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Cadasters, Asset Tangibility, and Growth

Can Sever

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Cadasters, Asset Tangibility, and Growth

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Authorized for distribution by Pablo Lopez Murphy

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ABSTRACT: Cadasters—records of land and property ownership—constitute an important pillar of a country's institutional landscape by enabling the assignment of property rights. This paper examines the impact of cadasters on long-term economic growth by identifying a specific channel in this link: asset tangibility. It hypothesizes that the more a firm's assets are tangible, the more relevant cadasters become. The analysis uses a cross-country dataset on cadasters together with granular data from industry panels over the last six decades. The results show that the development of cadasters fosters long-term growth, particularly in industries with high asset tangibility. Higher investment in those industries, resulting from stronger cadasters, contributes to this pattern. The growth impact of cadasters is more pronounced in (i) countries that lack strong cadasters, such as in Sub-Saharan Africa; and (ii) countries with typically more investment-conducive legal systems. The findings suggest that cadastral reforms can help stimulate investment and sustain long-term growth in many developing economies.

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WORKING PAPERS

Cadasters, Asset Tangibility, and Growth

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1. Introduction

Cadasters—records of land and property ownership—constitute an important pillar of a country's institutional framework. They formalize property rights, improve transparency of ownership, and help the state raise tax revenues. This paper explores the impact of cadasters on economic growth by identifying a specific channel in this link, i.e., tangibility of assets. The hypothesis is the following: The more a firm's assets are tangible, such as buildings and machinery, the more relevant cadasters become. Thus, the development of cadasters should stimulate growth more in activities that depend more on tangible assets.

To test this phenomenon, the analysis uses a recently established cross-country dataset on cadasters from D'Arcy et al. (2024) together with granular data from industry panels over the last six decades, and exploits the differences in asset tangibility across industries within countries. The results show that more developed cadasters boost long-term growth, particularly in industries with high asset tangibility. Cadasters have a similarly disproportionate effect on investment in physical capital in those industries. The impact of cadasters is more pronounced in countries (i) which lack strong cadasters, such as the Sub-Saharan African countries; and (ii) with typically more investment-friendly legal systems. The findings suggest that cadastral reforms can help countries foster investment and long-term growth.

There are several channels through which the introduction and quality of cadastral records can spur growth, particularly in industries that rely more on tangible assets. First, cadasters protect the security of tenure and ownership rights over a spatial unit through legally recognized and enforceable records. This is particularly relevant for firms with more tangible assets, since those assets face risks of confiscation by public authorities or illegal seizure by other agents in the absence of strong cadasters. By reducing such risks, cadasters can strengthen investor confidence and encourage investment in tangible assets. Formalized property rights can also improve access to credit, especially for firms that are more reliant on tangible assets, as those assets can be used as collateral. Moreover, those public records can improve the functioning of the land and real estate markets by lowering transaction costs, since they make the ownership information visible to all agents.

While this paper specifically focuses on the asset tangibility channel in the link between cadasters and growth, cadasters can affect growth via other channels as well. Cadasters can facilitate aggregate growth by strengthening the state's capacity to tax, providing information on taxable assets and liable parties. Those tax revenues expand the state's capacity to invest in growth-enhancing projects, such as physical infrastructure. Moreover, by making land and property legible to the state, cadasters enhance administrative capacity and contribute to rule-based governance. These in turn mitigate corruption risks, and improve transparency and implementation of public policies, such as public investment choices management.

The focus of this paper is state-administered cadastral records (henceforth, cadasters). D’Arcy et al. (2024) established a unique and comprehensive dataset on the existence, quality, and extent of state-administered cadastral records based on thousands of documents globally. The authors define a cadaster as a public record which includes information on land or real estate, and the party that holds interests such as rights, restrictions, and responsibilities over the asset. To construct an index on cadasters, the authors track information on (i) whether there exists a state-administered cadaster, (ii) whether the cadaster is narrative or cartographic, and (iii) how much of the country’s land is covered by the cadaster.

Using this rich source, D’Arcy et al. (2024) documents a positive association between the development of cadasters and economic growth. However, establishing causality based on macro-data remains a challenge for several reasons. First, there can be other factors driving both cadastral reforms and economic growth, raising concerns about omitted variables. Relatedly, cadasters can be introduced as a part of broader improvements in institutions, making it hard to disentangle the impact of cadasters on aggregate growth. Next, cadastral reforms may coincide with periods of accelerating growth, raising concerns about reverse causality.

This study makes a step forward toward causality in the interplay between cadasters and growth by addressing some of these concerns. For this purpose, the analysis adopts data from two-digit manufacturing industries from the UNIDO database, and exploits the variation in asset tangibility across industries within countries by adopting an empirical strategy in the spirit of Rajan and Zingales (1998). It tests whether industries with typically high asset tangibility disproportionately benefit from the development of cadastral records, compared to their peers with low asset tangibility.

In the baseline, the dependence on tangible assets for each two-digit manufacturing industry is calculated using data from large, listed firms from a benchmark country with a strong institutional framework and highly developed financial markets (i.e., the US). Therefore, the industry-level proxy for technological intensity is likely to be driven by the differences in the production needs and processes across two-digit manufacturing industries, rather than being influenced by institutional or financial frictions. Another advantage of benchmarking this measure using data from the US is that it remains unaffected by cadastral reforms other countries included in the sample, avoiding potential endogeneity. To the extent that industries’ reliance on tangible assets, as calculated from the US, carries over to other countries, industry-level data makes it possible to identify the differential effect of cadasters on industry growth within countries based on cross-industry differences in asset tangibility.

A further advantage of granular data is that growth in a two-digit manufacturing industry is unlikely to trigger a nationwide cadastral reform, thereby mitigating the issue of reverse causality. The use of industry-level data also makes it possible to control for the effects of unobserved factors on growth at a granular level, alleviating concerns about omitted variables. In the estimation, country-industry fixed effects isolate the variation in industry growth arising from some inherent characteristics that persistently influence growth in an industry in that country. Common impact of other policy changes or reforms, as well as supply

or demand shocks, are absorbed by country-year fixed effects. Finally, the roles of industry-specific global trends, or opportunities, are absorbed by industry-year fixed effects.

It is however worth noting that as a result of the inclusion of fixed effects at such granular level, the empirical approach in this paper does not directly capture the aggregate effects of cadastral reforms on growth. It instead enables identification of a mechanism in this link by focusing on the differential growth effects of cadasters by exploiting an exogenous cross-industry variation in asset tangibility within countries.

The estimated disproportionate effect of cadasters on industries with greater asset tangibility is sizable. For instance, when a country goes through a cadastral reform moving from the 25th to 75th percentile of the distribution of the cadaster index, a typical rubber products industry (an industry with high asset tangibility) sees an additional value-added growth of 4.3 percentage points cumulatively over the 10-year period compared to the furniture industry (an industry with low asset tangibility). Alternatively, following this reform, the top three industries with the highest asset tangibility experience an additional growth boost of 10.6 percentage points on average, compared to the three industries with the lowest asset tangibility. It is important to note that the estimation only captures the differential impact of cadastral reforms on growth in industries with higher tangible assets, relative to their peers which are less reliant on such assets (rather than the overall impact).

Additional analyses rule out several alternative explanations to this finding. First, as mentioned before, cadasters can reflect improvements in overall institutional quality, or state capacity, which can boost investment in tangible assets. Next, higher population density, larger share of urban population, or greater share of non-traditional production (e.g., non-agriculture) in economic activity can elevate the need for cadastral reforms, while facilitating growth in industries with more tangible assets. Third, economic development and trade can both raise the need for cadastral reforms, and also improve access to different types of assets, ultimately affecting growth in industries which heavily need tangible assets for production. Finally, I exclusively test whether a financial channel can be the driving force for the findings above. However, the result remains similar.

The impact of cadasters on growth in industries with high asset tangibility appears to be more pronounced in countries where cadastral institutions are weaker in the first place. The development of cadasters on average is the lowest in Sub-Saharan Africa (SSA) in the last year of the sample period. Latin America & Caribbean follows. In a scenario where the median country in SSA goes through a cadastral reform reaching the country at the 25th percentile in Latin America & Caribbean, the additional growth in rubber products compared to furniture industry over a decade is estimated to be 14.8 percentage points.

The analysis next goes one step further and examines a potential candidate driving the previous findings on industry growth, i.e., investment in physical capital. Cadastral reforms should boost investment in tangible assets, driving a higher growth in industries that rely more on those assets. This finding further underscores the importance of cadastral reforms in less developed countries with limited capital deepening.

Ultimately, for cadasters to be more effective, legal rules and procedures in a country should be conducive to investment, for instance, by ensuring strong protection of property rights and contract enforcement. The last part of the paper investigates the role of legal origin in the patterns above. In this regard, common-law systems (originating in English law) are on average found to have lower formalism of judicial procedures (Djankov et al. 2003) and greater judicial independence (La Porta et al. 2004) than civil-law systems. These features in turn tend to be associated with better contract enforcement and protection of property rights (Glaeser and Shleifer 2002, La Porta et al. 2008). The findings consistently show that cadastral reforms are more effective in facilitating growth in common-law countries, possibly driven by their legal frameworks which are more conducive to investment.

This paper contributes to the extant literature on the impact of property rights on growth by specifically focusing on cadasters and identifying a channel in this association in a cross-country setting. There has been a long discussion on the role of securing property rights in economic outcomes. Evidence shows that improvements in property rights facilitate investment and economic growth (e.g., Knack and Keefer 1995, Hall and Jones 1999, Acemoglu et al. 2001). A strand of this literature explores property rights in the context of land. While there is widespread evidence on the positive implications of securing land rights on investment and productivity, the literature finds that poor governance, market dysfunction, lack of institutional capacity to enforce contracts, and costs related to service provision can undermine this link (see, for instance, Feder 1987, Besley 1995, Deininger and Feder 2009, Place 2009, Besley and Ghatak 2010, Fenske 2011, Libecap and Lueck 2011).

D'Arcy et al. (2024) is the closest one to this study, where the authors present a positive association between the development of cadastral institutions and growth. However, causality based on macro-data is difficult to claim. To overcome this challenge, this paper adopts an identification strategy from Rajan and Zingales (1998), which has been widely used by the macro-finance literature. The analysis identifies a channel through which this impact can work, i.e., asset tangibility. Using granular data from industry panels it makes a step forward toward causality in this relationship by addressing the concerns about omitted variables and reverse causality to a large extent. To the best of my knowledge, this is the first study examining causality between cadasters and growth using granular industry-level data in a cross-country setting.

This paper also adds to the literature on legal origins, which discusses that countries with common law traditions tend to have better protection of property rights and contract enforcement. The findings in this paper are consistent with this reasoning: Cadastral reforms seem to work better in common-law countries.

The remainder of this paper is organized as follows. Section 2 explains the data. Section 3 introduces the empirical methodology. Section 4 illustrates the results. Section 5 concludes.

2. Data

2.1. Industry-level variables

Data on industry value-added and gross fixed capital formation (in US dollars) for two-digit manufacturing industries (ISIC Rev. 3, 15-36) are from the UNIDO database, which is compiled based on industrial surveys. It is available starting from the early 1960s. I calculate the 10-year change in value added as the log difference between years t and $t-10$, and winsorize it at the 1st and 99th percentiles. The 10-year change in gross fixed capital formation for each industry is similarly calculated. Industry value-added share in each country's manufacturing sector (in percent) is used as a control variable. Table A.1 in the Appendix provides data sources and summary statistics for these variables.

To examine whether cadastral records have a disproportionate effect on growth based on industries' use of tangible assets, I follow an approach in the spirit of Rajan and Zingales (1998). In their seminal work, the authors argue that some industries typically need more external finance than others driven by some underlying reasons. They argue that the impact of financial development on growth should be larger in industries with greater dependence on external finance, compared to others. To test this channel, the authors adopt a proxy for external finance dependence of industries, calculated based on data from large, listed firms in the US.

The goal of this paper instead is to investigate the differential impact of cadasters based on the cross-industry (within-country) variation in asset tangibility. For this purpose, I need an industry-level measure of asset tangibility, reflecting the variation in the need for tangible assets across industries driven by the differences in their production processes or technologies. This proxy is calculated by using data from publicly listed firms in the US (based on the Compustat database). It is the share of net property, plant and equipment in total book-value of assets, following the literature (Baker and Wurgler 2002, Braun 2005, and Braun and Larrain 2005), adopted from Igan et al. (2022). First, the average value of the firm-level annual ratios over the period 1980-1999 is calculated to smooth out temporal fluctuations. The median value within each two-digit industry is used as the time-invariant industry-level proxy for asset tangibility.

The first reason why it is adopted from a benchmark country is practical: Detailed historical data on tangible assets for two-digit industries is not available for most countries. Nevertheless, even if data were available, calculating this proxy from each country would lead to endogeneity. In particular, the use of tangible assets would be affected by country-specific developments, including cadastral reforms, rather than reflecting inherent differences in industries' production processes. This in turn would undermine the identification. In this regard, a common practice in the literature pioneered by Rajan and Zingales (1998) is to use the US as the benchmark country to gauge underlying differences in industry characteristics.

Moreover, in the current context, the US has highly developed institutions and financial markets, alleviating frictions that can lead to underinvestment in tangible assets. For instance, a full cadaster has been in place in the US during the sample period, according to the data from D’Arcy et al. (2024). Thus, it is reasonable to assume that this US-based proxy for asset tangibility likely reflects industry characteristics. On the other side, this proxy does not necessarily represent the “correct” value of asset tangibility. Rather, it is likely to provide a reasonable differentiation across industries’ needs for tangible assets, driven by industry-specific factors.

Benchmarking industries’ use of tangible assets may raise concerns, if production processes vary significantly based on local conditions.² However, this is not likely to alter the results, as long as the ordering of industries regarding asset tangibility stay similar across countries. For instance, if production of tobacco products requires fewer tangible assets relative to petroleum products in general (in line with the orderings in the US, see Table 1), this phenomenon does not generate a significant bias in the estimation. This requires an implicit assumption for identification to hold, similar to the literature pioneered by Rajan and Zingales (1998): The ordering of the intensity of tangible assets across industries should not change much across countries and over time. To address concerns about the exact values of this proxy, I also employ a test with a dummy variable splitting industries into two subsamples with high and low asset tangibility.

In robustness, I also use proxies for industries’ dependence on physical capital. Following Nunn (2007) and Ciccone and Papaioannou (2009), it is the ratio of total real capital stock to total value-added. This proxy is calculated similar to the proxy for asset tangibility, adopted from Igan et al. (2022). Alternatively, I adopt industries’ physical capital intensity from Erman and Kaat (2019), which is based on the NBER manufacturing database in 1980.

Table 1 reports these measures for each two-digit manufacturing industry. Column 1 documents asset tangibility. The mean value of this proxy across industries is 0.28 with a standard deviation of 0.13. The top industries with the highest asset tangibility are petroleum, paper and non-metallic products (ISIC 23, 21, 26). Wearing apparel, leather and office equipment industries have the lowest asset tangibility (ISIC 18, 19, 30). Columns 2 and 3 present the proxies for physical capital intensity, adopted from Igan et al. (2022) and Erman and Kaat (2019), respectively. As could be expected, both measures are highly correlated with asset tangibility, suggesting that industries that use tangible assets more intensely are typically the ones that are heavily dependent on physical capital.

In a robustness check, I also use two other proxies from Igan et al. (2022). First, I adopt a proxy for human capital intensity (HCI). It is the ratio of non-production worker wages to total wages (as with Nunn, 2007, and Ferguson and Formai 2013), averaged over the period 1980–1999 based on data from the US.

² For instance, large informality on low-income countries can affect the return on capital, thereby limiting incentives to invest in tangible assets.

Dependence on external finance is similarly calculated as the share of firm's capital expenditures which are not financed with cash flow from operations, following Rajan and Zingales (1998).

Table 1: Proxies for asset tangibility and physical capital intensity

Industry	ISIC	Asset tangibility	Physical capital intensity	Physical capital intensity (alternative)
Food and beverages	15	0.363	1.466	1.81
Tobacco products	16	0.219	1.047	0.86
Textiles	17	0.329	1.287	1.95
Wearing apparel, fur	18	0.116	0.440	0.49
Leather, leather products, footwear	19	0.128	0.630	0.61
Wood products (excl. furniture)	20	0.293	1.126	2.08
Paper and paper products	21	0.510	1.674	2.23
Printing and publishing	22	0.267	0.911	1.00
Coke, refined petroleum, nuclear fuel	23	0.617	2.496	2.42
Chemicals and chemical products	24	0.206	1.768	2.31
Rubber and plastics products	25	0.363	1.253	2.14
Non-metallic mineral products	26	0.421	1.600	2.63
Basic metals	27	0.397	2.272	3.35
Fabricated metal products	28	0.278	1.137	1.36
Machinery and equipment n.e.c.	29	0.216	0.995	1.39
Office, accounting, computing machinery	30	0.133	0.752	0.62
Electrical machinery and apparatus	31	0.245	0.938	1.04
Radio, TV, communication equipment	32	0.179	1.108	1.01
Medical, precision, optical instruments	33	0.155	0.549	0.69
Motor vehicles, trailers, semi-trailers	34	0.270	1.365	2.28
Other transport equipment	35	0.250	0.914	0.81
Furniture; manufacturing n.e.c.	36	0.204	0.764	0.97
<i>Correlation with asset tangibility</i>			0.84	0.76

Notes: Asset tangibility is the share of net property, plant and equipment in total book-value of assets (Igan et al. 2022). Physical capital intensity is the total real capital stock as share of value-added (from Igan et al. 2022 in column 2, and Erman and Kaat 2019 in column 3).

2.2. Cadasters

Cross-country analysis on the economic consequences of cadasters has been limited so far, mainly due to lack of data going back in time and enabling a reasonable comparison across countries and years. To overcome this challenge, D'Arcy et al. (2024) recently established a comprehensive dataset on cadasters providing information on the existence, quality, and extent of state-administered cadastral records, relying on thousands of documents globally.

The authors define a cadaster as a public record which includes information on a land or real estate asset and the party that holds interests such as rights, restrictions, and responsibilities over the asset. Thus, a cadastral record encompasses information on what, who, and which (interest). It compiles information on both fiscal cadasters, which are mainly established for the purpose of taxation, and legal cadasters, focusing on recording property rights.

To establish an index of cadasters, the authors follow a weighting scheme based on the answers to the questions of (i) whether there exists a state-administered cadaster, (ii) whether the cadaster is narrative or cartographic, and (iii) how much of the country's land is covered by the cadaster.³ This methodology generates a time-varying index. The index ranges from 0 to 1, a higher value of the index presenting more developed cadastral records. In particular, 0 represents no state-administered cadaster at all, and 1 stands for a mapped cadaster that covers at least 90 percent of the territory (full cadaster). The index is available until 2015.

2.3. Other Country-level Variables

To proxy for broader institutional environment, I use the index on liberal democracy from the V-Dem dataset by Coppedge et al. (2019). It ranges from 0 to 1. As alternative proxies, the policy score (ranging from -10 to 10), the index on democracy (ranging from 0 to 10), and the index on the degree of institutionalized constraints on political executives (ranging from 1 to 7) are adopted from the Polity V dataset provided by the Center for Systemic Peace. Higher values of these represent stronger institutions.

GDP (constant 2015 US dollars, in log), GDP per capita (constant 2015 US dollars, in log), population (in log), population density (people per square kilometer of land area, in log), trade (in percent of GDP), value-added in agriculture (in percent of GDP), infant mortality rate (per 1,000 live births, in log), urban population (in percent of total population), and gross fixed capital formation by the private sector (in percent of GDP) are from the World Bank World Development Indicators database. As a proxy for financial development, I adopt the IMF's composite index, which accounts for the multifaceted nature of financial development by compiling information on financial markets and institutions covering depth, access and efficiency. It is constructed based on a principal component analysis of the underlying series (as described by Svirydzienka 2016), and ranges from 0 to 1, higher values standing for more developed financial systems.

In the last part of the paper, I examine the role of a country's legal origin in the link between cadasters and growth in industries with greater asset tangibility. Data on legal origins is adopted from La Porta et al. (2008). I separate countries into two groups by adopting a dummy variable which takes 1 for the countries with English-originated common-law countries, and 0 for civil-law countries.⁴

³ The details of the weighting and coding are explained in D'Arcy et al. (2024).

⁴ Countries with Scandinavian legal origin are dropped in this part of the analysis, since there are only few countries in this category.

2.4. Sample

The sample in the main analysis covers 22 manufacturing industries (in two-digit ISIC, see Table 1) from 126 countries (where 36 of them are advanced economies) over the period 1963-2023. It is restricted by the availability of industry-level variables and the cadaster index.⁵ The US is excluded from the sample, since the industry-level proxies are calculated using the US data. The list of countries (together with the regions as used later in the analysis) is in the Appendix.

In the main sample, the mean value of the cadaster index is 0.729, while the median is 1. The standard deviation of the index across the sample is 0.351. The 25th and 75th percentiles of the distribution correspond to 0.459 and 1, respectively.

3. Stylized Facts

3.1. Evolution of cadasters

Figure 1 documents the evolution of the cadaster index over the period 1960-2015 based on the data from D'Arcy et al. (2024).⁶ Chart A reports the share of countries with a low (below 0.25), medium-low (above 0.25 but below 0.5), medium-high (above 0.5 but below 0.75), and high (above 0.75) value of the cadaster index. Chart B follows a similar exercise, but categorizing countries with no cadasters at all (index is at 0), partial cadasters (index is above 0 but not 1), and a full cadaster (index is 1).

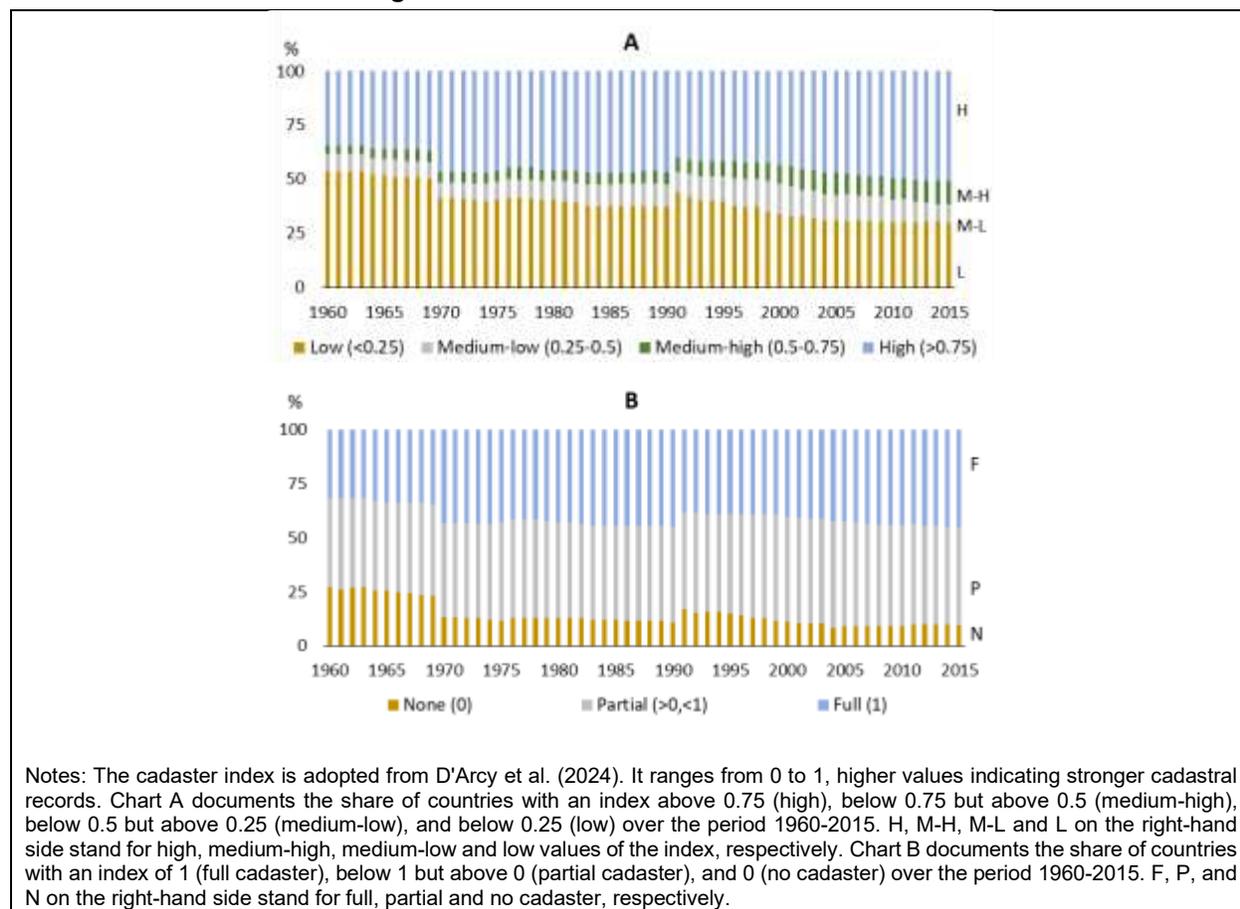
Global progress in improving cadasters has been slow, uneven over time, and also faced disruptions. Countries with a low or medium-low cadaster index (below 0.5) amounted to 62 percent of the global sample as of 1960, while it dropped to 29 percent in 2015 (Chart A). In the meantime, countries with a high or medium-high cadaster index (above 0.5) increased from 38 to 61 percent. Progress appears to be steadier starting from the early 1990s.⁷

Countries with no cadasters at all declined from 27 percent of the global sample in 1960 to 9 percent in 2015 (Chart B). While the share of countries with partial cadasters remained relatively stable during this time, the share of countries with a full cadaster rose from 32 to 45 percent. Overall, these patterns show that many countries still have significant scope to reform cadasters to ensure a clean assignment of property rights and land demarcation.

⁵ While data on cadasters ends in 2015, the regression analysis extends to 2023, since it is based on 10-year windows. The first year of the analysis (1963) is restricted by the UNIDO database.

⁶ In the dataset, the country sample (with available data on cadasters) stays mostly stable over this period.

⁷ Several ex-Soviet countries saw a full reversal of cadasters in 1991, based on the dataset.

Figure 1: Evolution of cadasters over time

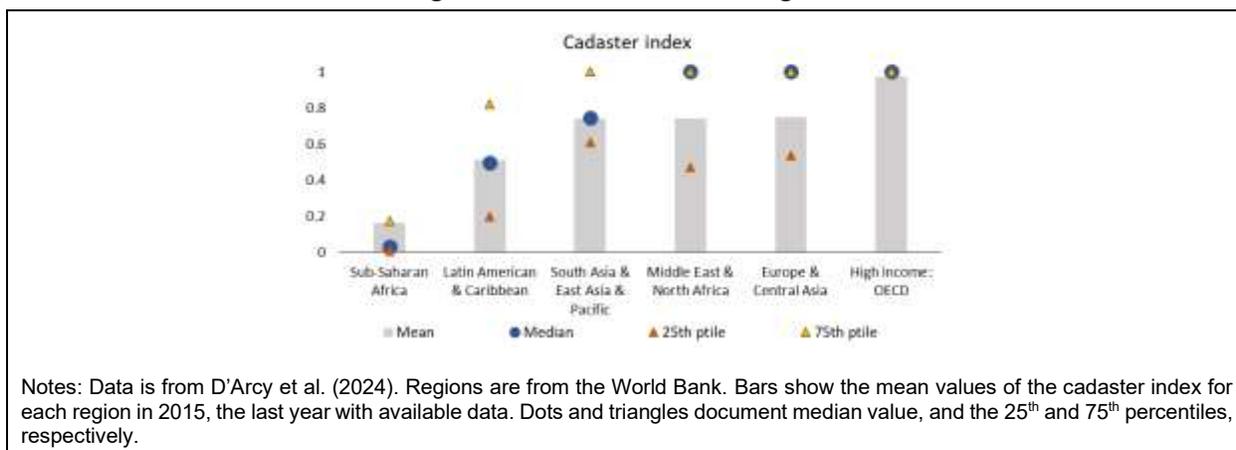
3.2. Cadasters across Regions

This section digs deeper into the extent of cadasters in different regions. Figure 2 documents the cadaster index in the latest year of data (2015). There exist large heterogeneities across and within regions. Sub-Saharan Africa lags other regions markedly. The mean value of the index in the region is 0.16, with the closest region (Latin American & Caribbean) having an average index of 0.51. South Asia & East Asia & Pacific, Middle East & North Africa, and Europe & Central Asia follow, where the average indexes remain close to 0.75. High-income countries stand out with an average index of 0.98.

While dispersion is minimal among high-income countries, it is much wider within other regions. In most regions except Sub-Saharan Africa, the gap between the 25th and 75th percentiles of the cadaster index remain large, indicating that some countries lead in cadastral reforms. However, in Sub-Saharan Africa, most of the countries continue to lack strong cadastral systems. Of the 39 countries in the region, 31 score below 0.25 on the index, and 7 of these lack a cadaster altogether. Only 4 countries have an index

above 0.75, with 2 of them having a full cadaster. These underscore the scope for cadastral reforms going forward across the region. These patterns are further examined in the analysis focusing on different regions.

Figure 2: Cadasters across regions

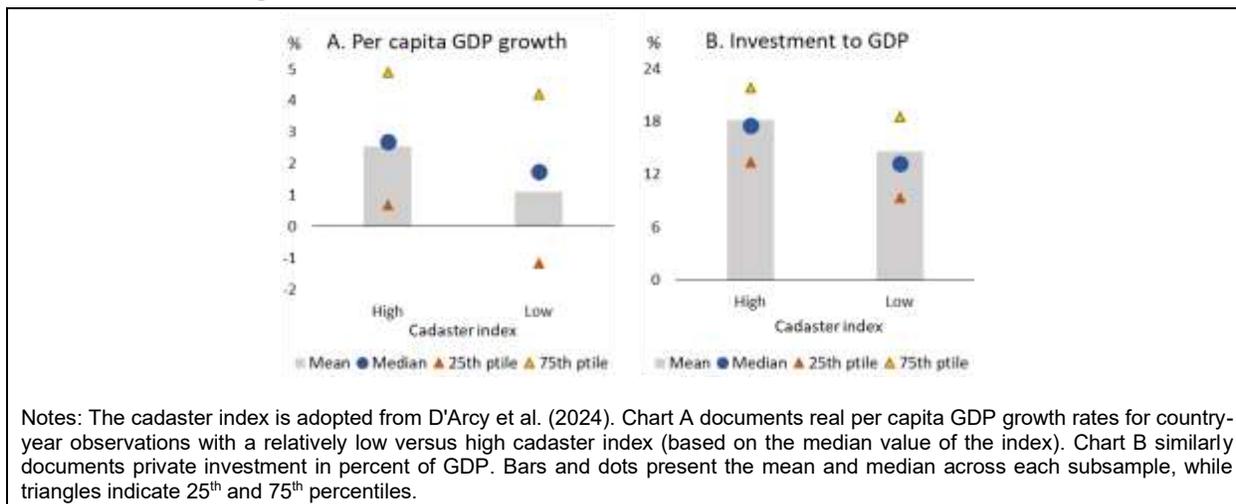


3.3. Cadasters and Aggregate Outcomes

Next, I document the associations between cadastral institutions and macroeconomic outcomes. For this purpose, I divide the global sample based on the median value of the cadaster index, and focus on per capita GDP growth and investment share in GDP in each subsample. Figure 3 shows the findings.

The average per capita GDP growth rate is 2.5 percent when the cadaster index is high, while it is 1.1 percent in the subsample with a cadaster index below the median (Chart A). Across the country-year observations where the cadaster index is above the median, the GDP share of private investment (gross fixed capital formation) amounts to 18.2 percent, but it remains 14.6 percent when cadaster index is low (Chart B).⁸ Although these associations are not causal and may be driven by other factors, they indicate that stronger cadasters correlate with higher growth and investment at the aggregate level.

⁸ These patterns remain similar, when I document the residual growth rates and investment ratios, after regressing each of them on the lagged values of per capita GDP level and the index on liberal democracy (and reporting the residual values from those regressions) to account for the level of economic development (alongside convergence effects) and institutional environment.

Figure 3: Associations between cadasters and macro variables

4. Methodology

4.1. Cadasters, Asset Tangibility, and Growth

The goal is to examine the differential impact of cadasters on industry growth based on the variation in industries' asset tangibility. The main specification is as follows:

$$\Delta \log(VA)_{c,i,t-10 \rightarrow t} = \beta_1 \text{Cadaster}_{c,t-10} \times I_i + \alpha \text{VA share}_{c,i,t-10} + \theta_{c,t} + \theta_{c,i} + \theta_{i,t} + \epsilon_{c,i,t} \quad (1)$$

where c , i , and t stand for countries, (two-digit) manufacturing industries, and years, respectively. The dependent variable $\Delta \log(VA)_{c,i,t-10 \rightarrow t}$ is the 10-year change in industry value-added from year $t - 10$ to t (in percent), allowing to examine long-term growth effects. In different regressions, I replace it with the 10-year change in investment in physical capital variables as well.

The variable I_i is the proxy for asset tangibility in each two-digit industry, allowing a comparison across two-digit manufacturing industries within countries. As an alternative, I also use industries' physical capital intensity in separate estimations.

$\text{Cadaster}_{c,t-10}$ is the index from D'Arcy et al. (2024), representing the development of cadastral institutions in each country, adopted from year $t - 10$. Industry value-added share in total manufacturing value-added in its country $\text{VA share}_{c,i,t-10}$ is also included.

The focus of the analysis is the interaction term between the index on cadasters and the proxy for asset tangibility. The coefficient estimate β_1 captures the asset tangibility channel of the growth impact of

cadasters. A positive estimate will suggest that stronger cadasters facilitate value-added growth, particularly in industries with greater asset tangibility.

The inclusion of the three sets of fixed effects is crucial for identification. Country-year fixed effects ($\theta_{c,t}$) isolate the variation in industry growth that is common across two-digit industries in a country in each year. They control for the common impact of all time-variant economic, political and institutional developments, as well as country-specific shocks (such as demand or supply shocks), on industry growth. Country-industry fixed effects ($\theta_{c,i}$) account for the unobserved reasons which can lead to a distinct growth pattern in an industry in a country, on average. These fixed effects account for, for example, whether industries with greater asset tangibility on average grow less, or more, in some countries due to some persistent country-specific forces. Finally, industry-year fixed effects ($\theta_{c,i}$) absorb any variation in growth arising from industry-specific global trends, shocks, or growth opportunities, in growth at an annual frequency. Overall, the use of industry-level data mitigates concerns about omitted variables to a large extent by allowing to control for the effects of a large set of factors.⁹

Fixed effects with the year variable (i.e., country-year and industry-year fixed effects) also absorb the role of inflation dynamics in the estimation. Industry-year fixed effects eliminate the influence of a common global (US dollar) inflation for each industry. In general, assuming a common global inflation for each industry is reasonable, since the manufacturing goods are tradable, and therefore, producers experience global common prices (Rodrik 2013). In some cases, though, domestic prices may move differently compared to world prices, even for tradables. To the extent this is an issue, country-year fixed effects absorb the role of the country-specific component of inflation.

It is also important to account for a potential convergence pattern, since initially larger industries may have limited additional resources or opportunities to grow, compared to their smaller peers. The 10-year lagged value of industry value-added share ($VA\ share_{c,i,t-10}$) captures this pattern. Standard errors are clustered at the country-year level where the policy variable changes.

Using industry-level data to identify the impact of cadasters on growth also has the advantage of alleviating reverse causality. Unlike macro-data, growth in a single (two-digit) manufacturing industry is unlikely to trigger a nationwide institutional reform.

⁹ Identifying the effect of cadasters and assessing its aggregate impact poses a trade-off. As a result of the inclusion of country-year fixed effects, the specification captures the differences within each country-year cell, while it is not possible to gauge the effect of cadasters on aggregate growth (since the overall effect is captured by the fixed effects).

Next, I employ local projections as proposed by Jorda (2005):

$$\Delta \log(VA)_{c,i,t-1 \rightarrow t+p} = \beta_1^p \text{Cadaster}_{c,t-1} \times I_i + \alpha \text{VA share}_{c,i,t-1} + \theta_{c,t} + \theta_{c,i} + \theta_{i,t} + \epsilon_{c,i,t} \quad (2)$$

I run this test for 10 years ($p = 0, \dots, 9$) and report the coefficient estimates of β_1^p . As opposed to the first specification, this analysis captures how the impact of cadasters on industries with greater asset tangibility evolves and accumulates over time.

The next set of tests accounts for the differential effects of various other country-level variables, if any, on growth in industries with greater asset tangibility. In particular, while country-year fixed effects isolate the common effects of all country-level variables on growth, it is still sensible to check whether those country-level factors tend to have a disproportionate impact on growth in industries with greater asset tangibility, possibly undermining the effect of cadasters. The specification is as follows:

$$\Delta \log(VA)_{c,i,t-10 \rightarrow t} = \beta_1 \text{Cadaster}_{c,t-10} \times I_i + \beta_2 X_{c,t-10} \times I_i + \alpha \text{VA share}_{c,i,t-10} + \theta_{c,t} + \theta_{c,i} + \theta_{i,t} + \epsilon_{c,i,t} \quad (3)$$

where $X_{c,t-10}$ is a set of country-level variables, including macroeconomic, institutional and financial development. The coefficient estimate β_2 captures the impact of those variables varying with industries' asset tangibility. To the extent that cadasters do not simply act as a proxy for those factors, I expect the coefficient estimate of β_1 in these tests to remain similar to the first specification.

4.2. Legal Origin

In the last part, I investigate whether a country's legal origin influences the differential impact of cadasters on industries with greater asset tangibility. For this purpose, I include a triple interaction term with a dummy variable which takes 1 for common-law countries, and 0 otherwise, as follows:

$$\begin{aligned} \Delta \log(VA)_{c,i,t-10 \rightarrow t} = & \beta_1 \text{Cadaster}_{c,t-10} \times I_i + \beta_2 \text{Cadaster}_{c,t-10} \times L_{UK} \times I_i \\ & + \alpha \text{VA share}_{c,i,t-10} + \theta_{c,t} + \theta_{c,i} + \theta_{i,t} + \epsilon_{c,i,t} \end{aligned} \quad (4)$$

where L_{UK} in specification (4) is the dummy variable representing common-law countries. It is worth noting that the interactions between (i) legal origin and asset tangibility and (ii) legal origin and cadasters cannot be included in this estimation, due to the presence of fixed effects (i.e., $\theta_{c,i}$ and $\theta_{c,t}$). A positive coefficient estimate for β_2 would indicate that the differential impact of cadasters on growth on industries with greater asset tangibility becomes more pronounced in common-law countries.

5. Results

5.1. Main Results

Table 2 illustrates the main results. Column 1 adopts the proxy for industries' asset tangibility. The positive and statistically significant coefficient estimate of the interaction term suggests that cadasters lead to higher growth, particularly in industries with greater asset tangibility. I follow a simple exercise to provide insight into how much additional growth is achieved in industries with greater tangibility compared to others, when a country goes through a cadastral reform.

For this purpose, I consider a reform scenario based on the 25th and 75th percentiles of the distribution of the cadaster index across the sample, i.e., an increase in the cadaster index from the 25th percentile (with an index of 0.459) to the 75th percentile (with an index of 1).¹⁰ I similarly compare two industries at the 25th and 75th percentiles of asset tangibility. Rubber products industry (ISIC 25) uses tangible assets more than furniture products (ISIC 36), with those industries being at the 75th and 25th percentiles of the distribution of asset tangibility (Table 1). When a country implements a reform with the cadasters index moving from 0.459 to 1, a typical rubber products industry sees an additional growth of 4.3 percentage points over the 10-year period compared to the furniture industry.¹¹ Alternatively, following this reform, the top three industries with the highest asset tangibility (ISIC 26, 21, 23) experience an additional growth boost of 10.6 percentage points on average, compared to the three industries with the lowest asset tangibility (ISIC 18, 19, 30).

Instead, transitioning to a full cadaster from no cadaster, yields an additional 8.0 percentage points growth over a decade for rubber products compared to furniture industry. In the case of a full cadastral reform, the top three industries with the highest asset tangibility see a growth boost of 19.5 percentage points on average, compared to the three industries with the lowest asset tangibility. As a comparison, in the sample, the average (median) of the 10-year changes in industry value is 71.6 (61.3) percent. These estimated differential growth gains are economically sizable, especially since they only capture the additional growth boost in industries that use tangible assets more intensely compared to others.

The rest of the columns test the robustness of the findings to different industry-level variables. Column 2 adopts a dummy variable which takes 1 for the half of two-digit industries with a value of asset tangibility above the median value, aimed at alleviating concerns about the exact values of the proxy.

¹⁰ To put this improvement in cadasters into context: In the historical series since the 1000s, there were 261 substantial reforms, as defined by D'Arcy et al. (2024), with the absolute value of the change in the index being above 0.1. The average change in the index across those cases was about 0.3. Moreover, there were 40 cases in which countries transitioned to full cadaster from no cadaster (the index moving from 0 to 1).

¹¹ This estimate for the differential growth impact is calculated by multiplying the coefficient estimate of the interaction term (50.090, Table 2 column 1) with the gap between the proxy for asset tangibility across those industries (0.363 versus 0.204, Table 1 column 1) and the jump in the cadaster index in this exercise (from 0.459 to 1).

Columns 3-4 show the results when asset tangibility is replaced by proxies for industries' physical capital intensity, as adopted from Igan et al (2022) and Erman and Kaat (2019), respectively. The results are consistent. For the rest of the paper, I use the proxy for asset tangibility, unless noted otherwise.

Finally, the negative coefficient estimate of the lagged value-added share points to convergence: Smaller industries grow faster (consistent with Rodrik 2013, and Hardy and Sever 2025a, 2025b).

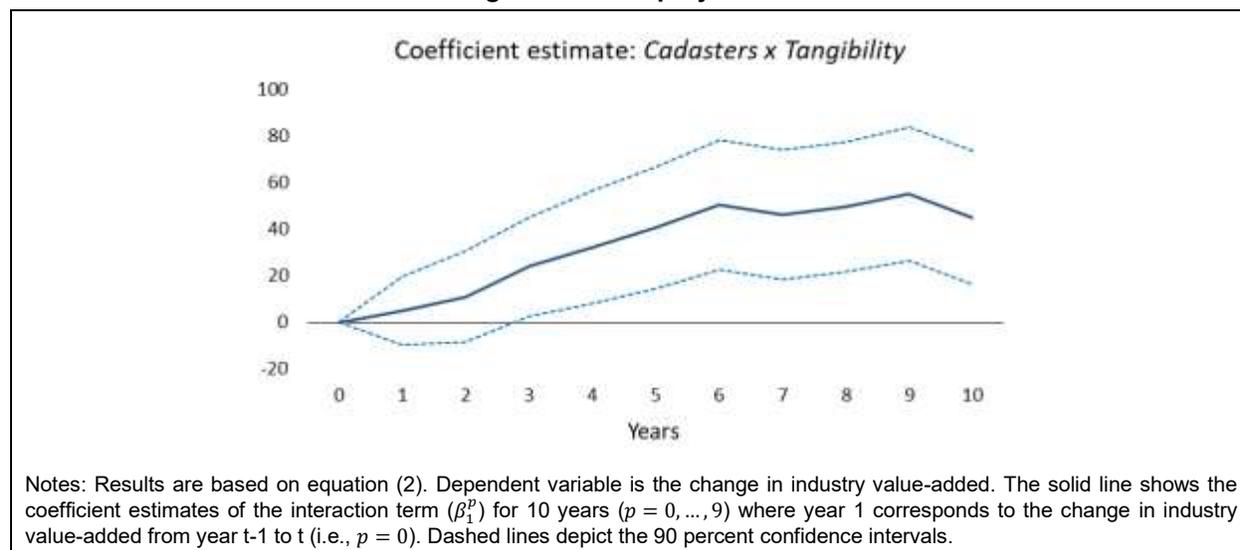
Table 2: Cadasters and industry growth

Variable	Industry-level feature (<i>I</i>)			
	Tangibility (baseline)	Tangibility (dummy variable)	Physical capital intensity	Physical capital intensity (alternative)
<i>Cadasters</i> × <i>I</i>	50.090*** (18.754)	15.398*** (4,816)	14.890*** (4.866)	8.421*** (3.217)
<i>VA share</i>	-6.731*** (0.143)	-6.730*** (0.143)	-6.729*** (0.143)	-6.729*** (0.142)
Country-year F.E.	Yes	Yes	Yes	Yes
Country-industry F.E.	Yes	Yes	Yes	Yes
Industry-year F.E.	Yes	Yes	Yes	Yes
Observations	61,473	61,473	61,473	61,473
R-squared	0.745	0.745	0.745	0.745

Notes: Results are based on equation (1). Dependent variable is the change in industry value-added. Industry-level variable *I* is asset tangibility (column 1, as adopted from Igan et al. 2022), a dummy variable based on this measure of asset tangibility (column 2), and physical capital intensity (as adopted from Igan et al. 2022 in column 3, and from Erman and Kaat 2019 in column 4). Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Figure 4 reports the coefficient estimates of the interaction term for the 10-year period based on local projections based in equation (2). It shows that the effect of cadasters becomes statistically significant by the third year and remains so throughout the decade, consistent with earlier findings.

Figure 4: Local projections



5.2. Robustness

This section first aims to mitigate concerns about other country-level factors as a potential driver of the previous findings. Table 3 presents the findings based on the specification in (3). To start with, better institutions in general can promote capital deepening, improving growth potential of industries that use tangible assets. If cadasters develop as a part of comprehensive institutional reforms, accounting for the strength of institutions can undermine the results above. To check whether this concern is indeed relevant, I include the interaction term between the index on liberal democracy (adopted from the V-Dem dataset) and industry asset tangibility (column 1). The main result remains similar, while growth in industries with greater asset tangibility appears to be higher under more liberal democracies. In the Appendix (Table A.2), I also test the results with 3 different proxies for institutional quality from the Polity V dataset.

The second column in Table 3 controls for the impact of population density. Population pressures can trigger cadastral reforms. If higher population density somewhat affects growth in industries with greater asset tangibility, it can be the underlying force driving the previous findings. A similar concern can be relevant for the share of population living in urban areas (column 3). On the other hand, in economies dominated by more traditional rural activities, such as agriculture, industries that rely on tangible assets face growth constraints, and the demand for cadastral reforms may be less pressing (column 4).

Next, cadastral reforms may take place as part of a reform package aimed at increasing state capacity, which can bolster capital deepening as well. A reasonable measure to account for this scenario is a country's health infrastructure, following D'Arcy et al. (2024). In column 5, infant mortality serves as a proxy for the development of the public health system.

Columns 6-7 account for economic and financial development and trade, respectively. Table A.2 in the Appendix shows the results, when the size of the economy (real GDP) and total population are accounted for. The findings are similar.

Table 3: Accounting for other country-level variables

Variable	Country-level variable						
	Democracy	Population density	Urban population	Agriculture	Infant mortality	GDP per capita	Trade
<i>Cadasters</i> × <i>I</i>	42.491*** (19.336)	50.543*** (19.018)	45.108** (18.780)	88.514*** (29.243)	50.717*** (19.525)	60.387*** (19.628)	50.834** (21.215)
<i>X</i> × <i>I</i>	75.584*** (19.716)	-30.529* (16.661)	1.064* (0.578)	0.552 (0.897)	-14.362*** (12.062)	42.562*** (10.257)	0.333* (0.179)
<i>VA share</i>	-6.897*** (0.137)	-6.676*** (0.145)	-6.705*** (0.143)	-7.205*** (0.161)	-6.908*** (0.138)	-6.650*** (0.144)	-7.130*** (0.161)
Country-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	59,018	59,560	60,658	47,575	59,170	59,146	54,517
R-squared	0.744	0.744	0.744	0.749	0.744	0.744	0.750

Notes: Results are based on equation (3). Dependent variable is the change in industry value-added. *X* is the country-level variable as indicated in the columns. Standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Financial development is also important to scrutinize as an alternative explanation. Reforms to enhance the availability of finance can elevate the need for a stronger cadaster, since industries with tangible needs would need secured property rights to use their assets as collateral to access available financing. In this case, as found above, a cadaster reform can increase growth in those industries with high asset tangibility. However, one can argue that the underlying force is the disproportionate effect of financial development on growth in industries with greater dependence on external finance (as found by Rajan and Zingales 1998). This can even be a larger issue if the industry-level proxies of dependence on tangible assets and external finance are highly correlated. However, this is not the case in the data. The correlation between those proxies is negative and small (-0.17). It is also possible to empirically test this phenomenon by extending the specification in (3). I include the interaction between the proxies of financial development (country-level) and dependence on external finance (industry-level), and run a horserace regression. Table A.3 in the Appendix shows no evidence on the role of financial development via the asset tangibility channel (columns 1 and 3). While financial development appears to have a disproportionate effect on growth in industries that need more external finance (column 2), this does not undermine the previous findings on cadasters (columns 1-3).

In the Appendix (Table A.4), I run two placebo tests. First, I replace the 10-year lagged value of the cadaster index in equation (1) with the 10-year forward value, and test the lead effects (column 1). The coefficient estimate of the interaction term becomes statistically insignificant, suggesting that future values

of the index cannot significantly predict the growth in industries with high asset tangibility. Second, I test whether cadasters somewhat generate differential growth effects through other sources of industry heterogeneity which should matter less than asset tangibility. For this purpose, I replace the proxy for asset tangibility with a proxy for human capital intensity. The coefficient estimate of the interaction term is statistically insignificant, as expected.

In Table A.5 in the Appendix, I test the results in two relevant subsamples. First, I drop the advanced economies from the sample, since they have highly developed cadastral systems, leaving less room for future reforms (column 1). Second, I estimate the relationship by using data only from the countries which had at least one cadastral reform in the sample (column 2). The results still hold.

In unreported tests, I confirm that the results still hold when (i) industry value-added growth is not winsorized, or winsorized at different levels (such as at the 5th and 95th or 10th and 90th levels); (ii) the period of analysis starts from the 1980s or 1990s, or ends in 2019 (to exclude the Covid-19 pandemic); (iii) weighted regressions are employed to make sure that larger or smaller, or poorer or richer economies do not drive the findings (with the weights being the 10-year lagged values of the logarithm of real GDP or GDP per capita, or inverse of those); (iv) weighted regressions are run with the weights being the 10-year lagged value of the logarithm of industry value-added or inverse of it, to confirm that it is not larger or smaller industries driving these patterns; (v) standard errors are not clustered, but robust to heteroskedasticity; (v) the US is included in the sample; (vi) few countries with the full reversal of cadasters in 1991 (as mentioned above) are excluded from the sample; (vii) the two outliers as highlighted by D'Arcy et al. (2024), i.e., Kuwait and Qatar, are dropped. These results are available upon request.

5.3. Non-linearity and Heterogeneity across Regions

This section delves into potential non-linearity in the previous findings, as well as the heterogeneity of the effects across regions. There is more room for cadastral reforms in some regions, particularly in Sub-Saharan Africa and Latin America & Caribbean (Figure 2). To the extent that the impact of the improvements in cadasters is stronger in countries and years where those institutions are relatively limited, those regions can particularly benefit more from such reforms.

First, I extend the specification in (1) by including an interaction term between the squared value of the cadaster index and industry asset tangibility to explore non-linearity in the full sample. Table 4 shows the findings. The coefficient estimates in the first and second rows suggest that the impact of a similar degree of improvements in cadasters is more pronounced in countries and years where those institutions are weaker in the first place. However, a joint evaluation of those coefficient estimates suggests that even when the index is close to 1, the impact remains positive and statistically significant at the 1 percent level.

Table 4: Non-linearity

Variable	(1)
<i>Cadasters</i> × <i>I</i>	313,327*** (73,898)
<i>Cadasters</i> ² × <i>I</i>	-262,936*** (70,752)
<i>VA share</i>	-6.749*** (0.143)
Country-year F.E.	Yes
Country-industry F.E.	Yes
Industry-year F.E.	Yes
Observations	61,473
R-squared	0.745

Notes: Results are based on equation (1) by adding the interaction term with the squared value of the cadaster index. Dependent variable is the change in industry value-added. Regions are indicated in the columns. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Next, the results in Table 5 show that the coefficient estimate of the interaction term is positive and statistically significant in Sub-Saharan Africa (column 1), Latin America & Caribbean (column 2), and Europe & Central Asia (column 5). Given the high coefficient estimate of the interaction term and the lack of strong cadastral institutions across SSA, I focus on the economic implications of the estimated differential impact for the region. I assume a reasonable reform scenario where the median country in SSA as of 2015 goes through a cadastral reform reaching the country at the 25th percentile of the second region with a lower cadaster index on average (i.e., Latin America & Caribbean). This means an increase in the cadaster index from 0.03 to 0.197. As a result of this reform, the additional growth in rubber products compared to furniture industry over the next decade would be 14.8 percentage points. This is large, considering that the mean value of the 10-year industry growth rates in SSA is 79.2 percent. This underscores the role of cadastral institutions as a powerful policy tool for sustaining long-term growth in the region.

Table 5: Heterogeneity across regions

Variable	Region					
	Sub-Saharan Africa	Latin American & Caribbean	South Asia & East Asia & Pacific	Middle East & North Africa	Europe & Central Asia	High income: OECD
<i>Cadasters</i> × <i>I</i>	479.124*** (166.096)	228.219** (98.441)	12.400 (58.398)	25.468 (33.591)	90.743** (42.567)	80.553 (84.050)
<i>VA share</i>	-5.079*** (0.234)	-6.517*** (0.347)	-6.767*** (0.383)	-6.817*** (0.336)	-8.216*** (0.423)	-8.393*** (0.265)
Country-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Country-industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Industry-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,638	9,258	10,274	6,104	5,762	23,196
R-squared	0.745	0.783	0.753	0.719	0.714	0.820

Notes: Results are based on equation (1). Dependent variable is the change in industry value-added. Regions are indicated in the columns. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5.4. Investment

This section goes one step further and examines the link between cadasters and investment in physical capital. As countries go through cadastral reforms, industries start to invest particularly in tangible assets, thereby driving a disproportionately high growth gain in industries with high asset tangibility. To test this, I replace the 10-year value-added growth with the 10-year change in gross fixed capital formation, and replicate the analysis in Table 2. The sample shrinks by almost half due to limited data in investment. Table 6 shows that investment dynamics in industries with greater asset tangibility likely drives the findings above.

I follow a similar exercise as above to calculate the estimated differential impact of cadasters on investment in industries with greater asset tangibility. The 25th and 75th percentiles of the cadaster index in this sample are 0.693 and 1, respectively. When a country goes through a cadastral reform with the index moving from 0.693 to 1, growth in investment in a typical rubber products industry sees an additional 7.9 percentage points growth boost over the 10-year period, compared to the furniture industry. This is economically important, considering that the 10-year change in gross fixed capital formation in the sample is 63.6 percent. This implies that cadastral reforms are a particularly important policy instrument in less developed countries with limited capital deepening.

The results are similar when the dummy variable for asset tangibility is adopted (column 2), while the interaction term becomes statistically less significant when tested with physical capital intensity (columns 3-4).

Table 6: Cadasters and investment in physical capital

Variable	Industry-level feature			
	Tangibility (baseline)	Tangibility (dummy variable)	Physical capital intensity	Physical capital intensity (alternative)
<i>Cadasters</i> × <i>I</i>	162.548*** (77.768)	32.699** (16.096)	36.862* (20.040)	7.729 (12.167)
<i>VA share</i>	-4.703*** (0.257)	-4.681*** (0.260)	-4.691*** (0.258)	-4.676*** (0.260)
Country-year F.E.	Yes	Yes	Yes	Yes
Country-industry F.E.	Yes	Yes	Yes	Yes
Industry-year F.E.	Yes	Yes	Yes	Yes
Observations	33,438	33,438	33,438	33,438
R-squared	0.606	0.606	0.606	0.606

Notes: Results are based on equation (1). Dependent variable is the change in industry investment in physical capital. Industry-level variable *I* is asset tangibility (column 1, as adopted from Igan et al. 2022), a dummy variable based on this measure of asset tangibility (column 2), and physical capital intensity (as adopted from Igan et al. 2022 in column 3, and from Erman and Kaat 2019 in column 4). Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5.5. Legal Origin

This section investigates the role of legal origin in the impact of cadasters on growth. The estimations are based on equation (4).¹² Table 7 illustrates the findings. L_{UK} is the dummy variable which takes 1 for common-law countries. In column 2, I account for broader institutional environment by including the interaction term with the index on democracy.

The positive coefficient estimate of the triple interaction term in the first column implies that cadastral reforms appear to be more effective for growth via the asset tangibility channel in common-law countries. Controlling for the index on democracy (column 2) does not alter this pattern.

¹² Among 122 countries in this analysis, 32 of them have English common-law tradition, based on the data from La Porta et al. (2008).

Table 7: Legal origin

Variable	(1)	(2)
<i>Cadasters</i> × <i>I</i>	22.009 (18.877)	26.375 (19.682)
<i>Cadasters</i> × <i>L_{UK}</i> × <i>I</i>	300.400*** (75.464)	219.173** (92.807)
<i>Democracy</i> × <i>I</i>		64.975*** (19.996)
<i>VA share</i>	-6.712*** (0.144)	-6.876*** (0.139)
Country-year F.E.	Yes	Yes
Country-industry F.E.	Yes	Yes
Industry-year F.E.	Yes	Yes
Observations	57,879	55,424
R-squared	0.743	0.742

Notes: Results are based on equation (4), while the second column adds the interaction with the index on democracy. Dependent variable is the change in industry value-added. *L_{UK}* is the dummy variable representing common law countries. Democracy is the index adopted from the V-Dem dataset. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

6. Conclusion

This paper provides evidence on the impact of cadasters—an important pillar of a country’s institutional landscape—on long-term economic growth. The analysis relies on a recently established global dataset on cadasters and granular data from industry panels since the 1960s. It examines a potential channel through which cadasters can affect growth, i.e., asset tangibility. The results show that the development of cadastral institutions fosters long-term growth, particularly in industries with greater asset tangibility. Increased investment in physical capital in those industries as a result of more developed cadasters contributes to this pattern. The growth impact of cadasters is more pronounced in (i) regions which lack strong cadasters, such as Sub-Saharan Africa; and (ii) common-law countries.

These findings imply that strengthening cadastral institutions can be a catalyst for economic development by unlocking investment and bolstering long-term growth. It is, however, important to acknowledge that effective cadastral reforms can take time, and typically require administrative capacity and financing. Moreover, the cadastral systems do not work in a vacuum. Progress toward an institutional and legal environment conducive to investment helps those reforms achieve their objectives.

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Appendix

Sample

The list of countries in the industry-level analysis (with the regions from the World Bank) is below.

Sub-Saharan Africa: Burundi, Botswana, Central African Republic, Côte d'Ivoire, Cameroon, Republic of Congo, Eswatini, Ethiopia, Gabon, Ghana, Kenya, Madagascar, Mali, Mauritius, Malawi, Namibia, Niger, Nigeria, Senegal, Tanzania, South Africa, Zambia.

Latin America & Caribbean: Argentina, Bolivia (Plurinational State of), Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, Peru, Puerto Rico, Paraguay, Trinidad and Tobago, Uruguay, Venezuela (Bolivarian Republic of).

High income: OECD: Australia, Austria, Belgium, Canada, Switzerland, Chile, Czechia, Germany, Denmark, Spain, Estonia, Finland, France, Greece, Hungary, Ireland, Israel, Italy, Japan, Korea, Lithuania, Luxembourg, Latvia, Netherlands, Norway, New Zealand, Poland, Portugal, Slovakia, Slovenia, Sweden, United Kingdom.

Europe & Central Asia: Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Cyprus, Georgia, Croatia, Kazakhstan, Kosovo, Kyrgyzstan, Moldova, North Macedonia, Montenegro, Romania, Russia, Serbia, Türkiye.

Middle East & North Africa: Bahrain, Algeria, Egypt, Iran (Islamic Republic of), Iraq, Jordan, Kuwait, Lebanon, Morocco, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, Yemen.

South Asia; East Asia & Pacific: Bangladesh, India, Sri Lanka, Nepal, Pakistan; China, Fiji, Hong Kong SAR, Indonesia, Lao, Macao SAR, Mongolia, Malaysia, Philippines, Papua New Guinea, Singapore, Thailand, Taiwan Province of China, Vietnam.

Tables

Table A.1: Industry-level variables: Data sources and summary statistics

Variable	Source	25 th ptile	Mean	75 th ptile	Std. dev.
Asset tangibility	Igan et al. (2022)	0.204	0.280	0.363	0.126
Physical capital intensity	Igan et al. (2022)	0.911	1.204	1.466	0.520
Physical capital intensity	Erman and Kaat (2019)	0.860	1.548	2.230	0.801
Human capital intensity	Igan et al. (2022)	0.313	0.381	0.429	0.103
Value-added (10-year change, %)	Based on UNIDO	11.487	71.590	121.979	93.908
Value-added (share, %)	Based on UNIDO	1.642	5.726	6.894	7.339
Investment in physical capital (10-year change, %)	Based on UNIDO	-12.118	63.545	122.404	112.710

Table A.2: Accounting for other country-level variables (additional tests)

Variable	Country-level variable				
	Polity score (Polity V)	Democracy (Polity V)	Constraints on executives (Polity V)	GDP	Population
<i>Cadasters</i> × <i>I</i>	40.687** (19.201)	40.305*** (19.195)	38.511** (19.235)	56.164*** (19.500)	51.517*** (19.021)
<i>X</i> × <i>I</i>	0.514 (0.671)	1.604 (1.223)	3.405 (2.159)	36.292*** (10.190)	-29.725* (16.378)
<i>VA share</i>	-6.910*** (0.137)	-6.910*** (0.137)	-6.910*** (0.136)	-6.657*** (0.144)	-6.704*** (0.143)
Country-year F.E.	Yes	Yes	Yes	Yes	Yes
Country-industry F.E.	Yes	Yes	Yes	Yes	Yes
Industry-year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	59,518	59,518	59,518	59,146	60,748
R-squared	0.746	0.746	0.746	0.744	0.744

Notes: Results are based on equation (3). Dependent variable is the change in industry value-added. *X* is the country-level variable as indicated in the columns. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.3: Testing finance as an alternative explanation

Variable	(1)	(2)	(3)
<i>Cadasters</i> × <i>I</i>	56.441*** (20.627)	56.808*** (20.601)	56.410*** (20.623)
<i>FD</i> × <i>I</i>	-32.496 (34.384)		-24.148 (35.256)
<i>FD</i> × <i>EFD</i>		5.910** (2.816)	5.534* (2.909)
<i>VA share</i>	-7.672*** (0.205)	-7.670*** (0.205)	-7.671*** (0.205)
Country-year F.E.	Yes	Yes	Yes
Country-industry F.E.	Yes	Yes	Yes
Industry-year F.E.	Yes	Yes	Yes
Observations	42,823	42,823	42,823
R-squared	0.727	0.727	0.727

Notes: Results are based on the extended version of equation (3) where an interaction term between the proxies for financial development (FD) and industries' dependence on external finance (EFD) is included. Dependent variable is the change in industry value-added. *I* is the proxy for asset tangibility. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.4: Placebo tests

Variable	Cadaster index from 10-year ahead	<i>I</i> : Human capital intensity
<i>Cadasters</i> × <i>I</i>	-56.946 (35.900)	29.111 (39.151)
<i>VA share</i>	-8.041*** (0.271)	-6.727*** (0.142)
Country-year F.E.	Yes	Yes
Country-industry F.E.	Yes	Yes
Industry-year F.E.	Yes	Yes
Observations	30,554	61,473
R-squared	0.792	0.745

Notes: Results are based on equation (1). Dependent variable is the change in industry value-added. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.5: Subsamples

Variable	Sample	
	EMDEs	Countries with cadaster reform
<i>Cadasters × I</i>	55.953*** (20.941)	86.292*** (21.634)
<i>VA share</i>	-6.769*** (0.158)	-6.605*** (0.205)
Country-year F.E.	Yes	Yes
Country-industry F.E.	Yes	Yes
Industry-year F.E.	Yes	Yes
Observations	36,833	26,891
R-squared	0.720	0.719

Notes: Results are based on equation (1). Dependent variable is the change in industry value-added. Subsamples are indicated in the columns. EMDEs stand for emerging markets and developing economies. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.



PUBLICATIONS

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