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A B S T R A C T

By improving access, without altering the underlying information, computerization of land registration provides a unique case to test for credit supply effects of improved land administration that have often been elusive in the literature. We exploit the variation in the timing of the shift from manual to digital operation of Andhra Pradesh’s 387 subregistry offices during the state-wide rollout of this intervention between 1999 and 2005. Administrative data on credit disbursed and registered land transactions from 1995 to 2007 point to significant, though quantitatively modest, increases in credit access in urban but not rural areas. Institutional factors allow us to explain these results.

1. Introduction

It is increasingly recognized that well-defined property rights are crucial for realizing the benefits of market exchange and that such rights are not exogenously given but evolve over time in response to economic and political forces. Establishment and maintenance of a property rights system is an important public good and a large literature documents the benefits of public investment in securing property rights to land which, in virtually all countries, is one of households’ most important assets. The reduction of expropriation risk and the facilitation of market transactions are identified as the two main categories through which property rights systems affect economic outcomes (Besley and Ghatak, 2010). Reduced expropriation risk increases investment incentives and reduces the need to spend private resources on protecting property. Greater scope for market transactions allows both trade in assets and the use of assets as collateral in financial markets.

The mechanisms by which these two categories affect outcomes differ in important ways. As long as minimum legal recognition is enforced, adjudication processes that are based on local consent can significantly reduce expropriation risk. By contrast, full realization of gains from trade requires that reasonably complete, current, and authoritative information on the assignment of property rights – which is normally provided by public registries – be available at low cost to agents with sufficiently diverse skills to allow efficiency-enhancing transactions. Credit impacts from land titling or registration would be expected only if such efforts are comprehensive, registries remain up to date over time, and third parties, such as mortgage lenders, can access reliable registry information at low cost on a routine basis. The fact that many empirical studies find significant investment but no credit effects from land administration interventions could thus imply that these interventions managed to increase tenure security at the local level but failed to create the pre-conditions for efficiency-enhancing trade (Field and Torero, 2006; Galiani and Schargrodsky, 2010).

In practice, distinguishing the impact of information access from that of adjudication of property rights in practice has often been a challenge. In this paper, we focus on a program that computerized land registries in the South Indian state of Andhra Pradesh (AP). We argue that, although it will not alter the quality of underlying property

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rights information, computerization can reduce the cost associated with keeping the property register up to date, eliminate informal side payments that have traditionally been associated with property registration, and improve third party access to registry information. All of these effects could increase the volume of registered transactions, reduce the level of informality, and thus improve registry comprehensiveness. The program studied here also made records and abstracts of past transactions available online to interested third parties including banks, thereby allowing them to ascertain ownership status or existence of pre-existing liens on any property that might be offered as collateral. This could reduce banks’ cost of extending credit, facilitate an expansion of credit supply, either by lending to customers who had previously been ineligible or by extending more credit to existing ones.

While this leads us to expect that state-wide computerization of land registries can help improve credit access, institutional factors characteristic to India imply that such an effect will be stronger in urban settings than in rural ones where it may even be completely absent. In urban areas, land registries are the only available form of documentary evidence on land ownership. In rural areas, by contrast, land records maintained by revenue department officials at the village level are more accessible than land registries maintained at the taluk ('block') level, and thus more frequently used and up to date. Although AP computerized land records about a decade ago, it failed to either maintain or link them to registry information. This limits potential impacts of registry computerization even under ideal circumstances and acts as a warning against viewing computerization as a miracle cure to the ills of land administration systems. Institutional factors including limited liquidity of rural land markets due to restrictions on the transferability of land as well as mandated levels of lending to the rural sector and repeated episodes of credit forgiveness further limit the scope for credit effects in rural areas.

To test whether registry computerization affected credit access, we use variation in the date of shifting to fully computerized operations across the state’s 387 sub registry offices (SROs), a process that started in February 1999 and was completed in March 2005. The main dependent variable is the volume of credit disbursed by all scheduled commercial banks, based on banks’ mandatory reporting to the Reserve Bank of India, on a quarterly basis for the 1995 to 2007 period. To allay concerns that pre-existing differences in the growth of credit could drive results, we test whether the timing of computerization is related to this variable. Data on the volume of different types of registered land transactions at the SRO level allow us to independently test the paper’s main hypothesis; if there is a significant credit effect, we should see an impact of computerization on mortgages but not on other types of land transactions.

The results point towards a significant impact of computerization on credit in areas that are fully or partially urbanized but not in entirely rural ones, with the point estimate suggesting that, in a completely urban area, access to credit increased by 10.5% on average. The effect appears to grow stronger with time; for a fully urbanized area, we estimate increases of approximately 3% and 5% in the 2 years immediately following computerization and 15% thereafter. Data on the volume of registered land transactions support the hypothesis of computerization having led to an expansion of credit access in urban but not in rural SROs: point estimates suggest that, in entirely urban SROs, the number of registered mortgages increased by 18 percentage points in the 2 years immediately after computerization and by 32% thereafter. The fact that these numbers reflect the intervention helped expand coverage rather than provide higher volumes of credit to existing borrowers. Computerization had no effect on either the volume of registered land sales or that of non-monetary land transfers such as gifts, inheritances, and leases, supporting our argument that reduced transaction cost of institutional providers of credit in urban areas could act as a main channel for direct effects of computerization to materialize.

Evidence of credit effects of land registry computerization highlights that the ease with which information on property rights is accessible can affect economic outcomes. The modest size of estimated impacts and the fact that they are limited to a narrow segment of urbanized locations without other means of documenting land ownership suggests that the extent to which changes to property rights will affect outcomes is context specific and the magnitude of impact will depend on the characteristics of existing property institutions, and alternative options to document property available to economic agents.

The paper is structured as follows. Section 2 provides context by summarizing literature on credit and land regularization, highlighting some of the particularities of land records and land registration in India, and describing how land registration was computerized in Andhra Pradesh. Section 3 introduces data and descriptive statistics, in addition to discussing our estimation strategy and various robustness tests. Section 4 reviews main results on credit access and volume of registered land transactions and discusses potential implications. Section 5 concludes by drawing out implications for research and policy.

2. Context and hypotheses

To put our arguments into context, we describe the two main channels through which increased security of property rights and better information on such rights can affect outcomes, either by reducing risks of expropriation or by allowing transfer of assets and their use as collateral, and review relevant evidence from the literature. Discussion of institutional arrangements governing land administration in India, in particular the difference between land records and land registration, provides local context and allows us to formulate more specific hypotheses. Documentation of the nature of the computerization program in AP, and other relevant reforms undertaken over the same time period illustrates how this applies to the intervention at hand and provides a basis for predicting its impact.

2.1. Linking property rights interventions to economic outcomes

Development economists have long highlighted the central role of institutions, i.e. socially imposed constraints on human interaction that structure incentives in any exchange, in shaping growth and the distribution of its gains among the population (Gref, 1993; North, 1971). How land rights are defined and distributed in a society will determine social relations, the power structure, and the extent of economic development. Property rights to land and associated real estate are a key institution that allows individuals or groups to lay residual claim on the benefit streams from land assets and that is normally backed by the enforcement power of the state or the community. From the earliest days of recorded history, societies developed customs and laws on how to define land rights and many set up registries to put information on assignment and transfer of rights among private parties on public notice (Powelson, 1988).

One way through which secure property rights affect economic outcomes is by reducing expropriation risk, thereby increasing investment incentives and reducing the need for individuals to spend resources to protect their rights. In situations where property rights are insecure or boundaries ill-defined, clarification of rights through a process of adjudication can be a cost-effective way to increase tenure security, especially if this process is systematic in nature. The magnitude and distribution of the associated benefits will depend on the reduction in enforcement effort through formal recognition, the increment in security through the intervention (which may be affected by the legitimacy and legality of existing arrangements and the level of disputes), and the availability of

1 Index of past transactions, locally known as ‘encumbrance certificates’ (ECs), were made available for a 13-year period that exceeds the state’s statute of limitations. While this did not eliminate the need for specialist inspection of the underlying documents, it made accessing them easier.
investment opportunities. Benefits will be larger if the increment in tenure security is large, e.g. if land tenure had been insecure or conflict-ridden before, the payoff from land-related investment is high, and new arrangements enjoy wide legitimacy.

Following a seminal study in Ghana (Besley, 1995), positive impacts of efforts to increase land tenure security on investment in rural areas have been documented in China (Jacoby et al., 2002), Thailand (Feder et al., 1988), Latin America (Bandiera, 2007), Eastern Europe (Rozelle and Swinnen, 2004), and Africa where weak rights, often held by disadvantaged groups or outsiders, lead to significant reduction in fallowing that can be linked to lower yields (Deininger and Jin, 2006; Fenske, 2010, 2011; Goldstein and Udry, 2008). In urban areas, efforts to enhance tenure security have led to increased levels of self-assessed land values (Lanjouw and Levy, 2002), greater investment in housing, and female empowerment (Field, 2005). Receipt of titles allowed former squatters, especially women, to join formal labor markets instead of staying at home to guard their land, thereby increasing their income and reducing child labor (Field, 2007). In Vietnam, awarding certificates prompted higher investment in perennials and led households, especially the poor, to spend more time in non-agricultural activities (Do and Iyer, 2008). Titles to women in Argentina are also credited with having helped to reduce fertility and increase investment in children's human capital (Galiani and Schargrodsky, 2004). However, it is clear that impacts arise through investment in physical and human capitals rather than through improved credit access (Galiani and Schargrodsky, 2010).

A second channel for land tenure to have an economic impact, i.e. the ability to transfer assets to more productive users and use them as collateral to access credit (Besley et al., 2012; de Soto, 2000). Titles to land that can be foreclosed upon at reasonable cost (Besley and Ghatak, 2010). Lack of investment opportunities, risk aversion (Boucher et al., 2008), and political, social or economic constraints on the liquidity of land markets that make foreclosure difficult (Ambrus et al., 2009) are key causes identified in the literature. Importantly from our perspective, if registry information is inconclusive, incomplete, or out of date, possibly because high registration costs have in the past driven transactions into informality (Deininger and Feder, 2009), the scope of using land as collateral will be limited irrespective of credit demand. Thus, although there will be situations where improving access to and quality of registry information could have economic impacts, such an effect is unlikely to be universal.

2.2. The institutional setting of land administration in India

Before discussing how computerization may affect our outcomes of interest, it is important to understand key features of India’s land administration system, in particular the distinction between land records and land registration and the way in which these have been established historically, separately in rural and urban areas. Land records were introduced swiftly after colonization in rural areas with agricultural potential (i.e. excluding forests as well as urban areas) and aimed not to document rights but to collect taxes. Indeed, ‘land revenue’ constituted the main source of government income throughout the colonial period. Introduction of a deeds registration system through the 1882 Transfer of Property Act that requires all transfers of immovable property above a certain value to be registered implies that, with the exception of urban areas, land records and registration systems operate in parallel throughout the country. Unsurprisingly, maintenance and synchronization of these recording systems have been a major challenge ever since.

Given their fiscal purpose, responsibility for updating (rural) land records was with the state rather than individual owners. While changes in records due to inheritance and sub-division were expected to be registered by local revenue officers on an ongoing basis, systematic updates of maps to take account of changes in land use such as expansion of cultivated area and demographic change were to be undertaken every 30 years through so-called ‘revisional surveys’. After independence, land taxes were reduced to low levels or entirely eliminated, reducing the government’s incentive to keep records up to date. The maps used are thus on average 60 to 80 years old and have not been systematically revised for generations. Original parcels may still be recognizable in areas that continue in agricultural use although the extent to which transfers and subdivisions were recorded and charted on maps differs widely, affecting among others the nature and frequency of land disputes.

In urban settlements where no land records had been issued and in areas where land use has changed from agriculture to urban, registered deeds, managed by a different Government Department, provide primary evidence of land ownership. Three problems exist with this arrangement: First, records are of a presumptive nature only, i.e. registration puts an agreement between two parties on public notice but says nothing about the legal validity of the underlying transaction (Panagariya, 2008). Second, the information to be registered is not standardized and may thus be insufficient to ascertain not only the nature of rights being transferred of the transaction but also

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2 The large differences in the ratio of credit to GDP across countries is used as a key argument to justify interventions to formalize land rights that could then allow greater use of land as a collateral to access credit (Besley et al., 2012; de Soto, 2000).

3 Land revenue amounted to 60% of government income in the 1840s. The magnitude of tax obligations and the modality of their collection were determined in a process called settlement that was first undertaken when a territory was colonized. The way in which property rights were assigned during the settlement process, in particular whether revenue was collected through intermediaries (zamindars) or assessed directly from farmers (nypans), continues to have far-reaching impacts on current institutions and economic outcomes (Banerjee and Iyer, 2005).

4 While the revenue department manages land records, registration is with the Department of Stamps and Registration in virtually all states. In addition, many states have separate survey departments. Synchronizing the records held by these different departments has been a challenge.

5 Registrars will register any instrument received without checking its validity or the absence of counterclaiming claims. To deal with the high level of drawn-out conflicts this generates, many observers have recommended shifting to a system of title registration (Wadhwa, 2002).
the precise nature or boundaries of land being transacted. Specifically, inclusion of survey plans in the set of documents offered for registration is at the discretion of the transacting parties, implying that in many cases maps are missing or very imprecise. Conflicts over property boundaries can therefore rarely be resolved by resorting to registry records. Third, high rates of stamp duty for property registration foster petty corruption to undervalue property\(^6\) and tend to drive transactions into informality, thus jeopardizing the completeness of the registry.\(^7\) Together, these factors create ample opportunity for fraud, e.g. by failing to disclose pre-existing encumbrances and, for example, selling or collateralizing the same piece of land many times over.

To improve the value of registry information, registry offices provide encumbrance certificates (ECs), i.e. abstracts that list all registered transactions by a person or for a specific parcel. Legal experts can use these to trace the chain of registered transactions for a given property and, on this basis, provide an assessment of the likelihood that challenges may appear later. This is especially useful if the period for which ECs are kept exceeds the statute of limitations.

2.3. Computerization of land registries: rationale and implementation

In response to backlogs that delayed processing of simple registrations by more than 10 years and reports about undervalue of property causing rampant corruption and revenue loss, the state of Maharashtra developed software that was deployed to all of the state's land registry offices in 1997 through a public–private partnership. Results are reported to have been very positive (World Bank, 2007); instead of requiring days, standard registration processes could be completed in 30 min and automated property valuation eliminated officials’ discretion in undervaluing property. The number of registered transactions increased by more than 50%, from about 1 million in 1998/99 to more than 1.5 million in 2004/05. Thus, despite a significant reduction in rates (from 13% to 8%), stamp duty revenue more than doubled, from Rs. 16 billion to Rs. 41 billion, over the same period. The initiative provided a basis for modernization of land administration in Maharashtra and was emulated by other states suffering from similar problems.

Following this model, the state of Andhra Pradesh started introducing a program for Computer-Assisted Registration of Deeds (CARD) in the late 1990s. This program comprised of three elements, namely (i) streamlining of procedures to be followed in registration of property transactions at each of the state's 387 SROs; (ii) automatic property valuation to eliminate officials’ discretion in setting fees; and (iii) digitization of all ECs from 1983, and making these as well as other key documents such as market valuations and deed extracts available online. CARD was rolled out to cover all of Andhra Pradesh's 387 SROs, starting from those with the highest transaction volumes. Specifically in three rounds, 54% of SROs were computerized in February 1999, 12% in November 2001, and the remainder in March 2005.

As computerization affects the cost of accessing property information and registering transfers without altering the nature or security of the underlying rights, it allows us to test whether, as predicted by theory, easier access to information can help expand credit supply and registered land transactions. However, one would expect such effects to be more pronounced in urban areas where no useable alternative records exist, and we use the initial share of urban population to examine such heterogeneous effects.

3. Data and estimation strategy

Data on credit disbursed by commercial banks and the total number of registered land transactions from 1995 to 2007 point towards a significant increase in the supply of credit as well as the volume of registered land transactions. To assess whether these increases can be attributed to computerization rather than other changes, e.g. the reduction of stamp duties, we exploit the variation in the timing of the introduction of this intervention across SROs to identify the impact of computerization on credit supply and the different types of registered land transactions. Below we discuss the approach and assumptions underlying our estimates of the impact.

3.1. Data and descriptive evidence

The data we use in this paper comes from three different sources. First, quarterly data on credit disbursed by all scheduled commercial banks\(^8\) to retail customers from 1995 to 2007 in all of AP's 1064 taluks is available from the Reserve Bank of India 2008. Annual Report. India's Central Bank, based on routine reports that need to be submitted to the regulator, aggregated from the branch level. This provides a total of 52 observations per taluk, from Q1 of 1995 to Q4 of 2007, i.e. 16 quarters before the first set of registry offices were computerized and 8 quarters after the last of AP's SROs had shifted to operating on a fully digital basis. Second, the Andhra Pradesh Department of Stamps and Registration made available annual data on different types of registered land transactions in the 1995–2007 period for each of the state's 387 SROs. These transaction data include land sales, mortgages, and non-monetary land transactions, mainly in the form of gifts and partitions. Third, in light of the differences between land administration in rural and urban areas highlighted above and the rapid pace of urbanization in AP over the period considered here, we use the 2001 Census to obtain the initial share of urban population in any taluk or SRO.\(^9\)

Panel A in Table 1 illustrates that credit markets in AP evolved rapidly over the period under concern. The volume of credit almost quintupled in real terms, from Rs. 525 billion in 1995 to Rs. 2503 billion in 2007 (i.e. approximately Rs. 15,000 or US $300 per person).\(^10\) Prima facie, the rate of growth seems to have accelerated after 2003, at a time when most SROs had already been computerized. Registration also accelerated notably; non-monetary transactions more than tripled, while registered sales doubled and mortgages increased by almost 50%. Sales and mortgages together made up approximately 80% of registered land transactions in 2007, down from 85% in 1995. The absence of clear shifts and the fact that other policy changes, most notably a state-wide reduction of stamp duties for sales and non-monetary transfers but not for mortgages in 2005, occurred during the period and may have affected outcomes, imply that a more disaggregated and differentiated analysis will be required to assess computerization impacts.

As a first step in this direction, panel B in Table 1 summarizes total credit volume as well as mean numbers of transactions for each land transaction type by SRO, overall and separately for rural and urban areas. Total volume of credit disbursed by commercial banks varies extensively between urban and rural areas with the amount of urban credit (Rs. 2 billion) significantly higher than rural (Rs. 0.06 billion), on average. After computerization, credit is estimated to have doubled in both; from approximately Rs. 1 billion to Rs. 2.55 billion in urban and from Rs. 2.55 billion in rural areas.

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\(^6\) A nation-wide survey of 8000 users of land administration in all states estimates the amount of bribes paid annually in this sector at US $700 million, three-quarters of the public spending on science, technology, and environment (Transparency International India, 2005).

\(^7\) The stamp duty to be paid for registering deeds ranges between 5% and 12.5% of the property's market value for sales and 0.5 to 2% for mortgages, often with surcharges for properties located in cities. Registration fee is normally between 0.5% and 2% of the property value.

\(^8\) Scheduled commercial banks include all public and private sector banks with the exception of cooperative banks who contributed less than 10% to total lending from 1997 to 2006 (RBI, 2008).

\(^9\) In few cases where SROs did not match with taluk boundaries, we used lists of villages from the 2001 Census to establish a match. Overall, approximately 40% of SROs are at least partly urbanized with the mean level of urban population at 34%.

\(^10\) Credit is reported in billions of 1993 Rupees using the RBI wholesale price index with 1993–94 as the base year.
3.2. Estimation strategy

The goal of the empirical analysis is to examine the impact of computerization of land registration on expansion of credit supply over time. We utilize panel data on credit disbursed by commercial banks and exploit the variation in the timing of land registry computerization across all the 387 sub-registry offices of the state to identify the effect. We start by estimating the following equation:

\[ C_{it} = \alpha_0 + \alpha_i \text{Comp}_{it} + \gamma_i + \theta_t + \epsilon_{it} \]

where \( C_{it} \) is the log of credit disbursed in taluk \( i \) at quarter \( t \), represents a full set of taluk fixed effects to control for unobserved time invariant heterogeneity such as differences in taluk-level endowments or economic structure that may affect the volume of recorded land transactions or credit disbursement, \( \theta_t \) represents quarter-year fixed effects to control for time varying factors such as common demand or policy shocks that may affect disbursement of credit or land transactions across all taluks of the state. Standard errors are clustered at taluk level and \( \epsilon_{it} \) is a taluk-quarter specific error term. \( \text{Comp}_{it} \) is an indicator variable for whether computerization had been introduced in taluk \( i \) in quarter \( t \), and the key coefficient of interest is \( \alpha_i \), measuring the effect of computerization on the average quarterly volume of credit disbursed by commercial banks. Replacing \( C_{it} \) with \( T_{it} \), i.e. the log of different types of land transactions registered in SRO \( i \) in year \( t \) allows us to undertake a similar analysis for the volume of registered land transactions to explore whether various types of transactions moved in parallel with credit supply. The rationale for doing so is that, if the effect of computerization is indeed driven by credit, we would expect mortgages but not land sales or non-monetary transfers to be affected by this variable.

To examine whether the effect of computerization varies over time, we include additional pre- and post-binary variables that indicate time periods immediately preceding or following computerization. This allows us to differentiate between a level and a trend effect of the intervention. A lagged effect may, for example, be due to banks needing to get acquainted with the information provided online and rewrite loan approval procedures accordingly. By the same argument, inclusion of indicator variables for a certain number of quarters or years before an SRO was computerized allows us to perform a placebo test and we would expect the coefficient on these variables to be insignificant.

While fixed effects estimates address concerns that the introduction of computerization may be driven by unobserved time-invariant factors that also cause changes in credit, results could be driven by pre-existing differential trends in the growth of credit or registered land transactions between SROs that computerized early and those that computerized later. This is an empirically important concern in view of the fact that roll-out of computerization was designed to move from high to low volume SROs. Fortunately, with credit and transaction data going back to 1995, we can explicitly test for whether the timing of computerization is correlated with pre-existing levels or trends of credit and land transaction volume.

Results from estimating probit regressions of the timing of computerization are reported in Appendix Table A1 for credit (panel A) and the number of mortgages (panel B). The dependent variable is 1 if the SRO was computerized in 1999 and 0 if the SRO was included later. Independent variables are levels and changes in credit volume or the number of registered land transaction before computerization was introduced (i.e. 1995–1998), interacted with the share of urban population in each SRO. Columns 1–3 of panel A suggest that neither levels nor changes in pre-computerization credit volume are predictive of the timing of computerization. All the coefficients on levels as well as changes are small, none are statistically insignificant, and the direction of the effect is not consistent across the variables giving us no reason to believe that the timing of computerization was correlated with differential pre-existing trends in credit supply. In panel B, the coefficient on one of the level variables (1997) in pre-computerization level of mortgages is significant and positive. While this suggests that the roll-out plan, from high to low transaction SROs, has been adhered to, it points towards a weak correlation between mortgages and overall transactions. Also, coefficients on the change in mortgage volume from 1995 to 1998 together with their urban share interactions are miniscule suggesting

Notes: In panels A and B, nominal values of credit are deflated using the RBI wholesale price index with 1993 as base year, credit is reported in billions of 1993 Rupees. In panel A, volume of land transactions (land sales, mortgages, non-monetary land transactions) are reported in millions. Panel B reports average number of land transactions registered per SRO.

0.04 billion to Rs. 0.09 billion in rural areas. Evidence on registered land transactions is consistent with this trend in terms of much higher numbers in urban than in rural areas. For instance, registered land sales and non-monetary transfers in urban areas are three times that of rural areas. In addition, the number of registered land sales almost doubled after computerization, from 3171 to 5077 in urban and from 1014 to 2003 in rural areas. Similarly there are significant differences in the number of registered mortgages between rural and urban areas (548 vs. 712), although an increase in registered mortgages after computerization, from 673 to 798, appears to remain confined to urban environments. While the above changes are large, they may have been due to macroeconomic conditions or location-specific factors rather than a result of CARD. To explore whether and to what extent observed increases in credit supply are a causal effect that can be attributed to computerization, we rely on plausibly exogenous variation driven by the intervention, as explained below.

<table>
<thead>
<tr>
<th>Year</th>
<th>Credit</th>
<th>Sales</th>
<th>Mortgages</th>
<th>Non-monetary transactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>525</td>
<td>0.48</td>
<td>0.19</td>
<td>0.11</td>
</tr>
<tr>
<td>1996</td>
<td>579</td>
<td>0.51</td>
<td>0.21</td>
<td>0.12</td>
</tr>
<tr>
<td>1997</td>
<td>627</td>
<td>0.52</td>
<td>0.23</td>
<td>0.12</td>
</tr>
<tr>
<td>1998</td>
<td>667</td>
<td>0.54</td>
<td>0.31</td>
<td>0.13</td>
</tr>
<tr>
<td>1999</td>
<td>736</td>
<td>0.55</td>
<td>0.29</td>
<td>0.13</td>
</tr>
<tr>
<td>2000</td>
<td>817</td>
<td>0.60</td>
<td>0.27</td>
<td>0.15</td>
</tr>
<tr>
<td>2001</td>
<td>874</td>
<td>0.61</td>
<td>0.26</td>
<td>0.16</td>
</tr>
<tr>
<td>2002</td>
<td>973</td>
<td>0.65</td>
<td>0.26</td>
<td>0.18</td>
</tr>
<tr>
<td>2003</td>
<td>1094</td>
<td>0.72</td>
<td>0.27</td>
<td>0.20</td>
</tr>
<tr>
<td>2004</td>
<td>1432</td>
<td>0.84</td>
<td>0.28</td>
<td>0.26</td>
</tr>
<tr>
<td>2005</td>
<td>1986</td>
<td>0.88</td>
<td>0.28</td>
<td>0.30</td>
</tr>
<tr>
<td>2006</td>
<td>2050</td>
<td>0.93</td>
<td>0.29</td>
<td>0.34</td>
</tr>
<tr>
<td>2007</td>
<td>2503</td>
<td>1.09</td>
<td>0.33</td>
<td>0.36</td>
</tr>
</tbody>
</table>

Panel A

Panel B

| | Total | Credit | | Sales | | Mortgages | | Non-monetary trans. |
|---|---|---|---|---|---|---|---|
| | All | Before comp. | | After comp. | |
| Credit | 0.24 | 0.10 | 0.37 |
| Sales | 1704 | 1115 | 2302 |
| Mortgages | 595 | 552 | 663 |
| Non-mon. trans. | 488 | 258 | 722 |
| Credit | 0.06 | 0.04 | 0.09 |
| Sales | 1491 | 1014 | 2003 |
| Mortgages | 548 | 545 | 551 |
| Non-mon. trans. | 393 | 227 | 570 |
| Credit | 2.00 | 0.97 | 2.55 |
| Land sales | 4453 | 3171 | 5077 |
| Mortgages | 712 | 673 | 798 |
| Non-mon. trans. | 697 | 512 | 980 |

Notes: In panels A and B, nominal values of credit are deflated using the RBI wholesale price index with 1993–94 as base year, credit is reported in billions of 1993 Rupees. In panel A, volume of land transactions (land sales, mortgages, non-monetary land transactions) are reported in millions. Panel B reports average number of land transactions registered per SRO.

As the value of credit disbursed is likely to change proportionally we use logs. Value of credit also appears to be positively skewed whereas the log transformation is much more symmetrically distributed. Results are qualitatively similar when estimated in levels.
that pre-existing trends in mortgage volume are uncorrelated with the timing of SRO computerization. Overall, the results in Table A1 suggest that there appears to be no substantial evidence that the timing of computerization is driven by pre-existing differential trends in the relevant outcomes. The causal effect is thus isolated by exploiting the variation in the timing of land registry computerization across all the 387 sub-registry offices of the state.

4. Econometric results

Although we fail to ascertain impacts of computerization on overall credit supply, we find a significant impact in areas that were at least partly urbanized and where therefore land records can no longer be relied upon to provide a reliable basis to document land ownership. Consistent with the interpretation of reduced transaction cost for banks as the underlying driver, computerization in urbanized areas is found to have significantly increased the overall number of registered mortgages, but had no effect on the number of registered land sales or non-monetary land transactions.

4.1. Computerization and credit supply

Results in Table 2 point towards a robust effect of computerization on credit supply in urbanized areas that increases over time. We use the initial share of urban population as a proxy for the share of land parcels for which the most recent information is likely to be available in the registry rather than in the land records office. Although a naïve estimate (column 1) would suggest a large effect, inclusion of proper controls implies that computerization had no effect on overall credit supply (column 2). At the same time, it affected credit supply in partly or fully urbanized areas with the magnitude of the estimated effect proportional to the share of urban population. In completely urban SROs, land registry computerization increased, according to the point estimate, credit supply by 10.5%. This is consistent with the notion that, in these areas, land records are either unavailable or unreliable so that the land registry is the only source of ownership documents.

To examine whether and how the effect varies over time, we include additional pre- and post-binary variables that indicate time periods immediately preceding or following computerization in columns 3 and 4. To illustrate, Post Q0–4 is an indicator variable for the quarter in which computerization is introduced and the first four quarters thereafter, Post Q5–8 is an indicator variable for the fifth to eighth quarters (representing the second year) after computerization, and Post Q9+ is an indicator variable for the ninth quarter after computerization and beyond. In column 3, there appears to be no evidence for lagged effects of computerization in the aggregate as the relevant coefficients are individually and jointly not significantly different from zero. In contrast, the impact of computerization on credit disbursed by commercial banks appears to increase with the degree of urbanization in column 4, and with some delay, where the effect increases from approximately 3% in the first four quarters to 5% in the first eight quarters immediately following computerization to 15% thereafter, possibly as a result of banks learning about the uses of the information provided by computerized registries or adjusting their business process to take advantages of it more routinely.

We also add an indicator variable Pre Q1–4 for the four quarters leading up to computerization (placebo test) and find that the difference between the pre and post coefficients is significantly positive the more urban the area. There appear to be no observable changes in credit before the introduction of computerization (the coefficients

| Table 2 |
| Effects of computerization on credit access. |

| Dependent variable: log of credit disbursed by banks | (1) | (2) | (3) | (4) |
| Computerization | 0.854*** | 0.0163 | 0.0195* | 0.0495* |
| Computerization × urban share (US) | 0.0114 | 0.0130 | 0.0117 | 0.0136 |
| Comp. × Post Q0–4 | 0.0152 | 0.0189 | 0.0199 | 0.0209 |
| Comp. × Post Q5–8 | 0.0231 | 0.0326 | 0.0273 | 0.0296 |
| Comp. × Post Q9+ | 0.0246 | 0.0340 | 0.0246 | 0.0340 |
| Comp. × US × Pre Q1–4 | 0.0137 | 0.0123 | 0.0137 | 0.0123 |
| Comp. × US × Post Q0–4 | 0.0519*** | 0.0210 | 0.149*** | 0.0586 |
| Comp. × US × Post Q5–8 | 0.0308 | 0.0594 | 0.0308 | 0.0594 |
| Comp. × US × Post Q9+ | 0.0278 | 0.0367 | 0.0278 | 0.0367 |

Notes: Robust standard errors clustered at taluk level. US = share of population urban.

* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

on Pre Q1–4 are small and insignificant), with a sharp and persistent acceleration in credit occurring only after the introduction of CARD, suggesting that the timing of CARD introduction can be considered plausibly orthogonal to pre-existing differential trends in credit. The evidence lends support to the identification strategy and the consequent validity of the estimated effect.

4.2. Computerization and registered land transactions

Exploring effects on the volume of registered land transactions provides an additional robustness check to support the plausibility of the credit supply effects postulated above. Table 3 reports the results separately for land sales, non-monetary land transfers, and mortgages. Two results are of interest: first, we find no evidence of computerization having affected either the volume of land sales or that of non-monetary land transfers, either in the aggregate or for urbanized locations (columns 1–4). This is consistent with the notion that the increase in these variables observed in descriptive statistics may be due to contemporaneous fee reductions. It also suggests that any impacts of registry computerization on improving governance and reducing corruption may have been more limited than often assumed. Second, while a similar lack of significance is observed for mortgages overall, computerization is estimated to have led to an increase of approximately 31% in the number of mortgages in SROs with a completely urban population (column 5).

Consistent with the credit effect evident earlier, we examine whether and how the effect varies over time and include additional pre- and post-binary variables that indicate time periods immediately preceding or following computerization. We fail to detect any changes in the number of registered (urban) mortgages before the introduction of computerization, i.e. the coefficient on Pre Y1–4 by itself and interacted with the urban share is insignificant. This supports the notion that the result is not driven by unobserved factors associated with computerization. Interaction with the post-variables in column

12 Similar results, which are available from the authors on request, are obtained if the number of total transactions rather than mortgages is used.
13 The F statistic for equality of Pre 1–4-US and Post 0–4-US coefficients is 4.56 (p = 0.03), suggesting that the coefficients are statistically different from each other.
and where many restrictions on the functioning of land markets have been abolished more than a decade ago. In rural areas, land ownership ceilings, restrictions on alienation of land that had been acquired through certain schemes, and prohibition of leasing continue to constrain land market liquidity. Also, India’s commercial banks are already required by law to direct 18% of their loan portfolio to rural areas. As long as this constraint binds, even significant reductions in the transaction cost of gaining access to information would not increase the volume of rural credit. Finally, a history of agricultural debt cancellations – often politically motivated and imposing at least temporary loses on banks – may undermine banks’ willingness to lend to the rural sector.13

5. Conclusion and policy implications

This paper has been motivated by two considerations. First, since systems to document property rights (e.g. land registries) are viewed as part of a country’s institutional infrastructure, their establishment and maintenance warrant public investment. Quantification of the benefits from specific (incremental) improvements in the quality or accessibility of land records can thus help to determine whether such investments can be worthwhile, an issue that is of particular relevance in light of the drop in cost of IT services. For policy makers, efforts to computerize existing registry information are attractive because of their relatively low cost and promise of quick results. In fact, influential rankings such as the ‘doing business’ indicators that are often portrayed as assessing the quality of a country’s property rights system, focus on registration cost only and as a result have recently come under criticism for failing to consider either the quality or the coverage of the underlying information (Arrunada, 2007). Second, while the investment impacts from efforts to increase tenure security, often via systematic adjudication campaigns, have been well studied in the literature, the impact of easier access to more reliable land rights information on credit supply is less well documented. Exploring credit effects is of particular interest especially since marketability- and credit-effects are likely to become more important with higher levels of economic development.

In line with the conceptual model, our results illustrate that interventions to lower the cost of updating registry information, and make it more easily available to lenders can increase credit access. However, factors such as limited coverage of records, defects in the quality of underlying information, and structural characteristics of the land administration system may limit the scope for such effects to materialize. As a result, we observe credit effects only in urban areas – where the registry is the main source of land information – but not in rural environments. Our results imply that better access to land records is unlikely to universally and immediately increase credit access and that a more nuanced assessment will be appropriate.

Even in highly urbanized areas, the impact of computerization is relatively modest. Combination of computerization with efforts to improve the quality and relevance of the underlying information, e.g. by synchronizing records and registries or by adding a survey that would allow one to unambiguously locate the property in question and determine its boundaries, could provide an avenue for realizing additional benefits from careful analysis of similar efforts to improve land administration by other Indian states.

13 While available data from AP do not allow us to empirically discriminate between these explanations, information from other states that have computerized records and registries and may have established village-based kiosks as well, could allow such testing.

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6 points towards growth of the impact over time: from approximately 18% in the first two years after computerization to 33% thereafter.14

To interpret the result that computerization-induced reductions in transaction costs increase credit supply in urban but not in rural areas, it is useful to recall the two assumptions that conceptually underpin the credit market argument. First, for an intervention to affect credit supply by allowing greater use of land as collateral, it needs to reduce the transaction cost of accessing accurate land ownership information. This is likely to be the case in urban areas where, as argued earlier, registration of deeds is the main means of documenting land rights, and land records are irrelevant. While computerization has not made registry information conclusive, it did result in full indexation of deeds so that physical inspection of pre-screened records by legal experts is possible at a reduced cost. In rural areas, land records are available at village level and are more accessible and up-to-date than registry information which can only be accessed and modified at the taluk headquarters. However, even though AP did computerize land records, continued use of paper record has not only made digitized information obsolete but also precluded establishment of back-office integration with a direct link to the registration system. Such a step could have allowed realization of synergies from cross-checking, an integrated process, and gradual synchronization of the information in both databases. In the absence of such integration, even full registry computerization will not obviate the need to check paper-based land records, maintained by land revenue officers at village level, to ascertain whether the information provided by the registry is reliable. As a consequence, registry computerization will have little, if any, impact on the cost of obtaining land information in rural areas.

Second, better access to information on ownership of property will affect credit supply if, before the intervention, agents are credit constrained and have illiquid wealth that can be foreclosed upon at low cost in reasonably liquid markets. This is plausible in urban areas where land prices, which were already high in international comparison earlier, have increased tremendously over the last decade.
**Appendix A**

**Table A1**

Computerization timing and initial values and changes in credit and transaction volume.

<table>
<thead>
<tr>
<th>Year</th>
<th>Panel A: credit</th>
<th>Panel B: mortgages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>1995</td>
<td>0.006 [0.022]</td>
<td>0.002 [0.002]</td>
</tr>
<tr>
<td>1996</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td>1997</td>
<td>0.005 [0.043]</td>
<td>0.0004 [0.002]**</td>
</tr>
<tr>
<td>1998</td>
<td>0.003 [0.057]**</td>
<td>0.0001 [0.002]</td>
</tr>
</tbody>
</table>

\[ \Delta_{2001-1999} \text{credit} = 0.006 [0.004] \]
\[ \Delta_{2005-1999} \text{credit} = 0.005 [0.004] \]
\[ \Delta_{2005-1999} \text{mortgages} = 0.006 [0.005] \]
\[ \Delta_{2005-1999} \text{urban pop. share} = 0.005 [0.008] \]
\[ \Delta_{2005-1999} \text{urban pop. share} = 0.007 [0.115] \]
\[ \Delta_{2005-1999} \text{urban pop. share} = 0.005 [0.007] \]

\[ N = 387 \]
\[ R^2 = 0.32 \]

Notes: The dependent variable is 1 if a SRO computerized in 1999 and 0 if this happened in 2001 or 2005. Change in credit or mortgages is the absolute change at SRO level. Estimates are probit coefficients. Standard errors in brackets.

* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

**References**


Transparency International, New Delhi.
