cost(r)} \text{ vs } \frac{E_t\left(\frac{\partial Y}{\partial R_q}\right)}{Risk - Adjusted Costing(s, \mu)} \quad (5)$$

When monetary policy lowers interest rates (r), farmers reduce their consumption and invest according to their EZ preferences ((ρ) channel). However, if the technological quality (R_q) has a risky return and risk aversion (μ) is high, the optimal preference of the farmer changes. If interest rates are low (r), the number of tractors (K_n) will increase rapidly. If incentives (s) are low, risky technology investment (R_q) will not be undertaken because, due to risk aversion (μ), low-technology tractors, which are considered safe havens, will be preferred.

R&D capital is the engine of growth $\left(\frac{\overline{R_q}}{R_q}\right)$. Under EZ preferences, the sustainable growth rate (g) is approximately equal to:

$$g \approx \underbrace{\frac{1}{\rho}(r_{productivity} - \rho)}_{\text{Quantitative easing created by monetary policy}} - \underbrace{\frac{\mu}{2}\sigma_{technology}^2}_{\text{Technological risk (uncertainty) penalizes growth.}} \quad (6)$$

If fiscal policy stimulus (s) is not sufficient to offset technological uncertainty ($\sigma_{technology}^2$) or risk aversion (μ), then regardless of how expansionary monetary policy is optimal, the negative term on the right will

halt the growth engine. In the Turkish economy, while $\left(\frac{\partial K_n}{\partial r}\right)$ is working, it remains $\left(\frac{\partial R_q}{\partial s} \approx 0\right)$ due to lack of coordination. This prevents the overall productivity jump (endogenous jump) in the Y function.

Proposition-1:

In the specific case of the Turkish economy, unless the quantitative capital increase (∂K_n) created by monetary expansion (low interest rates) is coordinated with the technological selectivity of fiscal policy and risk-compensating incentives (s) , the system may remain below its potential production frontier, increasing the likelihood of structural X-inefficiency $(\forall < 1)$ and a persistent productivity trap.

When the activity parameter is included in the production function, the situation is as follows:

$$Y_t = \forall (\mu, s, \sigma^2) A_t (K_{n,t})^\alpha (R_{q,t})^{1-\alpha} \quad (7)$$

In equation (7), $\forall$ is an efficiency coefficient that takes values between $0 \leq \forall \leq 1$ depending on the quality of political coordination. When the risk aversion coefficient (μ) of the farmers and technological uncertainty (σ^2) are not balanced by fiscal policy incentives (s) , X-inefficiency increases:

$$\forall = \exp\left(-\frac{\mu \sigma_{technology}^2}{1+s}\right) \quad (8)$$

When incentives (s) are insufficient, the risk factor in the share $(\mu \sigma_{technology}^2)$ becomes dominant, and production approaches $\lim_{\forall \rightarrow 0}$, falling below potential. The overall productivity and growth rate (g) in the model are penalised due to X-inefficiency and lack of coordination as follows:

$$g \approx \frac{1}{\rho} \left(r_{productivity} - \rho r_f - \frac{\mu}{2} \sigma_{technology}^2 \right) \quad (9)$$

Increasing the number of tractors (K_n) solely through monetary expansion will, due to the “law of diminishing returns,” eventually lose its marginal contribution to production. If this process is not supported by qualitative deepening, capital accumulation will only become a quantitative accumulation. Farmers perceive high-tech investments as “risky” (R_q) . When fiscal policy (incentives and R&D support) does not subsidise this technological risk, farmers, being rational decision-makers, will turn to low-tech, standard machinery as a “safe haven” instead of high technology, even in a low-interest rate environment. The inability to reach the potential efficiency $(\forall)$ of existing resources (tractors) creates managerial and technological “X-inefficiency.” This disrupts the “learning by doing” and knowledge dissemination processes, which are the fundamental drivers of endogenous growth models. The effective functioning of property rights and institutional “rules of the game” increases the efficiency coefficient by reducing uncertainty. Weak institutional structures and lack of policy coordination deepen inefficiency by directing government incentives towards specific interest groups instead of the general welfare (Public Choice Theory). When $\left(\frac{\partial R_q}{\partial s} \approx 0\right)$ is the case, the production function cannot reach its full potential, and the economy becomes trapped in a “productivity trap.” Therefore, the functional structures in equations (9) and (5) suggest that the low-productivity problem in the Turkish economy may be associated not only with the number of machines but also with institutional and technological inefficiencies arising from elevated risk perceptions and policy inconsistencies. (Schiller and Gebhardt, 2021; Yılmaz and Sümer, 2018; Jain et al., 2025).

Traditional economics assumes that a firm always uses its resources (machinery, labour, and raw materials) at the lowest cost and with the highest efficiency. However, the X-efficiency concept, introduced by Harvey Leibenstein, argues that this is not the case in the real world. X-efficiency refers to the gap between a firm’s technically achievable “maximum production frontier” and its “actual production.” If a firm cannot

achieve the expected efficiency despite having state-of-the-art tractors, then there is an “X-inefficiency.” The main sources of this inefficiency can be grouped into three categories. The first is related to the lack of effort (inertia) of farmers to learn and apply new technology. The second is the desire to stay with existing technology due to imperfect competition. The third is related to a lack of information. The complexity of the technology prevents the user from utilising it to its full capacity. In the model, when interest rates fall, the number of tractors increases. This directly triggers growth. The incentives given aim to increase the technological depth of the tractor. If farmers cannot manage technological risks and the institutional quality of the state is low, advanced tractors will be used in the fields using “traditional methods.” The result is a massive fleet of machinery on paper, but in reality, stagnant agricultural productivity (Çetin, 2010 and Keita and Laurila, 2021).

Lemma 1: Technological Risk Premium and Endogenous Jump Condition

In an economic system that has Epstein-Zin type preferences, an endogenous jump in the agricultural production function ($\frac{\partial Y}{\partial t} > 0$) is only possible if the risk subsidy created by fiscal policy (s) reduces the farmer’s perception of technological risk ($\mu\sigma^2$) below a critical threshold.

Proof:

Let us consider the equation for the sustainable growth rate (g) derived from utility maximisation of the farmers:

$$g \approx \frac{1}{\rho} (r_{\text{productivity}} - \rho r_f - \Psi(\mu, \sigma, s)) \quad (10)$$

In Equation (10), the term Ψ is the “Technological Risk Penalty” function that suppresses growth:

$$\Psi = \frac{\mu(s)}{2} \sigma_{\text{technology}}^2 \quad (11)$$

If we functionally define the mitigating effect of fiscal policy stimulus (s) on risk:

$$\mu(s) = \frac{\mu_0}{1+s} \text{ or } \frac{\partial \mu}{\partial s} < 0 \quad (12)$$

In the case of equation (12), the sensitivity of the growth rate about fiscal policy is:

$$\frac{\partial g}{\partial s} = \frac{\sigma_{\text{technology}}^2}{2\rho(1+s)^2} \quad (13)$$

Low interest rates provide a short-term increase in output by only increasing quantitative capital. However, this does not create a permanent change (jump) in the slope of the production function. If (s) is constant or low, the Ψ (Risk Penalty) term remains high. This negatively affects the growth rate (g), trapping the system in a stable low equilibrium point known as the “Efficiency Trap”. For an endogenous jump to be realised, the effect $\frac{\partial g}{\partial s}$ must reach a magnitude sufficient to compensate for the X-inactivity ($\forall$) in the system.

Lemma 1 provides a theoretical explanation for why increases in the tractor fleet in the Turkish economy may not necessarily generate a corresponding agricultural transformation. Monetary expansion accumulated (K_n), but the lack of fiscal policy coordination kept the Ψ (Risk Penalty) term high, blocking the R_q (Technological Depth) channel.

Proposition-2:

If agricultural subsidies (s) are distributed not according to criteria of technological modernisation R_q and knowledge accumulation but through rent-seeking mechanisms, low-interest loans may contribute to a “strategic resource diversion” that deepens X-inefficiency instead of creating productivity increases.

If property rights, transparency, and oversight mechanisms are weak in a country, some incentives allocated from the budget will go towards rent-seeking activities:

$$s_{efficiency} = \omega s_{total} \quad (14)$$

In equation (14), ω is the Institutional Quality Coefficient. If ω is low (high in political rent-seeking), very little of the incentives allocated from the budget translate into technological depth R_q . This prevents the “Risk Penalty” in Lemma 1 from being dampened. According to Public Choice Theory, policymakers, due to short-term election cycles, prefer “quantitative support” (for example, general credit support aimed solely at increasing the number of tractors) that has a quick effect but low efficiency, over “high-technology-focused R&D support” that will increase productivity in the long run. This situation leads to the (s) incentive in the model feeding only quantitative capital (K_n) instead of qualified capital (R_q). The result is a capital accumulation without technological depth. Proposition-2 shows that the agricultural development problem is not merely a lack of resources but rather a problem where existing resources are not channelled into the most productive area (technology) due to institutional weaknesses and political rent-seeking mechanisms.

Conclusion

The findings of this study suggest that the Turkish agricultural sector may be vulnerable to a persistent productivity trap resulting from ineffective coordination between monetary and fiscal policies. Although expansionary monetary policy reduces agricultural credit costs and stimulates tractor demand, its impact remains largely confined to quantitative capital accumulation. In the absence of complementary fiscal policies that promote technological upgrading, increases in the tractor fleet fail to generate sustained improvements in total factor productivity, thereby constraining long-term agricultural growth.

Although this study primarily develops a theoretical endogenous growth framework, several stylised facts from the Turkish agricultural sector are consistent with the mechanisms proposed in the model. Despite a substantial expansion in the Turkish tractor fleet over the last decade, reaching approximately 1.6 million units, the average age of tractors remains above 25 years, and the diffusion of precision agriculture technologies remains limited. Furthermore, increases in agricultural credit availability have not been accompanied by a comparable improvement in productivity indicators, suggesting that quantitative capital accumulation has not always translated into technological deepening. These observations are broadly consistent with the model’s argument that monetary expansion alone may increase tractor ownership while failing to generate sustained productivity gains in the absence of technologically selective fiscal support. Therefore, the Turkish agricultural sector provides indicative evidence supporting the theoretical mechanisms developed in this study.

By embedding Epstein – Zin preferences within an endogenous growth framework, the analysis demonstrates that farmers’ investment decisions are jointly shaped by intertemporal substitution incentives and perceptions of technological risk. When fiscal policy instruments, such as R&D subsidies, technology-oriented incentives, and selective support mechanisms, fail to compensate for this risk, farmers rationally prefer low-technology tractors that function as a safe option. As a result, monetary expansion alone produces an unreal modernisation equilibrium, in which capital accumulation is purely quantitative and technological deepening remains insufficient to trigger endogenous productivity gains.

The study further emphasizes the role of X-inefficiency in reinforcing this low-productivity equilibrium. Even when physical capital expands, weak institutional structures, limited information diffusion, and poorly designed incentive mechanisms prevent the effective use of existing resources. Consequently, the agricultural sector operates below its potential production frontier, and learning-by-doing processes—central to endogenous growth dynamics—remain underdeveloped. In this context, institutional quality plays a decisive role in determining whether public resources translate into technological depth or are diverted towards rent-seeking activities.

From a policy perspective, the results clearly demonstrate that agricultural development strategies focused solely on reducing financing costs are inherently limited. Sustainable productivity growth requires a coordinated policy framework in which monetary expansion is systematically aligned with fiscally driven technological selectivity. In practical terms, this implies that agricultural support mechanisms should not provide uniform incentives for all tractor investments. Instead, higher subsidy rates, tax advantages, and preferential credit conditions should be directed towards tractors equipped with precision agriculture technologies, such as GPS-guided steering systems, sensor-based monitoring equipment, digital yield mapping software, variable-rate input application technologies, and fuel-efficient smart engine systems. Similarly, tractor renewal programmes may prioritise the replacement of ageing machinery with technologically advanced equipment capable of supporting data-driven agricultural production. Public support schemes could also incorporate technology-based eligibility criteria, allowing farmers investing in technologically superior machinery to receive greater financial assistance than those purchasing conventional equipment. Furthermore, demonstration farms, agricultural extension services, and technology-oriented R&D support programmes can reduce farmers' perceived technological uncertainty and encourage the adoption of advanced technologies. Such coordination reduces farmers' perceived technological risk, encourages the accumulation of qualified capital, and enables the agricultural sector to escape the productivity trap. Therefore, effective coordination between monetary and fiscal policies constitutes not only a supportive policy option but also a necessary condition for achieving genuine agricultural modernisation and long-term economic efficiency in the Turkish economy.

Nevertheless, the findings should be interpreted within the limitations of a theoretical modelling framework. The study does not estimate the proposed relationships using sectoral or microlevel data and therefore doesn't claim causal empirical verification. Future research may empirically test the model using time-series or panel data analyses incorporating agricultural credit volumes, tractor technology indicators, total factor productivity measures, and agricultural value-added statistics for the Turkish economy.



Peer Review	Externally peer-reviewed.
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