Daves de Azevedo Cordova

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Dissertação apresentada à Universidade Federal de Mato Grosso – Faculdade de Economia, para obtenção do título de Mestre em Economia.

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DEDICATION

To Franciane, who daily shapes our path to common growth and brings joy to our ride.

Acknowledgments

This thesis is rooted in an attempt to bring social conscience to economic studies. For this, I am deeply grateful to my entire family, especially my parents, who instilled in me the values of altruism.

My maternal grandparents, though no longer with us, deserve special mention for their life story. Their move from a disadvantaged region in Rio Grande do Norte to the 'Marvelous South' was the *raison d'être* for this thesis and became a central theme in my exploration of why some regions prosper while others decline, often forcing people to leave."

I extend my gratitude to all my teachers at Unesp, who fostered the historical perspective that forms the foundation of this thesis' cliometric analysis. The faculty at UFMT, both during my undergraduate and Master's studies, also played a significant role.

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Beyond all these efforts to acknowledge every contributor, I must give special thanks to my wife, Franciane Basso dos Santos Cordova, for her unique and invaluable role in the research and writing process.

ABSTRACT

This thesis examines the divergent paths of economic growth among the Immediate Regions of Mato Grosso, Brazil, stemming from institutional changes initiated during the Military Regime (1964-1985). This era catalyzed transformations with lasting consequences for the region's economic landscape, with some regions experiencing growth while others stagnated. The thesis tests the hypothesis that the nature of economic institutions, whether inclusive or extractive, played a decisive role in shaping these trajectories. Inclusive institutions, characterized by broad participation, secure property rights, and equitable access to resources, are considered promoters of economic dynamism. Extractive institutions, marked by concentrated power, insecure property rights, and limited access to opportunities, do not allow for sustained growth. The research employs a multifaceted approach, combining historical, econometric, and demographic analysis. The historical analysis traces the evolution of institutional structures in Mato Grosso. Econometric modeling, using data from the Agricultural and Demographic Censuses, evaluates the impact of Land Market development, Transports, and the emergence of Rural Enterprises on growth. Demographic analysis complements these components by examining population dynamics and labor force participation. The results reveal a pattern of regional differentiation where regions with more inclusive institutional changes experienced significant economic growth, driven by reduced transaction costs and increased productivity. Conversely, regions without these changes tended toward stagnation, as extractive institutions hindered economic diversification. These findings underscore the critical role of institutions in shaping long-term economic growth, where inclusive institutions are a catalyst for economic dynamism, while extractive institutions can trap regions in poverty and stagnation. This research suggests that targeted institutional reforms are crucial for unlocking the growth potential in similar contexts.

Keywords: Inclusive institutions; Extractive institutions; Agricultural production

RESUMO

Esta dissertação examina as trajetórias divergentes de crescimento econômico entre as Regiões Imediatas de Mato Grosso, Brasil, decorrentes das mudanças institucionais iniciadas durante o Regime Militar (1964-1985). Transformações ocorreram no período com consequências duradouras para o cenário econômico da região, em que algumas regiões experimentaram crescimento enquanto outras ficaram estagnadas. A tese testa a hipótese de que a natureza das instituições econômicas, inclusivas ou extrativas, desempenhou um papel decisivo na formação dessas trajetórias. As instituições inclusivas, caracterizadas pela ampla participação, direitos de propriedade seguros e acesso equitativo a recursos, são consideradas promotoras do dinamismo econômico. As instituições extrativas, marcadas pela concentração de poder, direitos de propriedade inseguros e acesso limitado a oportunidades, não permitem um crescimento sustentado. A pesquisa emprega uma abordagem multifacetada, combinando análise histórica, econométrica e demográfica. A análise histórica traça a evolução das estruturas institucionais em Mato Grosso. A modelagem econométrica, utilizando dados dos Censos Agropecuário e Demográfico, avalia o impacto do desenvolvimento do Mercado de Terras, dos Transportes e do surgimento de Empresas Rurais no crescimento. A análise demográfica complementa esses componentes ao examinar a dinâmica populacional e a participação da força de trabalho. Os resultados revelam um padrão de diferenciação regional onde as regiões com mudanças institucionais mais inclusivas experimentaram um crescimento econômico significativo, impulsionado pela redução dos custos de transação e pelo aumento da produtividade. Por outro lado, as regiões sem essas mudanças tenderam à estagnação, pois as instituições extrativas dificultaram a diversificação econômica. Essas conclusões ressaltam o papel crítico das instituições na formação do crescimento econômico de longo prazo, onde as instituições inclusivas são um catalisador para o dinamismo econômico, enquanto as instituições extrativas podem aprisionar regiões na pobreza e na estagnação. Esta pesquisa sugere que reformas institucionais direcionadas são cruciais para liberar o potencial de crescimento em contextos semelhantes.

Palavras-chave: Instituições inclusivas; Instituições extrativas; Produção agrícola.

Acronyms and abbreviations

2SLS – Two Stages Least Squares (regression technique)
Acarmat – *Associação de Crédito e Assistência Rural de Mato Grosso*
BASA – *Banco da Amazônia S.A.*
BR-070 – Federal Highway BR-070
BR-080 – Federal Highway BR-080
BR-158 – Federal Highway BR-158
BR-163 – Federal Highway BR-163
BR-174 – Federal Highway BR-174
BR-242 – Federal Highway BR-242
BR-251 – Federal Highway BR-251
BR-364 – Federal Highway BR-364
CAPEM - *Cooperativa Agropecuária Extrativa Mariópolis Ltda*
CODECO – *Comissão de Desenvolvimento do Centro-Oeste*
CODEMAT – *Comissão de Desenvolvimento de Mato Grosso*
CONAGRO – *Colonizadora Agropecuária (empresa privada*)
DF – Degrees of freedom
DNIT – *Departamento Nacional de Infraestrutura de Transportes*
D.T.C. – *Departamento de Terras e Colonização*
Emater – *Empresa de Assistência Técnica e Extensão Rural*
Embrapa – *Empresa Brasileira de Pesquisa Agropecuária*
Embrater – *Empresa Brasileira de Assistência Técnica e Extensão Rural*
e-MEC – *Cadastro Nacional de Cursos e Instituições de Educação Superior*
FBC – *Fundação Brasil Central*
GVA – Gross Value Added
GDP – Gross Domestic Product
IBGE – *Instituto Brasileiro de Geografia e Estatística*
IMAM – *Índice de Modernização Agrícola Municipal*
IMCOL – *Instituto de Colonização (referência histórica)*
INDEA – *Instituto de Defesa Agropecuária de Mato Grosso*
IPCA – *Índice de Preços ao Consumidor Amplo*
IPEA – *Instituto de Pesquisa Econômica Aplicada*
I PND – *Primeiro Plano Nacional de Desenvolvimento (1972-1974)*
II PND – *Segundo Plano Nacional de Desenvolvimento (1975-1979)*
l – prefix indicating a variable is expressed in its natural logarithm (for example lProduction)
OLS – Ordinary Least Squares
PIN – *Programa de Integração Nacional*
PNATER – *Política Nacional de Assistência Técnica e Extensão Rural*
POLAMAZÔNIA – *Programa de Polos Agropecuários e Agrominerais da Amazônia*
PRODECER - *Programa de Cooperação Nipo-Brasileiro para o Desenvolvimento Agrícola dos Cerrados*
POLOCENTRO – *Programa de Desenvolvimento dos Cerrados*
PROMAT – *Programa Especial de Desenvolvimento de Mato Grosso*
Pronazem – *Programa Nacional de Armazenamento*
PROTERRA – *Programa de Redistribuição de Terras e Estímulo à Agroindústria do Norte e Nordeste*

RADAM – *Projeto Radar da Amazônia*
SNCR – Sistema Nacional de Crédito Rural
SPVEA – *Superintendência do Plano de Valorização Econômica da Amazônia*
SSR – Sum of Squared Residuals
SUDAM – *Superintendência de Desenvolvimento da Amazônia*
SUDECO – *Superintendência de Desenvolvimento do Centro-Oeste*
TFP – Total-Factor Productivity
VIF – Variance Inflation Factor
WAP – Working-Age People

List of equations

List of figures

List of frames

List of graphs

List of tables

SUMMARY

1. INTRODUCTION

This master's thesis analyzes the divergent paths of agricultural growth across municipalities in the state of Mato Grosso from the 1960s onward. It seeks to understand why some regions became economically dynamic in the second half of the 20th century while others stagnated. The comparative analysis examines why the dynamic regions successfully integrated into the capitalist economy through the development of inclusive institutions, in stark contrast to the stagnant ones, which retain legacies of the Portuguese colonial era characterized by extractive institutions.

1.1. Underlying and key issues

The underlying issue addressed in this thesis is to identify the mechanisms that drove agricultural economic growth within the Immediate Regions of Mato Grosso. The key issue is to demonstrate that institutions, when considered in public policies, can generate economic growth. These issues connect to the main goal of this thesis: to show that inclusive institutions promoted growth in Mato Grosso state. This analysis provides lessons that can be applied today, although not by the same means as in the past.

First, the geographical delineation of the analysis was set in Immediate Regions, as the aggregation of the cities made by IBGE. They are structured from close urban centers to satisfy people's immediate needs. Hence, the metropolitan network is the principal element. They are grouped in Intermediate Regions, which organize territory by a superior hierarchical pole from the fluxes of public and private affairs and the existence of urban functions of higher complexity (IBGE, 2017, p.20). There are 18 Immediate Regions[1] and 5 Intermediate Regions[2], as it is shown in the map provided by IBGE, in ANNEX A – IMMEDIATE REGIONS OF MATO GROSSO.

Therefore, the underlying issue shifts focus to demonstrate how regions like Sorriso, Primavera do Leste, and Água Boa could emerge as highly productive, when there was little or no human occupation within these areas. The proper proliferation of cities since the 1960s indicates that growth has emerged in those regions.

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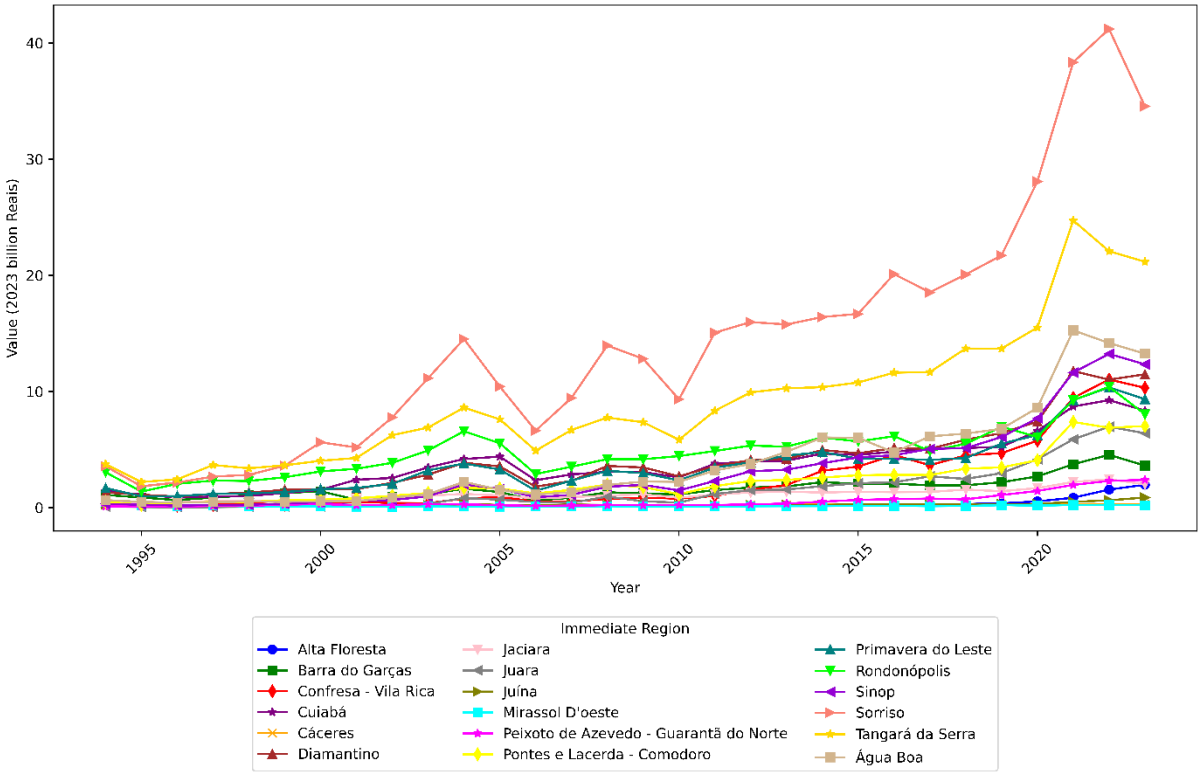
[1] Água Boa, Alta Floresta, Barra do Garças, Cáceres, Confresa-Vila Rica, Cuiabá, Diamantino, Jaciara, Juara, Juína, Mirassol d'Oeste, Peixoto de Azevedo-Guarantã do Norte, Pontes e Lacerda-Comodoro, Primavera do Leste, Rondonópolis, Sinop, Sorriso and Tangará da Serra.

[2] Barra do Garças, Cáceres, Cuiabá, Rondonópolis and Sinop.

The key issue revisits the fundamental aspects to provide a perspective on the future. This will illustrate that incorporating institutions into public policies designed for economic growth can generate the anticipated outcomes.

An initial analysis of Gross Domestic Product (GDP) data (IBGE, 2024a) reveals the varying economic trajectories within Mato Grosso. The data indicates a clear divide, with some regions on a more prosperous path than others. This economic divergence, driven by institutional differences, can be seen in Graph 1:

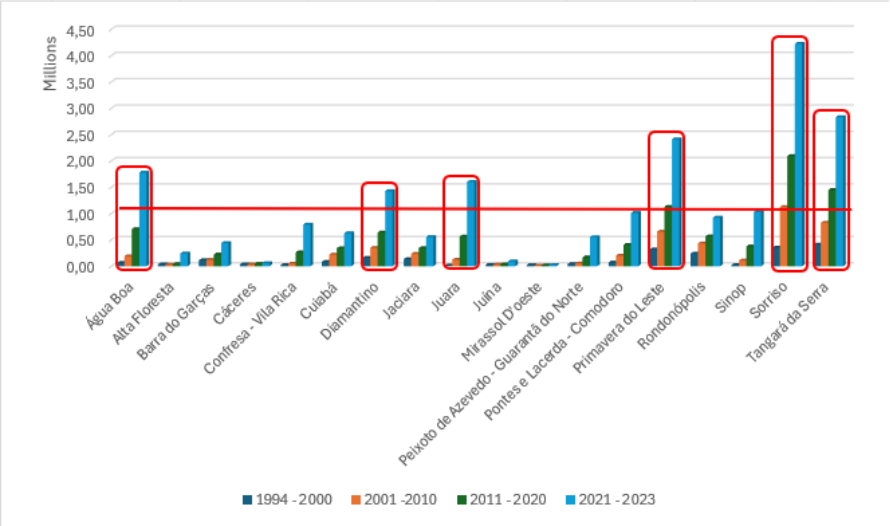
Graph 1 - GDP of Immediate Regions of Mato Grosso (2023 billion R$ basis)



Source: IBGE (2024a). **Elaborated by the author with Python language program.**

Alternatively, by grouping the Gross Value Added from Agriculture and Cattle by region, Graph 2 shows a clear trend. In the 2021-2023 period, the regions of Água Boa, Diamantino, Juara, Primavera do Leste, Sorriso, and Tangará da Serra all reached levels exceeding the previous decade's peak, which was held by Primavera do Leste.

Graph 2 - Average GVA from Agriculture and Cattle per Immediate Regions of Mato Grosso, 1994-2023 (in 2023 constant Billion R$)



Source: IBGE (2024a). **Elaborated by Arturo Alejandro Zavala Zavala in Excel.**

The underlying issue will focus on agricultural institutions, given the State of Mato Grosso's strong connection to the agricultural sector[3]. These institutions, defined as the humanly devised constraints that structure economic interaction (North, 1991, p. 97), are considered inclusive based on the framework of Acemoglu and Robinson (2012, p. 80). They posit that political centralization and pluralism are fundamental to inclusive institutions, noting that the absence of either fosters extractive ones. This institutional inclusiveness, in turn, facilitates Schumpeter's (2006, p. 83) process of creative destruction, a key driver of sustainable growth.

1.2. Former institutions of Portuguese America

The earliest Portuguese institutions in what is now Mato Grosso, which can be characterized as extractive, emerged with the discovery of gold in Cuiabá in 1721. This discovery spurred the growth of a significant geopolitical and economic center, boasting one of the largest populations in Portuguese America at the time (Faria et al., 2015, p. 323). However, this flourishing was notably brief, as the alluvial gold deposits began to decline as early as 1727.

In this period, the second characteristic of region development becomes feasible: occupying spaces to contain the Spanish frontier. For this reason, the Madrid Treaty was celebrated

[3] This is detached from all this thesis, and it is also shown in Vieira Júnior *et alI* (in Buianain *et al* (org.), 2014, pp. 1149-1151), who demonstrate that the other sectors are related to agro and cattle affairs, being by processing its products in industry, being by providing services like barter.

in 1750, which made Vila Bela da Santíssima Trindade the capital in 1752, (*ibidem*, 2015, p. 328). This was the culmination of a process of continuous breaks of Tordesillas's Treaty caused by new gold discoveries in Galera River, 1734; Santana's Fields, 1735; Alto Paraguai Mines (1747); and São Francisco Xavier's Fields (1751) as pointed out by Ramminger (2008, p. 19). The region's economic development was initially permitted by its river link to Amazon Bay. This connection, however, became unviable by 1796 due to several converging factors: the increasing decay of metal deposits, a shortage of enslaved labor, persistent difficulties in the food supply, and mounting debts to commercial capital from Portugal and Pará (Faria et al., 2015, p. 331).

Due to the cyclical nature of alluvial gold at the beginning of the XIX century, Grão-Pará and old monsoon routes were made unfeasible. In 1820, Cuiabá became the capital, a status it achieved because it was the most populous city and due to the political articulation of the latifundium elite and merchants. These groups derived their economic and political power from the remaining gold mining operations near the city (in Poconé and Nossa Senhora do Livramento), as well as from sugarcane plantations, cattle, and subsistence farming (Ramminger, 2008, pp. 19-20). South of the province, remembering that it includes what is now Mato Grosso do Sul state, was not occupied until 1830 by cattle farming, because it was constituted only by clean fields, low cerrado and Pantanal, being only an appendix for mining and a break to Spanish possible claims (Ramminger, 2008, pp.22 – 23). Cattle rising and ipecac were key activities that gave to Cáceres and Corumbá, due to being in the Paraguay River, the ability to be points of growth until the Paraguay War (1864-1870).

At the beginning of the XX century, activities in rubber, yerba mate, and ipecac permitted economic dynamism. However, navigation conditions did not allow the flourishing of activities, and the Vargas government took measures against Laranjeira Mendes & Companhia, affecting mate production (Faria *et al*, 2015, p. 339).

This condensed historical overview of two hundred years highlights gold mining activities in the second quarter of the 18th century. Until the onset of institutional changes in the 1960s, Mato Grosso experienced a period characterized by a relative absence of dynamic economic activity. Those that did exist occurred within an environment of limited state presence, difficulties in land access, and a lack of investment. As Ramminger (2008, p. 15) notes, until 1970, agriculture and cattle activities, primarily rural enterprises focused on production, held

little significant importance for the state's economy. This was due to the prevalence of subsistence farming, extensive cattle ranching practices, and extractive activities largely carried out by family labor for local markets.

For this reason, the remaining institutions of Portuguese America can be characterized by a reliance on primary goods in raw form, without statal presence. Furthermore, it is possible to point out that large groups of interest, as individuals or companies, have a large share of economic activities, individually bigger than the government; the labor market was marked by slavery, and there is a relative void of dynamic activities. Economic extractive institutions lagged in the 21st century in Mato Grosso regarding raw products, concentration of activities, a deficient labor market, and relative lack of dynamism.

1.3. Path to changes in Central Government policies during the military Regime: constitution of the Green Revolution in Brazil

First, a distinction must be made between two concepts of development. While Agricultural and Cattle activities are linked to the material basis of the economy, the concept of Rural Development, as Navarro (2001) suggests, considers the capacity to transform the environment. During the 20th century, Brazil adopted a Keynesian approach specifically towards this latter concept of Rural Development. This involved government regulation of economic cycles without challenging private property rights or market mechanisms (Castro and Pereira, 2020, p. 11).

Despite research institutions being already founded in the 19th century, the state intensified its policies on agricultural development in the 1930s, considering only Agricultural and Cattle development (*ibidem,* pp. 18-19), therefore, productivity. In Vargas's first term, from 1930 to 1945, the authors remember that institutions and mechanisms were put in place to foment agricultural diversification and establish rural credit lines through the Agricultural Credit Portfolio in 1937.

The actions did not end after the 1930s. However, in 1964, an intense modernization process took place, directed at Agricultural Development, as Silva (2001, p. 46) stated. A key feature of this process was the National System of Rural Credit (SNCR), created in 1965. Evolving from a previous portfolio, the SNCR directed substantial capital toward modern inputs. Taking advantage of backward linkages, it united agricultural politics with substituting imports. Also taking forward linkages, agro-industries emerged, consolidating the integration of the technical-agricultural-industry under close mediation of the public sector through SNCR, in the concept of Delgado (2001, pp. 164).

Another remark was the creation of the Agricultural and Cattle Research Brazilian Company (*Empresa Brasileira de Pesquisa Agropecuária*, Embrapa) in 1973. The company encompassed previous institutions and acted in a system with subnational organizations of research, universities, and other actors. Moreover, the company was structured through four bases: diffusion of modern technology, activity planning, articulation with the external environment, and multidisciplinary, contributing to consolidating Brazilian leadership of grains, fibers, and oilseeds (Fuck and Bonacelli, 2007, pp. 89-95).

In 1975, the Brazilian Company for Rural Extension (Empresa Brasileira de Assistência Técnica e Extensão Rural), known as Embrater, was founded with the aim of transferring technology to address the challenges faced by rural producers (Canuto and Quesada, 1984, p. 171). According to Wolfart (2023, pp. 24-25), the company also promoted Agricultural Development, with a particular focus on improving the productivity of small farmers. Nevertheless, Embrater was dissolved in 1991[4].

Those policies in Agricultural Development were also accompanied by others directed to specific regions. In Mato Grosso, there is especially SUDECO, Bureau of Development of Centro-Oeste, in 1967, whose purpose was to elaborate regional programs, according to Ribeiro (2013, p. 89), which took the form of the expansion of the agricultural frontier.

The National Integration Program (PIN) of 1970 and the Land Redistribution and Stimulation to the Agroindustry in the North and Northwest Program (Proterra) of 1971 were initiatives undertaken by this bureau to achieve its objectives. According to Joanoni Neto and Guimarães Neto (2019, p. 100), these programs aimed to address social issues related to land, particularly the unequal distribution of the population. Notably, PIN initially envisioned the construction of a significant highway system, most prominently the Transamazônica and the Cuiabá–Santarém highways (idem, pp. 103-107).

These programs were subsequently integrated into the National Development Plans of 1972-1974 and 1975-1979. Consequently, the agricultural frontier expanded significantly into the Centro-Oeste region, particularly in the 1980s, driven by productivity gains resulting from innovations, as noted by Beckmann and Santana (2017, p. 102). Furthermore, Hoffman's (1992) factorial analysis of Mato Grosso's microregions revealed a negative F1 score for all of them in both 1975 and 1980 (*ibidem*, pp. 276-280). This negative F1 is associated with the intensity of

[4] BRASIL. **Decreto de 5 de setembro de 1991**. Disponible at: https://www.planalto.gov.br/ccivil_03/DNN/Anterior%20a%202000/Dnn7-05-09-91.htm#art3. Acessed: 18 fev. 2025.

land exploitation, indicating its extensive use. Meanwhile, F2, associated with the capital/labor ratio, showed a significant increase, becoming positive in 1980 for all microregions except Alto Guaporé-Jauru and Baixada Cuiabana (ibidem, pp. 284-285). Similarly, a factorial analysis of the 2006 Agricultural and Cattle Census by Medeiros et al. (2012) positioned Mato Grosso as: first in factor 2, linked to the adoption of new technologies in the labor force; near the bottom (upper last) in factor 1, related to the use of technologies on exploited land; and 25th in factor 3, associated with logistics (*ibidem*, 2012, pp. 49-51).

As a conclusion of the modernization process, Beckmann and Santana (2017, pp. 12-) developed the Municipalities Agricultural Modernization Index (IMAM). Their findings indicate that 34.07% of the municipalities scored above the median, with a significant concentration of these in the agricultural frontier of the state's northern region. Despite this progress, none of the municipalities reached an elevated level of modernization, defined as an IMAM score above 0.7, due to the presence of at least one limiting factor. This highlights another dimension of economic growth disparity among localities within Mato Grosso, stemming from variations in the adoption of technical advancements.

This provides a concise overview of the Green Revolution in Brazil, during which a new technological pattern emerged throughout the 1970s and 1980s. This entailed integrating new forms of productive rationality (Navarro, 2001, p. 84) to modernize agriculture in the Amazon region and connect it with agro-industrial development in the South and Southwest (Joanoni Neto and Guimarães Neto, 2009, p. 103). Despite these advancements, fiscal consolidation measures were implemented in the 1980s, and it wasn't until the 1990s that other movements gained traction, creating space for Rural Development, as Castro and Pereira (2020, pp. 22-23) point out. In the 21st century, the rural sector experienced increasing income driven by external factors, such as commodity prices, and internal ones, including increased credit availability and income transfer programs. These internal factors are largely an outcome of the central government's role in family agriculture policies, agrarian reform, and food security initiatives (ibidem, pp. 23-24).

1.4. Embracing the science of contract: path to Transactional Costs and New Institutional Economy

During the period described in the previous section, a new set of institutional changes emerged, potentially responsible for the significant agricultural dynamism observed in Mato Grosso. The development of the Land Market, the Transports, and the Rural Enterprise could

foster growth in the regions where they were established. This interplay of institutions and agricultural dynamism will be the central theme of this research.

A preliminary analysis of such a path can be read by Cordova (2022), who has shown that the institutional changes implemented in the 1960s were primarily directed towards the North mesoregion, which corresponds to the Sinop Intermediate Region here, due to preoccupations other than economic ones. This initial focus was driven by concerns beyond purely economic factors. However, this research will utilize more disaggregated data, as the former mesorregional groupings hid significant internal variations. Therefore, the new regional division provided by IBGE will be employed for a more nuanced analysis.

Despite Neoclassical models used further in Neoclassical growth: exogenous or endogenous growth, there is an assumed break with them because the science of choice is rejected in favor of the science of contract. According to Williamson (2002, pp. 172-176), the last one focus on the rules of the game with bounded rationality, being alert to all significant behaviors; alternative modes of governance differing in discrete structural ways; much of the action residing in the microanalytic; and the importance of cooperative adaptation.

As Melo (2013, p. 3) argues, this contrasts with neoclassical theory, which assumes perfect rationality, where agents possess complete knowledge of all opportunities to maximize their profits. Consequently, neoclassical models tend to overlook the fundamental differences arising from variations in efficient resource allocation and the uneven distribution of knowledge about opportunities (*idem*, p. 13).

As Coase (pp. 391-394) argued, the assumptions of neoclassical economics are often implausible due to the costs associated with utilizing the pricing mechanism. These costs arise from marketing expenses and the inherent uncertainty surrounding future prices. As he concluded in his 1960 work (*idem*, p. 6), these transactional costs impede the achievement of efficient resource allocations. Expanding on this, Williamson (2002, p. 175) identified three key dimensions of transactional costs: asset specificity in its various forms, the frequency of transactions, and the disturbances that can affect these transactions.

Nevertheless, there is another crucial point where this analysis diverges from neoclassical theory: the conceptualization of uncertainty. Here, uncertainty will be defined as imperfect knowledge encompassing production risks stemming from the unpredictable nature of influencing variables such as weather patterns and pests, as Hardaker et al. (2015, pp. 4-5) explain. Additionally, this definition will incorporate specific uncertainties prevalent in agricultural frontier regions, such as the extent of state presence, access to credit, and other related factors.

Hence, the Theory of Transactional Costs arises when an asset passes from one step to another, or passes through a technological interface, according to Fiani (pp. 172-174). Bounded rationality becomes relevant in a context of complexities and uncertainty, in which free riders see opportunities through the specification of assets because the rivalry between numerous agents diminishes opportunistic behavior. Notwithstanding, there is the possibility that a transaction of large numbers converts itself in time to a small number.

Therefore, the higher the specification of an asset, the higher its transactional costs will be, in which governance will be demanded to avoid them (Williamson, 2002, pp. 180-181). The governance structure depends on the incentive intensity, administrative control, and contract law regime to deal with the specifications of assets and uncertainty (*ibidem*, p. 180). In a framework made by Fiani (2013, p. 177), there are three structures: by market, especially for recurrent transactions; trilateral, specification of a third-party to evaluate or to solve; and specifically for a transaction, without patterns, risks increase, and by instance, its solutions. Such structures encompass not only formal rules, as in contracts, but also those informal ones that condition the relationship between agents in an activity by determining incentives and resource allocation, as Buianain and Silveira wrote (2000, p. 168).

This framework of the science of contract, with bounded rationality, different structures of governance, uncertainty, and complex or incomplete contracts, embarks upon the Theory of Transactional Costs. It provides a better understanding of organizations or trade mechanisms. This leads to the New Institutional Economy, in which the rules of engagement evolve into institutions.

1.5. Reasons for research institutions in Mato Grosso

As highlighted by the underlying and key issues, the central justification for this thesis is to analyze why agricultural economic growth has concentrated in certain regions of Mato Grosso while others have experienced stagnation. This understanding can inform the development of new approaches to public policies aimed at achieving higher levels of economic growth and improving the living conditions of all our people.

Therefore, this research will study the spatial dispersion of this growth throughout Mato Grosso. The central hypothesis is that institutional changes initiated during the Military Regime (1964-1985) fostered the creation of more inclusive economic institutions in dynamic regions, in contrast to the persistence of extractive institutions, with roots in Portuguese America, in

stagnant regions. To assess this hypothesis, which is the main goal of this thesis, it is necessary to: first, identify the key institutional changes that have occurred since the Military Regime (1964-1985) through a comprehensive literature review; second, analyze their contribution to reducing costs and promoting growth, determining whether they have been inclusive or extractive, using the framework of the New Institutional Economy; and third, extend the analysis into the 21st century to understand the long-term consequences of the development path taken.

For this analysis, there are three sets of intermediate goals. First, an econometric approach will be used to identify the factors driving agricultural growth, with the results highlighting the regions experiencing the most dynamic expansion. At such point, a secondary hypothesis will be tested that Populational growth leads to economic growth, because it accompanies institutional changes.

The second goal is to examine changes in the working-age population (WAP) from the mid-20th century onward. The hypothesis here is that the changes in WAP are more considerable in Immediate Regions of the institutional changes. These findings will then allow to extend the analysis of growth into the 21st century, focusing on Gross Domestic Product (GDP) inside the cities, what connects to the main hypothesis.

The findings on what contributed to divergent economic growth paths can lead to new approaches to developing stagnant regions. It is essential to understand why these regions did not experience similar growth, as these insights can guide public policy design. By addressing these gaps, public funding can be allocated more effectively, and income generation can reach higher levels.

1.6. Standard of proceedings in the research

Having established the central issues and the main goal of this thesis, defined the research period, and situated this work within the field of Economic Science, the following proceedings will be employed to achieve the primary objective. First, the THEORETICAL FRAMEWORK chapter will establish how the New Institutional Economy relates to economic growth through the quality of institutions to achieve exogenous growth, thus providing the analytical framework for examining production. Following this, the literature review will describe the INSTITUTIONAL CHANGES IN MATO GROSSO, detailing their formation and characterizing two major institutional developments: the Land Market and Transport. These two will

be synthetized in a third, the Rural Enterprise. Furthermore, the literature review will also address the constraints encountered which have influenced the quality of these institutions.

Following the establishment of both the economic theory and the historical data, METHODOLOGY chapter will detail the econometric and cliometric approaches used to derive a production function aimed at achieving the first intermediary goal. It will also describe the methods for analyzing demographic data to address the second goal, and the analytical techniques for the third. After this methodological description, the OUTCOMES AND DISCUSSIONS for each of these goals will be presented, based on the explored data.

Finally, the FINAL CONSIDERATIONS chapter will synthesize the findings regarding the institutional changes that have driven growth, addressing the underlying issue of this research. By demonstrating how institutions have promoted growth, the key issue, this section will ultimately address the thesis' main goal. Furthermore, it will offer insights into potential actions that can be taken in the present day based on these findings.

2. THEORETICAL FRAMEWORK

2.1. New Institutional Economy: growth under extractive institutions

New Institutional Economics composes the framework for the analysis, as seen in the central hypothesis. First, Douglas North (2018, pp. 13-17) defines institutions as the mechanisms for executing the rules of economic comportment to decrease uncertainty by reducing transactional and production costs. By informal constraints or formal rules, they structure interaction among humankind and determine the costs of production and transactions (North, 1991, p. 97). For that reason, they provide a structure of governance that promotes incentives, connecting Williamson (2002) to North (1991 and 2008). Nevertheless, they can change what occurs because the actors perceive that political and economic organizations can achieve better results by altering the array (NORTH, 2018, pp. 20-21).

In an alternative definition that follows the same path, Ruttan and Hayami (1984, pp. 3 – 4) propose institutions as the rules that facilitate coordination among people to form expectations from each part of the exchanges. In the economic field, institutions play a crucial role while those expectations function as the rights to income from activities, which reduces the scope of uncertainty.

The definition of property rights and the existence of legal power to refrain from its violations are the link between production factors and economic growth. This is caused by good economic institutions, as the definition made by Acemoglu, Johnson, and Robinson (2004, p.9) in which they provide security and equal access to economic resources and promote prosperity, as in the case of the Netherlands and England. Even now, in the evolution of the concept of inclusive institutions, as Acemoglu and Robinson (2012, pp. 72-73) have noted, the power to enforce property rights within the limits of the law is corollary to granting them.

Economic growth, read as an increase in productivity, occurs by reducing transactional costs, as North pointed out (1989, pp. 1323-1324). Since the definition of how these costs decrease by reducing the uncertainty of property rights, Institutional Theory can constitute a better comprehension of the differentiation economic process between regions in Mato Grosso state, in the sense of Acemoglu and Robinson (2012).

Such institutional studies can be traced to earlier theories popular in Brazil regarding economic development, particularly the differentiation between exploratory and settlement colonization, as articulated by Caio Prado Júnior (2011). He differentiated the former as being intensive in land and reliant on enslaved labor, while the latter were intensive in labor due to

the influx of European migrants, with the former producing high-value goods and conditioning a particular sense of colonization[5]. Monasterio and Ehrl (2015) provided a link to these theory, starting from Arnold Herrmann Ludwing Heeren (1760-1842) in its *Handbuch der Geschichte des Europäischen Staatensystems und seiner Kolonien*[6] in which he divides colonization into settlement, exploration, mining, and mercantile forms (*idem*, p. 11), reaching Acemoglu, Johnson and Robinson[7], but passing through Caio Prado Júnior and its provided theory master, Pierre Paul Leroy-Beaulieu (1843-1916).

Notwithstanding, those authors stated that Caio Prado Júnior's perspective is driven by climate, political, and populational forces from the metropolis, while Acemoglu, Johnson, and Robinson's analysis derives from climate and European mortality. These factors led to inequality for the former and to different institutions for the latter, despite a shared element of elite exploitation (*idem*, pp. 25-26).

Despite such a notable link, the general approach of Acemoglu and Robinson (2013) challenges geographical theories of economic development, focusing instead on consequences such as the structure of land ownership and incentives for farmers (*idem*, p. 51), as well as culture, through comparisons like English/non-English and European/non-European, but their central argument remains the primacy of institutions (*idem*, p. 63). They also dismiss ignorance as an explanation for either the origins of prosperity or the geographical context (*idem*, p. 67). For these reasons, it is possible to agree with Monasterio and Ehrl (2015) regarding the role of climate and mortality as drivers of exploitation[8], but it should be highlighted that climate conditions economic development in the works of Caio Prado Júnior, whereas institutions drive development according to Acemoglu and Robinson (2013).

As they stated (*idem*, 2012, p. 25), capitalistic institutions were motivated by private property, while appropriation of labor surplus occurred in slavery institutions. The first, which occurred in North America, promoted democracy, and especially, for the reason of this thesis,

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[5] As sawn in the chapter: *sentido da colonização.*

[6] HEEREN, A. H. L. **Handbuch der geschichte des europäischen staatensystems und seiner colonien**: von der entdeckung beyder indien bis zur errichtung des französichen kaiserthrons. Gottingen: M. Lechner, 1817.

[7]Citing ACEMOGLU, D.; JOHNSON, S.; ROBINSON, J. The colonial origins of comparative development: an empirical investigation. **The American Economic Review**, v. 91, n. 5, p. 1369-1401, 2001. Disponible at: http://goo.gl/IXgLcw and ACEMOGLU, D.; JOHNSON, S.; ROBINSON, J. Reversal of fortune: geography and institutions in the making of the modern world income distribution. **The Quarterly Journal of Economics**, v. 117, n. 4, p. 1231-1294, Jan. 2002. Disponible at: http://goo.gl/HLqzDl.

[8] Which constituted a critical juncture, according to Acemoglu and Robinson (2012, p. 106), in which "… a major event or confluence of factors disrupts the existing balance of political or economic power in a nation."

institutions more reliable, which promote property rights, in contrast to others, occurred in Portuguese and Spanish America, which secured the appropriation of outcomes (*ibidem*, 2012, p.31). For these historical paths, the difference in growth is due to ownership of the land and to incentives of farmers, marked in the institutions, as they stated (*ibidem*, 2012, p.51) in America. Expanding this description, they conclude that different institutions are the cause of economic growth, which, in the first case, promoted growth, being inclusive, and in another, did not (*ibidem*, 2012, p. 73), being extractive. Institutions in politics are inclusive, in the sense of the authors (*ibidem*, 2012, p. 80), when there is sufficient centralization and pluralism. When only one is present, they function as extractive ones. Notwithstanding, economic growth could be present even when a situation like this occurs.

2.1.1. Key determinants of institutional quality

Torres (2015) has already conducted research that follows a similar path of this thesis, in which she prospects the role of institutions in growth inside the poor countries, (*idem*, pp. 30-32). The relevance of institutions to growth is derived from the quality of them, as the New Institutional Economics highlight (*idem*, p.42), in which they are included through three major fields.

Economic theories highlight liberty or secularization. Especially for the case of this thesis, the reinforce of property rights and the grant of them, as in North (1991 and 2018) promoting incentives in the structure of governance, as in Williamson (2002), which were described more detailed in the previous section.

Cultural theories highlight the ideologies of a society that can foster good governance. While Torres (2015, pp. 45-48) discusses classical studies, contemporary research also explores the link between culture and growth, as in the randomized study by Bryan et al. (2021), whose authors found a noticeable increase in income after the adoption of Protestantism in a community. However, while social norms stemming from religion or culture are relevant to economic growth, religion or culture alone cannot fully explain it. Furthermore, the emphasis on simplistic binary comparisons, such as European versus non-European or English versus non-English, does not explain how inequalities arose, according to Acemoglu and Robinson (2012, pp. 57-63), which is due to different institutions and institutional history.

Sociopolitical theories rely on the appropriation of incomes, to maintain the elites. Those theories, described by Torres (2015, pp. 49-50) have a great range, however it can be traced to

the institutional changes as taken by Acemoglu and Robinson (2012), which book will distinguish between extractive, corresponding to the maintained elites, and inclusive institutions, in which the creative destruction allows social openness.

However, there are also other relational theories of economic growth, such as commercial openness[9], rent inequality[10], geographical conditions[11], education[12], the fiscal system[13], and historical factors, as described by Torres (2015, pp. 50-57). It is within the framework of extractive and inclusive institutions, as proposed by Torres (2015, pp. 52-54) offers a critique. She argues that this framework is argued to suffer from excessive generalization, an absence of sufficient historical data, and an excessive confidence in a deterministic trajectory that leads to an objectionable interpretation.

Despite it being more than the need of its research, Torres (2015, p. 62) highlights that there is a consensus that institutional quality is related to income level, legal origin, institutional

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[9] As can be consulted in: FRANKEL, J. A.; ROMER, D. Does trade cause growth? **The American Economic Review**, v. 89, n. 3, p. 379-399, 1999. Disponible at: https://www.aeaweb.org/articles?id=10.1257/aer.89.3.379. Accessed on: June 28, 2025.; or in ISLAM, R.; MONTENEGRO, C. E. What determines the quality of institutions? **Policy Research Working Paper Series 2764**, The World Bank, 2002. Disponible at: https://openknowledge.worldbank.org/entities/publication/d2b35aae-71b2-5371-8df2-353c77f050d8. Accessed on: June 28, 2025.

[10] As can be consulted in: in ISLAM, R.; MONTENEGRO, C. E. What determines the quality of institutions? **Policy Research Working Paper Series 2764**, The World Bank, 2002. Disponible at: https://openknowledge.worldbank.org/entities/publication/d2b35aae-71b2-5371-8df2-353c77f050d8. Accessed on: June 28, 2025; or in WEI, S. Natural openness and good government. **National Bureau of Economic Research Working Paper Series**, n. 7765, 2000. Disponible at: https://www.nber.org/system/files/working_papers/w7765/w7765.pdf. Accessed on: June 28, 2025.

[11] As can be consulted in: SACHS, J. D.; WARNER, A. M. Natural resource abundance and economic growth. **Development Discussion Paper**, n. 517a, Harvard Institute for International Development, 1995. Disponible at: https://www.nber.org/system/files/working_papers/w5398/w5398.pdf. Accessed on: June 28, 2025; EASTERLY, W.; LEVINE, R. Tropics, germs, and crops: How endowments influence economic development. **Journal of Monetary Economics**, v. 50, n. 1, p. 3-39, 2003. Disponible at: https://www.sciencedirect.com/science/article/abs/pii/S0304393202002003. Accessed on: June 28, 2025; and ENGERMAN, S. L.; SOKOLOFF, K. L. Colonialism, inequality, and long-run paths of development. **National Bureau of Economic Research Working Paper Series**, n. 11057, 2005. Disponible at: https://www.nber.org/system/files/working_papers/w11057/w11057.pdf. Accessed on: June 28, 2025.

[12] As can be consulted in: TABELLINI, G. Culture and institutions: Economic development in the regions of Europe. **Journal of the European Economic Association**, v. 8, n. 4, p. 677-716, 2010. Disponible at: https://academic.oup.com/jeea/article/8/4/677/2295864. Accessed on: June 28, 2025, 2025; EICHER, T.; GARCÍA-PEÑALOSA, C.; YPERSELE, T. Education, corruption, and the distribution of income**. Journal of Economic Growth**, 2009. Disponible at: https://link.springer.com/article/10.1007/s10887-009-9043-0. Accessed on: June 28, 2025; GLAESER, E. L.; SAKS, R. E. Corruption in america. **Journal of Public Economics**, v. 90, n. 6-7, p. 1053-1072, 2006. Accessed on: June 28, 2025; and GLAESER, E. L.; PONZETTO, G. A. M.; SHLEIFER, A. Why does democracy need education? **Journal of Economic Growth**, v. 12, n. 2, p. 77-99, 2007. Disponible at: https://link.springer.com/article/10.1007/s10887-007-9015-1. Accessed on: June 28, 2025.

[13] As can be consulted in: ALONSO, J. A.; GARCIMARTÍN, C. E. Criterios y factores de calidad institucional: Un estudio empírico. **Revista De Economía Aplicada**, v. 19, n. 55, p. 5-32, 2011. Disponible at: http://revecap.com/revista/numeros/55/pdf/alonso_garcimartin.pdf. Accessed on: June 28, 2025.

heritage, and culture of societies. These are the preconditions to the institutions inside of a society that lead to a path of growth; for this reason, they trace trajectories of possible paths of increase.

2.2. Economic growth originated from institutional changes

The decrease of uncertainty, by establishing property rights and diminishing opportunist behavior, occurs when the Land Market is constituted after the Land Statue in 1964 and the highways were paved, when dynamized access to land decreases the financial cost of acquisition and allows owners to appropriate productivity by forming their expectations in the manner that Ruttan and Hayami (1984, pp. 3 – 4) proposed. Besides equity concerns, as pointed out by Cunha (2006) and Ribeiro (2013), and further opportunistic movements during fiscal consolidation, there are reductions in transactional costs with the Land Market instituted by the new law and made feasible by government actions, especially by the Central Government, and by Transports.

An orthodox proposition about how institutions allow economic growth can be found in Acemoglu et alli (2004, pp. 2-9). The authors demonstrate that good political institutions reinforce the property rights structure and market perfection by generating incentives to invest in physical or human capital or to improve technology, making institutions more economically efficient. For this reason, political institutions and resource distribution allow economic institutions to achieve better economic performance and increase resource distribution in the future. Another heterodoxical proposal may be found in Zysman (1994, pp. 279-280), who states that institutional structure conditions how markets operate and how policies are executed, so a particular array of growth can be established in the form of international insertion. In the concrete case of institutional changes in Mato Grosso, Acemoglu's et alli (2004) formulation is present due to the state action formulated from top to bottom, which aligns with the private sector to alter economic institutions.

2.2.1. Neoclassical growth: exogenous or endogenous growth

For instance, post-Keynesian models do not seem adjusted to the analysis because the banking sector and investments do not present themselves as quintessential to economic growth now analyzed, as land is. Thus, models like Kim and Lavoie (2016), which relate investment to growth rate and this to animal spirits, returns by capital stock, interest by loan, Tobin´s q, utility

capacity, and technical progress, do not relate themselves to economic growth in the institutional changes in the Mato Grosso state during the Military Government. However, there are significant components, such as animal spirits and utility capacity, taken as the expansion of the agricultural frontier.

Solow's neoclassical model (1956) may be the one that links institutional changes to productivity gains, therefore uniting institutions and growth in Mato Grosso. According to the model, different growth rates depend on different saving rates, which are comprehended as more significant rates of capital by workers. However, the essential productivity factors are not machines nor equipment but land; therefore, responsiveness to increased land per worker allows us to assess this hypothesis. Nonetheless, they operate by the newer institutions promoting another, rural enterprise, which can all be the reason for different economic growth by influencing the economy and incentives of people, in the sense of Acemoglu and Robinson (2012, p. 73).

Such models of exogenous growth contrasted to endogenous in Romer (1986), in which knowledge is an investment choice of the firms, that provides long-term economic growth which spreads thorough other firms. The knowledge provides increasing returns contrasted to decreasing returns in goods, which uses labor and capital. Also, it contrasts with Lucas (1988), in which differences in technology means differences in knowledge, and savins rate define capital growth and human capital growth.

Notwithstanding, technological progress assumes a role in growth differences between regions due to Total-Factor Productivity (TFP) so as human capital. Thinking like Romer (1986), which relates productivity gains to knowledge by the investment function of the firm, technological progress could be represented in this model indirectly by TFP. However, in the sense of Acemoglu and Johnson (2023, p. 241), the progress is explicit, despite being intermediate. TFP, to the authors, determines product growth caused by technological innovations and efficiency increases, which is a more precise measure of technological progress. As in Lucas (1988), the movement of human capital can explain the increase in production, despite it is encompassed by an increase in labor.

2.2.2. Economic growth originated from labor development

As stated, Lucas (1988) relates growth to human capital growth. This is not the specifical case appearing here, but the growth of labor. Although the relationship between population

growth and economic growth was previously considered negative in economic literature, from a Malthusian perspective, a positive correlation can be achieved.

As Headey and Hodge (2009, p. 221) stated, in the 1960s and 1970s there were no signs in literature to a robust correlation with populational and economic growth, which has shifted in the 1980s, and again in the 1990s by a neutral revision. They also highlight that models like the Solow model (Solow, 1957) have adverse short-run effects on growth (p. 223), despite Kuznets' divergence, due to their implications for resource dilution and diversion.

Through its meta-regression analysis, they achieve a framework that relates demographic indicators to increasing or decreasing effects on growth, which is presented in Figure 1:

Figure 1- Summarizing the effects of methodological choices on the significant levels of demographic effects on economic growth

Demographic indicator	Factors that increase estimated effects	Factors that lower estimated effects
Total population (average effect is negative but close to zero)	Control set includes health indicator* Control set includes inequality* Control set includes investment*	Dependent variable is GDP per worker** Estimator is weighted least squares (WLS)** Data is 10-year panel structure** Time span mostly covers post-1980 period*** Control set includes coastal population density***
Adult population (average effect is positive)	Sample is developing countries rather than developed*** Sample is land-poor or population-dense** Time span covers 12–25 years*** Control set includes South Asia dummy*** Control set includes governance quality* Control set includes public education expenditure** Control set includes savings*	Time span mostly covers post-1980 period*** Control set includes East Asia dummy*** Control set includes health indicator*** Control set includes coastal population density* Control set includes education indicator*
Young population (average effect is negative)		Dependent variable is GDP per worker** Time span covers 12–25 years* Time span mostly covers post-1980 period** Control set includes public education expenditure**

NOTES: Table summarizes the results of three separate regressions—corresponding to the three demographic indicators listed above—of Model 2. (*), (**), and (***) indicate that the methodological dummy variable in question yielded a slope coefficient that was significant at the 10%, 5%, and 1% levels, respectively. The full results are listed in the tables presented in Appendix B.

Source: Headey and Hodge (2009, p. 233).

To achieve a positive effect, it is needed to see the adult population increase, especially in developing areas with intensity on labor resources, especially for a period of a quarter of century. In factors that apply to Mato Grosso, savings, governance, and public education lead to higher estimations so beyond 1980s, health and education indicators lead to lesser.

For these reasons, if WAP and change in young dependence ratio is achieved, economic growth can be also achieved, by increasing in savings, as Rios-Neto (2009, p. 48) stated after commenting the revision made by Headey and Hodge. This is due to the demographic transition

bringing an optimistic economic outlook; therefore, the demographic dividend implies an increase in the WAP relative to the general population. Rios-Neto (2012, pp. 27-29) highlights this when commenting on the results presented in the book *Population Matters*[14].

2.2.3. Newer institution: Rural Enterprise as the synthetic institution of the previous

The most intriguing aspect of this analysis lies in its connection between the institutions of the Land Market and Transportation infrastructure, and the theoretical framework proposed by Acemoglu and Robinson (2012). As they posit, disparities in economic growth are fundamentally linked to the distribution of land ownership and the incentives faced by economic actors, factors that are, in turn, shaped and maintained by the prevailing institutional environment (Acemoglu & Robinson, 2012, p. 51). Within the context of Mato Grosso, the establishment of a functioning Land Market, coupled with the reduction of geographical isolation facilitated by Transportation networks and the consequent decrease in transactional costs, suggests a mechanism through which regions experiencing such institutional improvements could potentially erode pre-existing institutional systems. This could pave the way for enhanced economic growth, even without a fundamental shift away from the state's established specialization in agriculture and cattle activities.

Consequently, the induction of growth in Mato Grosso was channeled into a newer institutional synthesis termed Rural Enterprise by Moreno (2007, pp. 286-288). While other regions might have been characterized by informal rules of conduct, Rural Enterprises fostered more formalized, capitalistic modes of coordination, potentially leading to greater economic dynamism and integration within the state's agricultural sector.

As pointed out before, the incentive of private property is the basis for capitalistic institutions (*ibidem*, 2012, p. 25). Such property is guaranteed by the institution of Land Market in Mato Grosso and became feasible by connections that romped the isolation with the Transports, so as the presence of the state. Being the confluence of these institutions, the Rural Enterprise, with sufficient shreds of evidence to be centralized, as stated at the beginning of this chapter, and of being more inclusive than the reminiscences of Portuguese America.

As centralized, even if it would be characterized as extractive, growth could be placed as the elites allocated resources in high-productivity activities, such as commodity exportation.

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[14] BIRDSALL, N.; KELLEY, A.; SINDING, S. (Eds.). **Population matters**. New York: Oxford University Press, 2001.

Nonetheless, the case is like the *commendas* of Venice, when the elites allowed the creation of new institutions that facilitated creative destruction (*ibidem*, 2012, pp. 152 – 157). In Mato Grosso, lands were sold to companies that did colonization projects, which brought a new class of landowners and incentives to be productive farmers.

It is possible to interpret the destruction within the agricultural sector of Mato Grosso through the lens of Rogers' (1971, p. 37) innovation-decision process, which he categorizes as optional (made by individuals), collective (by consensus), or authority (by a relative few individuals). The inherent pressures for increased productivity within the framework of Rural Enterprise, which, while an institution, shares similarities with Rogers' (1971, p. 248) concept of an organization despite not necessarily requiring stability, common goals, or a formal hierarchy, coupled with the prevalence of opportunistic behavior, significantly limits the scope for truly optional decision-making.

Instead, decisions regarding adoption and adaptation are often guided by the actions of a few influential farmers or actors. Consequently, this dynamic fosters a process of creative destruction within the institution of Rural Enterprise, leading to the marginalization of those who fail to keep pace with evolving productivity standards and technological advancements in Mato Grosso's agricultural landscape.

Inclusive institutions foster economic growth by enabling this destruction, even when the core technology is adopted rather than locally created, a point supported by Procópio et al. (2024), aligning with the exogenous technological change model of Solow (1957) and contrasting with the endogenous growth theories of Romer (1986) and Lucas (1988). This framework positions the evolutionary process of capitalism, wherein internal transformations drive out less productive older systems, as described by Schumpeter (2006, p. 83).

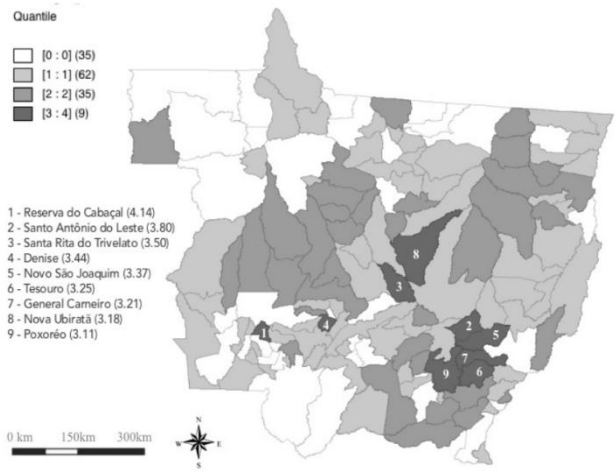
Several factors, as highlighted by Procópio et al. (2024, pp. 862-866), positively influence the adoption of technology by rural producers in regions like Mato Grosso. These include well-defined property rights, the specific characteristics of the rural environment, favorable pedological conditions (soil fertility and potential returns), and a supportive socio-economic context, including collective organizations and effective rural extension services.

Consequently, when inclusive institutions provide access to technology, its adoption becomes feasible based on these enabling conditions. This adoption, in turn, fuels creative destruction, potentially weakening established players and empowering new ones, a dynamic explored by Dasgupta (2018, p. 1), who further connects the technological shifts of the Green Revolution to instances of political change (Dasgupta, 2018, p. 3).

For this reason, it is possible to realize that, in these Immediate Regions of institutional changes, Rural Enterprise could install a highly productive sector with a higher degree of specialization than in other regions of old colonization, which is spreading through other sectors, as seen in Felippe *et alli* (2021, p. 20). In other Immediate Regions, it is possible to realize that the lack of centralization and pluralism from Portuguese America, which continued in the Republican years, continued despite variations, which maintained stagnation.

An agricultural specialization will be achieved after these changes, passing the last quarter of the 20th century. As Moi (2018, p. 62) wrote, almost the entire state, 106 cities of a total of 141, at that time, depended on agricultural and cattle activities in their GDP, as shown in Figure 2:

Figure 2 - Agricultural and cattle specialization of Cities in Mato Grosso (QLagro[15]), during 2005 - 2014, according to quartile



Source: Moi (2018, pp. 61).

A direct consequence of the Land Market innovation was the emergence of colonization projects. These projects, facilitated by Transports, led to the development of Rural Enterprises, which can be considered a direct and desirable outcome, in the sense described by Rogers (1971, pp. 31-32), due to their role in increasing productivity during the Green Revolution.

[15] The methodology is shown in Moi, 2018, p. 54.

Nevertheless, this process also encompassed an indirect and essentially unanticipated consequence[16]: the erosion of the remaining institutional structures inherited from Portuguese America in these regions, thereby creating space for creative destruction.

2.2.4. How the creative destruction from Rural Enterprise connects itself to Solow (1957) model

To connect Solow's (1957) foundational growth model with both earlier concepts like Schumpeter's creative destruction (2006, p. 83) and later theories such as Acemoglu and Robinson's (2013) inclusive institutions, it is helpful to turn to Jones and Romer (2010). Their work, by articulating newer stylized facts, provides a more comprehensive lens through which to understand the interplay of population growth, TFP and institutional dynamics. This integrated perspective is crucial for explaining how Solow's model contributes to our understanding of the growth spurt experienced in Mato Grosso during that period.

Starting from the second stylized fact presented by Jones and Romer (2010), it is possible to observe that both GDP per capita and population growth have significantly accelerated from virtually zero over the past centuries. This acceleration suggests that new ideas, which are inherently non-rival, lead to increasing returns. While one might expect diminishing returns to new ideas over time, their accelerating adoption and impact have counteracted this, as the authors explain (idem, 2010, pp. 233-236). For this reason, economic growth in Mato Grosso could depend on demographic growth. This demographic expansion, in turn, can capitalize on opportunities opened by institutional changes and the effective channeling of new ideas into the production process closely related to Schumpeter's concept of creative destruction (2006, p. 83).

The third stylized fact notes that growth rates vary with a country's distance from the technological frontier (Jones and Romer, 2010, pp. 236-237). This phenomenon is particularly relevant to Brazil's agricultural sector, which exhibits significant structural heterogeneity, as described by Fornazier and Vieira Filho (2013). This heterogeneity, in turn, reflects the interplay between the previously mentioned new inclusive institutions and the enduring legacy of older extractive institutions from Portuguese America.

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[16] This significant scale of change is evident in the substantial structural break identified by Chow tests in the production function of Mato Grosso, in Structural break in the production function of Mato Grosso, and is further underscored by the ascendance of China as Mato Grosso's leading commercial partner in the 21st century, particularly in the trade of commodities, as in Production counterpart: demand function.

Furthermore, the fourth stylized fact highlights that differences in how poorer countries utilize their inputs often lead to persistently lower levels of growth (*idem*, pp. 236-240). Finally, the fifth fact observes the global trend of rising capital per worker (*idem*, p. 240), underscoring a key aspect of economic development worldwide.

Building upon these stylized facts, institutional changes underscore their contemporary importance for the Solow (1957) model of growth. These changes foster a virtuous circle between population growth and the generation of ideas, a dynamic that fundamentally stems from the extent of the market, the first stylized fact. Globalization, by increasing the flow of goods, services, and information, further expands this market's reach. This expanded market provides powerful incentives to connect as many individuals as possible (*idem*, 2010, pp. 229-233). The reasoning is that because the benefits derived from effective institutions are non-rival, the potential gains from trade are only fully exhausted when nearly everyone is interconnected.

To integrate these stylized facts within the Solow (1957) growth model, a Cobb-Douglas production function will be employed. Within this framework, in Equation 1, capital accumulation will proceed according to a saving function, assuming that economic agents maximize their utility both presently and intertemporally, as in Equation 1.

Equation 1 – Form of production function

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$$

Legend:

- Y_t: Total production
- A_t: Labor productivity
- K_t: Capital
- L_t: labor
- α: coefficient

Equation 2 – Maximizing utility

$$\max U_j = U(C_{jt}) + U(S_{jt})$$
$$U(C_{jt}) = \int_0^{\infty} C_{jt} e^{-\beta_j t}\, dt$$

Legend:

- U_j: Utility for each planning
- C_{jt}: Consume for each planner now, t
- S_{jt}: Saving for each planner now,
- $U(C_{jt})$: Utility for intemporal consumption
- e: Euler's constant
- $-\beta_j t$: decrease rate of intertemporal change for consumption
- dt: derived in relation to time

As population grows, labor productivity (A) is expected to increase. This growth is not automatic; it depends on the employability conditions of the labor force. In essence, this productivity growth is influenced by the prevailing institutional conditions, which can be symbolized by the variable γ. This Growth condition, presented in Equation 3, connects to institutional factors aligns with Jones and Romer's (2010) discussion on the importance of institutions in facilitating growth and resource allocation, particularly as it relates to the extent of the market (their first stylized fact) and how efficiently inputs are utilized (related to their fourth stylized fact).

Equation 3 - Growth condition

$$\frac{dA_t}{dt} = \gamma L_0 e_t^n$$

$$\frac{dA_t}{dt} = \gamma \frac{dL_t}{dt}$$

Legend:

- $\frac{dA_t}{dt}$: derived Labor productivity in relation to time
- γ: institution
- L_0: initial population
- n: populational rate of increase
- L_t: labor

For these reasons, the growth rate of the economy depends on population growth, and stationarity is reached when n converges to zero. This implies that population growth reaches a plateau, following a logarithmic curve. Exogenous shocks to γ and on n explain changes in the behavior of these functions, because the γ shocked both by institutional changes or derived from the shocks on growth of population could leave to became closer from the technological frontier and increase growth, the third fact.

These shocks explain the critical junctures that appeared throughout history. The Black Death serves as a prime example of such a critical juncture, perfectly illustrating what the model

posits. Due to a drastic decrease in population across Europe, the labor market was fundamentally altered. In Western Europe, this demographic shock led to significantly improved conditions for the population, particularly in terms of wages. However, this was not the case in Eastern Europe. This divergence stemmed from the comparatively greater power of landlords in Eastern Europe than in the West. This imbalance allowed Eastern landlords to consolidate landholdings, diminish urban populations, and erode the freedoms of their laborers, as argued by Acemoglu and Robinson (2013, pp. 96-100). This differentiation of power dynamics is a crucial element within the model, specifically represented by the γ variable.

Shifting focus to Mato Grosso, its total agricultural output is derived from the combined agricultural production of its cities, as presented in Equation 4:

Equation 4 - Mato Grosso Production Function

$$Y_t = \sum_{1}^{j} A_{jt} K_{jt}^{\alpha} L_{jt}^{1-\alpha}$$

Legend:

- Y_t: Total production
- A_t: Labor productivity
- K_t: Capital
- L_t: labor
- α: coefficient
- *j* cities in Mato Grosso

For long run stability, the global model requires *n* to converge to zero across all *j* cities. Consequently, local growth within a city is driven by two main factors: populational growth, n_j, and the specific institutions present, γ_j. This implies that changes in TFP can result from exogenous shocks affecting institutional changes or from shifts in the rate of populational growth.

As S_{jt} representing both capital and land increases, then the expansion of the land frontier will lead to higher economic growth. This is because a higher β_j, contributes to greater utility, for instance, by allowing for more efficient resource allocation or production. Consequently, accelerated growth stems from accelerated populational growth, a finding consistent with the second stylized fact.

This behavior within the Solow (1957) model relates to the concept of inclusive institutions, as they correspond to different γ variables in the framework. Institutional changes, such as those introduced by the Military Regime, are a clear example of exogenous shocks. These shocks

created conditions that allowed for different rates of return on savings, which, in turn, reinforced the increase in production. This production growth was channeled through the creative destruction of previous economic and social institutions. Notwithstanding this, the two distinct sets of institutions—the newer, inclusive ones and the older ones, reminiscent of Portuguese America—also mark the structural heterogeneity of Brazilian agriculture, as described by Fornazier and Vieira Filho (2013).

3. INSTITUTIONAL CHANGES IN MATO GROSSO

3.1. Constitution of institutional changes in Mato Grosso: the presence of the state as an inclusive or extractive institution

From an economic perspective, the period between the decline of gold mining in the mid-18th century and the onset of significant institutional changes in Mato Grosso during the second half of the 20th century was marked by a relative lack of dynamic economic activity, characterized by the rise and fall of successive economic cycles. However, beginning in the 1960s, the development of the Land Market and Transportation infrastructure led to the emergence of a newer, more centralized institution: the Rural Enterprise. The establishment of the Land Market and Transportation networks represented direct institutional efforts to occupy the then-underutilized spaces within the territory, converging to fostering the more dynamic Rural Enterprise, a departure from previous economic institutions.

Centralization occurred through public and private alignment beginning in that decade, building on previous movements to occupy the land and increase production. In the 1950s, the infrastructural basis was consolidated to start a new moment in the economic, historical region: sale of vacant lands; road integration; reduction of informational costs due to improvements in communications; labor force regimented by the land acquisition, as pointed out in Faria et alli (2015, p. 345); and the central role of the state took place by reducing structural risks, with Agricultural Policy, as Heck (2019, pp. 44) wrote). This sale and the labor force are linked to the Land Market, while the integration and the reduction of informational costs are linked to Transports, and the State's role is linked to centralization.

According to Cunha (2006, p. 88-89), the Centro-Oeste region modified its productive structure with governmental actions in the 1960s in a national integration project made specially by programs and agencies, such as SUDECO in 1967, whose instruments began to be seen in the 1970s, as it is shown in Frame 1:

Frame 1 - Chronological appearance of organizations in the Brazilian Amazon and Centro-Oeste

INSTITUTION	YEAR	FUNCTION
BASA – Banco da Amazônia S.A. *	1942	Credit bank of Amazon
FBC - Fundação Brasil Central	1943	To explore and colonize zones between the Araguaia and Xingu rivers and Central Brazil.

SPVEA - Superintendência do Plano de Valorização Econômica da Amazônia	1953	To develop regional production and exchange relations.
CODECO - Comissão de Desenvolvimento do Centro-Oeste	1961	To prepare and give subsidies to the creation of the law of SUDECO.
SUDAM-– Superintendência de desenvolvimento da Amazônia Legal	1966	To elaborate the Amazon Economic Valorization Plan and coordinate or promote its execution, directly or by agreement with agencies or public entities, including mixed economic societies, or contracts with persons and private entities.
SUDECO – Superintendência de desenvolvimento do Centro Oeste	1967	Studies and diagnosis to regional programs. Replaced FBC and created Polocentro in 975.
PIN – Programa de Integração Nacional	1970	Construction of Amazon highways – Transamazonica, Cuiabá-Santarém.
PROTERRA - Programa de Redistribuição de Terras e de Estímulo à Agroindústria do Norte e Nordeste	1971	Expropriation of surplus properties, with compensation to posterior sell to small and medium farmers; credit concession to land acquisition; fixation of minimum prices to exportation products.
POLAMAZÔNIA Programa de Polos Agropecuários e Agrominerais da Amazônia	1974	To promote integrated agriculture, agroindustry, forestry, and minerals utilization in the determined program areas.
POLOCENTRO Programa de Desenvolvimento dos Cerrados	1975	To promote the occupation of selected areas with Cerrado predominance.
PROMAT – Programa Especial de Desenvolvimento de Mato Grosso	1977	Directed to the State Planning Secretary. Arise with state Division; it would guide budget and resources distribution between 1979 and 1988.

Source: Ribeiro (2013, p. 89). **Translated by the author.**

That agency was the instrument for the Military Regime to integrate the projects of occupation of the sparsely populated áreas of the Centro-Oeste region to the rest of the country, according to the competencies described in its law of creation (Brasil,1967). As Sá (2010, p. 133) pointed out, this shift reframed the concern over social land conflicts into an opportunity for the private objectives of larger economic groups. This proposition followed the orientation of the First National Plan of Development, the I PND (1972-1974), which has the purpose of national integration to create an internal market with self-sustainable and accelerated growth, with decentralization of economic activities. In the case of Centro-Oeste, actions would be directed to agriculture and mining to complement the great axis São Paulo – Rio – Belo Horizonte, as written by Rodrigues (2013, p.105).

As already stated, the National Integration Program (PIN) and Land Redistribution and Stimulation to the Agroindustry on Norte and Northwest Program (Proterra) were platforms of SUDECO, especially in the Amazon area. PIN turned its attention to the construction of *Transamazônica*, its installation and colonization programs, infrastructure, and the RADAM project. PROTERRA supported small producers by redistributing land and implementing agricultural projects with business arrays (RIBEIRO, 2013, pp. 105-107).

II PND (1975-1979) treated Amazon and Centro-Oeste as the most significant areas in the world without agricultural or industrial development. This corresponds to a challenge to overcome, because of their weak and flooded soils, according to Rodrigues (2013, pp. 111-112), which demands research investment. With 4 billion[17] of 1975 Cruzados[18] and resources of PIN and PROTERRA, fifteen development hubs were established, three in Mato Grosso. The north hub included the Juruena region, encompassing the cities of Diamantino, Sinop, Porto dos Gaúchos, and Alta Floresta. On this matter, Mato Grosso was one of the states that had more private colonization projects, as Sá wrote (2010, p. 109), who distance PAC Ranchão, Carlinda, Peixoto de Azevedo e Braço Sul, in Guarantã do Norte.

Government actions were essentially made by the Central Government due to the weakest state government position, from 1950 to 1964, as pointed out by Moreno (1999, p. 79), both due to the Mato Grosso regional government losing its capability to influence land affairs and to the productive activities were in the Southeast portion, divided in 1977 by Complementary Law nº 31 (BRASIL, 1977). The central government's most expressive participation was in the creation of the CODEMAT in 1968, which took place in the resumption of the colonization policy, in which the state had been torn apart since the early 1950s. For this reason, the centralization of the state, essential to more dynamism, from which derives growth, is owed to the Central Government's actions.

The Green Revolution in Brazil, as treated in Path to changes in Central Government policies during the military Regime: constitution of the Green Revolution in Brazil, passes through a new definition of rural credit, through SNCR, and by new agencies of technical development, especially Embrapa. Those actions represent the presence of the state, which is needed to maintain property rights. As proposed before, by Acemoglu and Robinson (2012, p. 73), the power to enforce property rights in the limits of the law is a corollary to grant them, however, creating conditions, by credit or by technical development, is also corollary, because they also grant possibilities of using the rights.

Notwithstanding, remembering the bounded rationality in the New Institutional Economy, the agents did not have all the information, this is the reason for having rural extension. As the fiscal consolidation during the 1980s and the extinction of Embrater, such presence of

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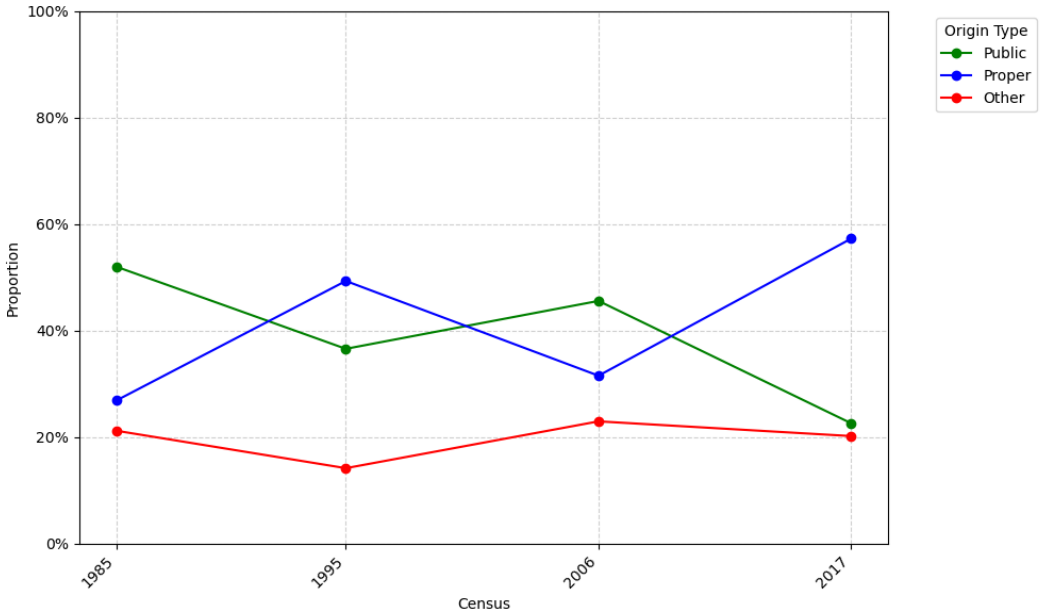
[17] This represents R$ 3.706.499.419,74 in 2025, January, reais as calculated with *Calculadora do cidadão*, with the inbdex IIPC-SP, the only available already in 1975, in https://www3.bcb.gov.br/CALCIDADAO/publico/corrigirPorIndice.do?method=corrigirPorIndice.

[18] Monetary pattern that was in force from 1942 to 1986 in Brazil.

the state became more difficult, as presented in Graph 3, using the variables of technical assistance in the Agricultural and Cattle Census[19]:

Graph 3 – Proportion of Technical Assistance Origin by Agriculture and Cattle Census



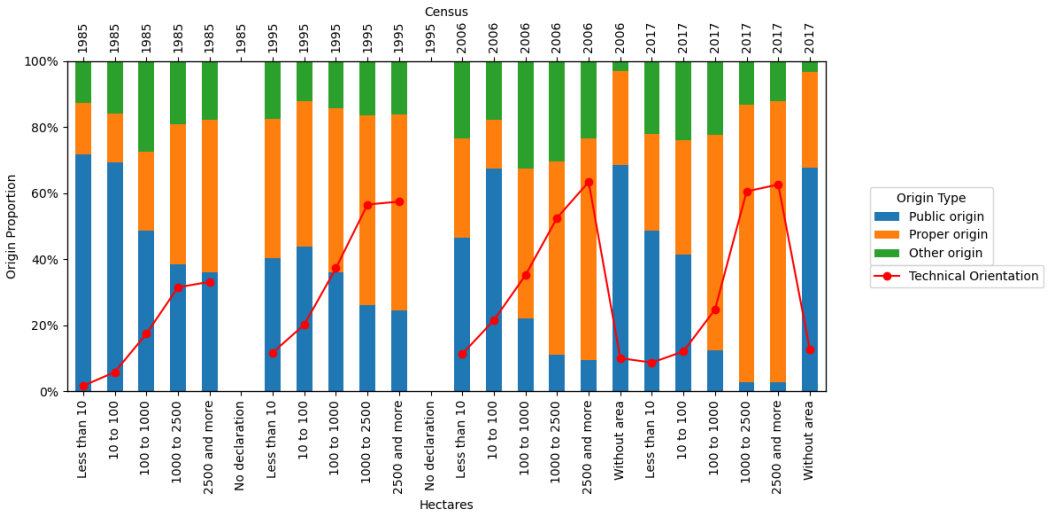
Source: (BRASIL. **IBGE**. 1975, 1979, 1983, 1991, 1997, 2025a and 2025b). **Elaborated by the author with Python language program.**

A clear trend of decline in public technical assistance can be observed from 1985, when it was the primary source, to 2017, when it became almost negligible, despite a temporary recovery in 2006. Even with improved fiscal performance in later years, public technical assistance did not return to its pre-1985 levels, even considering that fiscal consolidation efforts were already underway in 1985. Interestingly, public assistance shows a negative correlation with private technical assistance, which is an expected dynamic. Conversely, other sources of technical assistance exhibit a positive correlation with private assistance, contrary to initial expectations. These "other origins" can be attributed to the emergence of new institutions, both private, such as the Famato System, and governmental, such as INDEA (founded in 1979), as described by Moi (2018, pp. 35-41). This institutional development has likely played a role in the changing landscape of technical assistance in Mato Grosso.

[19] The 1970, 1975 and 1980 did not have a question about these variables, hence the first time in which it appears is in 1985 Census. From this to 1995-1996, there is no tabulated data in Sidra, therefore the data will be taken from the published versions. Furthermore, they were aggregated into classes: Less than 10; 10 to 100; 100 to 1000; 1000 to 10000; and 10000 and more. As 2006 Census have its aggregation made in 1000 to 2500 and 2500 and more, linear interpolation was made with the other Census to adapt the data.

That said, a decomposition of the data pertaining to farmers in rural areas clarifies additional patterns through Graph 4:

Graph 4 - Technical Assistance: Coverture and Origin Proportions per Land Area (Agriculture/Cattle Census)



Source: (BRASIL. **IBGE**. 1975, 1979, 1983, 1991, 1997, 2025a and 2025b). **Elaborated by the author with Python language program with the normalization of land area and origin type.**

The reduction in public assistance did not affect all producers equally because larger land areas received more assistance from other origins, including private aid, and relied less on public support. Furthermore, the share of private assistance increased with farm size in each Census, becoming nearly the sole source of aid for the two largest size classes by the 2017 Census.

This trend in technical assistance has implications for TFP, as technology is a key determinant of growth (Vieira Filho, 2024, p. 1). Although Vieira Filho's study focuses on the state of São Paulo and faces limitations with its time series data, it indicates that investment in research funding, research activities themselves, capacity building, and extension services positively influence TFP (*idem*, pp. 8-9). Notably, only capacity building showed a statistically significant difference from zero, and this variable also positively impacted the others. A second model in the same study (idem, pp. 10-11), excluding research funding, yielded similar conclusions, although the impact of rural extension was not significant. In a third model (idem, pp. 12-13), the first three factors were grouped under Science & Technology, and along with extension, all showed a positive influence on TFP, despite rural extension remaining statistically insignificant.

The pattern observed in São Paulo regarding the drivers of TFP may not directly apply to Mato Grosso. Firstly, the state government has historically faced challenges in adequately providing the variables that influence TFP, as Moreno (1999, p. 79) noted, due to the legacy of extractive institutions and the state's division in 1977, which impacted its fiscal position. Regarding human capital development, data from e-MEC (BRASIL. Ministério da Educação, 2025) indicates that the first Agronomy course in Mato Grosso appeared in the capital, Cuiabá, in 1974. However, the second only emerged in 1999 in Várzea Grande, adjacent to the capital. Regions that experienced significant institutional changes saw the establishment of such courses even later, with Rondonópolis and Tangará da Serra each having one two years after 1999. Furthermore, rural extension in Mato Grosso has largely depended on the Central Government. Acarmat, established in 1964, only completed its initial diagnosis for the state's agriculture and cattle sectors in 1972, and its projects remained tied to federal programs until 1976, as detailed by Moraes (2018, pp. 128-129). Subsequently, Acarmat was replaced by Emater, which continued to implement federal programs like Pronazem, Poloamazônia, and Polocentro (*idem*, pp. 130-131).

For these reasons, fiscal consolidation of Central Government affects directly TFP of Mato Grosso, what could significate not greater increases in TFP through at least the 1990s, but especially in 2006. It is expected that the TFP shows a medium increase in the data provided for 1995 Census, and a greater one in 2006. Consequently, it also increases the problems for the people already in the areas during the 1970s and 1980s, which can suffer from opportunistic behavior.

This represents a form of development akin to Argentinization way of development, according to the terminology of Buianain *et al* (in Buianain *et al* (org.), 2014, pp. 1179-1180), where Brazilian agrarian development is characterized by the dominance of large-scale agriculture achieved through demographic depletion alongside high productive and technological efficiency. Concerns regarding demographic transition may or may not lead to a similar displacement of rural populations as seen in Argentina, which lends consistency to the observations regarding the WAP in this context. However, it is crucial to emphasize that the limited presence of the state, specifically the absence of effective trilateral governance often results in market-driven solutions.

Therefore, there is a need to return to the Science of Contract, as opportunistic actions took place through these decays of the technical presence of the state. These actions became feasible for other agents with a higher degree of information because the time during which the

agricultural frontier was being expanded was the time of high increment and mechanization of agriculture and cattle, as exposed before. Furthermore, as the uncertainty increased, free riders took advantage, converting a larger number of producers to a smaller one, in the sense of Fiani (2013, pp. 172-174). Therefore, through increasing the specification of the assets, in the sense of Williamson (2022), and through the increased uncertainty, the disturbances lead to property concentration.

Furthermore, the seventh thesis represents an important characteristic of Mato Grosso's rural development, the scale, because it is needed to maintain viability. The state's historical isolation, partially addressed by highways, which are less efficient than railroads and waterways, and deficiencies in warehousing, as detailed by Vieira Júnior et al. (in Buainain et al. (org.), 2014, pp. 1130-1133), have contributed to a situation where the limited presence of the state, the fifth thesis, has fostered the self-organization of producers (Buainain et al. (org.), 2014, pp. 1175-1179). This self-organization is reflected in the patterns of participation in technical assistance.

These actions represent a critical juncture, in the sense described by Acemoglu and Robinson (2012, p. 106), where the Central Government strategically deployed federal legislation and agencies to sparsely populated regions, driven by concerns about territorial occupation. This created a confluence of factors that disrupted the existing balance of economic power in the subsequent decades, facilitating the rise of a new class of high-productivity farmers in Mato Grosso.

For these considerations, the regions experiencing institutional changes tend to be more inclusive, as they foster land distribution through purchase. Centralization and pluralism are significant aspects of this case. However, these features might also be observed in stagnant regions during the period of Redemocratization (1985-1988)[20]. Notwithstanding this, the institutions in these latter regions could be less inclusive. In cases with extractive political institutions, for instance, elites might allocate resources to high-productivity activities, and institutions could permit some development of inclusive economic institutions. Determining the specific point at which pluralism fully emerges is a matter for future research, which could explore the extent to which Rural Enterprise influences equality. Nonetheless, the institutional shifts

[20] The first civil president was elected in 1985, although it has died before taking office, which can mark the beginning of the process. Despite, measures being taken after 1988, this is the time in which Constitution took into force.

promoted by these changes achieve a higher degree of inclusiveness compared to the remnants of Portuguese America.

Centralization is more sensed in regions of newer colonization due to the concerns of the Central Government, and pluralism will be present in these areas due to the Land Market. This leads to the conclusion that the decreasing uncertainty by economic rules entailed by new institutions is more present in the regions of dynamism.

3.1.1. New institutions: Land Market

Besides centralization, public policies rely on meeting business groups' interests and actions, such as the INDECO and SINOP companies, which originated Alta Floresta and Sinop, as Santi (2016, without page). Either by large-scale projects in the 1970s or by the smaller ones in the 1980s, institutional changes have taken place, despite difficulties in implementation, which causes a lag in changing productivity in the areas recently occupied.

According to Moreno (1999, pp. 11-13), in 1949, the first Codex of Land in Mato Grosso was made with liberal districts, modified in 1951 with validation and dilation of the limits to the legalization of land acquisition of the state and authorization to colonization. This land re-organization has the mark of indiscriminate vacant sales. The colonization became a prosperous affair for concessionaires, transforming their business into speculation, leading to the end of D.T.C. This represented the state's lack of control in access to land and the weakness of oligarchical pressures in land appropriation, which led Mato Grosso to a significant investment in the Federal Government in the Amazon. For this reason, the institution of the Land Market is the essential component of the production function from which the labor market is derived, due to the concerns during the Emílio Garrastazu Médici years (1969 to 1974), in which this market stimulates deployment of rural workers so as alleviating land problems regarding its value in South, according to Joanoni Neto and Guimarães Neto (2019, pp. 112-113).

The projects of colonization took place, as stated by Moi (2018, p. 32), in the years presented in Table 1:

Table 1 - Projects of Colonization in Mato Grosso

City	Immediate Region	Company/ Responsible	Year
Porto dos Gaúchos	Juara	Conomali	1955
Canarana	Água Boa	Cooperativa 1 de Março Ltda	1970

City	Immediate Region	Company/ Responsible	Year
Água Boa	Água Boa	CONAGRO	1970
Nova Monte Verde	Alta Floresta	CONAGRO	1970
Vera	Sorriso	Colonizadora Sinop	1972
Colíder	Sinop	Colider S.A.	1973
Sinop	Sinop	Colonizadora Sinop	1974
Alta Floresta	Alta Floresta	Colonizadora Indeco	1976
Apiacás	Alta Floresta	Colonizadora Indeco	1976
São José do Rio Claro	Diamantino	IMCOL	1976
Vila Rica	Confresa - Vila Rica	Colozação Vila Rica	1978
Paranaíta	Alta Floresta	Colonizadora Indeco	1979
Marcelândia	Sinop	Colonizadora Maiká	1980
Juara	Juara	Sr. Zé Apraná	1981
Nova Bandei-rantes	Alta Floresta	Colonizadora Bandeirantes	1982
Sorriso	Sorriso	Colonizadora Sorriso	1986
Terra Nova do Norte	Sinop	COPERCANA	1986
Novo Horizonte do Norte	Juara	COPERCANA	1986
Nova Mutum	Sorriso	Mutum Agropecuária S.A.	1988
Matupá	Peixoto de Azevedo - Guarantã do Norte	Colonizadora Agropecuária Cachimbó	1988
Tapurah	Sorriso	Empresas Tapurah	1988
Juruena	Juína	Sr. João Carlos Meirelles	1988
Brasnorte	Tangará da Serra	Cravari	1989
Cotriguaçu	Juína	Cooperativa Paranaense	1991

Source: Moi, 2018, p.32. **Adapted by author**

These projects operated under a state-oriented private colonization model, which fundamentally relied on the establishment of a Land Market to expand the agricultural frontier in the Amazon, exemplified by POLOAMAZÔNIA in 1974, and in the Cerrado, with POLOCENTRO starting in 1975, as noted by Moi (2018, p. 33). As Ribeiro (2013, pp. 225-231) points out, the acquisition of unclaimed lands at very low prices facilitated the formation of large-scale productive arrangements. This contributes to increase econometrical estimations of land and WAP to production, because individuals migrating to these regions purchased the land.

Consequently, these surpluses, combined with the learning by doing they brought, led to increased production driven by population growth, a phenomenon linked to WAP, as stated by Headey and Hodge (2009, p. 233). Therefore, future productive gains were enabled by the institutional changes that established the Land Market.

The Land Statute, created by Law number 4.504/1964, opened space to other modalities of land acquisition but buying. This evolution in the 1850 Land Law gives preferential access

to those closer to the State, according to Ribeiro (2013, p.59), because of the difficulty of agrarian reform, due to its lack of implementation; associated with taxation as the main form of land release; and with the lack of state disposal to equip itself to run it, as Heck (2019, 44) wrote. This led to a market solution in the years ahead of the 1960s and 1970s.

As pointed out by Moreno (1999, pp. 68-69), this was not new in Mato Grosso, because the first land law of the state, Law 20/1892, guaranteed regularization of consolidated occupation, land grants, and land allotments until 1889, postponing 1850 Land Law limits and demanded just Municipal registry, subject to local influence. Nevertheless, these limits were dilated until at least 1930 and counted with the legalization of excess on the area incorporated in the original title.

Furthermore, the local government lost its capacity to influence land affairs after land reorganization from 1950 to 1964, what was stated before, citing Moreno (1999, p.79). This was the period of the first colonization projects, hence, the interests of the Military Regime could operate to an even higher degree in the upcoming period than the already unequal correlation of forces and budgets, which affected the outcome of the game directly toward the central interests, expressed in the I PND, national integration to create an internal market with self-sustainable and accelerated growth, and in the II PND, integrating Amazon and Cerrado, which both corresponded to private interests, as the colonization made by the companies presented in Table 1.

Consequently, a critical juncture emerged during the Military Regime. This was driven by the Central Government's interest in occupying unoccupied territories and the weakening of local forces, which manifested as a decline in the government's ability to influence land affairs. Nevertheless, the allocation of land alone was insufficient. Capital, public governance, rural extension services, and credit were also essential, as highlighted by Barrozo (Barrozo (org.), 2010, p. 23).

3.1.1.1.Constraints to Land Market operating in higher degree

The central element is the constitution of the Land Market, which was established during the Military Regime. The colonization projects were an expression of the existing Land Market, not the other way around. When this institution did not function effectively, particularly in conjunction with inadequate transportation infrastructure, colonization projects often failed to achieve their objectives, as exemplified by the Japanese colony of CAPEM.

CAPEM was a project by the state of Mato Grosso to sell vacant lands to colonizers who were tasked with accessing and opening the land, as well as bringing people from Okinawa (Fernandes da Silva, 2018, pp. 142 – 143). However, the promises made were not fulfilled, and they were left to their own devices (*idem*, pp. 157).

Along with Rio Ferro, they were the only two regulated after 1955 (*idem*, pp. 149-150) suspension of constitution of colonizer companies in Mato Grosso according to Table 2:

Table 2 – Societies of colonization previous institutional changes

Companies	City	Date
1.Sociedade de Agricultura e Colonização Araraquara Mato Grosso	Araraquara –SP	24/04/1953
2. Companhia Agropecuária e Extrativa Mariópolis Ltda. (CAPEM)	Cuiabá	07/12/1953
3. Empresa Colonizadora Rio Ferro Ltda.	Cuiabá	16/12/1952
4. Consorcio Industrial Bandeirante de Incentivo a Borracha S.A.	São Paulo	24/04/1953
5.Companhia Agrícola MADI S.A.	Boa Vista	28/09/1953
6. Companhia Comercial de Terras – Sul do Brasil S.A.	Marília – SP	23/09/1953
7. Colonizadora CUIABÁ Ltda.	Cuiabá	03/10/1953
8. Colonizadora MATO GROSSO – PARANÁ	Cuiabá	02/10/1953
9. Colonizadora e Imobiliária REAL S.A.	São Paulo – SP	12/12/1953
10. Colonizadora CAMARARÉ Ltda.	Cuiabá	17/12/1953
11. Casa Bancária e Imobiliária Ltda.	Cuiabá	16/11/1953
12. Construções e Comércio CAMARGO CORRÊA S/A	São Paulo	15/12/1953
13.Imobiliária Ipiranga	Cuiabá	03.12.1953
14.Companhia PANAMERICANA DE ADMINISTRAÇÃO	São Paulo	29/12/1953
15. Companhia de Terras do ARIPUANÃ S.A.	Londrina	07/05/1954
16. Empresa Colonizadora AGRICOLA PASTORIL LTDA.	Cuiabá	06/05/1954
17.Industrial Colonizadora	Porto Alegre	08/05/1954
18. SORIVANTI SIQUEIRA & CIA.	Porto Alegre	21/07/1954
19. Colonizadora SÃO PAULO-GOIÁS-MATO GROSSO LTDA.	Cuiabá	25/06/1954
20. Colonizadora e Melhoramentos MATO GROSSO LTDA.	Guaíra – PR	29/10/1954

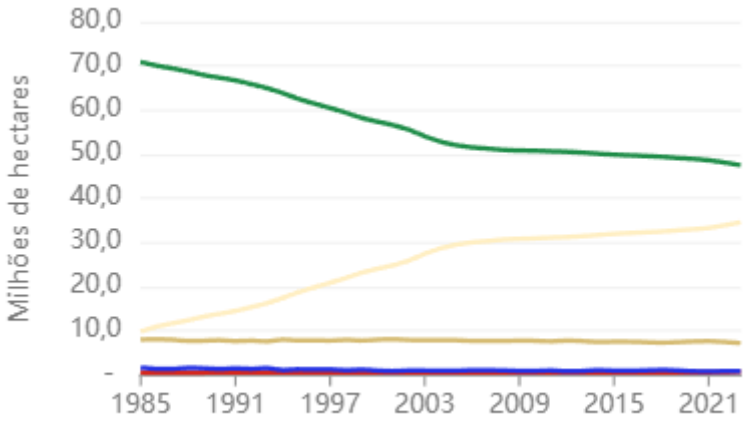
Source: Fernandes da Silva, 2018, p. 148. **Adapted by author.**

Nevertheless, this institution faced another critical juncture in 2012 with the enactment of the new Code for Forest Affairs (Brasil, 2012). Article 12 of this code stipulated the following land reserves within the Legal Amazon, where Mato Grosso is located according to Law n° 5.173/1966 (BRASIL, 1966)[21]: 80% of land for native vegetation in forested areas; 35% in the cerrado; and 20% in other vegetation types.

Notwithstanding, the path of deforestation has a more ancient stabilization basis, that can be detached from Figure 3:

[21] This Law stablishes the Paralel 16 as the mark of Legal Amazon on Mato Grosso, however it is also the division of the state in 1977, as in the Complementary Law nº 31 (BRASIL, 1977).

Figure 3 - Legal Amazon in Mato Grosso with coverture of land in millions of hectares



Legend:

Forest	**Arbustive and herbace vegetation**	**Non-vegetable areas**
Agro and cattle	**Water corps**	

Source: BRASIL, 2023.

The observed decrease in the rate of deforestation around 2002, followed by stabilization around 2006, can be attributed to legislative changes implemented prior to the new code. Although Law n° 4.771/65 prescribed a percentage for the legal reserve to be established by decree, this only occurred in 2006 with Decreto n° 5.975/2006. Prior to that, a provisional 50% reserve was adopted in 1989 due to Law n° 7.803/1989.

This significant delay helps explain why the forested area in regions like Mato Grosso maintained itself at approximately 50 million hectares until shortly after 2021. This relative stability, followed by potential changes, signifies a shift in the Land Market institution. Within this evolving landscape, technological alternatives for increasing sustainable production are being sought, such as no-till farming, integrated pest and disease management, and integrated production systems, as Vieira Júnior et al. outline (in Buainain et al. (org.), 2014, p. 1136). This trend supports the central thesis of a new trajectory for rural development in Mato Grosso and Brazil, where capital investment is increasingly crucial for wealth generation in agriculture and cattle activities, potentially diminishing the singular importance of land ownership (Buainain et al. (org.), 2014, pp. 1167-1169).

Notwithstanding, the Land Market were also constraint by fiscal consolidation. Individuals were often drawn into these colonization projects by promises of production and living infrastructure that frequently went unfulfilled, as documented by Joanoni Neto and Guimarães Neto (2019, pp. 113-118). This situation, as synthesized by these authors, is vividly portrayed

in the 1984 documentary OS HOMENS DO PRESIDENTE (Plante que o João Garante), filmed during the colonization years. In the documentary, the very farmers who were promised these benefits voice their grievances about the lack of infrastructure and the unfulfilled promises, notably regarding the purchase of their rice production. Their frustrations even led to a riot in Brasília, occurring during a period that was still undemocratic in Brazil.

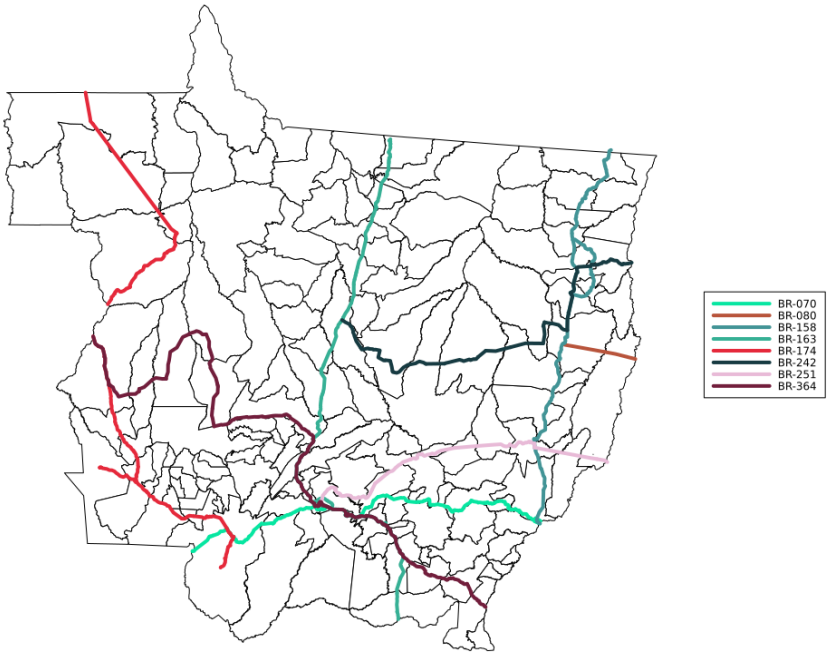
Consequently, the Land Market could not fully regulate interaction, production, and transactional costs. With one pillar of trilateral governance weakened, the government, due to the State of Mato Grosso's limited operational capacity and its greater inclination to follow Central Government policies, coupled with the Central Government's fiscal consolidation efforts, space for opportunistic actions arose between the 1970s and 1990s. Therefore, it is reasonable to expect that institutional changes did not function flawlessly. This was due to these limitations of the institution at that time, alongside challenges in rural science and technology, which further created space for opportunistic behaviors within Mato Grosso's expanding agricultural frontier.

3.1.2. New institutions: Transports (highways)

Along with the Land Market constitution, there were other points of institutional changes made by Transports. The highways provided connections between regions, allowing old practices to be replaced by newer capitalistic ones, eroding the previous isolation that was a chronic challenge to Mato Grosso’s economy during the eras of Portuguese America, the Brazilian Empire, and the Republic.

Connections were preferentially made by roads in the Military Regime, following a path started by Juscelino Kubitschek's years. Breaking away from isolation, they will connect Mato Grosso with the outside, as it is seen in Graph 5 below:

Graph 5 - Federal highways in Mato Grosso on a 2024 basis



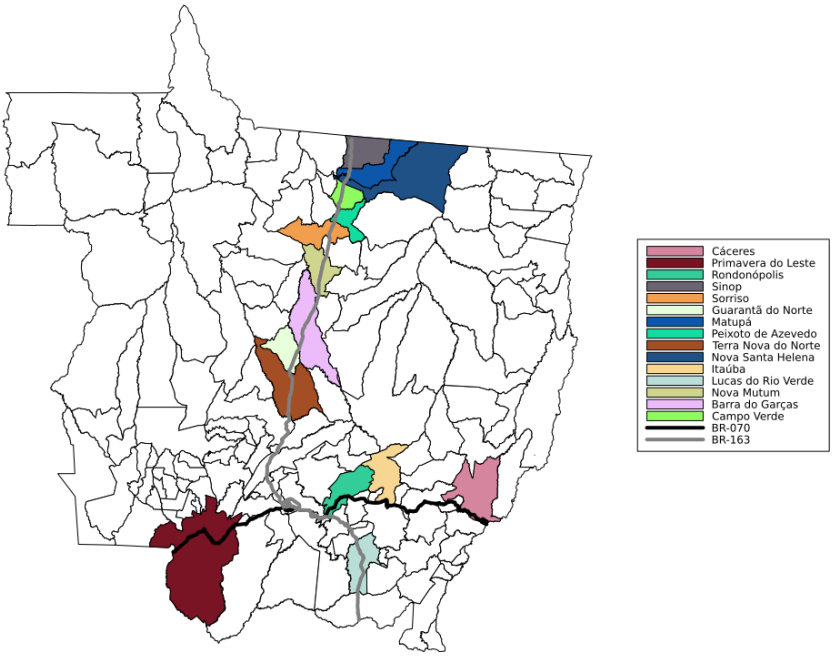
Source: DNIT (2024), IBGE (2023). **Elaborated by the author with Julia's language program.**

Highways could function as new institutions by promoting new rules of engagement, however, only two can have data to support them as a source of change. BR-163 functioned as one, alongside the Land Market, as is seen in the regions north of the capital. As shown in Bernardes (2005, p. 18), this highway allows a transformation of the outflow of grains, as it becomes itself in reduction of costs of transactions and time, and, by instance, allows opening new areas with soils suitable to mechanized agriculture, as Fortuna (2005, p. 90) stated.

BR-070 also functioned as an institutional change in at least one case, as will be seen further ahead, but not always. As Martins *et alli* (2019, p. 278), the highway was not concluded, albeit being part of PND, and it is not a completely new route because its origin dates from the colonial era (*ibidem*, p. 272). As Acemoglu and Robinson (2012, p. 106) pointed out, these differences trigger responses among their parts in a critical juncture, leading to different institutional outcomes. For this reason, not its entire extension promotes the reduction of transaction costs and facilitates coordination, due to this connection to other routes and lack of finishing, but only its area that connected with other changes, especially in the Land Market, as in Primavera do Leste, but not in Cáceres, for example.

The BR-163 cities are located along a North-South geographical axis in the state, while the BR-070 ones are located along the Southwest-Northeast axis, as seen in Graph 6:

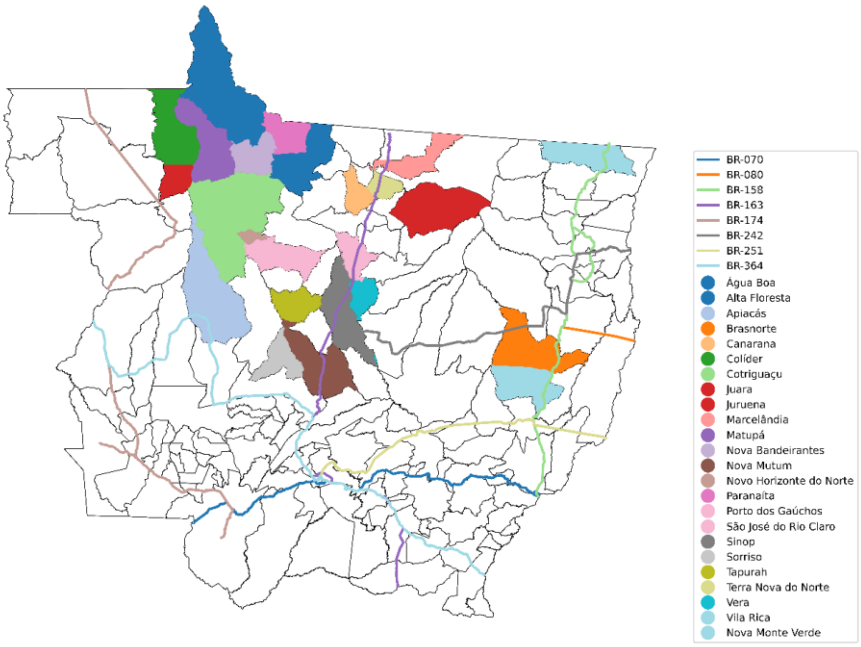
Graph 6- Cities in BR-070 and BR-163 in 2024 basis



Source: DNIT (2024) and IBGE (2023). **Elaborated by the author with Julia's language program.**

Spatially analyzing the distribution of federal highways in Mato Grosso in conjunction with the locations and temporal implementation of colonization projects, what is provided by Graph 7, offers a robust methodology for discerning patterns in their development and for subsequent analysis of associated economic growth trajectories:

Graph 7 - Projects of colonization with federal highways in Mato Grosso (highways on a 2024 basis and projects by their cities on a 2024 basis)



Source: DNIT (2024) and IBGE (2023). **Elaborated by the author with Python language program.**

An analysis of Mato Grosso's federal highway network reveals a discernible structure of primary transportation axes and a central hub. **BR-163** and **BR-070** are identified as the principal transportation corridors, each intersecting with more than two other federal highways, thereby facilitating significant north-south and east-west transit both within and beyond the state. This prominence arises from BR-163's function as a major through-corridor, establishing it as a key hub of connections. Similarly, BR-070, a significant through-corridor connected to BR-163, serves as a primary east-west axis within the state's transportation framework.

While **BR-251** has three connections, its east-to-central trajectory limits its role as a major through-corridor, like **BR-242**, which also follows an east-west direction but with only two connections, rendering it largely complementary to the hub of BR-163 and the axis of BR-070. **BR-080**, with its single connection to BR-158, functions as a more localized access route rather than a significant axis of broader connectivity.

BR-174 serves as an important axis for accessing the northern regions of Mato Grosso; however, its effectiveness is currently constrained by paving deficiencies and incomplete sections, as documented by Kanai et al. (2012).

BR-364 constitutes a significant southeast-to-northwest axis within Mato Grosso, connecting with three other federal highways. However, its connections primarily reinforce the importance of the axis, BR-070, and the hub, BR-163, indicating a hierarchical structure within the state's transportation framework.

Furthermore, a secondary transportation hub appears to be developing in the northeastern region of Mato Grosso, centered around the increasingly significant axis of **BR-158**. This highway connects with three other federal routes, including BR-163, and unlike BR-070, is not directly integrated within the immediate network of another major transportation corridor. BR-158 provides crucial extra-state connectivity for agricultural projects located in the municipalities of Água Boa and Canarana, a role like that of BR-163 in facilitating external connections for the significant colonization areas along its route.

Conversely, colonization projects situated in the northwestern quadrant of the state lack direct access to any federal highway. This absence of primary transportation infrastructure necessitates a reliance on regional connections for the movement of goods from production areas to markets outside Mato Grosso, likely resulting in elevated production and transactional costs for these more isolated agricultural endeavors.

As **BR-163** connects to more highways than the others in Mato Grosso, it is possible to conclude that it forms a hub; hence, the colonization projects located within its borders have more chances to grow, which is also true for BR-070 and BR-158. Notwithstanding, the problems pointed out about the first and the connection between it and BR-163 turn BR-070 complementary to BR-163; and to the second, the importance of the highways connected to it and the number of colonization projects in its borders lead to lesser importance than BR-163. All of that can be reflected in rates of economic growth.

Hence, transportation infrastructure plays a crucial role in diminishing both transactional and production costs (North, 2018, pp. 13-17) and in facilitating coordination among economic agents, thereby fostering the formation of shared expectations (Ruttan & Hayami, 1984, pp. 3-4). These very attributes, the reduction of costs and the facilitation of coordination, are defining characteristics of effective institutions.

3.1.3. Quality of institutional changes

Institutional quality depends especially on income level, legal origin, institutional heritage, and culture, as Torres (2015, p. 30 – 62) highlighted, but also on commercial oppeness. In the institutional changes of Mato Grosso, it is possible to see that presence, because the total growth depended of each one of this causes.

Initially, economic growth in Mato Grosso faced significant challenges, including geographical isolation and limitations in agricultural technology. However, these constraints were actively addressed through Transport institution and the advancement of agricultural practices

facilitated by trilateral governance, notably through Embrapa's role in the Prodecer program with Japan. This initiative disseminated new productive patterns and crops, effectively expanding the agricultural frontier (Vilela, 2020, p. 95). Consequently, while geographical factors presented initial hurdles, they did not ultimately prove to be insurmountable obstacles to economic growth in Mato Grosso.

Culture and commercial openness were crucial drivers of economic growth in Mato Grosso. Settlers arriving from the South, possessing practical expertise in commercial agriculture and access to capital for land acquisition, were able to effectively leverage the Land Market and transportation infrastructure, fostering the development of rural enterprises. Furthermore, the opening to international trade, significantly boosted by Kandir Law, enabled Mato Grosso to become more closely connected to international markets by reducing transactional costs for its primary commodities, including decreased taxes and transportation expenses. This was further complemented by the evolution of the fiscal system in the 1990s, which became more aligned with the commodity-based nature of the state's agriculture, particularly following the introduction of new crops in the 1980s during the second phase of Prodecer (Vilela, 2020, p. 95-96)

The significant influx of immigration from the South suggests that income level must be carefully considered. The Land Market depended on income to buy land, what explicates the influx of human factor with specialized abilities to produce from highly produced areas to not productive ones, for this reason it also allowed the influx of institutional heritage of commercial agriculture from South to Mato Grosso.

For these reasons, the preconditions for institutional development in Mato Grosso that fostered economic growth align with findings from international studies. These studies particularly highlight economic institutions, which are the key institutions discussed in this context: the Land Market, Transportation infrastructure, and Rural Enterprise. These institutions are characterized by the economic liberty provided through the possibility of land acquisition and the security of property rights. Culture is also present in the form of the social norms inherited from South immigrants who brought expertise in commercial agriculture, while commercial openness spurred significant production growth following the implementation of the Kandir Law.

Notwithstanding, the most remarkable key qualities of these institutions lie in sociopolitical theories that, through historical development, shape the appropriation of income. As Torres (2015, pp. 49-50) already synthesized, the extractive or inclusive characteristic of institutions,

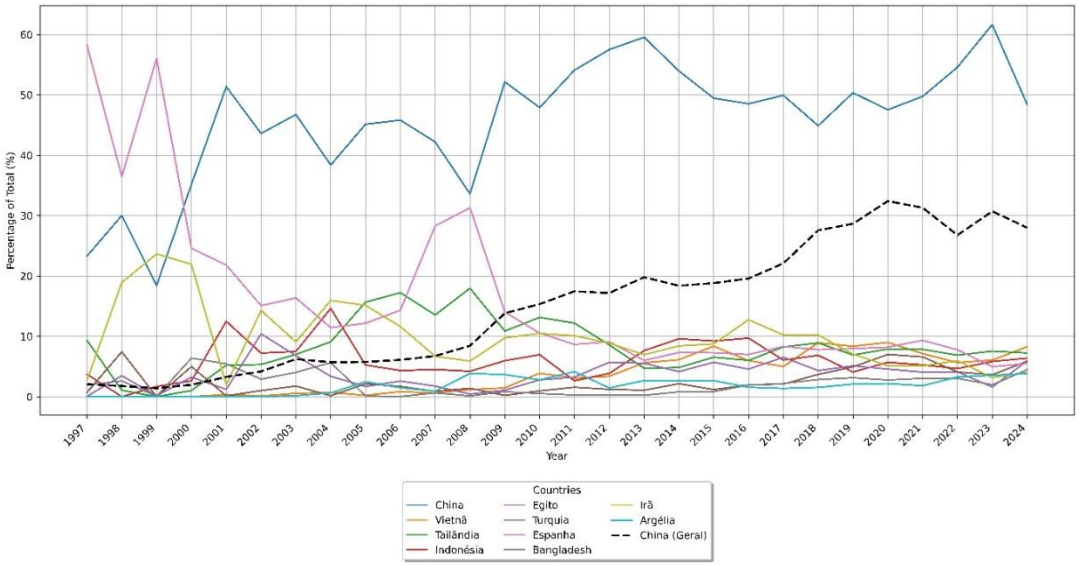
as outlined by Acemoglu and Robinson (2012), leads to different patterns of income appropriation, which either hinders or fosters economic growth, respectively. Furthermore, there are historical reasons for the development of one or the other type of institution, a lineage that can be traced back to Heeren and Caio Prado Júnior, as Monasterio and Ehrl (2015) demonstrated. However, critical junctures shape the historical path in distinct ways, even minor initial differences can set in motion vastly different responses, according to Acemoglu and Robinson (2012, p. 106). This dynamic was evident during the Military Regime in Brazil, where the Central Government's interests in occupying sparsely populated áreas and the demobilization of local forces, such as the loss of governmental capacity to influence land affairs, represented such a critical juncture.

3.2. Production counterpart: demand function

Although a detailed analysis of the demand function for agricultural and cattle products extends beyond the scope of this thesis, a consideration of demand behavior is pertinent here. Mato Grosso's current economic specialization was not achieved through the cultivation of commodities like rice, as depicted in the 1984 documentary OS HOMENS DO PRESIDENTE (Plante que o João Garante). In that context, rice was commonly considered a normal good, often consumed domestically. This contrasts with the current large-scale, often export-oriented production of agro-cattle products that defines Mato Grosso's economic landscape today.

The specialization in products demanded by China growth were the paved way to economic growth as Guimarães da Silva's thesis (2019, especially on p. 107) shown and, this is particularly true for Mato Grosso, as described through Graph 8:

Graph 8 - Participation of the then higher commercial partners of Mato Grosso and participation of China in Brazil



Source: BRASIL. Ministério da Economia. 2025**. Elaborated by the author with Python language program.**
Note: The China plot line (--) in Graph 8 is related to the share of China in Brazil's total foreign trade, while the individual-colored lines represent Mato Grosso's higher commercial partners, including China.

This presented difficulties for innovators and early adopters, as illustrated by the Rio Ferro and CAPEM cases, and in the situation depicted by the documentary. For this reason, following Rogers' definition (1971, pp. 246-251), when the necessary institutional conditions are in place, the innovators who persisted, exhibiting opportunistic behavior, could see the benefits of their ventures alongside the early adopters, who are well-integrated into the agro system.

The data indicates that China has been a significant commercial partner for Brazil since the beginning of the time series, with Brazil reaching a comparable level of engagement only in 2017. Furthermore, China became Mato Grosso's leading partner in the early 2000s, whereas for Brazil, this only occurred in 2009. For these reasons, China's economic growth undoubtedly benefited Brazilian growth and, more significantly, Mato Grosso. The state's institutional changes facilitated a path to explosive growth, as will be shown in Structural break in the production function of Mato Grosso.

3.3. Components of the production function

As pointed out, based on the Solow (1957) model partially accounted for by TFP and labor (including human capital movement), output is influenced by land per worker. This represents the Land Market institution, whose outcomes are contingent on Transports, which facilitate access to markets.

Consequently, institutions were implemented to foster a capitalist form of production, embodied in the concept of the Rural Enterprise as defined by Moreno (2007, pp. 286 – 288).

According to her definition, this involves the rational appropriation of land, overcoming large traditional estates since the 1980s. This transformation, aided by State resources in the 1970s as previously mentioned, consolidated capitalist production relations. These enterprises are market-oriented, particularly overseas as saw in the previous section, resulting in a technician-driven approach in areas such as fertilizer use and agricultural machinery, with a network-based organization in which labor is subordinated to capital.

Rural Enterprise emerged after land speculation in which federal and state governments facilitated land acquisition and provided infrastructure to colonist workers, which became highly profitable. This process can be traced to the end of Estado Novo, 1946, when state governments could sell public and vacant lands, promoting colonization and land regularization, as Moreno points out (1999, pp. 11-13).

Rezende (2002, p. 4) states that the agricultural occupation of the Cerrado region depends on facilitated land access, primarily due to low land prices compared to other productive areas. Despite the severity of the dry season, the regularity of the rainfall regime contributes to a regional competitive advantage for grains and cattle. This is because the dry period hinders activities dependent on humidity, and as pointed out by Rezende (2022, p. 8), the low climate variance diminishes risks, thus leading to specialization in soil-dependent productivity, namely agriculture and cattle activities. This climate rigorousness adversely affects familiar agriculture and the labor market.

Combined with the state's flat terrain, pedological characteristics (depth and drainage), and other physical features, there is a propensity for mechanization, fostering large-scale production. Notwithstanding the importance of climate, the lack of comprehensive data since the 1960s or 1970s prevents its inclusion in the production function. Meteorological stations were primarily established in the mid-1980s, with the exceptions of Cuiabá (1910) and Diamantino (1931) (Brasil, INMET, 2024). This data limitation necessitates leaving climate out of the production function. Consequently, its importance lies in conditioning the labor market in relation to the Land Market, for example, through the seasonality of agricultural work.

Mato Grosso attracted people from the South of the country who faced land scarcity due to high population density, what is shown in the documentary 'OS HOMENS DO PRESIDENTE' (Plante que o João Garante), 1984, and supported by Joanoni Neto and Guimarães Neto (2019, pp. 113-118). This suggests that the Land Market created an influx of a human factor with specialized production abilities. This phenomenon aligns with Lucas (1988)'s considerations on the role of human capital and to the fifth stylized fact of Jones and Romer (2010,

p. 240). Notwithstanding, labor flowed to both highly productive and less productive areas. Furthermore, opportunistic behavior during fiscal consolidation did not allow for a straightforward realization of Lucas' growth path (1988), but enabled the inclusion of TFP, which is particularly, though not exclusively, related to human capital.

Therefore, the final function form can be presented as a Cobb-Douglas one, in which the Land Market is represented in the sense of capital; work and other forms of capital, as machines, in its proper sense of labor and capital, respectively; TFP as productivity multiplying other variables; while human capital depends on increase of WAP, which is encompassed by labor, what leads to Equation 5:

Equation 5 - Functional form

$$Y = A\ x\ K^{\alpha} x\ L^{\beta}$$

Legend:

- Y: Total production
- A: TFP
- K: Capital
- L: labor
- α,β: coefficients

Transport is not presented directly in the equation, as its effects provide access to the outflow of goods, allowing productivity to be sold, and to frontier lands, allowing expansion during that time. For this reason, it affects both independent and one dependent variable, however, it can be traced to the regions, making a regression to each Immediate Region, as in the upcoming chapter.

Therefore, the functional form would be incomplete without TFP, which is calculated here based on the difference between the rates of increase in production and the rates of increase in the supply of inputs. The definition provided by Gasques et al. (2022, p. 8) implies that not all changes in production arise from different allocations of labor and land within the framework of this thesis. Instead, changes in overall productivity, as captured by TFP, are reflected in changes in production.

4. METHODOLOGY

Using the functional form provided, regression analysis can determine whether institutional changes were responsible for the differentiation in agricultural economic growth between the Immediate Regions of Mato Grosso. The process consists of reaching the production function geographically and historically identified, with the regions identified.

Regression with linear models can be used to achieve the production function with high significance. First, obtaining data to perform initial estimations is necessary to achieve a model whose parameters fit that data in the form described in Frame 2:

Frame 2 - Variables used in regression

Variable	Measured in	Years disponible	Form of obtaining	Source
Independent Variables				
Production	R$ 1,000.00 from 2010	1970, 1975, 1980, 1985, 1995 and 2006	Extraction from Census	BRASIL. IPEA, 2024a
Temporary Tillage	Hectare	1970, 1975, 1980, 1985, 1995 and 2006	Extraction from Census	BRASIL. IPEA, 2024a
Permanent Tillage	Hectare	1970, 1975, 1980, 1985, 1995 and 2006	Extraction from Census	BRASIL. IPEA, 2024a
Totall Tillage	Hectare	1970, 1975, 1980, 1985, 1995 and 2006	Sum of Temporary and Permanent Tillage	BRASIL. IPEA, 2024a
Dependent Variables				
Occupied People	Unity	1970, 1975, 1980, 1985, 1995 and 2006	Extraction from Census	BRASIL. IPEA, 2024a
Productivity Land Unutilized	Hectare	1970, 1975, 1980, 1985 and 1995	Extraction from Census	BRASIL. IPEA, 2024a
Planted Pastures	Hectare	1980, 1985, 1995 and 2006	Extraction from Census	BRASIL. IPEA, 2024a
Natural Pastures	Hectare	1980, 1985, 1995 and 20065	Extraction from Census	BRASIL. IPEA, 2024a
Annual Investment	R$ 1,000.00 from 2010	1970, 1975, 1980, 1985 and 2006	Extraction from Census	BRASIL. IPEA, 2024a
Capital Stock	R$ 1,000.00 from 2010	1970, 1975, 1980, 1985 and 2006	Calculated as: *Valor dos Bens Agropecuária total - Valor dos bens terra*	BRASIL. IPEA, 2024a

Variable	Measured in	Years disponible	Form of obtaining	Source
WAP	Unity	1970, 1980, 1991, 2010, and 2022	Calculated as the aggregated 15 to 65 years old to the years of other variables as na exponential function	BRASIL. IBGE, 2024b and 2024c
TFP		1970, 1975, 1980, 1985, 1995 and 2006	Calculated as production minus supplies Gasques and Conceição (1997, p. 18)	BRASIL. IPEA, 2024a

Although the central hypothesis being institutional changes that started in the 1960s and caused differences in growth between regions in Mato Grosso, our data will begin in 1975. While most data series began in 1970, the series for Annual Investments only started in 1975. A further constraint is the absence of data for Value of agricultural and cattle goods and Value of land for 1995, which prevented the calculation of Capital Stock for that year.

Furthermore, the 2017 Agricultural and Cattle Census data is incompatible with the coming proposed model due to significant omitted variable bias. The Census lacks several key regressors, including data on Pasture, Annual Investment, and the variables required to compute Capital Stock. Although it provides data on Production, Tillage, and Occupied People, while Wap could be calculated from Demographic Census, a model relying on this limited set of variables would be misspecified.

This misspecification would be particularly detrimental to the instrumental variables approach, where Tillage is treated as an endogenous regressor for Production. The use of incomplete 2017 data would bias the coefficients on the demographic variables, which, in turn, would bias the crucial estimated relationship between Tillage and Production.

Data was organized in a panel, which included geographical dummies for Mesoregions[22], Immediate Regions, and Intermediate Regions. The last, as the newer regional division stated by IBGE (2017), provided geographically the divergences of growth at a level not as small as cities but not as large as intermediary regions, allowing a description of patterns in the immediate ones. There are also time dummies in the data in 1975, 1980, 1985, 1995, and 2006 to reach a historical function.

[22] CENTRO-Sul (Center-South), Nordeste (North-East); North (Norte); South-East (SUDESTE); e South-West (Sudoeste).

Institutional changes in Transports were placed indirectly in the model. Another approach became difficult, especially because highways should be included in the model only when the specific section is completed and operational. As this data is not freely available, placing institutions indirectly as regional dummies can make a significant model. This directly impacts the Transport institution, as well as the Land Market, as both depend on highways for market access and productivity. Notwithstanding, the Land Market is placed under the Total Tillage, and its increase demonstrates the advance of the agricultural frontier and the market itself. As Rural Enterprises are the confluence of both institutions, it is the proper dependent variable, geographically identified by the dummies.

To not fall into perfect multicollinearity problems, not all dummies were included. By doing that, it also established control regions and years. The control regions were always those in which the capital, Cuiabá, is located: the Center-South mesoregion, Cuiabá immediate region, and Cuiabá intermediate region. The control year is 1975, which enables us to see the increase in production over time in a direct way.

The Cobb-Douglas functional form was used to regress the data; however, it will be linearized with logarithms in all variables but dummies. It also allows research to achieve percentage increases. The logarithm of Production will be the independent variable, and the other variables will be dependent ones with least squares in robust standard error to prevent heteroscedasticity. Notwithstanding that form, the independent variable was regressed against each other individually to see if there was non-significance in any of them to drop them out of the model. Secondly, if there is a problem of endogeneity, the two-stage squares will be used.

At such a point, no consideration of the effects on the panel will be made because it will be assumed that random effects are the appropriate form. If first differences were used, all the variables that do not change from period to period, especially dummies like the geographical and the historical ones presented in the model, would be dropped out, as Wooldridge (2002, p. 432) points out. A random-effects model was chosen over a fixed-effects model. The primary independent variables are the time-invariant regional dummies, which are essential for testing the thesis's central hypothesis. A fixed-effects estimation, by design, would remove these time-invariant variables, making it impossible to assess the impact of these crucial regional differences. For these reasons, the non-observed effect is assumed to be not related to independent variables, which allows the use of random effects, as Wooldridge (2022, p. 461) advertises,

because it comes from the variables not included, such as climate and pedological characteristics, or from error. Indeed, a Hausmann test must be made to confirm this hypothesis assumed to maintain the significance of the model.

Such a panel is highly unbalanced, because data becomes available as the cities becomes emancipated[23]. For this reason, variance estimators must be addressed to not lead to biased and inconsistent standard-errors. To test heteroskedasticity, a manual test will be made to test the correlation of the square of the residuals to the independent variables at the first stage. Subsequently, an autocorrelation test will be performed to check for correlation between the residuals and their lagged values in the same regression. Autocorrelation means that errors in one period are related to errors in previous periods, which violates a key assumption of regression analysis.

If either heteroskedasticity or autocorrelation is detected, the standard Swamy-Arora[24] procedure may not be sufficient for accurate variance estimation, unlike what is standard in some statistical software packages. In such cases, alternative methods will be employed. These include using Huber-White/sandwich robust standard errors, cluster-robust standard errors, or the Baltagi-Chang estimator, and the heteroskedasticity and autocorrelation tests will be repeated. If more than one specification is optimal to address the heteroskedasticity or the autocorrelation, the Wlad chi squared will be used to choose a model.

After reaching a fitted functional form in a significant model, it is time to use Chow test to analyze two possible structural breaks. The first is in the proper Production function and the other is in the change of the TFP component of it.

In the Production Function, it will be tested that Kandir Law (Brasil, 1996) allowed a structural break in the production function. This law introduced tax exemptions for the export of raw materials to promote an increase in the presence of Brazil in international trade. In this test, if the break is achieved, an explosive production function will be reached with a boom of growth.

For the TFP variable, a test will be conducted to determine whether TFP during the 1975-1985 period is equal to TFP in 2006. Data from 1995 will be excluded due to fiscal consolidation and a decay in TFP during that year. Consequently, it is assumed that another structural break occurred between 1985 and 1995. If a statistically significant difference between the

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[23] Such year is shown at an interactive plot in: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/municipal_emancipation_timeline.html.

[24] SWAMY, Paravastu Aananta Venkata Bhattandha; ARORA, Swarnjit S. The exact finite sample properties of the estimators of coefficients in the error components regression models. **Econometrica: journal of the Econometric Society**, p. 261-275, 1972.

TFP of the 1975-1985 period and 2006 is found, this result (interpreted as a break) would demonstrate a different growth path, or a changed inclination of the trend line, for TFP within the Production Function. This, in turn, would serve as evidence that the Land Market institution has nearly reached its maximum operational extent, as described in Constraints to Land Market operating in higher degree.

Wooldridge (2017, p. 422) performs it with three regressions. One, without restrictions, is the production function as reached, and the other two are the regressions until the possible structural break and after it. After these estimations, the Chow statistic is calculated, according to the formula provided in Equation 6:

Equation 6 - Chow test

$$F = \frac{[SSR(production\ function) - (SRR + RSSafter95)]}{(SRRuntill95 + SRRafter95)} \cdot \frac{[n - 2(k+1)]}{k+1}$$

Legend:

- RSS (production function): Squared sum of residuals of the production function, including all years
- RSStill1995: Squared sum of residuals of the production function until possible structural break, in 1995
- RSSaf1995: Squared sum of residuals of the production function after possible structural break, in 1995
- n: observations of the production function
- k: parameters of the production function

Source: Wooldridge (2017, p. 422).

Due to the unavailable data for all years and cities, and due to the unavailable Value of land in this Agricultural and Cattle 1995 Agricultural and Cattle Census, a regression can reach only a point at which not all regions can get a significant degree, and the regression cannot extend into the 21st century. For this reason, another analysis will be conducted using populational data. This is convenient for transporting the analysis until the 21st century and reaches the Gross Domestic Product Municipal available time series.

The demographic analysis was done using the Demographic Census. Populational data was taken from Sidra – IBGE (Brasil. IBGE, 2024b and 2024c) to analyze the behavior of the dependence ratio from young, old-age, and total, considering the working-age people between 15 and 64 years old. The more proportional gains in the last demonstrate higher attractiveness and retention of population, therefore being an adequate proxy for economic growth, and analyzing interregional catching-up movement.

The analysis of populational increase will be made by the logistic model based on demography theory, as shown by Weinstein and Pillai (2015, pp. 254 – 256), what is demonstrated in Equation 7:

Equation 7 - Logistic growth of population

$$\text{Logistic Growth: } P_t = \frac{k}{[(1+b)x(e^{-at})]}$$

Legend:

• P_1 is the population size at a selected date (for which data are unavailable)

• k is an estimate of the largest population size attainable over the observation period, based on but usually larger than P0

• b is another estimated constant that represents the length of time between P0 and the point at which growth begins to slow

• e is the exponential constant (indicating that this curve is related to the one for exponential growth

• a is an estimated average rate of growth for the entire period

• t is the number of five-year segments (our population data points are years apart) in the duration of the projected date

Source: Weinstein and Pillai (2015, pp. 255 – 256).

If the function does not converge, it will use the exponential function of Equation 8 instead:

Equation 8 - Exponential growth of population

$$\text{Exponential Growth: } P_t = P_0 x e^{GRxt}$$

Legend:

- P_t is the population size at a later date
- P_0 is the size at the earlier date
- GR is the growth rate
- t is the amount of time (number of years) between 0 and t
- e is the exponential constant = 2.71828

Source: Weinstein and Pillai (2015, pp. 253 – 254).

There will be used both static and interactive graphs to plot such functions. The last are placed here, while the others are in the cloud, which will be provided with a link to see them for better legibility. Notwithstanding, some cities are experiencing population decay. This is analyzed using a logarithmic function, with the logarithm of the total population as the dependent variable and a set of dummy variables representing each Census year as the independent variables. Once these functions were estimated, they were used to project when the population

in these cities would fall to near zero. This projection employed a linear method due to its conservative approach compared to geometrical and exponential calculations, according to Weinstein and Pillai (2015, pp. 260 – 264). The point of near-zero population in this linear projection is determined by where the projected population trend approaches the intercept of the linear regression.

After calculating populational data, the research shows growth in the 21st century by calculating real GDP increments in the immediate regions. It will be calculated using the historical series of *PIB Municipal* (Brasil. IBGE, 2024a), deflating them to 2002 basis using IPCA provided by IPEA (2024b). The average growth rate will be demonstrated by the Compound Annual Growth Rate, calculated from the deflated values spanning 2002 to 2021, accordingly to Equation 9:

Equation 9 - Compounding Annual Growth Rate for Municipal GDP

$$CAGR = \left(\frac{GDP_{2021}}{GDP_{2002}}\right)^{\left(\frac{1}{years}\right)-1}$$

Legend:

- CAGR: Compound Annual Growth Rate
- GDP_{2021}: GDP in 2021 expressed in 2002 values
- GDP_{2002}: GDP in 2022
- $years$: number of years, 20

All the data and resources used are stored in ANNEX B – DATA USED, Stata ™ DO-FILES AND NOTEBOOKS, which is located on this thesis's GitHub. It contains the do-files used to perform econometric regression in Stata™ and the programs in Python and Julia, made in Jupyter Notebook™, used to map data. Artificial intelligence tools, specifically Gemini, Claude, and DeepSeek, were utilized to support the coding process. Gemini was also employed to aid in enhancing the overall quality and readability of the text.

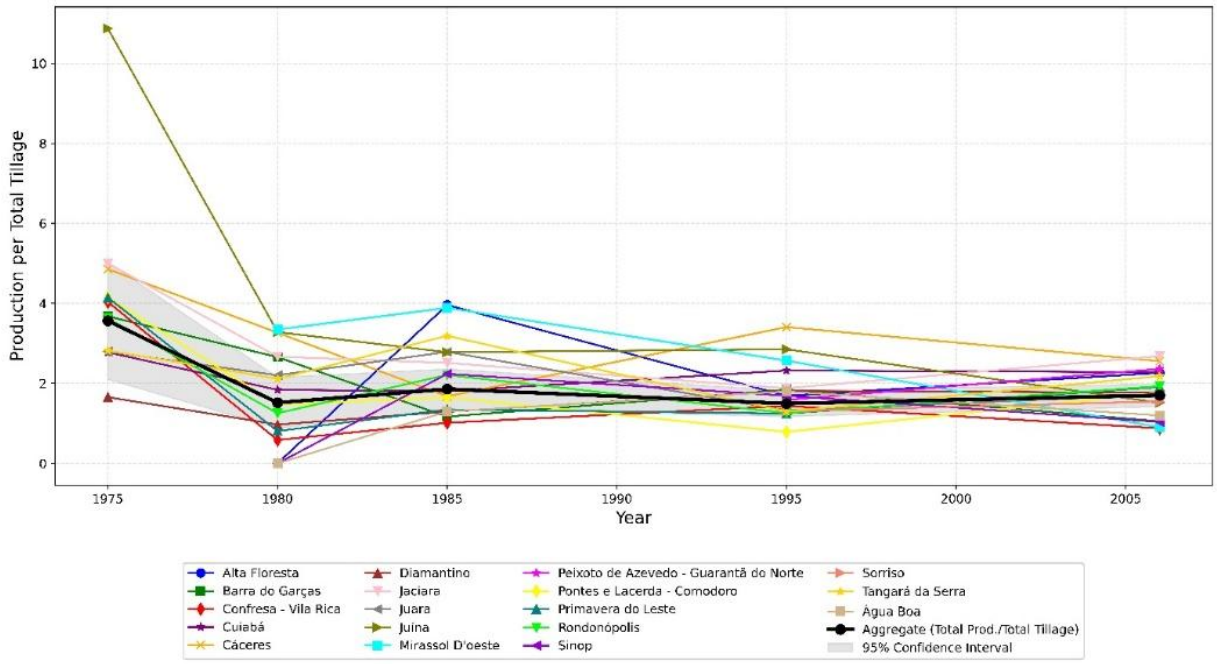
5. OUTCOMES AND DISCUSSIONS

5.1. Exploratory statistics of data

5.1.1. Agricultural data to reach a Production function

The first analysis to explore the data is how productivity behaves throughout the years, by setting the aggregated value of Production and Total Tillage as a ratio in Graph 9:

Graph 9 - Agricultural Production Value (in R$ 1,000.00 from 2010) per Hectare of Cultivated Land in Immediate Regions of Mato Grosso (1975-2006 Agriculture and Cattle Censuses)



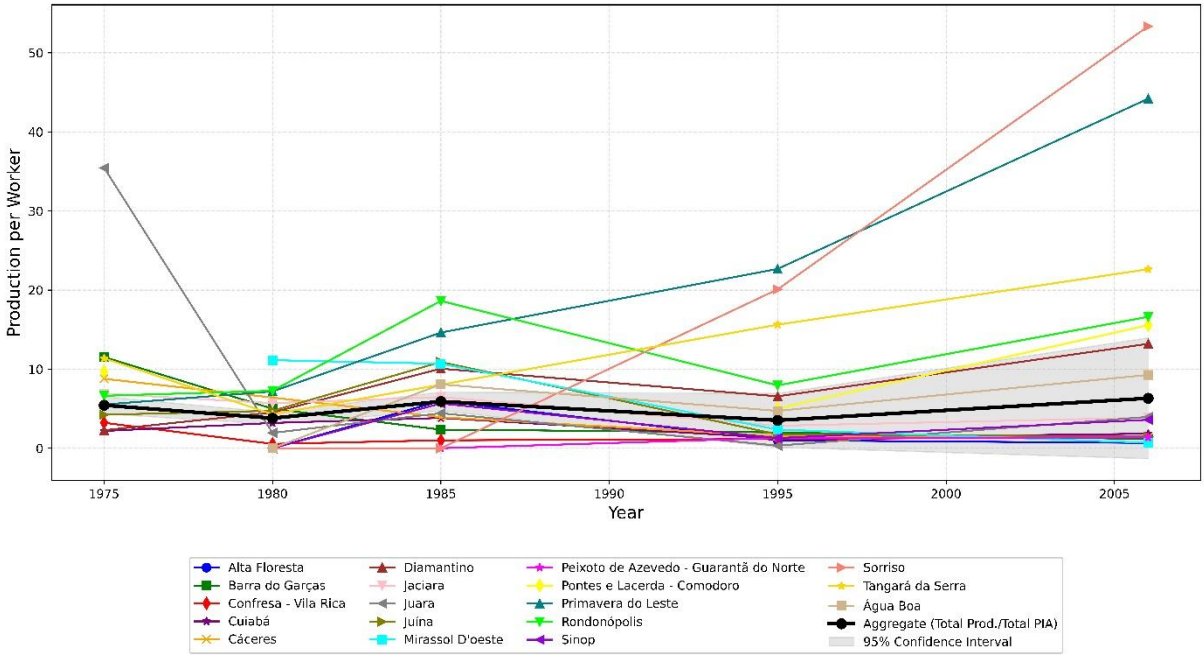
Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.** The interactive plot is shown at: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/Production_per_tillage_interactive.html.

The average, plotted in black, was calculated by summing the variables and dividing the sum by the number of observations. Its confidence interval has been shrinking over the years, which is due to the reduced variability of the data. This observation, coupled with the fluctuating pattern of variation over time, indicates that without a clear trend of increasing productivity from intensive land use, the rise in production is caused by an increase in the extent of Total

Tillage. This is consistent with the expansion of the agricultural frontier and is directly supported by the studies of Hoffman (1992) and Medeiros et al. (2012).

This is not the case of the factor of production people, as shown in Graph 10, which is made with WAP:

Graph 10 - Agricultural Production Value (IN R$ 1,000.00 FROM 2010) per Worker in Immediate Regions of Mato Grosso (1975-2006 Agriculture and Cattle Censuses)

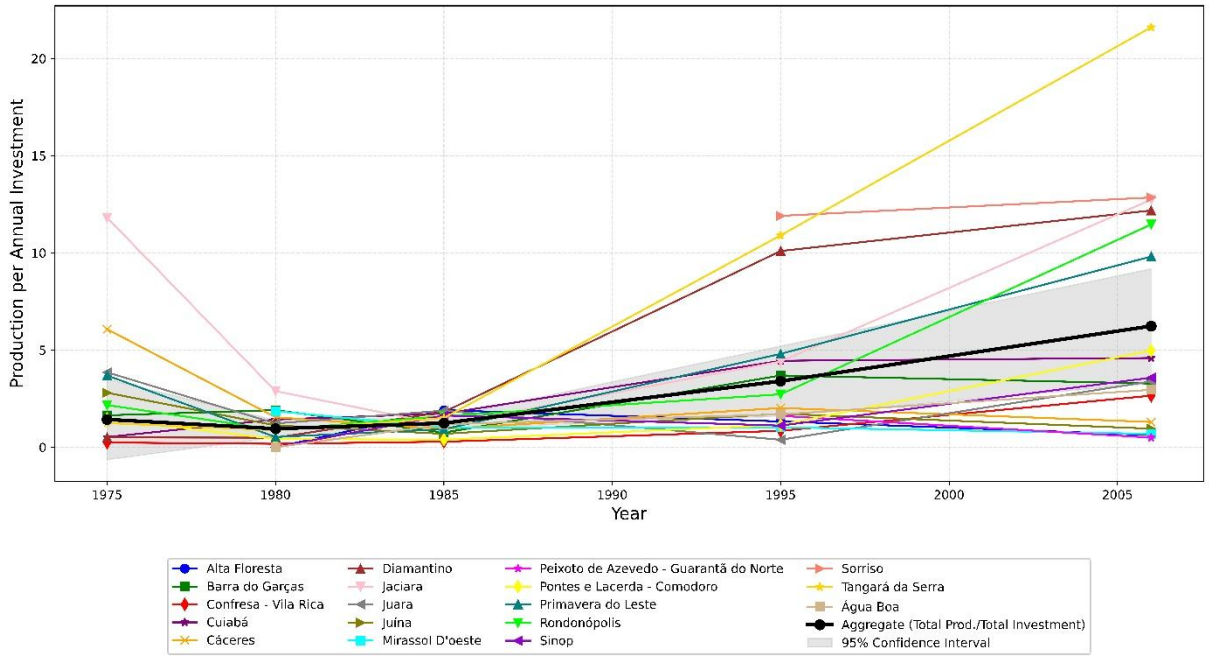


Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.** The interactive plot is shown at: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/Production_per_worker_interactive.html.

The variable WAP was included for reasons that will become clear later, as its regression is statistically significant, while that of Occupied People is not. It is evident that certain regions lie beyond the confidence interval for average production per worker. While Pontes e Lacerda – Comodoro did not pass through the institutional changes, Rondonópolis, Tangará da Serra, Primavera do Leste, and Sorriso did. The significant increase observed in Sorriso cannot be disregarded due to the potential impact of the Kandir Law, as will be shown. However, its subsequent position indicates this region became a leading one due to the influence of institutional changes.

Such presence of Pontes e Lacerda – Comodoro can be explained by the returns on investment, which are plotted in Graph 11:

Graph 11 - Agricultural Production Value (IN R$ 1,000.00 FROM 2010) per Annual Investment (IN R$ 1,000.00 FROM 2010) in Immediate Regions of Mato Grosso (1975-2006 Agriculture and Cattle Censuses)



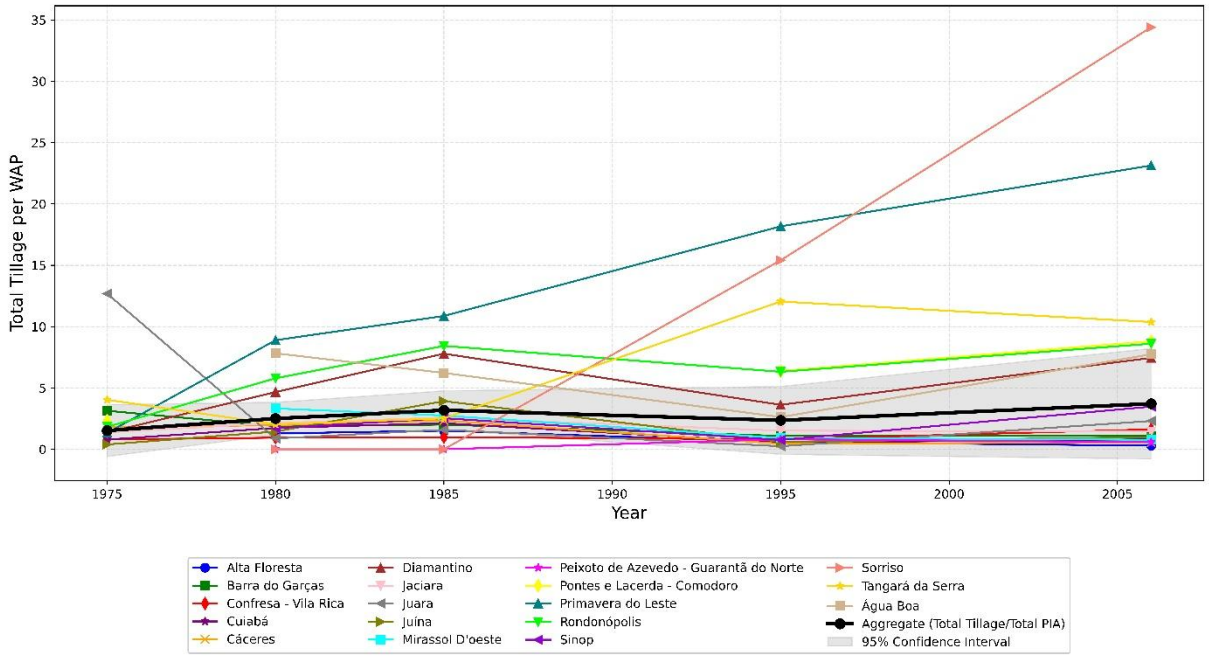
Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.** The interactive plot is shown at: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/Production_per_investment_interactive.html.

The increase in returns in that region stems from its previously less intensive land use. That area, which recorded the lowest returns in 1995, converged to the average by 2006. Notably, the municipalities of Sorriso, Jaciara, Diamantino, Rondonópolis, and Primavera do Leste exhibit returns above the average.

However, the presence of regions without institutional changes, and their higher inclination coefficients compared to regions with such changes, suggests that Annual Investment will not have a stronger effect on Production. This finding aligns with existing literature, specifically Hoffman (1992) and Medeiros et al. (2012), who found that production was primarily land-driven. This analysis does not extend to Capital Stock due to data limitations, as detailed in the METHODOLOGY section.

In a Solow (1957) model, higher capital per worker leads to economic growth, as already stated in THEORETICAL FRAMEWORK, for this reason, the ratio can show a pattern, when plotting the data in Graph 12:

Graph 12 - Total Tillage (Hectares) per WAP in Immediate Regions of Mato Grosso (1975-2006 Agriculture and Cattle Censuses)

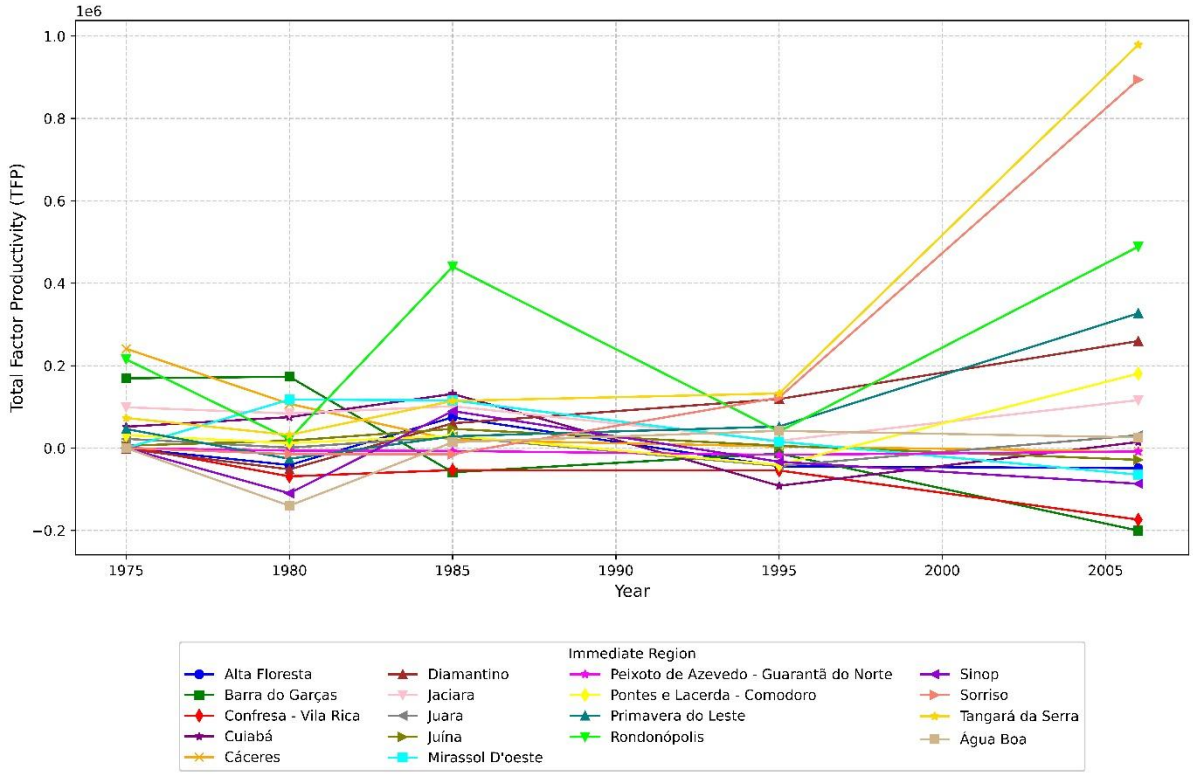


Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.** The interactive plot is shown at: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/Tillage_per_PIA_interactive.html.

Through the years, only Água Boa, Diamantino, Rondonópolis, Primavera do Leste and Sorriso are above the average, considering confidence interval, excluding Juara in the first Census, 1975. Institutional changes were observed in all of these regions, except for Juara, Diamantino, which, like Água Boa, returned to the average use of Total Tillage per WAP in the 1995 and 2006 Census, as stated previously. The significant increase in the growth pattern of Sorriso and the corresponding decrease in Diamantino's point directly to the model's correctness. This is attributable to the administrative division of cities that occurred between the 1985 and 1995 Censuses.

TFP has a path of ups and downs until 1985, but in 1995 almost all regions fell to recover in 2006, what Graph 13 enables to discover:

Graph 13 - TFP through the years of Agriculture and Cattle Censuses (1975-2006) in Immediate Regions of Mato Grosso

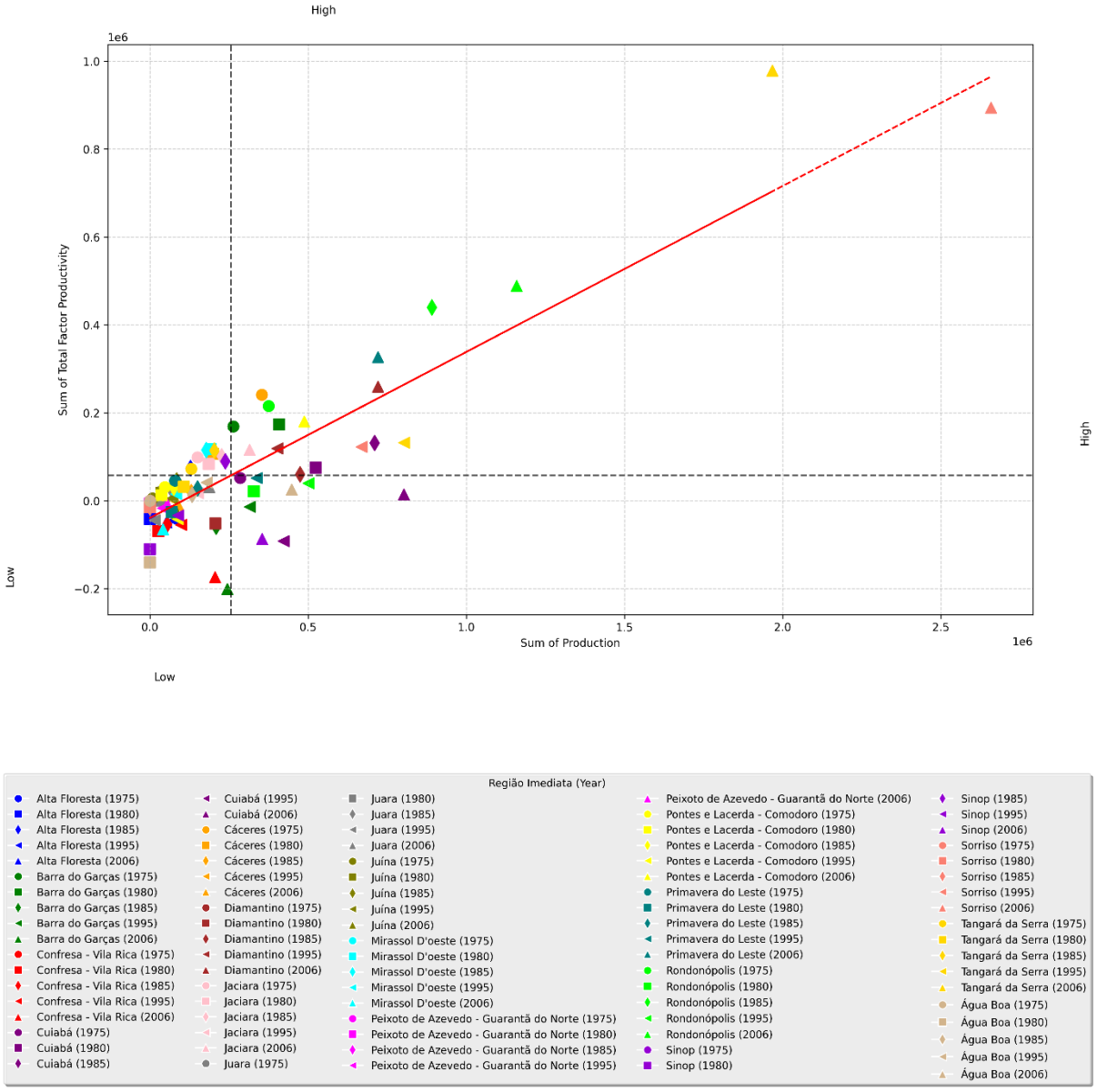


Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.** The interactive plot is shown at: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/TFP_by_Region_Interactive_Plot.html.

This pattern indicates that fiscal consolidation in the previous years, along with recession, provided a path for almost all regions decay its TFP. This was not true only to Tangará da Serra and Confresa-Vila Rica, with both nearly constant, and for Diamantino, Sorriso, Primavera do Leste, and Água Boa, which indicates that institutional changes prevented a higher decrease than in other regions, connecting to the fourth stylized fact from Jones and Romer (2010, pp. 237-240). Furthermore, the levels of increase in those region are not so high as the levels of decay in the others, assessing the impact of structural changes in the TFP during the 1985-1995 period.

Despite some variation through the years, analyzing the bivariate TFP to Production provides a pattern for a positive trend between the two, what Graph 14 plots:

Graph 14 - Quadrant Scatter Chart for Bivariate Analysis of TFP versus Production (R$ 1,000.00) in Immediate Regions of Mato Grosso from Agriculture and Cattle Censuses (1975-2006)



Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.** The interactive plot is shown at: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/TFP_vs_Production_Interactive.html.

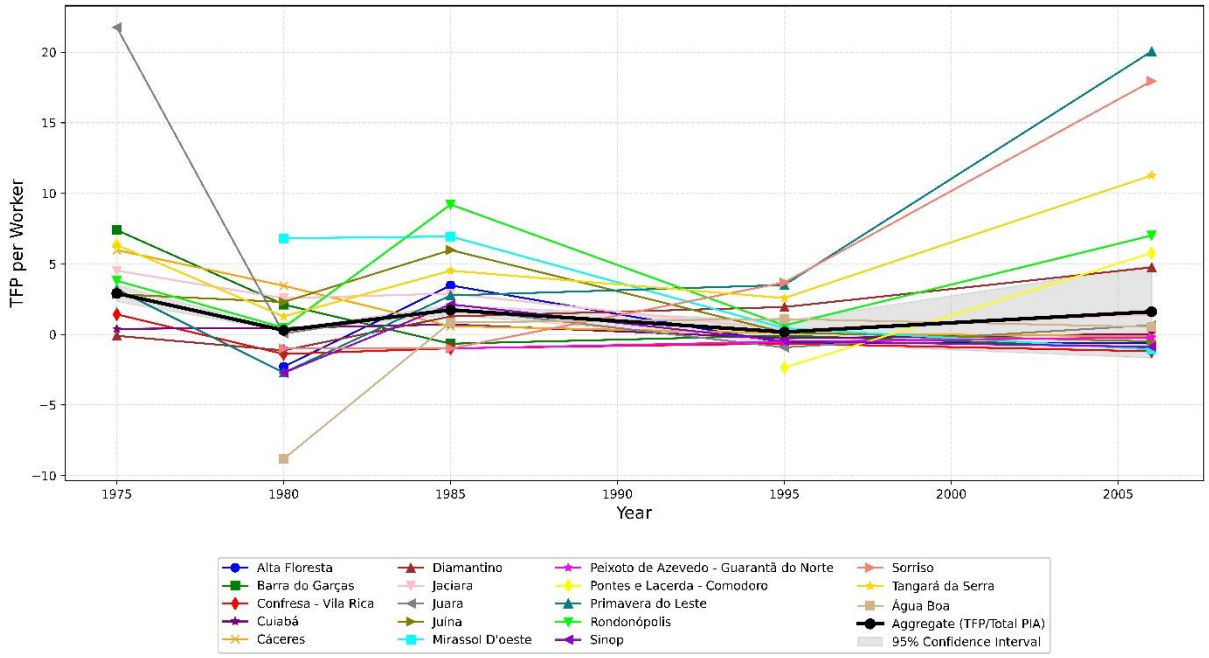
In the high-high quadrant, above the line trend there is: for 1975, Barra do Garças, **Rondonópolis**, and Cáceres; for 1980, Barra do Garças; for 1985, **Rondonópolis**; for 1995, none,

and for 2006, Jaciara, Pontes e Lacerda, and **Tangará da Serra**. Bellow the line trend, for 1975, none; for 1980, Cuiabá; for 1995, Jaciara and Cáceres; and for 2006, **Sorriso**, while the bolded regions passed through institutional changes. The inconsistence of them being presented in this quadrant could reveal that TFP cannot not explicate much of the Production through the years, because some other variable is more significant, what is consistent with the expansion of land frontier and reflects Hoffman (1992) and Medeiros et al. (2012).

The presence of two outliers in 2006 causes the bivariate analysis to align with the first thesis of Buainain et al. (2014, pp. 1167-1169). As already stated, the Land Market institution appears to be reaching a final stage, in which technological alternatives for sustainable production are being adopted, according to Vieira Júnior et al. (in Buainain et al. (org.), 2014, p. 1136).

Furthermore, TFP data also points to a critical element of Brazilian rural development: structural heterogeneous development. This concept suggests that advancements in technological modernization are not uniformly adopted or do not equally benefit all farmers (Fornazier and Vieira Filho, 2013, pp. 10-12). This pattern is especially noticeable in the TFP from labor, which is calculated as the added value generated by each employed individual (*idem*, p. 7), and becomes clear when plotting the values of TFP per worker in the data of this thesis, which is depicted in Graph 15:

Graph 15 - TFP per worker through the years in Immediate Regions of Mato Grosso from Agriculture and Cattle Censuses (1975-2006)



Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.** The interactive plot is shown at: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/TFP_per_worker_interactive.html.

Analysis of TFP per worker across the regions within Mato Grosso reveals distinct temporal patterns and significant regional disparities between 1975 and 2006. Initial observations indicate a general decline in TFP across most regions by 1980, followed by a subsequent increase peaking around 1985. Another period of decline is evident until 1995, after which TFP generally increased until 2006.

Notably, regions that experienced significant institutional changes during the 1985-1995 period demonstrated a catching-up movement within Mato Grosso, subsequently leading in TFP from 1995 onwards. While these regions exhibited the highest TFP values during these periods, they were juxtaposed with regions exhibiting considerably lower TFP. For instance, Alta Floresta, Mirassol D'Oeste, Barra do Garças, Confresa-Vila Rica, and Juína consistently recorded low TFP, reaching negative values. Similarly, Cáceres and Peixoto de Azevedo – Guarantã do Norte registered negative TFP, while Juara's TFP remained positive; however, all of them were close to zero.

Furthermore, at a 5% confidence level, the TFP for these lower-performing was statistically indistinguishable from zero in 2006. This suggests the presence of two distinct groups within the state: a leading group that successfully adopted technology and propelled TFP growth, and a lagging group that has fallen behind in this technological advancement path.

It is important to note the atypical trajectory of Sinop. Despite undergoing institutional changes that led to a significant increase in TFP per worker by 1985, its TFP subsequently declined to a negative value by 1995, reaching an even lower negative level in 2006. This outlier status may be attributable to the emancipation of new municipalities within the Sorriso Immediate Region during 1985-1995, notably Sorriso itself in 1986[25]. While this potential causal link is compelling, further in-depth research on this specific phenomenon is beyond the current scope.

The findings underscore the persistent structural heterogeneity in Mato Grosso's rural economic development. While certain regions exhibit robust growth reflected in positive and elevated TFP per worker, others register negative values that are statistically equal to zero. This divergence aligns with existing literature, particularly Procópio et al. (2024, pp. 862-866), who identify several crucial factors for technology adoption among rural producers. These factors include, but are not limited to, the clarity of property rights, the specific attributes of the rural landscape, a conducive socio-economic framework, and optimal soil conditions. Therefore, the higher TFP observed in leading regions implies the successful establishment and operation of advanced rural enterprises, effectively leveraging these facilitating conditions.

5.1.2. Relations between variables

After outlining the relationships between each variable and Production, which allowed us to identify positive associations, the next step is to conduct a preliminary analysis of the relationships among all variables. First, as shown in the table, there are no significant concerns of multicollinearity, as only one dummy variable exhibits a Variance Inflation Factor (VIF) higher than the threshold of 5 in Table 3:

Table 3 - Variance inflation factor

Variable	VIF	1/VIF
year1985	5.380	0.186
lTotalTillage	4.940	0.202
year1980	4.470	0.224
lCapitalStock	4.350	0.230

[25] As it can be sawn in Emancipation variable in Appendix B with a timeline located on https://daves-cordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/municipal_emancipation_timeline.html.

Variable	VIF	1/VIF
lOccupiedPeople	4.060	0.246
lAnnualInvestment	3.220	0.311
lTFP	3.210	0.311
lNaturalPastures	2.870	0.349
Rondonópolis	2.250	0.445
lPlantedPastures	2.240	0.446
Sorriso	2.170	0.460
TangarádaSerra	1.850	0.542
ÁguaBoa	1.710	0.585
Diamantino	1.700	0.587
Jaciara	1.600	0.624
PrimaveradoLeste	1.570	0.637
PonteseLacerdaComodoro	1.540	0.650
lWAP	1.520	0.657
BarradoGarças	1.410	0.707
AltaFloresta	1.390	0.718
ConfresaVilaRica	1.340	0.745
MirassolDoeste	1.310	0.763
Juina	1.280	0.780
Sinop	1.280	0.783
PeixotodeAzevedoGuarantãdo	1.260	0.792
Juara	1.230	0.812
Caceres	1.210	0.829
Mean	**VIF**	**2.310**

Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author.**

Notwithstanding, there is a strong correlation between almost all variables, as the Frame 3 provides, while all have a positive trend, as expected with the previous exploratory statistics:

Frame 3 - Correlation Matrix of variables

Variable	lProduction	lTFP	lOccupiedPeople	lTotalTillage	lAnnualInvestment	lCapitalStock	lPIA	lPlantedPastages	lNaturalPastages
lProduction	**1.000**	*0.699*	**0.840**	**0.939**	**0.922**	*0.629*	*0.677*	*0.672*	*0.625*
lTFP	*0.699*	**1.000**	*0.508*	*0.621*	*0.592*	0.462	0.324	0.336	0.331
lOccupiedPeople	**0.840**	*0.508*	**1.000**	**0.898**	**0.911**	*0.592*	*0.597*	**0.740**	*0.691*
lTotalTillage	**0.939**	*0.621*	**0.898**	**1.000**	**0.976**	**0.706**	*0.677*	*0.676*	*0.634*

Variable	lProduction	lTFP	lOccupiedPeople	lTotalTillage	lAnnualInvestment	lCapitalStock	lPIA	lPlantedPastages	lNaturalPastages
lAnnualInvestment	**0.922**	*0.592*	**0.911**	**0.976**	**1.000**	**0.731**	*0.677*	*0.666*	*0.622*
lCapitalStock	*0.629*	0.462	*0.592*	**0.706**	**0.731**	**1.000**	0.480	0.346	0.357
lPIA	*0.677*	0.324	*0.597*	*0.677*	*0.677*	0.480	**1.000**	**0.793**	**0.782**
lPlantedPastages	*0.672*	0.336	**0.740**	*0.676*	*0.666*	0.346	**0.793**	**1.000**	**0.951**
lNaturalPastages	*0.625*	0.331	*0.691*	*0.634*	*0.622*	0.357	**0.782**	**0.951**	**1.000**

Legend: *** p<0.01, ** p<0.05, * p<0.1
Bold/red values indicate correlations > |0.7|
Italic/blue values indicate correlations > |0.5| and < |0.7|
Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author.**

There is almost perfect correlation, close to 1, in lProduction to lTotalTillage and to lAnnualInvestment; lTotalTillage to lAnnualInvestment; and lPlantedPastures to lNaturalPastures. Furthermore, there is a high correlation, 0,7 to 0,9, in lOccupiedPeople to lTotalTillage; and lPIA to lPlantedPastures and lNaturalPastures. Due to collinearity, a 2SLS model is the most appropriate approach. In the first stage, the endogenous variable (lTotalTillage) is regressed on the instrumental variables. In the second stage, the predicted values of lTotalTillage from the first stage are used to explain the dependent variable (lProduction).

The apparent paradox of low VIFs with high correlation is caused by the way each variable's multiple correlation compensates for multicollinearity in the VIF calculation. This issue is exacerbated by problems with the size of the data, resulting from data unavailability for some cities. Therefore, careful attention must be paid to selecting a subset of variables to ensure coefficient stability and isolate their individual effects

5.1.3. Exploratory regression

As stated in the previous section, the logarithm of Production was regressed individually to each independent variable, and to Total Tillage. Each one but two is significant to explicate Logarithmical Production, as marked with an l before the variable name, already calculated with robust standard error with random effects, as demonstrated through Table 4:

Table 4 - OLS regression with each independent variable on the logarithm of the value of production with random effects

	(1) lProduction	(2) lProduction	(3) lProduction	(4) lProduction	(5) lProduction	(6) lProduction	(7) lProduction	(8) lProduction	(9) lProduction
lTotalTillage	0.826***								
	(28.65)								
lOccupiedPeople		0.460***							
		(4.61)							
lAnnualInvestment			0.492***						
			(7.81)						
lCapitalStock				0.191***					
				(5.83)					
lTotalPastures					0.106				
					(0.82)				
lPlantedPastures						-0.0558			
						(-0.48)			
lNaturalPastures							0.183***		
							(3.51)		
lWAP								0.271*	
								(2.14)	
lTFP									0.512***
									(15.55)
_cons	2.213***	6.367***	5.320***	8.107***	8.607***	10.47***	8.126***	7.498***	5.737***
	(7.99)	(7.75)	(8.73)	(21.42)	(5.60)	(7.84)	(15.91)	(6.70)	(17.50)
N	387	361	388	266	325	325	322	321	221

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author.**

Planted and total pastures were the only variables that did not bring explanatory capacity to the model, due to their coefficients in simple linear regression, and can be discarded for that purpose. Nevertheless, that significance in all variables, Total Tillage confirms the literature information, which, based on Hoffman (1992) and Medeiros et al. (2012), reflects a framework of intensive exploitation of the abundant resource (land), with the overall R-square explaining more than three-quarters of the variance (0.7622).

Due to almost all the variance in Production being explained by Total Tillage, the regression with all the variables of individual significance, as above, becomes poor, what is shown in Table 5:

Table 5 - Exploratory Multiple OLS Regression to Logarithmic Value of Production with Random Effects

	-1 lProduction		
lTFP	0.297***	Juína	0.159
	(6.54)		(0.51)
lOccupiedPeople	-0.0433	AltaFloresta	0.449
	(-1.08)		(1.59)
lTotalTillage	0.514***	PeixotodeAzevedoGuar-antãdo	-0.151*
	(10.68)		(-2.21)
lAnnualInvestment	-0.0174	Juara	0.112
	(-0.58)		(0.64)
lCapitalStock	-0.00367	BarradoGarças	0.0188
	(-0.18)		(0.12)
lWAP	0.133***	ConfresaVilaRica	-0.125
	(3.96)		(-1.41)
lPlantedPastures	-0.00961	ÁguaBoa	0.0848
	(-0.30)		(0.43)
lNaturalPastures	0.0127	Rondonópolis	-0.0918
	(0.70)		(-0.89)
TangarádaSerra	0.0790	PrimaveradoLeste	-0.0212
	(0.75)		(-0.16)
Diamantino	-0.0152	Jaciara	-0.0854
	(-0.11)		(-0.91)
Cáceres	0.0363	year1980	0.137
	(0.27)		(1.03)
PonteseLacerdaComo-doro	0.0299	year1985	0.0632
	(0.23)		(0.64)

	-1 lProduction		
MirassolDoeste	0.0528	year1995	0
	(0.50)		(.)
Sinop	0.0631	year2006	0
	(0.56)		(.)
Sorriso	0.0346		
	(0.30)	_cons	2.253***
			(5.27)
Wald chi2(1) = 657.87		*Prob > chi2 = 0.0000*	
N		*102*	

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Prob>chi2 = 0.0000
Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by author.**

Despite there being no concerns about collinearity, the pairs of correlations are high, as shown in this chapter. For this reason, variables must be taken out. First, WAP and Occupied People could capture the same phenomenon: the labor market. WAP is defined as people of working age, which includes people above 15 years old until 2001 and above 10 years after 2002[26], and Occupied People refers to people working, which makes it wise to choose one or another. The last refers to the labor market itself, while the first is a proxy, which the coefficients confirm.

Given this situation, WAP will be chosen as it is statistically significant in explaining Total Tillage in the model presented in the upcoming chapter, unlike Occupied People. This can be attributed to the exploratory situation explained by Joanoni Neto and Guimarães Neto (2019, p. 104), which results in the variable not capturing the labor market effectively. A model including Occupied People yields a p-value of 0.481 for this variable, which may be due to the rural environment having non-agricultural aspects, as Silva (2001) concluded. Another problem arises with Natural Pastures; when included in such a model, this variable reaches a p-value of 0.260. For these reasons, the model will be specified with all the variables presented above, excluding those related to Pastures and Occupied People.

[26] As seen in BRASIL.IBGE (2018. p. 17).

5.2. Econometric analysis of production function

A model with a satisfactory explanation could be fitted only with Total Tillage as an independent variable. However, it could not adequately explain the geographical distribution of the dependent variable. That is the main reason to use regression analysis in this thesis because it will demonstrate that institutional changes in the Military Regime caused the difference in the growth in regions in Mato Grosso.

The regression must take another path, in which all explanatory variables will be used as instruments to perform a two-stage least squares regression. The individual regressions are shown in the coming table, in which almost all variables explain a little of Production, as presented in the literature consulted, in Solow (1957), Romer (1986), Moreno (2007), Gasques *et alli* (2022), and Rezende (2002); however, Total Tillage explains almost all the Production, as it can also be found in Rezende (2022), but especially in Hoffman (1992) and Medeiros et al. (2012). Consequently, these independent variables will be used as instruments to predict Total Tillage in the first stage, and the predicted Total Tillage will then be used to explain Production in the second stage.

The first regression will be performed with Total Tillage as the dependent variable and the others as independent variables in multiple linear regression, what is provided with Table 6:

Table 6 - Multiple OLS Regression to Logarithmic Total Tillage with random effects

	lTotalTillage		
lTFP	0.370***	PeixotodeAzevedoGuarantãdo	-0.522
	(8.43)		(-1.49)
lWAP	0.267*	Juara	0.841*
	(2.46)		(2.46)
lAnnualInvestment	0.205**	BarradoGarças	0.878*
	(3.22)		(2.34)
lCapitalStock	0.182**	ConfresaVilaRica	-0.238
	(2.91)		(-0.65)
TangarádaSerra	0.888*	ÁguaBoa	1.374**

	lTotalTillage		
	(2.54)		(2.72)
Diamantino	0.622	Rondonópolis	0.676*
	(1.43)		(2.49)
Cáceres	-0.0716	PrimaveradoLeste	1.441*
	(-0.28)		(2.55)
PonteseLacerdaComodoro	0.932	Jaciara	0.578*
	(1.60)		(2.00)
MirassolDoeste	-1.186**	year1980	0.594**
	(-2.62)		(3.01)
Sinop	0.422	year1985	0.460*
	(0.51)		(2.22)
Sorriso	1.750***	year1995	0
	(5.37)		(.)
Juína	-0.455	year2006	1.435***
	(-1.82)		(5.64)
AltaFloresta	-1.323	_cons	-1.329
	(-1.44)		(-1.25)
Wald chi2(24) = 7865.89		*Prob > chi2 = 0.0000*	
N		*126*	

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Prob>chi2 = 0.0000
Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author.** Complete regression is located on ANNEX C – COMPLETE REGRESSION PRESENTED IN TABLES 4 AND 5**.**

As seen in the frame, most variable dependents are significant in explaining Total Tillage. TFP with a p-value less than 0.001 confirms the expected effects of productivity; Annual Investment and Capital Stock are significant at an elevated level of 0.01, and WAP at a level of 0.05, which can also be considered high. Furthermore, the F-statistic is highly significant ($p <$ 0.0001), which suggests that the chosen instruments are strong and of good quality.

Annual dummies are significant, but 1995 is omitted due to collinearity problems. This situation comes from the lack of observations of the Value of land in this Agricultural and Cattle Census, which did not allow the calculation of Capital Stock.

The available data lose some significance because most cities in Mato Grosso's agricultural frontier, where institutional changes were most active, are not included in the panel for all years, as shown by the Emancipation variable in Appendix B with a timeline located on https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/municipal_emancipation_timeline.html. Nonetheless, geographical dummies achieve at least a p-value of 0.1, except in Diamantino; Cáceres; Pontes e Lacerda e Comodoro, despite being close to it; Sinop; Alta Floresta; Peixoto de Azevedo e Guarantã do Norte; and Confresa e Vila Rica. A significance level of 0.15 will maintain only Cáceres, Diamantino, and Sinop without significance, despite Diamantino being close to it.

The Hausman test's p-value will reach 0.0501. Statistically, this indicates that differences in coefficients are not systematic, and random effects are preferable, but not for an elevated level of significance. Despite that, the geographical distribution of different growth rates grants more confidence in the test's results. For these reasons, random effects will be maintained.

Assured random effects, the heteroscedasticity in such model is not a concern, because the F-test of a regression of squared residuals to all the independent variables in the first stage reaches 0.9445. Notwithstanding, when regressing residuals against its lagged values for testing autocorrelation, the test is unconclusive due to the nature of the unbalanced panel, in which there are only four periods of time, which leads to only 2 observations for correlation of residuals and its lagged values. Hence, the suspicious about correlation leads to estimate all the models of variance with Swany-Arora, Huber-White/sandwich robust standard errors, cluster-robust standard errors, and Baltagi–Chang.

Table 7 demonstrates that there are differences between Swany-Amora's standard errors and significances from the other formulas of variance:

Table 7 – Regression of lTotal Tillage against independent variables with different estimators for variance

	(1) Model 1 (Swany-Amora)	(2) Model 2 (Huber-White)	(3) Model 3 (Cluster)	(4) Model 4 (Robust, Baltagi–Chang)
lTFP	0.3696***	0.3696***	0.3696***	0.3696***
	(0.0437)	(0.0438)	(0.0438)	(0.0438)

	(1) Model 1 (Swany-Amora)	(2) Model 2 (Huber-White)	(3) Model 3 (Cluster)	(4) Model 4 (Robust, Baltagi–Chang)
lPIA	0.2667**	0.2667**	0.2667**	0.2667**
	(0.1062)	(0.1082)	(0.1082)	(0.1082)
lAnnualInvest-ment	0.2054***	0.2054***	0.2054***	0.2054***
	(0.0664)	(0.0638)	(0.0638)	(0.0638)
lCapitalStock	0.1824***	0.1824***	0.1824***	0.1824***
	(0.0503)	(0.0627)	(0.0627)	(0.0627)
Tan-garádaSerra	0.8877**	0.8877**	0.8877**	0.8877**
	(0.4039)	(0.3496)	(0.3496)	(0.3496)
Diamantino	0.6224	0.6224	0.6224	0.6224
	(0.3834)	(0.4348)	(0.4348)	(0.4348)
Cáceres	-0.0716	-0.0716	-0.0716	-0.0716
	(0.5791)	(0.2579)	(0.2579)	(0.2579)
PonteseLacer-daComodoro	0.9315**	0.9315	0.9315	0.9315
	(0.4475)	(0.5821)	(0.5821)	(0.5821)
Mirassol-Doeste	-1.1859**	-1.1859***	-1.1859***	-1.1859***
	(0.5050)	(0.4524)	(0.4524)	(0.4524)
Sinop	0.4217	0.4217	0.4217	0.4217
	(0.5093)	(0.8193)	(0.8193)	(0.8193)
Sorriso	1.7496***	1.7496***	1.7496***	1.7496***
	(0.4114)	(0.3256)	(0.3256)	(0.3256)
Juína	-0.4549	-0.4549*	-0.4549*	-0.4549*
	(0.5706)	(0.2493)	(0.2493)	(0.2493)
AltaFloresta	-1.3227**	-1.3227	-1.3227	-1.3227
	(0.6016)	(0.9181)	(0.9181)	(0.9181)
Peixoto-deAzeve-doGuarantãdo	-0.5221	-0.5221	-0.5221	-0.5221
	(0.6085)	(0.3507)	(0.3507)	(0.3507)
Juara	0.8413	0.8413**	0.8413**	0.8413**
	(0.5666)	(0.3415)	(0.3415)	(0.3415)
BarradoGarças	0.8781**	0.8781**	0.8781**	0.8781**
	(0.3778)	(0.3756)	(0.3756)	(0.3756)
ConfresaVi-laRica	-0.2384	-0.2384	-0.2384	-0.2384
	(0.4098)	(0.3695)	(0.3695)	(0.3695)
ÁguaBoa	1.3736***	1.3736***	1.3736***	1.3736***
	(0.4468)	(0.5054)	(0.5054)	(0.5054)

	(1) Model 1 (Swany-Amora)	(2) Model 2 (Huber-White)	(3) Model 3 (Cluster)	(4) Model 4 (Robust, Baltagi–Chang)
Rondonópolis	0.6755**	0.6755**	0.6755**	0.6755**
	(0.3228)	(0.2712)	(0.2712)	(0.2712)
Primaverado-Leste	1.4406***	1.4406**	1.4406**	1.4406**
	(0.4825)	(0.5652)	(0.5652)	(0.5652)
Jaciara	0.5779	0.5779**	0.5779**	0.5779**
	(0.4427)	(0.2886)	(0.2886)	(0.2886)
year1980	0.5939***	0.5939***	0.5939***	0.5939***
	(0.1831)	(0.1976)	(0.1976)	(0.1976)
year1985	0.4600**	0.4600**	0.4600**	0.4600**
	(0.1872)	(0.2070)	(0.2070)	(0.2070)
year1995	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
year2006	1.4347***	1.4347***	1.4347***	1.4347***
	(0.2159)	(0.2543)	(0.2543)	(0.2543)
_cons	-1.3285	-1.3285	-1.3285	-1.3285
	(0.9959)	(1.0631)	(1.0631)	(1.0631)
Observations	126	126	126	126
Wald chi2	377.83	7865.89	7865.89	7865.89

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notwithstanding, Huber-White and the subsequent models exhibit similar standard errors and significance levels. For this reason, they will be used to overcome the statistical insignificance of Juína, Juara, and Jaciara, and to increase the significance for Mirassol D'Oeste, despite a potential loss of significance for Pontes e Lacerda and Alta Floresta. Furthermore, the increase in the Wald chi-squared value from 377.83 to 7,865.89 suggests that the Swany-Amora model's assumption of homoskedasticity was violated, even if initial tests strongly indicated otherwise.

It must be said that the regional dynamic does not operate perfectly, as the institutional changes do not reach all cities in the Immediate Regions, but those reached by the institution of the Land Market and those reached by Transports. That is the reason for obtaining pairs of dynamic and slower paces of growth-sided in the same region, as can be found in the duos of Poxoréo and Primavera do Leste, for example, constituting the same dilemma that in Nogales, as presented by Acemoglu and Robinson (2012, pp. 7-8).

Despite those problems, it can be shown that there are regions that confirm the hypothesis because their coefficients are more than one and significant. In Sorriso, Primavera do Leste, and Água Boa, the average production is more than the average production in the Cuiabá region, used as control, in an amount that can be seen after the last regression stage and demonstrated through Table 8:

Table 8 - Generalized 2SLS to Logarithm of Production with Random Effects

	(1) lProduction
lTotalTillage	0.850***
	(25.65)
_cons	2.487***
	(7.38)
N	126

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Prob>chi2 = 0.0000
Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author.** Complete regression is located on ANNEX C – COMPLETE REGRESSION PRESENTED IN TABLES 4 AND 5**.**

These estimations confirm what was stated previously: Solow's model (1957) is the most significant one to explain economic growth in Mato Grosso with the consideration of TFP. More capital per worker, taken as land per worker, leads to higher production, and as the overall R-square reaches 0.8619, it is authorized not to follow Kim and Lavoie (2016), including returns, animal spirits, and technical progress.

5.2.1. Production function in Mato Grosso after institutional changes

Despite the essential part of the production function, according to the hypothesis of this thesis, as already stated soon after presenting the first stage of the regression, it is a favorable start for the complete two stages. The reason lies in describing and discussing the coefficients in the geographical context.

In Table 8, the coefficient of Total Tillage reaches 0.850, which is a little less than one. This coefficient reaches high significance due to the low probability of z and represents a production function with decreasing returns to scale.

Nevertheless, the situation can reach other levels when managing that content geographically, as demonstrated in Table 9. Although not all geographical dummies are statistically significant in Table 6, those that contribute meaningfully to the production function.

Table 9 - Coefficients of geographical production function in Table 7 multiplied by Table 8

	Coefficient (Table 7)	Total increment (Table 7 x Table 8)
Tangará da Serra	0.888*	0.7548
Diamantino	0.622	0.5287
Cáceres	-0.0716	-0.06086
Pontes e Lacerda e Comodoro	0.932	0.7922
Mirassol D'oeste	-1.186**	-1.0081
Sinop	0.422	0.3587
Sorriso	1.750***	1.4875
Juína	-0.455	-0.38675
Alta Floresta	-1.323	-1.12455
Peixoto de Azevedo e Guarantã do Norte	-0.522	-0.4437
Juara	0.841*	0.71485
Barra do Garças	0.878*	0.7463
Confresa-Vila Rica	-0.238	-0.2023
Água Boa	1.374**	1.1679
Rondonópolis	0.676*	0.5746
Primavera do Leste	1.441*	1.22485
Jaciara	0.578*	0.4913

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Prob>chi2 = 0.0000
Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author.**

Due to unavailable data and city differences, not all the coefficients are significant, at least at a higher level. Despite that fact, the institutional changes implemented made regions advance significantly beyond the control region, Cuiabá. Remarkably, Sorriso, which is bordered by the hub of BR-163 and marked by the effects of Land Market, in the projects of colonization made in the region, Primavera do Leste, by the axis of BR-070, and Água Boa, by the axis of BR-158 and the effects of Land Market. Respectively, they reach coefficients of 1.4875, 1.22485, and 1.1679, which mark the crescent incomes in the production function.

In contrast, regions without those changes reach lower levels than the control region. Cáceres, Peixoto de Azevedo – Guarantã do Norte, and Confresa-Vila Rica reach negative coefficients, despite being not significant. Albeit being in the BR-163, Peixoto de Azevedo – Guarantã do Norte has two important cities and just two others, all of which were emancipated just in time to have data in 1995 but one in 2006, which turns impossible to regress because of the lack of observations, also due to the cited lack of Value of land in this Agricultural and Cattle in the 1995 Census. For instance, Mirassol D'Oeste reaches negative levels compared to the production function of Mato Grosso, confirming it as a region of lower pace with statistical significance.

Other regions, Tangará da Serra, Juara, Barra do Garças, Rondonópolis, and Jaciara, reach significant levels, despite being less than the control region. First, Rondonópolis and Jaciara are on the borders of BR-163, allowing them to achieve institutional changes, despite not being as high as Sorriso, because they were not touched by the effects of the Land Market. Juara is touched by these effects, but not by Transports, which can be seen in Graph 7, as the city depends on complementary access to federal highways. Tangará da Serra did not pass by any of the institutional changes directly; however, it is not an outlier, due to its closeness to BR-364, which connects to the BR-163 hub. Barra do Garças seems to be an outlier too, however, it is the largest city close to the possible hub forming along the BR-158 and is located on the BR-070, an axis directed to the Brazilian capital.

For these reasons, it is possible to see a pattern, in which institutional changes, marked by Land Market, especially through colonization projects that expanded the agricultural frontier, or Transports, in which hub, BR-163, or axes, BR-070 and BR-158, conducted, despite not perfectively, to differentiation in economic growth. These new institutions allowed rules of economic comportment that decrease uncertainty, as in the definitions of institutions by North (2018, pp. 13-17), and facilitated coordination to form expectations, as in the definition by Ruttan and Hayami (1984, pp. 3 – 4), which brought a reduction of transactional costs. In that

differentiation, reminiscent institutions from Portuguese America eroded themselves by implementing capitalistic ones, which led to an even newer institution, the Rural Enterprise that Moreno identified (2007, pp. 286 – 288).

5.2.2. Structural break in the production function of Mato Grosso

There is two potential breaks in the production function of Mato Grosso that can be detected through a Chow test. One is that Kandir Law allowed an explosive growth of production, while the other is if TFP changed from the period of 1975-1985 to the period 1995-2006, excluding 1985-1995, because of fiscal consolidation and decay of TFP in that period.

5.2.2.1.Kandir Law allowing a boom of growth

First, it is possible can assess whether the Kandir Law (Brazil, 1996) induced a structural break in the entire production function. Implemented in 1996, this law introduced tax exemptions for the export of raw materials, with the intent of fostering capital accumulation essential for economic development—a mechanism discussed by Santos and Marta (2013, pp. 225–226).

Despite what these authors wrote at that time, in which Mato Grosso fell from a more complex productive chain in the past to a rawer one, there is evidence on the contrary nowadays. The development of activities allowed a systematic change in agriculture and cattle production in the state, which led to the organization of complexes, such as those in BR-163. Throughout the highway, it is possible to perceive an articulation of the circuits of production with the sequencing of meat and grains, such as Felippe *et alli* (2021, p. 20).

A Chow Test can be employed to examine whether there is a structural break. The results of the three regressions are shown below, as the first is the one presented in Table 7; the second is the last, excluding 2006 observations and variables; and the last includes just that data, which turns it into cross-sectional data. All these results are put together in Table 10:

Table 10 - Multiple OLS Regression to Logarithmic Value of Production to calculate Chow statistics for Kandir Law structural break

Production function	Constant	Coeficient	Robust Standard Error	P>|z| or P>|t|	Prob>chi2 or Prob> F	Overall R-sq or R-sq
Without restrictions	1.5606	0.8969	0.0398	0.0000	0.0000	0.7695

Production function	Constant	Coeficient	Robust Standard Error	P>|z| or P>|t|	Prob>chi2 or Prob> F	Overall R-sq or R-sq
Untill 1995	2.4884	0.8195651	0.0761	0.0000	0.0000	0.6481
After1995	0.9417	0.9533	0.0412	0.0000	0.0000	0.8136
k		22		**n**		383

Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author.**

While the hypothesis could have been formulated earlier, it is more appropriate to present it at this stage, in Table 11, because it entails a dual proposition: its acceptance or rejection determines whether a structural break exists, thereby potentially altering the production structure in Mato Grosso:

Table 11 - Hypothesis in Chow Test for Production function

	Comparision	Situation to null hypothesis	Meaning	Conclusion
H0 No structural break	Chow statistics < Tabulated F	H0 did not reject	Absence of structural break	Kandir Law did not modify the production function in MT
Halternative Structural break	Chow statistics > Tabulated F	H0 rejected	Presence of a structural break	Kandir Law modified the production function in MT

Elaborated by author.

Table 12, by presenting the SSR for the three regressions and the degrees of freedom for the Chow statistics, allows for economic conclusions to be drawn:

Table 12 - Chow test made for structural break in the Production Function of Mato Grosso

		All years	untill 1995	only 2006	k+1
Regressions	**n**	387	247	140	23
	SSR	216.1206918	132.6288977	79.812138	383
Chow test	**DF**	numerator	22		
	DF	denominator	343		
	Chow statistics		0.253787885		
	F tabled	at 0.05 significance	0.554703946		
	P-value	0.00018983920			
Economic conclusion	**H0 rejected**	*Structural break reached*	*Kandir Law modified production function*		

Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author**

As the Chow statistic reaches 0.2538, for 22 degrees of freedom in the numerator and 343 in the denominator, tabulated F reaches 0.5547. For that reason, the null hypothesis is rejected, which implies that there is a structural break and Kandir Law modifies the production function of Mato Grosso. Consequently, institutional changes paved the way for Kandir Law to achieve a boom of growth. Without them, the effects would tend to be smaller, although there is significant importance in performing this test. As Kandir Law modifies the production function, it is possible to realize that it is amid the formation of another critical juncture, in which the differences lead to explosive growth in the 21st century.

It is a matter of interest to follow a path of breaking in two, one-panel data before and one cross-sectional data after the structural break. Such a method faces problems with collinearity in the variables Sorriso, Peixoto de Azevedo, and Guarantã do Norte and 1995, which first stage is presented in Table 13 and the complete is presented in Table 14:

Table 13 - Generalized Least Squares Regression of Logarithms of Total Tillage with Random Effects Before Structural Break

	-1 lTotalTillage		
lTFP	0.242***	PeixotodeAzevedoGuarantãdo	0
	(4.62)		(.)
lPIA	0.132	Juara	0.918
	(1.04)		(1.69)
lAnnualInvestment	0.297**	BarradoGarças	0.394
	(3.22)		(1.18)
lCapitalStock	0.256	ConfresaVilaRica	-0.466
	(1.86)		(-0.83)
TangarádaSerra	0.106	ÁguaBoa	1.400**
	(0.26)		(2.87)

	-1 lTotalTillage		
Diamantino	0.937*	Rondonópolis	0.429
	(2.14)		(1.59)
Cáceres	0.171	PrimaveradoLeste	0.692
	(0.30)		(1.36)
PonteseLacerdaComodoro	-0.0101	Jaciara	0.517
	(-0.02)		(1.48)
MirassolDoeste	-0.903	year1980	0.486**
	(-1.92)		(2.83)
Sinop	0.245	year1985	0.382
	(0.38)		(1.95)
Sorriso	0	year1995	0
	(.)		(.)
Juína	-0.504	_cons	-0.610
	(-0.91)		(-0.51)
AltaFloresta	-0.103		
	(-0.16)		
N		70	

t statistics in parentheses
(.) indicates collinearity
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Prob>chi2 = 0.0000
Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by author.**

Table 14 - Generalized Two-Stage Least Squares to Logarithmic Production with random effects before the structural break

	(1) lProduction

lTotalTillage	0.843***
	(14.16)
_cons	2.646***
	(4.58)
N	70

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Prob>chi2 = 0.0000
Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by author.**

The model's results for the period before the structural break must be interpreted with caution. High collinearity between the dummy variables for the Sorriso and Peixoto de Azevedo-Guarantã do Norte regions prevents the model from reliably isolating the independent effect of each region on agricultural production. This collinearity has its origins in the lack of observations in the great part of cities in this region, due to their recent emancipation, and in the lack of Capital Stock for the 1995 Census. For those reasons, the model more fits our purposes is the one presented in Table 6 and Table 7, which will be seen in more detail further ahead. It encompasses not only Solow's model but also all available data.

5.2.2.2. TFP changing from 1975-1985 to 2006

After, it is possible to perform the same test in the interaction term between TFP and 1995-2006 period, or the data provided by the 2006 Census. Along with excluding 1995 subset, due to the structural break achieved even without the test, this is the only difference between the other test made in the upward subsection, which return Table 15:

Table 15 - Multiple OLS Regression to Logarithmic Value of Production to calculate Chow statistics for TFP structural break

Production function	**Constant**	**Coeficient**	**Robust Standard Error**	**P>|z| or P>|t|**	**Prob>chi2 or Prob> F**	**Overall R-sq or R-sq**
Without restrictions	2.6177	0.8366	0.0304	0.0000	0.0000	0.8619
Untill 1985	2.646119	0.8426071	0.0595	0.0000	0.0000	0.7717
After 1995	2.6345	0.8259111	0.03980	0.0000	0.0000	0.9253
k			24		**n**	270

Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author.**

Using the same framework as before, adapted to a new finding, it will be reached that acceptance or rejection of the null hypothesis will lead to lTFP being equal or not during 1975-1985 than in 2006, as in Table 16:

Table 16 - Hypothesis in Chow Test for lTFP

	Comparision	Situation to null hypothesis	Meaning	Conclusion
H0 No structural breake	Chow statistics > Tabulated F	H0 accepted	Absence of structural break	TFP is equal during 1975-1985 and in 2006
Halternative Structural breake	Chow statistics < Tabulated F	H0 rejected	Presence of structural break	TFP is not equal during 1975-1985 and in 2006

Elaborated by the author.

Table 17, by presenting the SSR for the three regressions and the degrees of freedom for the Chow statistics, allows for economic conclusions to be drawn, as already made in the upward subsection:

Table 17 - Chow test made for structural break in the coefficient of TFP

		All years	untill 1985	only 2006	k+1
Regressions	**n**	270	130	140	24
	SSR	154.680624	69.334694	79.812138	270
Chow test	**Degress of freedom**	numerator	23		
	Degress of freedom	denominator	2224		
	Chow statistics		0.34320257		
	F tabled	at 0.05 significance	0.559478151		
	P-value	0.00182605962			
Economic conclusion	**H0 rejected**	*Structural break reached*	*TFP is not equal during 1975-1985 and in 2006*		

Source: BRASIL. IPEA, 2024a, BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author.**

As the Chow statistics reaches 0.3432, for 2^{27} degrees of freedom in the numerator and 224 in the denominator, tabulated F reaches 0.5598. For that reason, the null hypothesis is rejected, which implies that there is a structural break and TFP significant changes between the 1975-1985 period to 2006.

This leads to the direct finding that technology and other embodied factors in TFP are more present in the 21st century than until the 1980s. However, it also points out the constraint of the institution of Land Market that was placed during this century, in which the legal restraint of expanding land leads to a more intensive production in technology, reaching the central thesis of a new trajectory for wealth generation in agriculture and cattle activities of Buianain et al.((org.), 2014, pp. 1167-1169).

5.3. Demographic analysis of the behavior of the population of Mato Grosso since the 1970s

5.3.1. Dependence ratio between 1970 and 2022 Census

Table 6 and Table 7 demonstrated that a 1% increase in WAP is associated with a 30.60% increase in Total Tillage. Consequently, considering the coefficient of Total Tillage of 0.85, a 30.60% increase in Total Tillage would lead to 30.60%×0.85=26.01% increase in Production. Therefore, a 1% increase in WAP indirectly leads to an estimated 26.01% increase in Production.

First, it is necessary to establish concepts. According to IBGE (2018, p. 17), WAP is calculated as people above 10 years since 2002. Here, the older concept, in which 15 years is the minimum limit, will be used due to the starting point of the data in 1970. Furthermore, it makes the calculations of the dependence ratio more precise, because the group between 10 and 14 years is completely settled in the young dependence ratio. Furthermore, it represents better childhood efforts nowadays that set child labor less present and permits comparing these measurements through time. In addition to it, elderly people are settled as 65 years and above, despite IBGE calculating their dependence ratio as 60. The reason is also to settle comparisons and to reflect nowadays labor market, as the minimum age for retirement in case of age is 65 years for

[27] Remembering that degrees of freedom in the denominator are lesser here, due to the exclusion of 1995 data, and are higher in numerator, due to the inclusion of interaction term.

men[28], which also does not mean that they retire from the work labor force (Brasil. IPEA, 2012, p. 9).

The decline in the youth dependency ratio since the 1970s is calculated, for each inter-censal period, as the percentage change between a given Census and the prior one, using data aggregated by Immediate Regions based on municipal composition from IBGE (2017) aand demonstrated in Table 18:

Table 18 - Young dependence ratio change in the Immediate Regions of Mato Grosso from 1970 to the 2022 Census calculated to the immediate previous Census

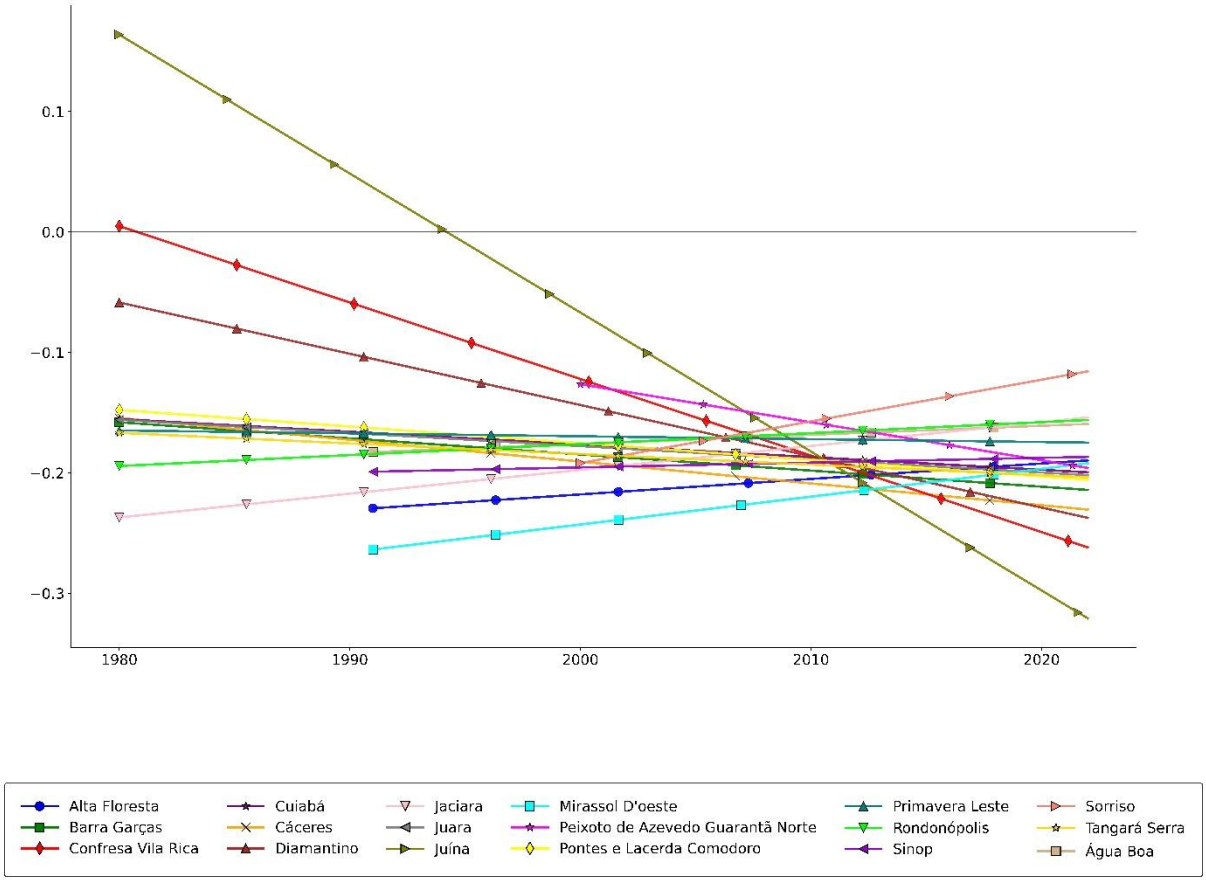
	Young				
Immediate Regions	**1980**	**1991**	**2000**	**2010**	**2022**
Água Boa	-	-15,44%	-21,82%	-16,42%	-14,98%
Alta Floresta	-	-25,36%	-15,03%	-26,71%	-17,15%
Barra do Garças	-6,01%	-24,33%	-24,84%	-24,25%	-13,39%
Cáceres	-8,38%	-20,50%	-27,58%	-22,11%	-17,33%
Confresa - Vila Rica	5,23%	-4,12%	-22,23%	-22,96%	-18,92%
Cuiabá	-8,69%	-16,37%	-27,38%	-25,68%	-10,42%
Diamantino	4,69%	-16,67%	-21,41%	-26,83%	-12,93%
Jaciara	-17,23%	-27,55%	-21,78%	-21,20%	-10,41%
Juara	-8,07%	-24,99%	-17,13%	-25,30%	-13,78%
Juína	38,38%	-19,42%	-15,33%	-19,71%	-20,87%
Mirassol D'oeste	-	-23,40%	-26,88%	-24,93%	-16,65%
Peixoto de Azevedo - Guarantã do Norte	-	-	-4,82%	-30,16%	-13,07%
Pontes e Lacerda - Comodoro	-12,23%	-15,42%	-22,37%	-21,27%	-16,83%
Primavera do Leste	-8,50%	-18,82%	-25,20%	-24,74%	-7,65%
Rondonópolis	-12,48%	-21,86%	-21,83%	-24,52%	-7,14%
Sinop	-	-22,14%	-11,91%	-27,41%	-15,84%
Sorriso	-	-	-12,40%	-28,19%	-5,92%
Tangará da Serra	-8,40%	-28,03%	-16,79%	-24,56%	-14,71%

Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by author.**
Legend: - Unavailable data, due to the cities not being emancipated

Fitted Lines can demonstrate better this process of constant fall of the rate of young dependency ratio in the Immediate Regions of Mato Grosso. They are plotted in a linear function with Python in Graph 16:

[28] Art. 52 from the Law 8213/1991. In: BRASIL. Lei nº 8.213, de 24 de julho de 1991. Dispõe sobre os Planos de Benefícios da Previdência Social e dá outras providências. Diário Oficial da União, Brasília, DF, 25 jul. 1991. Disponible at: https://www.planalto.gov.br/ccivil_03/leis/l8213cons.htm. Acessed: 16 fev. 2025.

Graph 16 - Fitted lines for young dependency ratio in Immediate Regions of Mato Grosso from 1970 to 2022 Census



Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.** The interactive plot is shown at: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/Young_dependency_ratio.html.

It is possible to achieve patterns, albeit nearly all regions decrease their rate of dependency ratio related to young people. Juína fell from the higher level to the lowest, as Confresa to the deputy's place in both. Notwithstanding, this state pattern has four regions of recovery: Sorriso, Jaciara, Rondonópolis, and Água Boa, which are regions in which institutional changes operated, especially Sorriso and Água Boa. Apart from considerations of a baby boom after COVID-19, it has been occurring since 1970, which could indicate a point of attraction for the labor force, WAP, which has led to an increase in births and increments in children already grown. Primavera do Leste could pave the same path due to institutional changes because it passes by another countermovement of stability.

Despite these considerations, the analysis here provides only indicative insights, as all Brazilian regions undergo demographic transition. As Vasconcelos (2012, p. 543) notes, increases in WAP may reduce the dependency ratio simply because of growth in the denominator.

According to him, in 1970, all Brazilian regions were already in this process because the fall in mortality, especially in the childish one, generalized itself, and fecundity started to fall. Therefore, the population was expected to grow with an increase in life expectancy. For this reason, it is remarkable that the demographic compound of the young dependence ratio in regions increases or maintains the indicator; however, it cannot indicate much to the purposes here when falling.

For instance, the rate of change in the elderly dependency ratio rises at the same time, as Table 19 demonstrates:

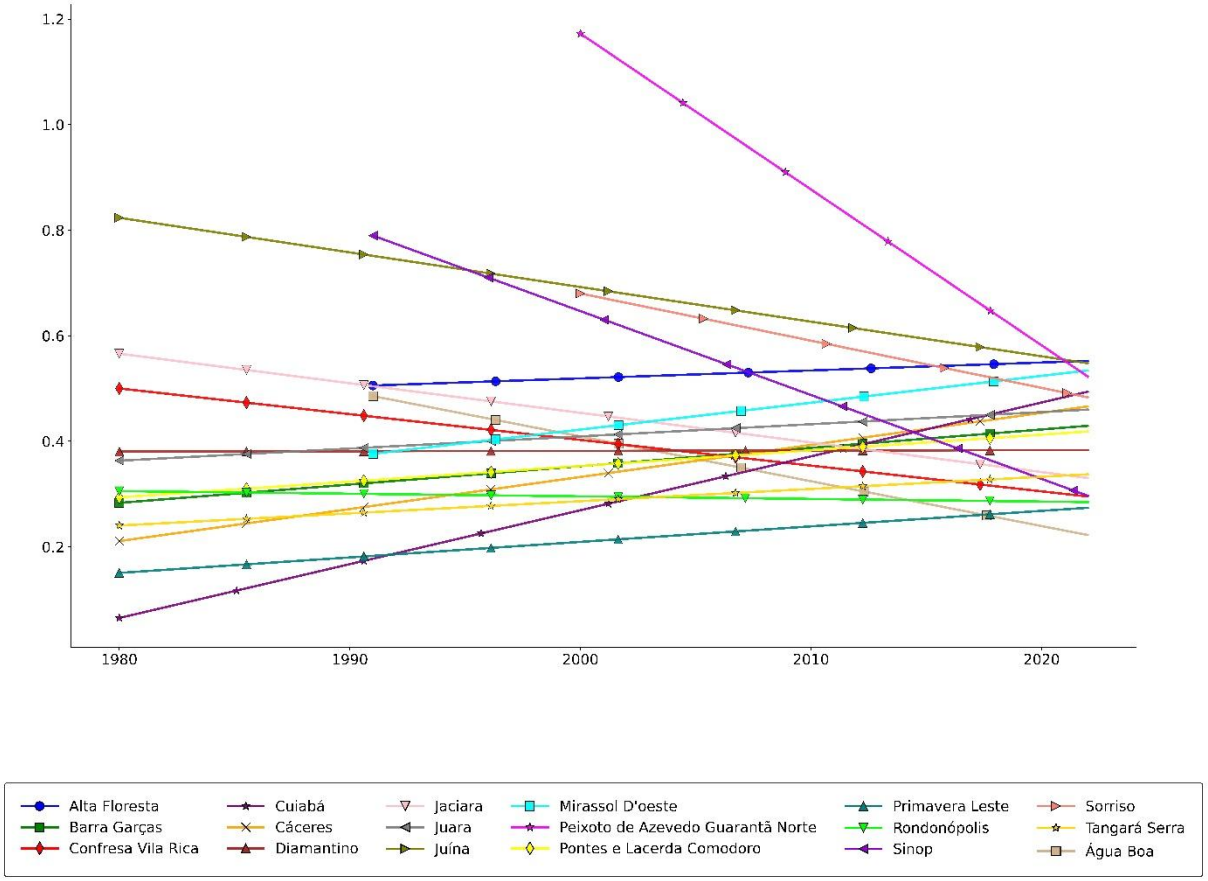
Table 19 - Elderly Dependence Ratio change in Immediate Regions of Mato Grosso from 1970 to 2022 Census calculated to the immediate previous Census

	Elderly				
Imediate regions	**1980**	**1991**	**2000**	**2010**	**2022**
Água Boa	-	53,31%	32,28%	35,97%	22,56%
Alta Floresta	-	26,78%	87,72%	49,18%	47,43%
Barra do Garças	40,16%	13,20%	34,42%	47,83%	41,81%
Cáceres	25,07%	27,24%	20,86%	49,33%	45,46%
Confresa - Vila Rica	71,46%	24,38%	24,00%	42,44%	37,53%
Cuiabá	19,74%	-8,66%	16,72%	32,96%	59,61%
Diamantino	59,62%	13,27%	36,63%	29,67%	51,68%
Jaciara	82,42%	28,56%	28,94%	36,06%	49,25%
Juara	47,75%	30,28%	31,11%	43,35%	52,82%
Juína	67,90%	116,42%	53,58%	35,25%	71,00%
Mirassol D'oeste	-	43,94%	37,37%	39,86%	59,37%
Peixoto de Azevedo - Guarantã do Norte	-	-	127,79%	68,38%	61,05%
Pontes e Lacerda - Comodoro	49,31%	0,75%	38,99%	44,10%	44,29%
Primavera do Leste	21,32%	12,19%	10,71%	36,37%	24,92%
Rondonópolis	50,21%	12,13%	20,18%	23,64%	41,50%
Sinop	-	91,88%	47,52%	46,85%	35,83%
Sorriso	-	-	83,42%	30,80%	61,17%
Tangará da Serra	44,61%	13,56%	7,78%	30,71%	47,25%

Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by author.**
Legend: - Unavailable data, due to the cities not being emancipated

It is also better analyzed with fitted lines, plotted in the same way as before, using Graph 17:

Graph 17 - Fitted lines for elderly dependency ratio in Immediate Regions of Mato Grosso from 1970 to 2022 Census



Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.** The interactive plot is shown at: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/Elderly_dependency_ratio.html.

There is a constant increase in the rate of elderly dependence ratio in all regions, but the same which has increased the young dependence ratio. Sinop decreased its ratio, which is consistent with its path of young dependence ratio, due to it being almost maintained, so as Juína, Jaciara, Rondonópolis, and Água Boa, which indicates that WAP could be attracted to this region, lowering the ratio by the denominator. Also, Peixoto de Azevedo – Guarantã do Norte decrease its rate, however maintaining in a higher level, the fourth. For the reasons above, it only shows patterns due to the demographic transitions when seeking the counter path, in this case falling ratio.

Another indicator can be shown seeking the total dependence ratio because the demographic transitions mean, in other words, that this index has been falling during this period, as provided through Table 20:

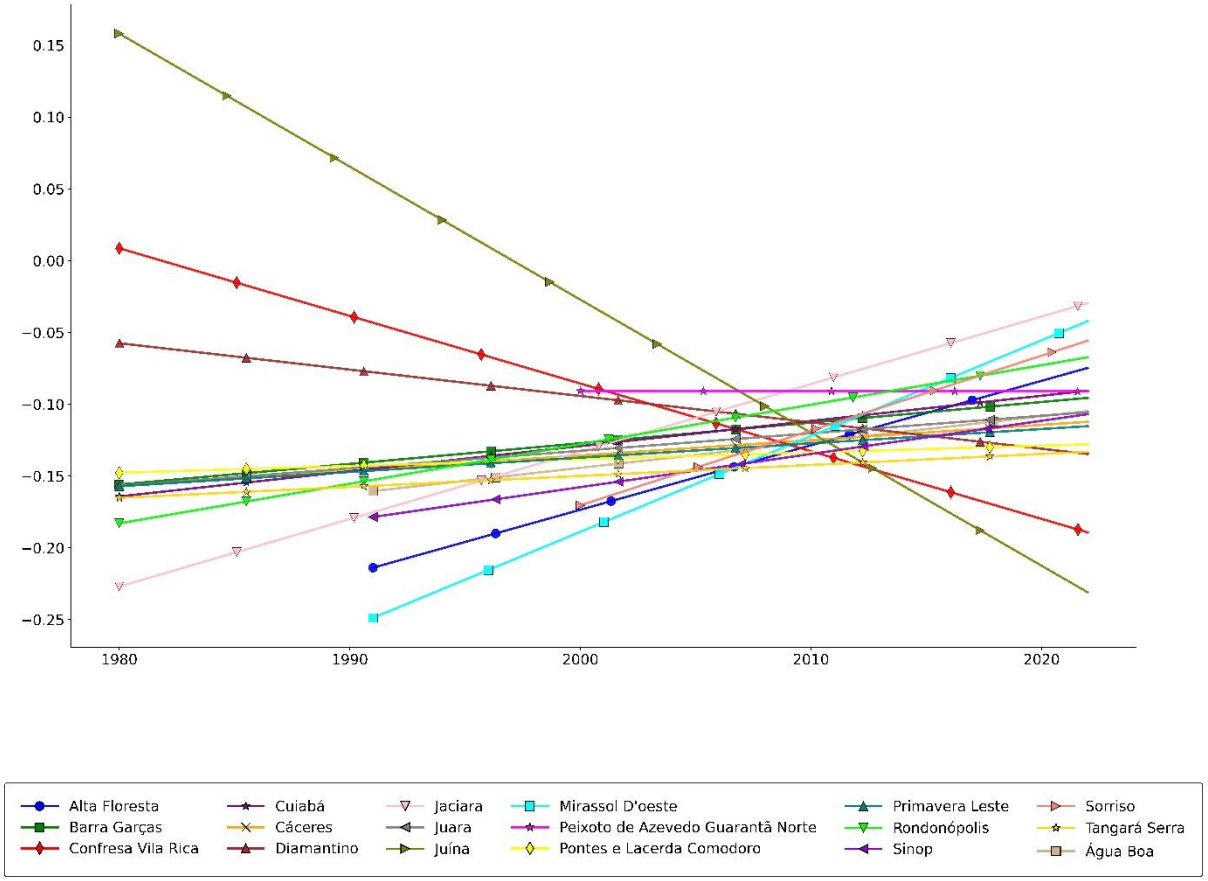
Table 20 - Total dependence ratio change in the Immediate Regions of Mato Grosso from 1970 to 2022 Census calculated to the immediate previous Census

	Total				
Immediate regions	1980	1991	2000	2010	2022
Água Boa	-	-13,29%	-18,83%	-11,70%	-9,77%
Alta Floresta	-	-23,91%	-10,26%	-19,34%	-5,55%
Barra do Garças	-4,37%	-22,37%	-20,33%	-15,01%	-1,08%
Cáceres	-7,20%	-18,22%	-23,97%	-13,66%	-4,48%
Confresa - Vila Rica	6,94%	-2,94%	-19,77%	-17,57%	-10,88%
Cuiabá	-7,22%	-15,85%	-24,19%	-19,16%	2,38%
Diamantino	6,55%	-15,15%	-17,48%	-20,49%	-1,11%
Jaciara	-14,59%	-24,38%	-16,90%	-12,66%	3,46%
Juara	-6,81%	-23,01%	-14,21%	-18,95%	-2,88%
Juína	38,78%	-17,22%	-12,41%	-15,62%	-9,91%
Mirassol Doeste	-	-20,74%	-22,27%	-16,71%	-0,47%
Peixoto de Azevedo - Guarantã do Norte	-	-	-1,07%	-23,75%	-2,43%
Pontes e Lacerda - Comodoro	-10,75%	-14,76%	-19,43%	-15,88%	-8,19%
Primavera do Leste	-7,34%	-17,24%	-22,73%	-18,72%	-2,27%
Rondonópolis	-10,03%	-19,64%	-18,00%	-18,09%	2,66%
Sinop	-	-19,71%	-8,88%	-21,28%	-7,90%
Sorriso	-	-	-9,85%	-25,00%	0,42%
Tangará da Serra	-6,96%	-26,27%	-15,19%	-19,98%	-6,33%

Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by author.**
Legend: - Unavailable data, due to the cities not being emancipated

Also, fitted lines can demonstrate this pattern better in Graph 18:

Graph 18 - Fitted lines for total dependency ratio in Immediate Regions of Mato Grosso from 1970 to 2022 Census



Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.** The interactive plot is shown at: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/Total_dependency_ratio.html.

All regions increase their rates during the period from 1980 to 2022, but Juara, Confresa – Vila Rica, and Diamantino. Nevertheless, they all are beyond the null level in the 21st century, which is consistent with the demographic transition, what means that total dependence phenomena did not describe patterns of economic growth. In Mato Grosso, Cunha (2006, p.93), which is translated here, described these demographic dynamics in the 1980s:

> (…) the state could be roughly divided into two portions: the north, comprising an area of greater demographic dynamism in the last two decades; and the south, forming a more consolidated area with lower rates of demographic increase. While localities in the far north, such as Alta Floresta, Colíder, and Alto Teles Pires, grew at very high rates in the 1980s, this did not occur in the more southern regions, except for Cuiabá and Rondonópolis, which, even in the 1990s, showed some "breath," growing at rates above 2% per year. In fact, in these two cases, there are micro-regions where important urban centers are located - the main cities of the state

> - which have greater economic diversification, not because the first concentrates practically all the state administrative apparatus as the capital of Mato Grosso (...)

5.3.2. Working-Age People

It is necessary to demonstrate how the WAP performed during that period to achieve clearer patterns, according to the model previously obtained and computed in Table 21:

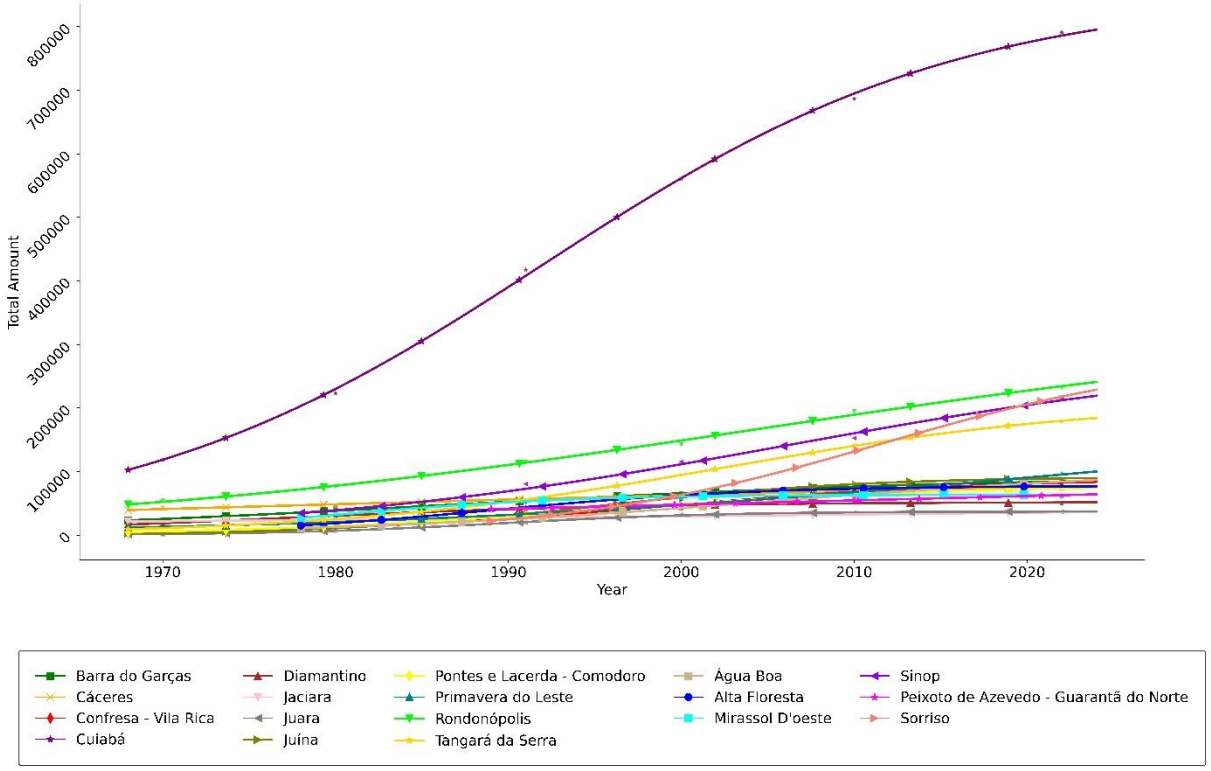
Table 21 - WAP change in Immediate Regions of Mato Grosso from 1970 to 2022 Census calculated to the immediate previous Census

	WAP				
Regions	**1980**	**1991**	**2000**	**2010**	**2022**
Água Boa	-	352.33%	41.59%	33.86%	44.26%
Alta Floresta	-	321.57%	8.36%	18.46%	14.10%
Barra do Garças	103.76%	27.82%	19.18%	9.79%	21.68%
Cáceres	6.38%	20.64%	15.51%	12.46%	1.85%
Confresa - Vila Rica	391.58%	95.54%	76.04%	41.02%	21.33%
Cuiabá	88.67%	86.88%	34.30%	22.42%	15.17%
Diamantino	65.63%	46.83%	-3.63%	21.74%	-4.25%
Jaciara	-13.44%	20.80%	22.35%	8.17%	4.33%
Juara	1206.82%	141.90%	65.47%	9.88%	4.32%
Juína	446.86%	400.50%	42.36%	48.68%	8.61%
Mirassol D'oeste	-	45.79%	8.30%	8.37%	-4.81%
Peixoto de Azevedo - Guarantã do Norte	-	-	-0.49%	31.52%	7.71%
Pontes e Lacerda - Comodoro	157.23%	164.61%	46.88%	24.60%	23.17%
Primavera do Leste	50.47%	49.45%	51.60%	31.97%	50.93%
Rondonópolis	41.86%	50.42%	23.89%	36.69%	18.93%
Sinop	-	164.05%	43.98%	32.09%	40.62%
Sorriso	-	-	114.81%	113.07%	64.77%
Tangará da Serra	155.64%	80.52%	81.32%	49.94%	25.94%

Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by author.**
Legend: - Unavailable data, due to the cities not being emancipated

It is interesting to fit lines for the values of WAP, not percentage change as before, to analyze its trajectory path in Graph 19:

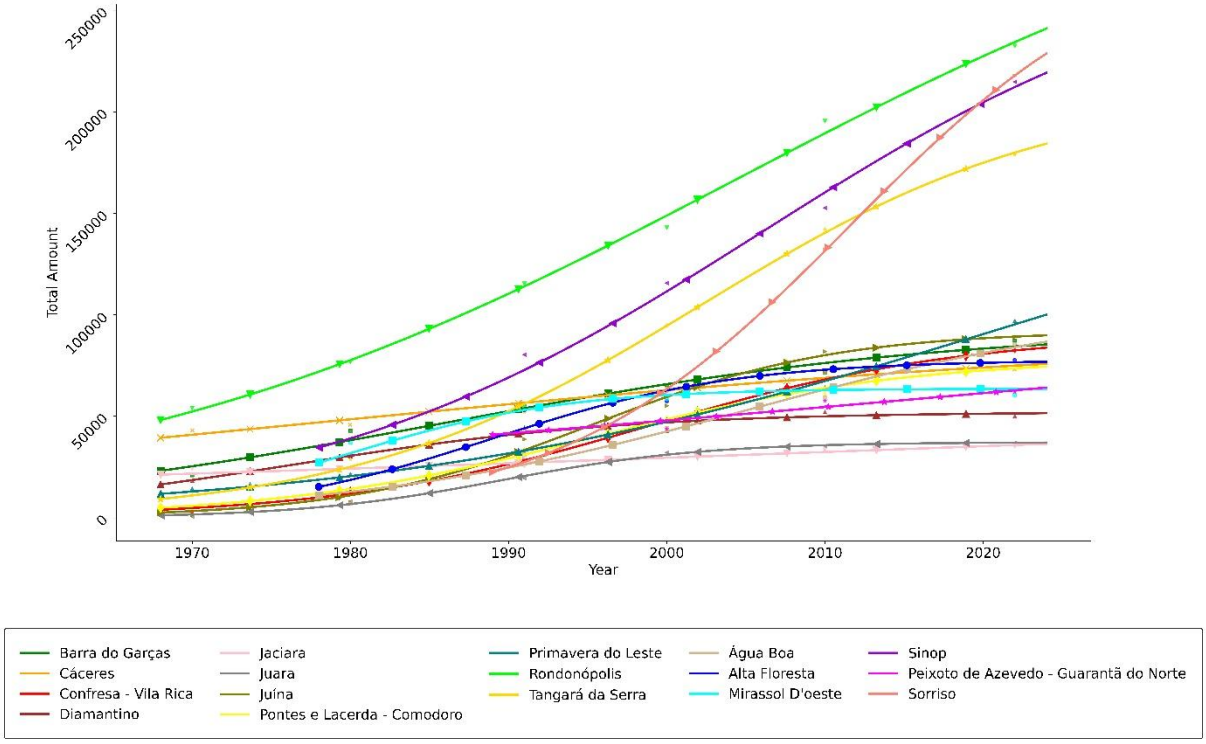
Graph 19 - WAP logarithmical fitted lines for the regions of Mato Grosso from 1970 to the 2022 Census



Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.** The interactive plot is shown at: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/WAP_interactive_fits.html.

All regions increase their labor force, as shown previously. However, the most populous areas, such as Cuiabá, Rondonópolis, Sinop, Sorriso, and Tangará da Serra capture the graph, and it is possible to see a pattern that regions that have appeared in institutional changes, and Cuiabá, are also highlighted here. Notwithstanding this, there is a need to use the logarithmic function. This throws out three regions, Confresa – Vila Rica, Peixoto de Azevedo – Guarantã do Norte e Pontes e Lacerda – Comodoro, as its regression cannot achieve sufficient observations, what authorizes to use exponential function on these, and to be more comprehensible, Cuiabá will be separated from the Graph 20:

Graph 20 – WAP logarithmical fitted lines in the Immediate Regions of Mato Grosso but Cuiabá, from 1970 to the 2022 Census



Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.** The interactive plot is shown at: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/WAP_interactive_fits.html.

The significance of WAP to the value of Production, as detailed in Table 7, underscores the critical role of institutional changes in shaping a region's demographic trajectory and consequently to economic growth. Regions that passed through the changes experience more proportional increases in their WAP, leading to a more notable decrease in their total dependency ratio, as observed by Cunha (2006). This aligns with Rios-Neto's (2009, 2012) observations that effective demographic transitions imply a demographic bonus, a period where a large WAP can fuel economic growth. Conversely, without these crucial shifts, the demographic transition can lead to stagnation, primarily characterized by a disproportionate rise in the elderly dependency ratio.

This also reflects the second stylized fact from Jones and Romer (2010, pp. 233-237), which posits an acceleration in economic and population growth. The exogenous shocks of the Military Regime, through institutional changes, led to varying rates of return in cities that underwent these changes and exhibited inclusive institutions. This suggests that the institutional changes caused by the observed population growth rates, as indicated by the analyzed data.

The regions undergoing institutional changes consistently occupy higher positions in terms of WAP increase. For example, Sorriso has ascended remarkably, reaching the third position in the 2022 Census, having surpassed Tangará da Serra, which held the sixth place since the 1980 Census. Similarly, Água Boa demonstrates significant upward mobility, improving its rank by three regions in the 2022 Census alone, and by eleven since the 1990 Census. In stark contrast, regions lacking these beneficial institutional shifts show relative decline. Cáceres has been overtaken by nine regions since the 1970 Census, a similar pattern seen with Mirassol D'Oeste. Jaciara, now at the lowest level in the 2022 Census, marks a significant drop from its seventh position in the 1970 Census. Interestingly, Juara, which was at the very last position in the 1970 Census, has managed to improve to the tenth position, suggesting some positive shifts in its development.

This pattern connects with institutional changes, as the regions marked by the new institutions of Land Market and Transports and newer Rural Enterprise are presented in the upper curves of the logarithmic fitted lines graph. Due to the positive correlation reached between WAP and Production, passing through Total Tillage, this leads to the contribution of labor force to economic growth differentiation, as the transactional costs are reduced, by the decrease of the uncertainty of property rights, as exposed in the Institutional Theory, as stated by North (2018, pp. 13-17).

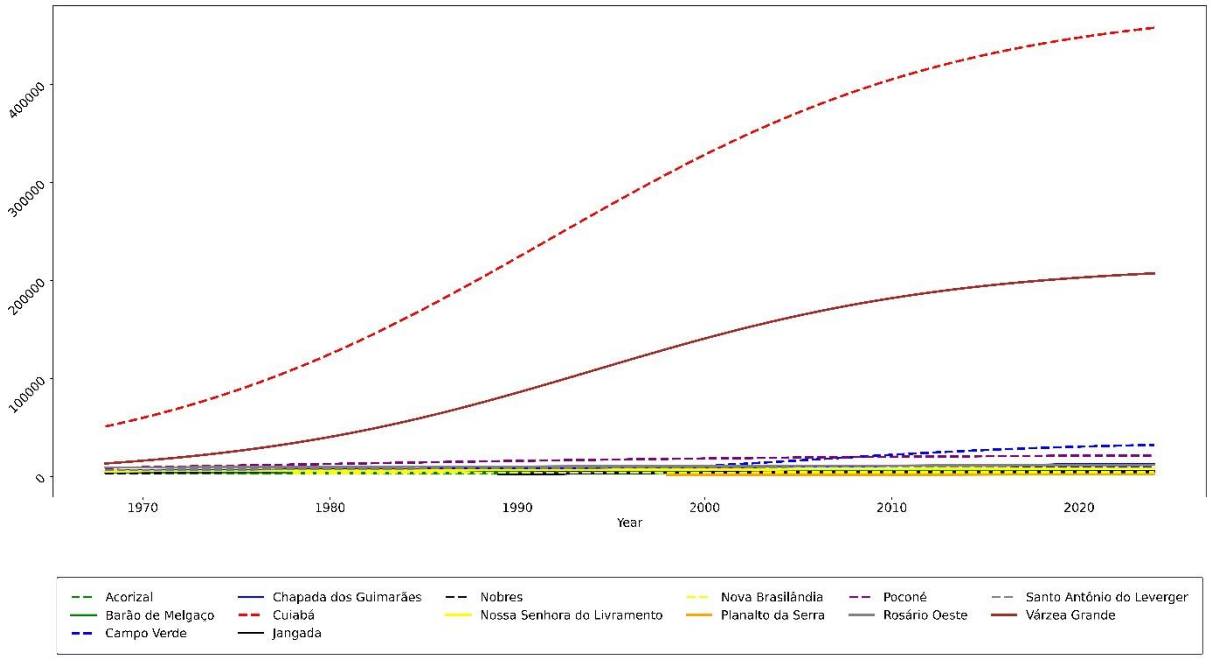
The definition of property rights and the existence of legal power to refrain from its violations are the link between production factors and economic growth. This, read as an increase in productivity, occurs by reducing transactional costs, as North pointed out (1989, pp. 1323-1324). Since the definition of how these costs decrease by reducing the uncertainty of property rights, Institutional Theory can constitute a better comprehension of the differentiation in economic growth between the Immediate Regions in Mato Grosso state.

Furthermore, the increase of WAP is interesting because it can accompany an improvement in income distribution, as Ananias (2015, p. 69) demonstrates in her research. Inequality is expressive in the, then, microregions that correspond here to first, Rondonópolis, and second, Sinop, despite the third, Tangará da Serra, deteriorated, and those in the bottom are the ones linked to the microregions of higher poverty, as also related by her (2015, p. 74). Furthermore, according to Moi (2018, p. 72), illiteracy, a symptom and a cause of inequality and poverty, has a negative coefficient with agriculture and cattle variables. The implications of inequality and poverty to agriculture and cattle affairs, whether in its impact on the production function or the

consequences of the function after the institutional changes, must be researched; however, not at this time.

The curve of Cuiabá, which is not presented above for reason of legibility, rests on the capital and Várzea Grande, due to the lack of growth in the other cities inside the metropolitan region, despite a small increase in Campo Verde and Poconé, as is seen in the logarithmic fitted lines close to zero in Graph 21:

Graph 21 – WAP logarithmical fitted lines inside the Cuiabá immediate region from 1970 to the 2022 Census.



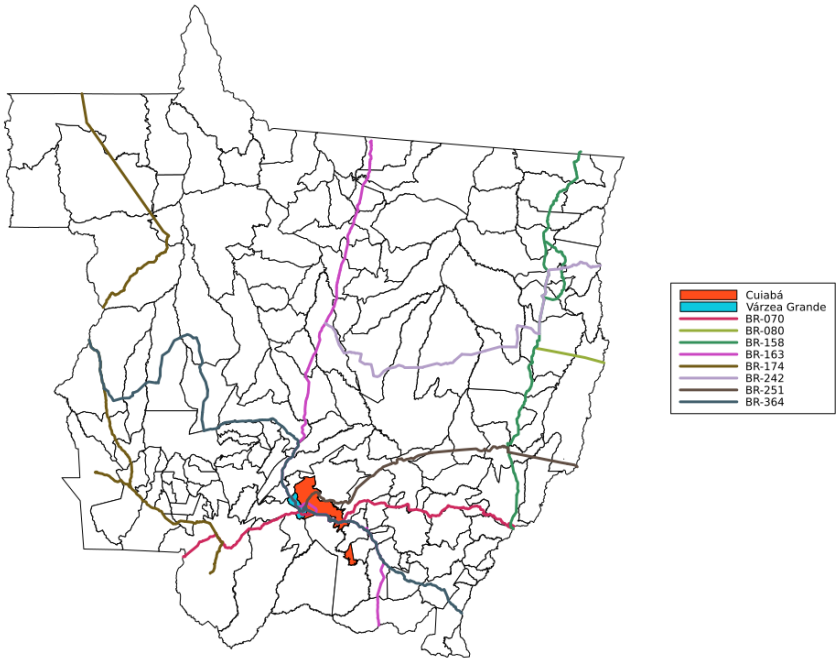
Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.** The interactive plot is shown at: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/WAP(Cuiabá Immediate Region).html.

The case here tends to be the same as the dilemma of Nogales, USA, and Nogales, Mexico, which are limited by each other, as Acemoglu and Robinson wrote (2012, pp. 7-8). The cities with more dynamic economies have better institutions, as is the case with Cuiabá and Várzea Grande, and the others have more reminiscent institutions of Portuguese America, in which changes like Land Markets and Transports did not operate to form Rural Enterprises or other types of capitalistic institutions.

In Cuiabá and Várzea Grande, one explanation for this growth path can already be shown, because the BR-163 hub borders them, as Graph 22 shows. The new institutions, marked by the hub which connects BR-070, BR-364, and BR-251, can promote changes to the rules of

comportment and reduce uncertainty. Notwithstanding, they are marked by urban economies, which can have another set of newer institutions that can significantly impact the differentiation of economic growth, as the institution in which this thesis was made, Ufmt.

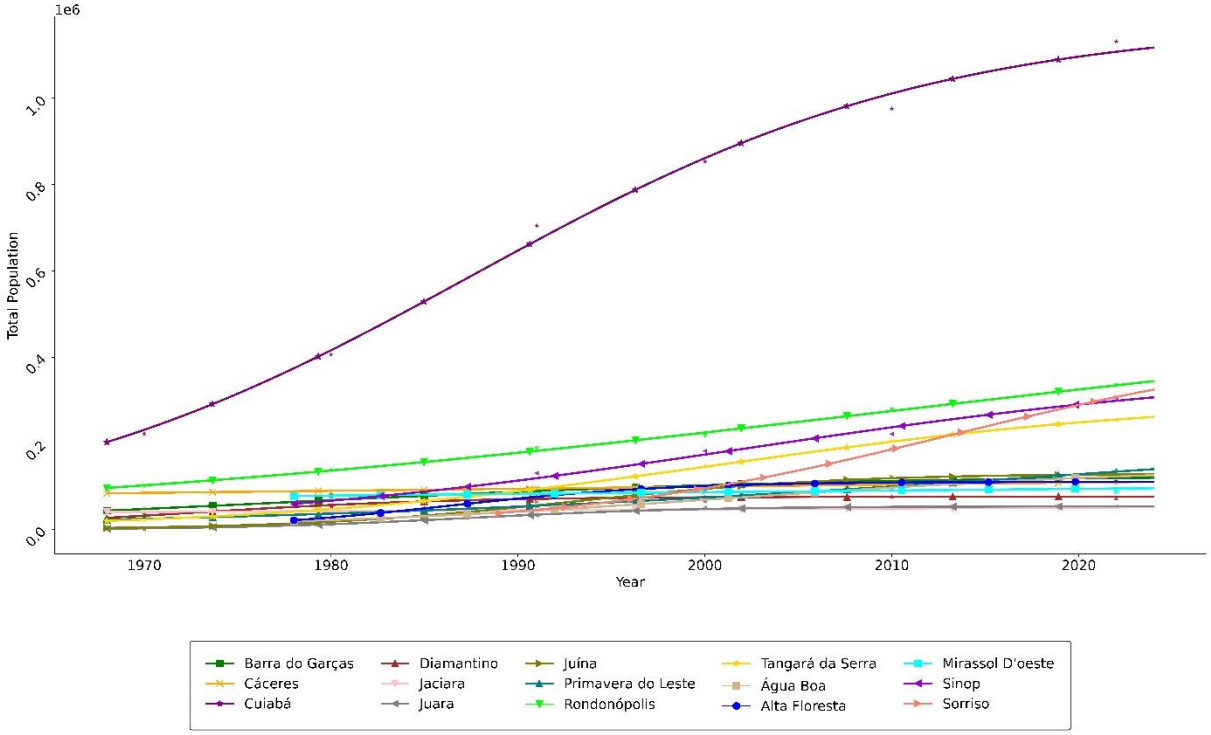
Graph 22 - BR-163 hub and cities of Cuiabá and Várzea Grande



Source: DNIT (2024), IBGE (2023), and Moi, 2018, p.32. **Elaborated by the author with Julia's language program.**

As stated before, Institutional Theory constitutes a better comprehension of the process of economic differentiation in Mato Grosso, due to its link to the definition of property rights and legal power to refrain from their violations. Adding to the fact that population has a positive correlation to production, as reached in Table 6, it is possible to follow populational data. They demonstrated that regions of institutional changes, and the region of Cuiabá, had a great increase in logarithmic population growth during the 21st century, while others came to a plateau, what is plotted through Graph 23:

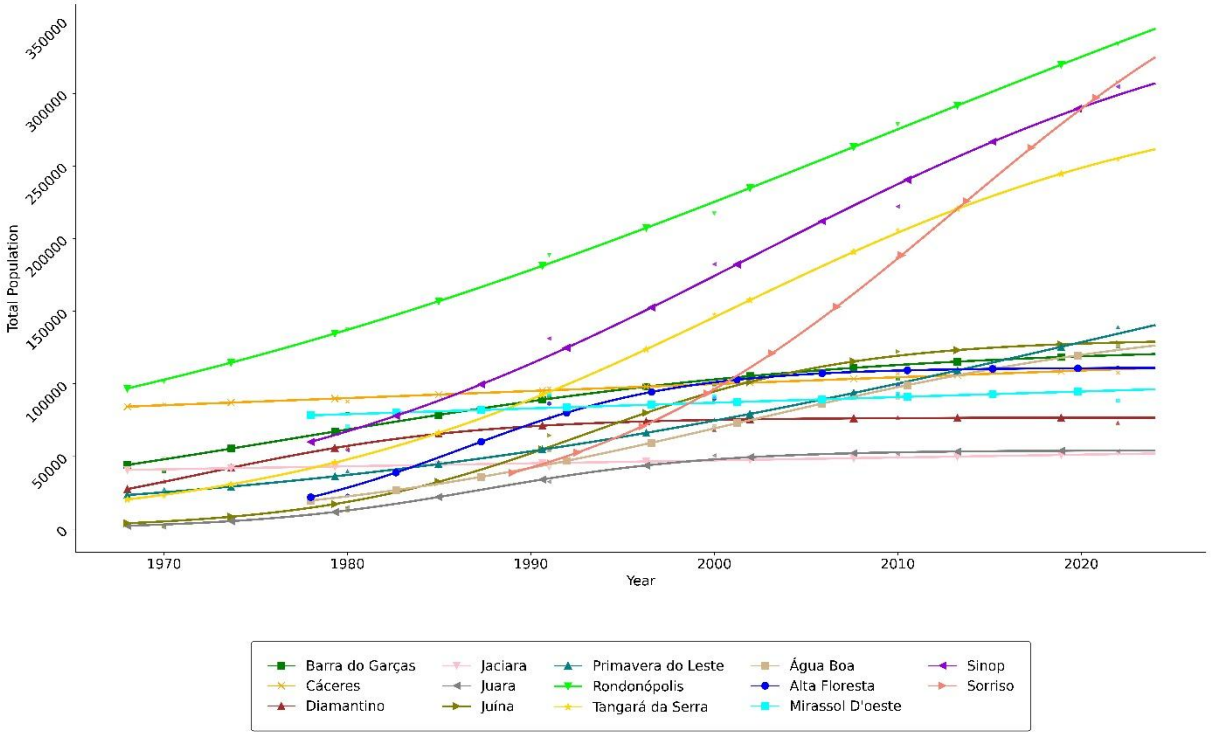
Graph 23 – Total population logarithmic fitted lines for total population from 1970 to the 2022 Census



Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.** The interactive plot is shown at: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/Total_population_interactive.html.

As expected Confresa – Vila Rica, Peixoto de Azevedo – Guarantã do Norte and Pontes e Lacerda – Comodoro did not achieve sufficient data to run logistic fitted lines, however at this time not even exponential fit could converge. Excluding Cuiabá, the legibility can be more adequate to see patterns, as Graph 24 demonstrates:

Graph 24 - Total population logarithmic fitted lines, excluding the Cuiabá immediate region, from 1970 to the 2022 Census

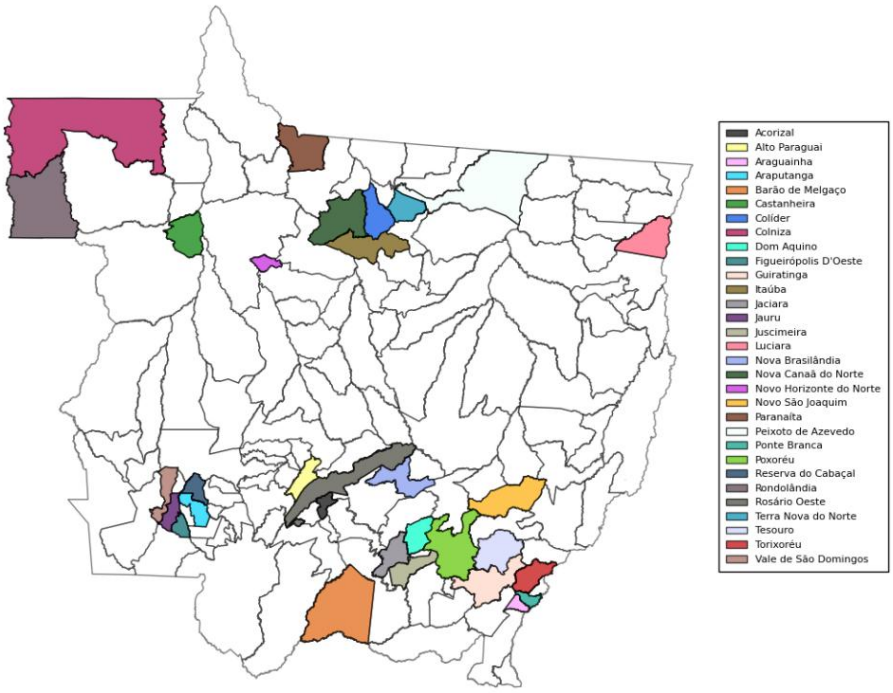


Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.** The interactive plot is shown at: https://davescordova.github.io/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-/Total_population_interactive.html.

Rondonópolis, Sorriso, Sinop, Tangará da Serra, Primavera do Leste, and Água Boa, marked by institutional changes, are increasing their population. Nevertheless, Cáceres is still slowly growing without passing them, and the other regions are on the plateau from the 2010 Census to 2022.

Furthermore, as shown in Graph 25, 31 cities are decreasing their total population. This trend is calculated using the earliest available Census data for these specific municipalities.

Graph 25 - Cities with a populational decrease



Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Julia's language program.**
Colors are placed only for legibility purposes without meaning the degree of falling.

Despite COVID-19 influences and city-specific situations, this process was already in progress before the pandemic. Furthermore, it is important to point out that recovery will be more difficult in those cities that have not passed the institutional changes or have other economic dynamism, like the capital's immediate region.

Hence, there is an estimation of how long these cities can endure in Table 22, using a logarithmic function for population change rate, as the model, and the linear method of Weinstein and Pillai (2015, pp. 260 – 264) for projection. After excluding Jaciara due to its positive coefficient, each of the others was used to project when the population declines to near zero, reaching the regression constant:

Table 22 - The time at which cities come to an end of the population

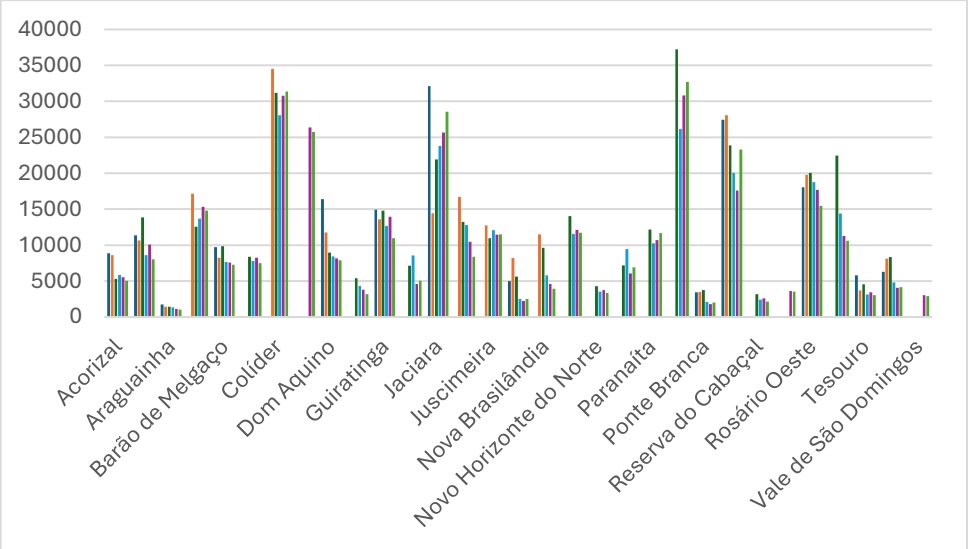
City	Immediate Region	Intermediary Region	Year of perishing
Acorizal	Cuiabá	Cuiabá	2109
Alto Paraguai	Diamantino	Cuiabá	2174
Araguainha	Rondonópolis	Rondonópolis	2124
Araputanga	Mirassol D'oeste	Cáceres	2988
Barão de Melgaço	Cuiabá	Cuiabá	2208
Castanheira	Juína	Sinop	2399

City	Immediate Region	Intermediary Region	Year of perishing
Colíder	Sinop	Sinop	2550
Colniza	Juína	Sinop	2531
Dom Aquino	Jaciara	Rondonópolis	2097
Figueirópolis D'Oeste	Mirassol D'oeste	Cáceres	2082
Guiratinga	Rondonópolis	Rondonópolis	2240
Itaúba	Sinop	Sinop	2083
Jauru	Mirassol D'oeste	Cáceres	2085
Juscimeira	Jaciara	Rondonópolis	2617
Luciara	Confresa - Vila Rica	Barra do Garças	2067
Nova Brasilândia	Cuiabá	Cuiabá	2058
Nova Canaã do Norte	Sinop	Sinop	2241
Novo Horizonte do Norte	Juara	Sinop	2180
Novo São Joaquim	Barra do Garças	Barra do Garças	2206
Paranaíta	Alta Floresta	Sinop	4133
Peixoto de Azevedo	Peixoto de Azevedo - Guarantã do Norte	Sinop	2628
Ponte Branca	Barra do Garças	Barra do Garças	2091
Poxoréu	Primavera do Leste	Rondonópolis	2177
Reserva do Cabaçal	Mirassol D'oeste	Cáceres	2112
Rondolândia	Juína	Sinop	2453
Rosário Oeste	Cuiabá	Cuiabá	2324
Terra Nova do Norte	Sinop	Sinop	2065
Tesouro	Rondonópolis	Rondonópolis	2116
Torixoréu	Barra do Garças	Barra do Garças	2100
Vale de São Domingos	Pontes e Lacerda - Comodoro	Cáceres	2263

Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by author.**

The fall could be due only to COVID-19, as Jaciara seemed to be. For this reason, it is wise to exclude those that constantly grew their population in the previous Census or on a clear path of recovery of the population, such as Araputanga, Castanheira, Colíder, Itaúba, Juscimeira, Novo Horizonte do Norte, Novo São Joaquim, Paranaíta, and Peixoto de Azevedo, which can be seen in Graph 26:

Graph 26 - Path of population growth in cities of fall in the 2022 Census



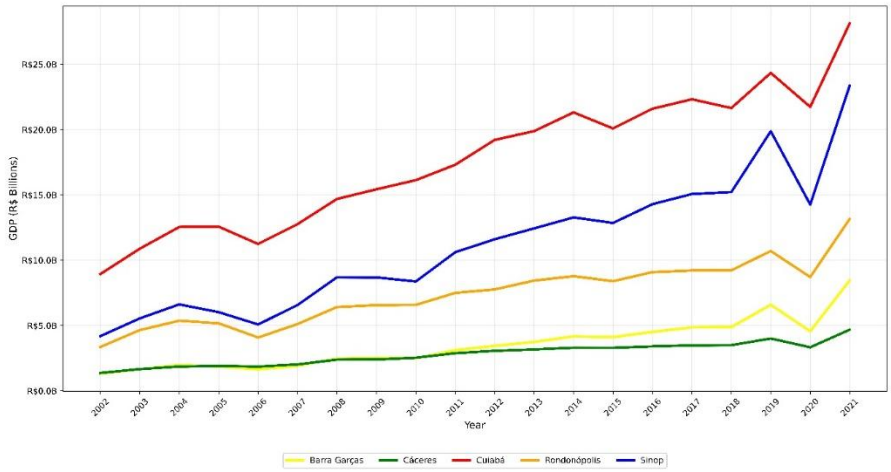
Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by author.**

That allowed the median year of perish by more than fifty years, from 2178, with all the data, to 2116, dropping those last listed. Furthermore, Immediate Regions marked by institutional changes have more cities excluded, as Alta Floresta dropped its unique city; same as Juara; Juína dropped one of its three, and Sinop two of its four. In Immediate Regions without institutional changes, Barra do Garças dropped one of its three, Jaciara one of its two, and Mirassol D'Oeste one of its four.

5.4. Economic growth in the 21st century

The increase in WAP, which reduces the dependency ratio, suggests higher economic growth due to the previously mentioned correlation, consistent with the literature on demographic transition, as noted by Rios-Neto (2009, p. 48). Therefore, as Production, including not only primary sectors but all, has been available to cities from 2002 until 2021 due to the initiation of the historical series of Municipal GDP IBGE (2024c), it can be used to seek patterns of growth by agglomerating them in Intermediate Regions, via Graph 27:

Graph 27 - Real GDP across the 21st century by Intermediate Regions (2002 values)

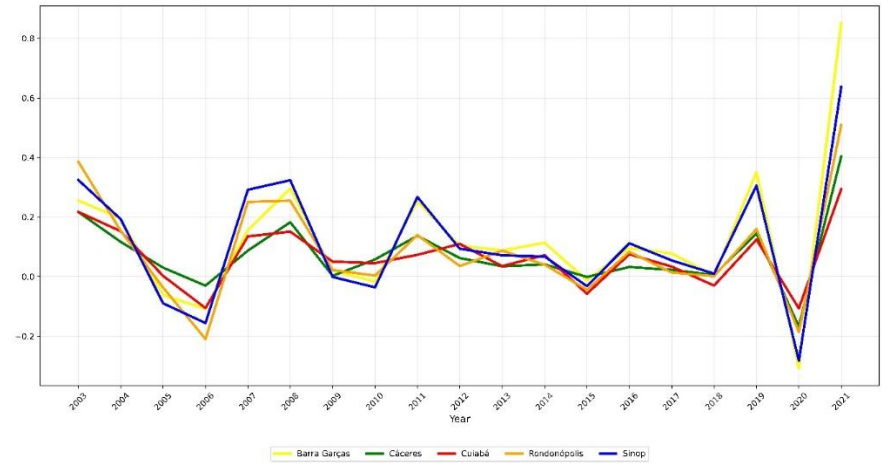


Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.**

The path of economic growth in all Intermediate Regions is shown; however, wealth generation is more consistent in the capital and Sinop. The short-run path approximates this region to that one, despite Rondonópolis also seeking to be closer to the Cuiabá region.

Looking at the percentage changes yearly in Graph 28, it is possible to see the non-constant growth during the century:

Graph 28 – Percentage increase of GDP calculated from the previous to the current year



Source: BRASIL. IBGE, 2024b and 2024c**. Elaborated by the author with Python language program.**

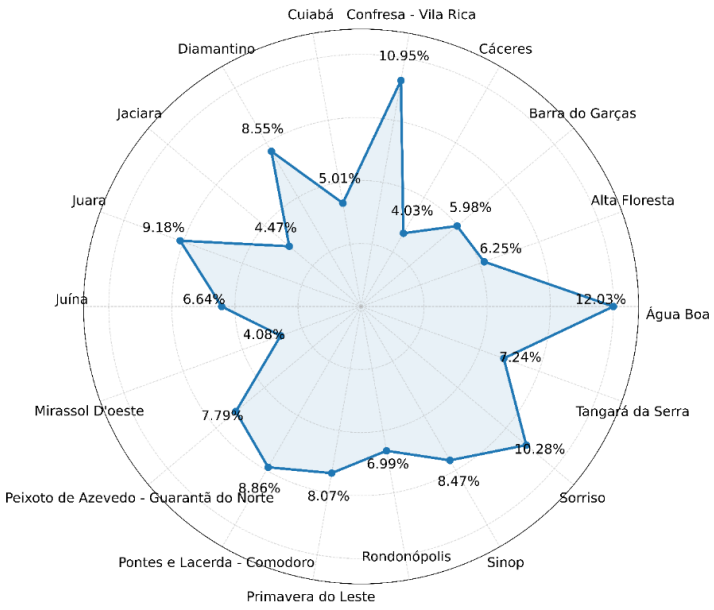
Despite its lack of constancy, Cuiabá exhibited a limited range of variation. In contrast, Rondonópolis and Sinop showed an almost constant increment from 2006 to 2015, despite some

declines. Barra do Garças experienced a significant recovery after COVID-19, which positioned it more dynamically among the regions and established it as a top performer in some years. Meanwhile, Cáceres remained almost unchanged.

The growth trajectory in these regions began when commodity prices initiated a steady increase. The primary slowdowns observed in Rondonópolis and Sinop directly corresponded to declines in the commodity price index, as detailed in Guimarães da Silva's thesis (2019, p. 38). Similar downturns were also evident in other regions. This pattern suggests that the economies of Rondonópolis and Sinop are more directly tied to agriculture and cattle production, a link that is less direct in other areas. Therefore, to foster more dynamic economic growth, institutional changes could be implemented within these cities, grouped by their respective regions. Such changes, when examined through disaggregated data, could reveal new pathways to enhanced regional dynamism.

The economic growth trajectory observed in the 21st century shows that all regions grew; however, those that underwent institutional changes achieved higher growth levels. The Compound Annual Growth Rate for GDP for each region was calculated using the historical municipal GDP (GDP per municipality) series (Brasil, IBGE, 2024a). The values were deflated to 2002 levels using the IPCA (National Consumer Price Index) provided by IPEA (2024b). For example, the exponential percentage used to adjust 2002 values to their deflated 2021 equivalents was calculated. The average growth rate is displayed in Graph 29 radar chart below:

Graph 29 - Average economic growth in the 21st century



Source: BRASIL. IBGE, 2024a. **Elaborated by the author with Python language program.**

The outer circles of the chart, representing higher growth, are predominantly occupied by regions that have undergone institutional changes. Conversely, the inner circles contain regions that have not experienced such transformations. These regions are primarily characterized by colonization projects driven by the Land Market institution or their location along Transport institutions, like BR-163 or other highway axes, which have been synthetized in Rural Enterprises.

Moving inwards, Diamantino is the first traditional region to appear, positioned near the outer edge of the fourth layer. It serves as a transition region, situated between areas like Cuiabá, Tangará da Serra, and Sorriso, where some cities hinder economic growth while others boost it. A similar dynamic applies to Rondonópolis, located next, as it borders a significant hub of Transports.

Cuiabá is found in the circle immediately preceding the innermost one. Though adjacent to the economic hub, most of its cities lack newer capitalist institutions. Jaciara lies between Cuiabá and the innermost circle. Finally, at the center are Cáceres and Mirassol D'Oeste, notable because BR-070 did not spur new institutional development in these areas. This spatial arrangement clearly illustrates how institutional changes correlate with distinct pathways to economic growth across the regions.

Such a pattern of growth is consistent with a process of differentiation in agricultural development, where regions with institutional changes achieved a higher growth trajectory. As pointed out by North (pp. 13-17) and Ruttan and Hayami (1984, pp. 3–4), and as further stated by Acemoglu and Robinson (2012, p. 73), these shifts profoundly influenced the economy and incentives among people during the period. However, the full potency of these changes did not occur due to opportunistic actions stemming from a limited government role in trilateral governance, a consequence of fiscal consolidation. After the critical juncture brought by the Military Regime, conditions were placed, specifically in the Land Market and Transports, synthesized in the Rural Enterprise, for these regions to achieve higher growth patterns than the stagnant ones. This reached an explosive outcome with further institutional changes provided by the structural breaks in the 1990s and in the 21st century, especially the Kandir Law and Chinese demand.

6. FINAL CONSIDERATIONS

These growth patterns clearly demonstrate that institutional changes have effectively differentiated economic growth trajectories among the Immediate Regions of Mato Grosso. While not without imperfections, partly due to opportunistic actions and partly to data limitations in an unbalanced panel, these changes significantly reduced transaction costs, minimized uncertainty, and enhanced coordination.

Although the establishment of new municipalities created data gaps that limited this research, it was still possible to analyze the connections between institutional changes and agricultural economic growth. The analysis indicates that the Land Market was a key factor in facilitating colonization projects. Furthermore, Transports were crucial for moving products to market, especially along the BR-163, BR-070, and BR-158 axes. As a result, a dynamic economic center is emerging along the BR-163 region, featuring three primary hubs: Rondonópolis, Sinop, and Sorriso. Other locations, such as Primavera do Leste on the BR-070 axis and Água Boa on the BR-158 axis, are gaining prominence but are not yet as significant as the top three.

Nevertheless, as bounded rationality consistently prevailed throughout the period in terms of complexity, uncertainty, and asset specificity, free riders exploited opportunities. This led to a decrease in the number of farmers as the necessary trilateral governance structure became less feasible due to fiscal consolidation.

Even at this critical juncture, there were signs of pluralism in economic institutions, akin to the *commendas* of Venice. Alongside centralization in the second half of the 20th century, mainly due to the presence of the Central Government, there was an incentive for private and profitable property, like North America as described by Acemoglu and Robinson (2012, p. 51), allowing for the discharge of the vestiges of Portuguese America.

For these reasons, this thesis makes three contributions. First, it reconstructs Mato Grosso's economic development trajectory, which is essential for understanding the reasons for high growth levels within the state and for improving living conditions. Second, it recovers and analyzes historical data to conduct cliometric analysis, a contribution without extensive exploration, and extends this framework into the 21st century using demographic data (the second goal) to achieve GDP metrics (the third goal). Finally, it provides empirical evidence for the positive relationship between the working-age population and economic growth, addressing inconsistencies in the existing literature where this association has been debated.

Nevertheless, the primary contribution of this research is to highlight that the intended outcomes of public growth policies are achievable when institutions are taken into consideration. It has been shown that inclusive institutions, by their nature, foster creative destruction within the agricultural system, leading to a pattern of sustained development. An analysis of economic and historical data underscores that pluralism is essential, as it enables policies that reinforce dynamic institutions capable of promoting change in stagnant regions in a manner consistent with local capacities. Consequently, generic, top-down policies that fail to consider the local specificities of current institutions are unlikely to prove effective in stimulating growth.

Regional development in areas other than those that experienced institutional changes during the Military Regime stands to benefit greatly from inclusive institutions. As seen with the Land Market, Transport, and Rural Enterprise, these can significantly contribute to economic growth. By connecting regions through infrastructure, these mechanisms can evolve into new institutions, reducing transactional costs, minimizing uncertainty, and enhancing coordination between agents.

While the exact reforms implemented during the Military Regime may not be directly applicable to these other regions, some alternative reforms can be applied, with one critical caveat: the necessity of state presence to sustain trilateral governance that prevent opportunistic action from free riders. This becomes clear as the decay of the state's presence from the 1980s onward diminished inclusiveness.

Nonetheless, future research should explore whether inclusiveness can maintain the path of the Venetian Republic, which eventually succumbed to ancient elites, or adopt the North American path, which more reliably promoted democracy and institutions. Consequently, efforts to study income distribution data, as well as poverty, can be made to construct a more assertive longitudinal panel to assess which inclusive institutions are taking hold, especially during the 21st century.

This path will lead to development rather than mere growth. This is especially important for Mato Grosso because of the potential end of the Land Market institution, as pointed out, which has impacts on technology adoption and employability. This can be outlined in a framework of how productivity will behave, whether it maintains its non-explosive growth trend until 1995 or reaches the outcomes of the 2006 Census for some regions, especially Tangará da Serra and Sorriso. Furthermore, it needs to be shown if the contribution of the WAP to production maintains its positive relation or if it will become negative, as in the 1980s, provided by Headey

and Hodge (2009, p. 221) in their revision of models after that decade. This is the proper ascertainment of Argentinization development in Mato Grosso agriculture.

Therefore, two complementary paths emerge. The first is to study the evolution of inequality as a measure of development. The second is to analyze the structural heterogeneity within Brazilian agriculture, or even restricting to Mato Grosso, in 21st century. Ideally, these two paths would be integrated, potentially using spatial econometrics. However, such an approach was not feasible in current research due to data limitations.

Despite all concerns regarding productivity, the eventual end of the Land Market, and opportunistic behavior, it is true that the changes during the Military Regime allowed for the creation of a highly productive sector, which eroded the remaining institutions of Portuguese America. Thus, the dynamic center capitalized on other critical junctures outside its borders, namely the Kandir Law and China's growth, which led to explosive growth.

However, it must be stressed that public policies for growth must account for institutions such as the Land Market and Transport to decrease transactional costs and uncertainty. Failure to do so leads to failures like previous colonization projects, like Pau Ferro and CAPEM, and the decline of rice producers, as depicted in the documentary OS HOMENS DO PRESIDENTE (Plante que o João Garante), 1984.

Hence, it can be concluded that the Rural Enterprise, as a synthesis institution, can be considered an inclusive one in Acemoglu's sense, which explains the growth differentiation between Immediate Regions in Mato Grosso, despite not reaching all its potential. It allowed for creative destruction that increased production levels where it was implemented and explains the divergent path of agricultural economic growth in the Immediate Regions of Mato Grosso.

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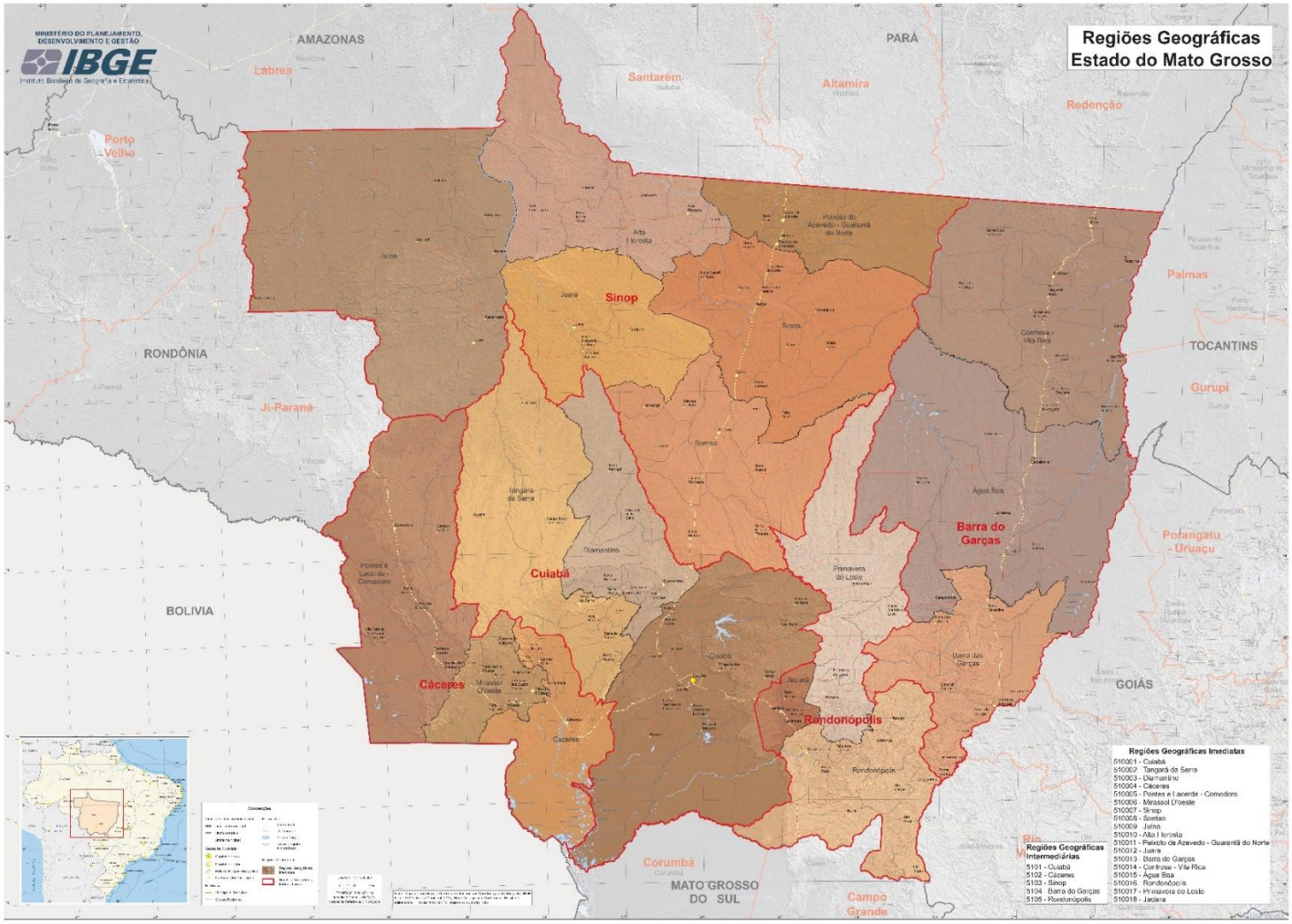
ANNEX A – IMMEDIATE REGIONS OF MATO GROSSO



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ANNEX B – DATA USED, Stata ™ DO-FILES AND NOTEBOOKS

The data, do-files, and notebooks are stored on the GitHub of this project at: https://github.com/davescordova/DIFERENCES-IN-ECONOMIC-GROWTH-PATH-.git.

ANNEX C – COMPLETE REGRESSION PRESENTED IN TABLES 4 AND 5

C.1 MULTIPLE OLS REGRESSION TO LOGARITHMIC TOTAL TILLAGE WITH RANDOM EFFECTS

```
                                                                    (R)
      ___  ____  ____  ____  ____
     /__    /   ____/   /   ____/
    ___/   /   /___/   /   /___/
Statistics/Data analysis

.
. xtreg lTotalTillage lTFP lPIA lAnnualInvestment lCapitalStock TangarádaSerra Diamantino Cáceres PonteseLacerdaCom
> vedoGuarantã do Juara BarradoGarças ConfresaVilaRica ÁguaBoa Rondonópolis PrimaveradoLeste Jaciara year1980 year19
note: year1995 omitted because of collinearity.

Random-effects GLS regression                   Number of obs     =       126
Group variable: Codigo                          Number of groups  =        78

R-squared:                                      Obs per group:
     Within  = 0.6762                                         min =         1
     Between = 0.8415                                         avg =       1.6
     Overall = 0.7949                                         max =         4

                                                Wald chi2(24)     =   7865.89
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.0000

                                               (Std. err. adjusted for 78 clusters in Codigo)
```

lTotalTillage	Coefficient	Robust std. err.	z	P>|z|	[95% conf.	interval]
lTFP	.3696469	.043844	8.43	0.000	.2837142	.4555797
lPIA	.2667418	.108249	2.46	0.014	.0545776	.478906
lAnnualInvestment	.2054016	.0637844	3.22	0.001	.0803864	.3304167
lCapitalStock	.1823583	.0627383	2.91	0.004	.0593935	.3053232
TangarádaSerra	.8876806	.3496015	2.54	0.011	.2024743	1.572887
Diamantino	.6224201	.4348085	1.43	0.152	-.229789	1.474629
Cáceres	-.071625	.2579058	-0.28	0.781	-.5771111	.4338611
PonteseLacerdaComodoro	.9315015	.5821137	1.60	0.110	-.2094203	2.072423
MirassolDoeste	-1.185905	.4523747	-2.62	0.009	-2.072544	-.2992673
Sinop	.4217387	.8192529	0.51	0.607	-1.183967	2.027445
Sorriso	1.74956	.3256496	5.37	0.000	1.111298	2.387821
Juína	-.4548659	.2492923	-1.82	0.068	-.9434698	.033738
AltaFloresta	-1.322678	.9181335	-1.44	0.150	-3.122187	.4768301
PeixotodeAzevedoGuarantã do	-.522097	.3507491	-1.49	0.137	-1.209553	.1653585
Juara	.8412614	.3415114	2.46	0.014	.1719114	1.510611
BarradoGarças	.8780502	.3755507	2.34	0.019	.1419843	1.614116
ConfresaVilaRica	-.2383926	.3694731	-0.65	0.519	-.9625465	.4857614
ÁguaBoa	1.373605	.5053874	2.72	0.007	.3830639	2.364146
Rondonópolis	.6755167	.271227	2.49	0.013	.1439217	1.207112
PrimaveradoLeste	1.440604	.565234	2.55	0.011	.3327658	2.548442
Jaciara	.5778918	.2885675	2.00	0.045	.01231	1.143474
year1980	.5939065	.1975984	3.01	0.003	.2066209	.9811922
year1985	.4600329	.207015	2.22	0.026	.0542909	.8657748
year1995	0	(omitted)				
year2006	1.434743	.2543298	5.64	0.000	.9362653	1.93322
_cons	-1.32853	1.063126	-1.25	0.211	-3.412219	.7551583
sigma_u	.58006144					
sigma_e	.48197828					
rho	.59157253	(fraction of variance due to u_i)				

C.2 GENERALIZED TWO-STAGE LEAST SQUARES TO LOGARITHMIC PRODUCTION WITH RANDOM EFFECTS

```
                                                              (R)
  ____/   /   ____/   /   ____/
 /___/   /   /___/   /   /___/
Statistics/Data analysis

.
. xtivreg lProduction ( lTotalTillage = lTFP lPIA lAnnualInvestment lCapitalStock TangarádaSerra Diamantino Cáceres
> resta PeixotodeAzevedoGuarantãdo Juara BarradoGarças ConfresaVilaRica ÁguaBoa Rondonópolis PrimaveradoLeste Jaciar
note: year1995 omitted because of collinearity.

G2SLS random-effects IV regression              Number of obs     =       126
Group variable: Codigo                          Number of groups  =        78

R-squared:                                      Obs per group:
     Within  = 0.6264                                         min =         1
     Between = 0.9133                                         avg =       1.6
     Overall = 0.8619                                         max =         4

                                                Wald chi2(1)      =    657.87
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.0000

                                (Std. err. adjusted for 78 clusters in Codigo)
------------------------------------------------------------------------------
             |               Robust
  lProduction|  Coefficient  std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
lTotalTillage|    .8497451   .0331298    25.65   0.000     .7848119    .9146784
       _cons |    2.487466   .3370002     7.38   0.000     1.826958    3.147974
-------------+----------------------------------------------------------------
     sigma_u |   .17767613
     sigma_e |   .44886872
         rho |   .13546242   (fraction of variance due to u_i)
------------------------------------------------------------------------------
Endogenous: lTotalTillage
Exogenous:  lTFP lPIA lAnnualInvestment lCapitalStock TangarádaSerra Diamantino
            Cáceres PonteseLacerdaComodoro MirassolDoeste Sinop Sorriso Juína
            AltaFloresta PeixotodeAzevedoGuarantãdo Juara BarradoGarças
            ConfresaVilaRica ÁguaBoa Rondonópolis PrimaveradoLeste Jaciara
            year1980 year1985 year2006

.
```