Going Digital: Computerized Land Registration and Credit Access in India

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Abstract: Despite strong beliefs that property titling and registration will enhance credit access, empirical evidence in support of such effects remains scant. The gradual roll-out of computerization of land registry systems across Andhra Pradesh's 387 sub-registry offices (SROs) allows us to combine quarterly administrative data on credit disbursed by all commercial banks for a 11 year period (1997-2007) aggregated to the SRO level with the date of shifting registration from manual to digital. Computerization had no credit effect in rural areas but led to increased credit-supply in urban ones. A marked increase of registered urban mortgages due to computerization supports the robustness of the result. At the same time, estimated impacts from reduction of stamp duty are much larger, suggesting that, without further changes in the property rights system, impacts of computerization will remain marginal.

1. Introduction

Even though the Coasian world of neoclassical economics departs from existence of well-defined property rights that can be enforced at no costs, it is increasingly recognized that in practice establishment and maintenance of institutions to define such rights and make information on them available freely is an important public sector role. Such institutions are generally believed to affect economic outcomes through three mechanisms, namely (i) the incentives to exert effort and make investments; (ii) the scope for separating ownership of an asset from its control; and (iii) the potential for financial market development (Besley and Ghatak 2008). The fact that, in many developing economies, formal land rights are largely absent has led influential observers to argue for acceleration of land titling to help transform large amounts of 'dead assets' into 'live capital' and provide the preconditions for emergence of a financial sector (de Soto 2000). However, despite a strong belief in the credit-enhancing impacts of property institutions, empirical evidence in support of such effects remains scant and sometimes non-existent even where programs had initiated with the express purpose of increasing credit access.

To explore the effect of improved functioning of property registries on credit access, this paper analyzes the impact of the *C*omputer-*A*ssisted *R*egistration of *D*eeds program (CARD) that computerized land registration in the Indian state of Andhra Pradesh (AP). In contrast to traditional titling programs that focus on adjudicating rights on the ground for the first time, this intervention reduced the cost of registering transactions for owners and that of accessing information on property rights, especially for lenders. At the same time, it affected neither the quality of the information maintained in land registries nor the institutional structure of land administration. Any potential benefits will thus be limited to those already in the formal system or able to join it at low cost. This makes such reforms of limited interest if property registries are non-existent, have limited outreach, or are not already used by banks. At the same time, registry reform is amenable to the innovative use of information technology, an area which India has pioneered and the impact of which remains controversial and not well documented empirically. An evaluation of simple procedural reform that stops short of more far-reaching institutional changes or

rights determination as such measures have recently gained currency, in large parts supported by initiatives such as 'doing business' (World Bank 2009). Proponents of such an approach argue that a focus on 'low hanging fruit' can create political momentum for more far-reaching reforms by demonstrating producing tangible benefits quickly (Djankov and McLiesh 2007). Opponents retort that focus on a very simplified set of indicators without consideration of the channels through which effects materialize, the quality of the underlying information, and the outreach of the concerned institutions, could result in window-dressing that, instead of acting as a stepping-stone towards broader reform, may obfuscate and obscure the real issues (Arrunada 2007).

At a conceptual level, computerization of land registries can possibly affect the operation of property rights institutions and credit markets in two ways. First, it can lower the cost of registering property transfers by reducing the processing time required and by eliminating discretionary side payments that have traditionally been associated with property registration. Second, it can make it easier for third parties such as banks to access information on property rights by making records, including abstracts of past transactions, so-called encumbrance certificates (ECs), available online. To the extent that this will increase the benefit-cost ratio of registering property transfers, it can prompt more owners to register their transactions, thereby reducing the level of informality. Also, easier access to information to ascertain the ownership status or existence of pre-existing liens on any property that might be offered as collateral can reduce banks' cost of extending credit, thus possibly leading to an expansion of credit supply - either by lending to customers who had previously been ineligible or by extending more credit to existing ones. As computerization did not alter quality or nature of the underlying information or other elements of the transaction costs of registering property, the nature and magnitude of predicted effects is likely to differ depending on initial conditions, for example between rural and urban areas.

To empirically test these predictions, we use annual data on the volume of registered sales and mortgages by sub-registry office (SROs) from 1997 to 2007 as well as quarterly data on credit supply from the Reserve Bank of India, aggregated from individual branches to the block level, for an 11-year period that covers the state-wide roll out of this intervention. As computerization affects the cost of accessing information or making changes to it, rather than the quality of the underlying data, our primary emphasis is on credit effects, a focus that is also warranted by the fact that in past studies credit effects have proved to be most elusive. Transaction data are then used to explore the plausibility of our results. Moreover, we use the fact that taxes ('stamp duties') to be paid upon property transfer were changed in 2005 throughout the state but differently for rural and urban areas, to compare the size of computerization effects to those of a known reduction of the costs of transferring land.

We find a computerization-induced credit increase of some 15 percent in urban areas but no credit impact in rural areas. This is consistent with evidence of a significant increase in the number of registered mortgages -but not sales- due to computerization in urban areas but no measured effect of CARD on registered land transactions of any type in rural ones. By comparison, reduction of stamp duties had a consistent and quantitatively large impact on all types of transactions in rural and urban areas. Clear evidence of credit effects in part of our sample highlights that property rights affect economic outcomes. At the same time, our results also highlight that credit effects will depend on the quality of the underlying information and the resulting reduction of transaction costs associated with accessing property information. These factors will need to be borne in mind when designing property rights reform or making predictions on its potential impacts.

The paper is structured as follows. Section two provides context by drawing together the literature on credit and land regularization, as well as the details of the computerization system in the state of Andhra Pradesh. Section three discusses estimation strategy, introduces the data used, and presents basic descriptive statistics. Section four presents empirical results on credit, and volume of transactions, and Section five concludes by drawing out implications for research and policy.

2. Context and hypotheses

To frame the debate, we highlight how, and under what conditions, programs to clarify and adjudicate rights or improve access to the registry could affect land-related investment and credit access. Description of institutional arrangements governing land administration in India, the nature of the computerization program in AP, and other relevant reforms undertaken over the same time period, then illustrates how this applies to the case at hand and provides a basis for predictions regarding the impact of these interventions.

2.1 Conceptual links between land registration and credit access

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 (Greif 1993, North 1971). How land rights are defined and distributed in a society will determine social relations, the power structure, and the potential for economic development. At virtually all levels of development, property rights to land and associated real estate are a key institution which, backed by the enforcement power of the state or the community, allow individuals or groups to lay residual claim to benefit streams from land. From the earliest days of recorded human history, awareness of the social and economic benefits from secure and well-defined property rights and public recording of transactions led many societies to develop customs and laws to define land rights, set up registries to record such rights (often to obtain tax revenue), and establish courts and police to enforce

them (Powelson 1988). At the same time, the notion that in some societies, lack of formal property rights to land may limit the scope for investment and operation of financial markets has prompted calls for interventions from various sides. Two types of interventions to improve this state of affairs are common.

In situations where property rights are ill-defined or entirely lacking, a systematic clarification of land rights through a process of adjudication and first-time registration will be required. Such 'traditional' interventions to clarify and register rights, are normally justified with reference to the expected increases in tenure security (and reduced level of enforcement efforts by owners to exclude others), in incentives for land-related investment and informal transfers of land to better users. The magnitude and distribution of such benefits will depend on the reduction in enforcement efforts afforded by formal recognition, the availability of investment opportunities, skill differences among local land owners, and the incidence of formal or informal land rights before the intervention. Benefits will normally be larger in cases where potential for land-related investment is high, tenure has been insecure or affected by conflict, and where documentation generated will be respected and affect behavior by third parties. Positive impacts of more secure land tenure on investment and land values in rural areas have been demonstrated in China (Jacoby *et al.* 2002), Thailand (Feder *et al.* 1988), Latin America (Bandiera 2007), Eastern Europe (Rozelle and Swinnen 2004), and Africa (Deininger and Jin 2006, 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 (Galiani and Schargrodsky 2005), and female empowerment (Field 2005). Receipt of titles has 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). Joint titles are credited with having helped to reduce fertility and increase investment in children's human capital (Galiani and Schargrodsky 2004). In Vietnam, awarding certificates is estimated to have prompted higher investment in perennials and prompted households, especially the poor, to spend more time in non-agricultural activities (Do and Iyer 2008).

Even if land rights are defined on the ground, improving access to such information through improved functioning of land registration can have positive effects on credit access. The reason is that availability of reliable information on land ownership at low cost via a public registry without the need of physical inspection or inquiry with neighbors reduces the cost of exchanging land in formal markets and provides the basis for low-cost use of land as collateral for credit.[1] Provision of credit is risky because uncertainty and asymmetric information lead to credit rationing in equilibrium and reduced lending volumes compared to a world of perfect information (Stiglitz and Weiss 1981). The use of collateral is a universal

[1] 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 and Ghatak 2008, de Soto 2000).

practice to reduce the extent of credit rationing and improve welfare. Its immobility and relative indestructibility make land ideal collateral. However, banks' ability to use it for this purpose on a large scale is contingent on a formal and low-cost way to unambiguously ascertain land ownership or the absence of other encumbrances for a specific plot (Arrunada 2009). With no other obstacles to the functioning of land and financial markets, reliable land registries can thus help to increase credit access. As this will allow borrowers to obtain funding for projects the true risk of which is less than what lenders would assume without collateral, it can increase the level of investment and improve economic efficiency. In such situations, formalizing land tenure can encourage financial market development and use of financial instruments that draw on the abstract representation of property by formal titles (de Soto 2000).

Quite surprisingly in view of the attention devoted to the use of land as collateral, evidence on credit effects is quite limited and often focused on land titling rather than registration. Moreover, while some studies report credit effects from land titling (Feder *et al.* 1988), there are many cases where credit effects from property rights reform were expected but did not materialize (Field and Torero 2006, Galiani and Schargrodsky 2005). Failure to detect credit effects is often attributed either to insufficiently secure rights or household or land market characteristics such as risk aversion, absence of bankable projects, and illiquid land markets. High cost of registering subsequent transactions, if combined with limited benefits, often leads to a perception that the cost of registration exceeds the benefits from doing so (Deininger and Feder 2009). Whether, as implicitly assumed by approaches that focus on regulatory reform, reduction of the cost of registering and transferring property can have an impact is open to debate (Arrunada 2007) but has not been analyzed in the literature. India provides an ideal case for doing for two reasons. First, it has a system of land records with reasonably wide outreach but huge amount of duplication and inefficiency that leads to widespread conflict and property rights insecurity. At the same time, it has taken a leadership role in applying IT to land administration to make it easier to access information on property rights and reduce the cost of registering transactions.

2.2 The institutional setting of land administration in India

India's system of land administration has its origin in colonial land taxation. Most of the institutions and processes currently in place resemble closely those established under British rule when land taxes (called 'land revenue') constituted the main source of government income.[2] The primacy of revenue for land recording had two implications. First, land records were a fiscal instrument that focused on use rather than ownership and provided neither a unified spatial framework nor mechanisms or incentives for owners to register transactions to keep their records up to date. In fact, it was incumbent on the administration to

[22] 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 incorporated into the empire. The nature of the settlement process continues to affect the nature and quality of land institutions and the nature subsequent growth (Banerjee and Iyer 2005).

update their records through revisional surveys, expected to be undertaken at generational intervals of some 30 years. Second, original settlement surveys were restricted to agricultural lands, excluding forests where the potential for revenue was low and urban areas inhabited by colonial elites who were not to be burdened with taxes. Following independence, responsibility for land policy and administration was transferred to states and the importance of land taxes declined greatly. While the Revenue Department continues to maintain textual databases for rural land records, the reduced importance of land as a revenue source led to other functions taking priority over maintenance of land information (World Bank 2007).

The flip side of the decline of the Revenue Department is the ascendancy of the Department of Stamps and Registration where deeds of land transactions are registered (stamped) and stored. Its *raison d'etre* is the 1882 Transfer of Property Act which stipulates that sale of any tangible immovable property worth Rs. 100 or more can only be made by registered instrument. As registrars will register any instrument presented to them without thoroughly checking its validity or the existence of countervailing claims, registration provide no conclusive evidence of ownership (Wadhwa 2002). Still, entries in the registry have value as they are admissible as evidence in court. Moreover, the registry department makes available summaries of all transactions that have been registered by a specific person or for a parcel through so-called encumbrance certificates (ECs). While ECs can not preclude that undisclosed or registered claims may surface, they provide evidence of the transaction history that can enable legal experts to provide an assessment of the likelihood that challenges against a specific claim may appear. The fact that any registered transaction incurs large amounts of stamp duty[3] has transformed property registration into a major source of government income (Alm *et al.* 2004). Given that it contributes as much as one third of revenue in many states, property registration has thus emerged as a system parallel to land records, especially in urban areas where land records had not existed to start with.

At the same time, property registration in many Indian states suffers from a number of problems. High fees and the fact that recording, storage, and retrieval of transactions were conducted on an entirely manual basis rendered the process cumbersome for customers and provided ample scope for petty and large-scale corruption. The need to pay 'speed money' to have certain transactions processed in a timely manner has been legendary and widespread.[4] More importantly, officials had significant discretion in determining property values, thereby reducing the amount of stamp duty to be paid on any given transaction and pocketing part of the difference. All of this reduced owners' incentives to register

[3] 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.

[4] A large survey of users of land administration services 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).

transactions and drove land transfers into informality. Measures to improve the functioning of the registry system should thus have a direct impact on observed outcomes.

In response to backlogs that delayed processing of simple registrations by more than 10 years and reports about undervaluation 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 for customers and government were very positive: standard registration processes now take 30 minutes rather than years to complete and automated property valuation eliminated officials' discretion. The number of registered transfers increased by more than 50%, from about 1 million (mn.) in 1998/99 to more than 1.5 mn. in 2004/05. Stamp duty collections more than doubled, from Rs. 16 billion. to Rs. 41 billion, despite a significant reduction in rates (from 13% to 8%) over the period. The initiative provided a basis for more thorough modernization of land administration in Maharashtra and was copied by other states that had suffered from similar problems to a lesser extent.

2.3 Computerization of land registries in Andhra Pradesh

Following the model of Maharashtra, a program for *C*omputer-*A*ssisted *R*egistration of *D*eeds, referred to as CARD, was introduced in Andhra Pradesh from the late 1990s. It comprised three elements, namely (i) streamlining of registration procedures to be followed in registration of property transactions at any 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 as well as making these and other key documents such market valuations and deed extracts available online to allow anybody to easily verify claims regarding property values and ownership. Contrary to Maharashtra where the scheme was implemented within one year, computerized registration was rolled out to cover all of the state's 387 SROs, starting with those having the highest transaction volume. Figure 1 illustrates the roll-out of SRO computerization, indicating that 54% of SROs were computerized in February 1999, 12% in November 2001, and the remainder in March 2005. In 2005, i.e. after computerization had been completed, stamp duty rates were adjusted throughout the state. The most significant reduction was from 13% or 11% for sales in urban or rural areas, respectively, to 9% and from 3% to 1% for gifts, partitions, and inheritances within the same family. Rates for registering mortgages remained unchanged throughout the period.

Although CARD signified an improvement over the earlier situation, three shortcomings are generally noted, namely (i) lack of a spatial framework combined with a unique parcel identifier that would allow easy retrieval of all registered transactions for a given physical parcel; (ii) the continued need, even for banks, to rely on the services of professional lawyers to check on the quality of the information recorded in individual deeds due to lack of standardization; and (iii) limited outreach and coverage, especially in rural areas where land records continue to be more popular, due to failure to integrate registration with

traditional land records and thus ensure automatic synchronization of records in case of changes to one of them. It thus allows us to test the extent to which reforms that improve the functioning of a registry system without radically changing the quality of the underlying information affects economic outcomes.

As computerization affects the cost involved in accessing property information and registering transfers rather than the security or nature of the underlying rights, we do not expect it to affect land-related investment but rather credit supply and the number of registered transactions. One main interest is to ascertain the extent to which computerization-induced transaction cost reductions increased credit supply. Also, improved governance and reduced transaction costs may have made it worthwhile to conduct or register transactions that had not been undertaken or registered earlier, implying that we would expect to see an impact of CARD on the volume of registered transactions. The ability to compare the impact of computerization to that of a reduction in stamp duties can ideally provide a bound on the magnitude of the associated reduction in transaction cost.

3. Data and estimation strategy

Data on credit disbursed by commercial banks and the number of total registered transactions for 1997-2007 point towards significant increases in supply of credit as well as land sales. To assess whether any of these increases can be attributed to computerization, we use the roll-out of this intervention across SROs to identify the impact of computerization on credit supply and transaction frequency in a way that can be compared to that of stamp duty reductions. Below we discuss the approach as well as the assumptions required to hold in order to be able to do so.

3.1 Data and descriptive evidence

We have quarterly data on credit disbursed by all scheduled commercial banks to retail customers for a 11 year period in all of AP's 1064 *taluks* (blocks) from India's Central Bank (Reserve Bank of India, RBI).[5] This provides a total of 44 observations per *taluk*, from Q1 of 1997 to Q4 of 2007, i.e at least 7 quarters before the first batch of registry offices was computerized to 2 years after the last of the state's SROs had shifted to operated on a fully computerized basis. The quality and reliability of these data derives from the fact that they are based on routine reports which all scheduled commercial banks are required to submit to RBI at regular intervals. To match them to information on computerization, we aggregate up from the branch to the *taluk* level. This information is combined with annual data on the total number of registered land transactions (incl. sales and mortgages separately) for the period of 1997-2007 from the Andhra Pradesh Department of Stamps and Registration for 242 of the 387 SROs where data predating computerization were available in electronic form. As rural and urban land administration systems will

[5] Scheduled commercial banks include all public and private sector banks with the exception of cooperative banks who contributed less than 10 percent to total lending from 1997 to 2006 (RBI 2008).

differ from each other, we also use the 2001 Census of India to obtain the share of urban population in any *taluk* or SRO.[6]

Figure 2 provides a graphical illustration of the dynamic nature of AP's land and credit markets over the period under concern. Overall, the volume of credit disbursed more than tripled in real terms, from approximately Rs. 700 billion in 1997 to Rs. 2,500 billion in 2007 (i.e. some Rs. 15,000 or US $ 300 per person). *Prima facie* most of the credit expansion happened after 2003, at a time when about two thirds of SROs in the state had already been computerized for some time. This suggests that more detailed analysis will be needed to assess the extent to which computerization is a factor driving the observed credit expansion. Similarly, the modest upward trend of sales observed before 2002 that was associated with an increase in the number of transactions from 0.4 to 0.5 mn., accelerated significantly thereafter and in particular after 2005, reaching almost 1 mn. in 2007. This translates into an increase from about 0.5 to 1.3 transactions per 1,000 people and year.

A summary of average amounts for the main transaction categories by SRO, separately for before and after computerization based on SRO specific computerization dates, is presented in Table 1. Amounts of credit vary between urban and rural areas with Rs. 2 bn. and 0.08 bn., respectively on average. After computerization, credit is estimated to have doubled in both; from Rs. 1 bn. to Rs. 2.37 bn. in urban and from Rs. 0.05 bn. to Rs. 0.11 bn. in rural areas. Evidence on registered transactions is consistent with this in terms of much higher numbers in urban than in rural areas that are driven by sales but very little movement in mortgages. Registered sales almost doubled after computerization, from 3,922 to 5,636 in urban and from 1,203 to 2,390 in rural areas. By contrast, there is little change over time in the number of registered mortgages between rural and urban areas (637 vs. 697) and a slight increase, from 672 to 796, that appears to remain confined to urban environments.

3.2 Estimation strategy

While the above changes are large, they may have been due to macro-economic conditions or location-specific factors that were uncorrelated with CARD. In fact, influential observers have argued that, without more rigorous checks on data quality or process re-engineering, mere digitization of what may be largely outdated data from a very old system will have no economic benefit (Saxena 2005). Rigorous data on impacts of this intervention remains limited (Ahuja and Singh 2006) and whatever evidence is available focuses on rural land records rather than registration (Lobo and Balakrishnan 2002). To explore whether observed increases on credit supply are a causal effect that can be attributed to computerization, we exploit variation in the timing of this intervention across *taluks*. The estimating equation is

[6] In a small number of cases where SROs did not match with taluk boundaries, we used lists of villages from the 2001 Census to establish a match.

$$C_{it} = \alpha_0 + \alpha_1 Comp_{it} + \gamma_i + \theta_t + \varepsilon_{it}$$

where C_{it} is the log of credit disbursed in *taluk i* at quarter t,[7] γ_i s represent 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, θ_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 throughout. We interact computerization with indicator variables for the amount of time passed since the intervention to explore whether potential computerization effects materialize instantaneously or only with some lag. A lag may, for example, be due to banks needing to get acquainted with the information provided online and rewrite loan approval procedures accordingly.

Replacing C_{it} with T_{it}, i.e. the log of number of different types of transactions registered in SRO i in year t allows us to undertake similar analysis for transaction volume to explore whether some transactions, in particular mortgages, moved in parallel with credit supply. Though possible complementarities between a 2005 state-wide change in stamp duties and computerization cannot be explored as by 2005 the latter had been completed, it is of interest to compare the impact of computerization to that of an exogenous change in stamp duty rates. This is possible as stamp duty varies between rural and urban areas.

In all cases, fixed effects estimates are used to deal with concerns about unobserved time-invariant factors. Still, our identification strategy relies on the assumption that there are no unobserved factors that contributed to differential trends in growth of credit or registered land transactions between SROs that computerized early and those included in later batches. This is an important concern especially in view of the fact that roll-out of computerization was designed to move from high to low volume SROs. With credit and transaction data that go back to 1997, we can test for this explicitly by considering whether the timing of computerization is correlated with pre-existing levels and trends of credit. To do so we run probit regressions of the timing of computerization. The dependent variable is 1 if the SRO was computerized in 1999 and 0 if the SRO was included later. Independent variables are levels or changes in credit or the number of registered transactions before computerization was introduced.

Results from doing so are reported in appendix table A1 for credit (panel A) and number of transactions (panel B). Panel A suggests that neither levels nor changes in pre-computerization levels of credit had any impact on the timing of computerization. Coefficients on levels as well as changes are small and none statistically significant, giving us no reason to believe that the timing of computerization was correlated

[7] 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.

with differential pre-existing trends in credit supply. For the 242 SROs for which we have information on number of transactions, panel B points towards high significance and positive sign of coefficients on the pre-computerization level of transactions. This is consistent with the roll-out plan that aimed to focus on high-transaction SROs first. At the same time, the coefficient on the change in transaction volume from 1997 and 1998 is close to zero suggesting that pre existing trends in transaction volume are uncorrelated with the timing of SRO computerization.

4. Econometric results

We find that, once time and SRO fixed effects are controlled for, computerization did not affect credit supply in rural areas but enhanced it, by 15%, in urban ones. This is consistent with the fact that CARD had significant impact on the number of registered urban mortgages but not sales and that stamp duty reductions had a spatially less differentiated and quantitatively larger effect on the number of registered transactions. It suggests that, if property rights reforms are undertaken, all elements of the system will need to be considered.

4.1 Did computerization increase credit supply?

Results from the credit supply regression in table 2 are of interest in two respects. First, inclusion of time and location fixed effects is critical to avoid erroneous conclusions. This is visible from comparison of columns 1 and 3 where addition of the relevant indicator variables not only improves the regression's fit but also illustrates that what might be interpreted as a significant and large effect of computerization on credit supply (almost a doubling as per column 1) is due largely to changes over time that affected all *taluks* and, to a lesser extent, location-specific factors. Once relevant controls are included, the point estimate for computerization becomes insignificantly different from zero and even turns negative, suggesting that this intervention had little effect on credit supply overall.

At the same time, the significant and positive coefficient of interacting the computerization variable with the share of urban population that points towards a positive impact of computerization on credit supply in urban but not rural areas. In urban SROs, computerization of land registries would, according to the point estimate, have increased credit supply by 15%. Interactions of computerization variables with indicators of the time elapsed since this intervention support the above conclusions; there is no evidence for lagged effects in the aggregate and the relevant coefficients are individually and jointly not significantly different from zero. By contrast, in urban areas, the effects appear to be persistent and tend to grow stronger over time, increasing from a significant point estimate of 5% to 18% five quarters after computerization, 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.

How to interpret these results? It is well known that changes in security of land tenure or availability of land ownership information will affect credit supply only if agents are credit constrained and have sufficient illiquid wealth that can be foreclosed upon at reasonable cost (Besley and Ghatak 2009). In rural India, these conditions may not hold for a number of reasons. First, India's commercial banks are already required by law to direct 18% of their loan portfolio to rural areas so that there may be few credit-worthy projects left that would benefit from credit access with reduced transaction cost from loan processing. Second, in rural Andhra Pradesh, the outreach of land registration is limited as both owners and banks prefer to use land records as the basis for processing credit applications. A main reason for this is that land records continue to be maintained manually by village-based representatives of the revenue department, implying lower transactions cost for updating them. Failure of officials or land owners to adhere to administrative processes that would help synchronize the two databases implies that registered deeds, if they exist at all, may be out of date.[8] This would eliminate any transaction cost effect from registry computerization. Third, other policy restrictions, in particular land ownership ceilings, imply that rural land markets are not very liquid and that therefore foreclosure may be associated with high transaction costs. Moreover, a history of often politically mandated agricultural debt cancellations may reduce banks' confidence in their ability to recover rural debts through foreclosure in case of default.[9]

In urban areas on the other hand, absence of land records implies that deeds registries will be the only source of data on land rights, land values will be higher, and better access to SROs will reduce total cost of registration compared to rural ones. Any fixed reduction of registration cost (e.g. due to elimination of informal payments) would thus result in a bigger relative decline of total registration cost, increasing the incentive to register. Interviews with banks suggest that, in light of the fact that underlying information is neither perfect nor conclusive, banks will still need to conduct detailed legal checks on applicants before disbursing credit. Still, online access to ECs provides lenders with low-cost access to information on existing encumbrances, in particular mortgages that can be used as a low-cost pre-screening of loan applications and thus reduce the cost of lending in urban areas.

4.2 Computerization as one factor affecting the number of land transactions

Exploring the effect of computerization on number of transactions allows us to assess the plausibility of the credit supply effects ascertained earlier by looking at mechanisms that might underlie them. However, as transaction data is available only from a subset of SROs, the validity of arguments along this line will depend on the ability to demonstrate that SROs for which data are missing do not systematically differ from the rest in observable attributes so that results will not be drive by selectivity bias. Descriptive data

[8] Having changes recorded at the village level is easier for owners than traveling to *taluk* headquarters but cases registries are often not updated.
[9] 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.

for the two samples of SROs show no statistically significant differences in a range of census-based socio-economic characteristics and credit access between the two groups. In fact, results from repeating the credit-supply regressions from Table 2 for the restricted sample of SROs with transaction data in appendix Table A2 are consistent to those obtained earlier, with point estimates for all the coefficients being very similar. This suggests that selection bias is unlikely to be an issue.

Table 3 reports results, separately for sales in columns 4-6, mortgages in columns 7-9, and total number of transactions (i.e. including sales, mortgages, and non-monetary transfers) in columns 1-3. In line with what was found earlier, we note that, after controlling for time and SRO fixed effects, computerization is estimated to not have had any effect on either of these variables in the aggregate. At the same time, we find significant computerization effects on the number of total transactions in urban areas, with a point estimate of 39%. However, there is no evidence for lagged effects in either urban or rural areas; in the former the full impact materializes in the first year after computerization with only a marginal increase thereafter while in the latter, passage of time does not lead to a more significant effect. Disaggregation by type of transfer suggests that, while computerization did not contribute to the rapid rise in the number of registered sales that was observed earlier even in urban areas, it led to a marked increase in the number of mortgages which is estimated to have increased some 60% as a consequence of the intervention. This is consistent with the notion that, in view of the large difference in stamp duty for the two transaction types (13% for sales vs. 3% for mortgages) in urban areas before the 2005 reduction, a given computerization-induced reduction in registration cost would have had a bigger relative effect on mortgages than on sales.

Table 4 provides results from an 'augmented' regression that includes not only computerization but also an indicator variable for reduced levels of stamp duty and its interaction with an urban indicator. The coefficients on computerization in urban areas are very similar to those obtained earlier. At the same time, stamp duty reduction is estimated to have had a significant, positive, and quantitatively large effect everywhere. The notion that registration is price elastic is supported by the finding that, for mortgages, the stamp duties for which remained unchanged in 2005, indicator variables are insignificant throughout. For other transactions, in particular sales, duty reductions are estimated to have increased the number of registered transaction by more than 50%, with no additional impact in urban areas. Together with earlier findings, this suggests that the relative size of the computerization-induced implicit reduction of transaction costs for sales -and for property registration in rural areas more generally- was too small to have had a measurable impact on observed transactions frequency. Although lack of more information on total costs of registering property precludes us from putting a bound on the size of any computerization-induced transaction cost reduction, we conclude that these have been small overall. It supports the notion that the impacts of computerization are context-specific.

5. Conclusion and policy implications

This paper contributes to the literature in two ways. Methodologically, our results suggest that high frequency administrative data can usefully complement information from individual or repeated rounds of household surveys. While care is needed to distinguish between time- and location-specific factors, we demonstrate that reduced cost of updating and accessing land information can significantly increase urban credit access. Such effects are remarkable in view of the fact that the shortcomings of land administration in India are widely recognized, in particular the fact that information provided by land registries falls far short of the security conveyed by full title (Panagariya 2008). Contrary to conventional wisdom according to which full title is needed as a precondition for credit effects, this suggests that better access to reliable land information of any type can help improve credit market functioning. Where they exist and operate reasonably well, there is thus considerable scope for better access to reasonably reliable information on property ownership to improve the functioning of financial markets. This is relevant for policy given the time and cost involved in establishment and maintenance of a full-fledged titling system.

While the ability to demonstrate a credit effect sets our paper apart from other studies, we note that, especially if compared to the estimated impact of stamp duty reductions and the overall expansion of credit supply during the period under concern the estimated magnitude of this effect is small, its outreach limited to urban property owners, and its impact on land markets and allocative efficiency negligible. In fact, the evidence of registration being very price elastic found here suggests that regulatory reforms are likely to lead to the desired results only if they provide affected parties with tangible benefits the magnitude of which exceeds the cost of formal registration. By implication, the costs of registering most types of property transfers in AP remain high compared to the benefits. This illustrates that, while computerization of existing systems can provide benefits, more far-reaching measures are likely to be needed to broaden and deepen these effects. In the case of AP, the relative success of computerizing land registries did not prompt adoption of more far-reaching property reforms, suggesting that the link between 'quick wins' and more far-reaching reform efforts is not automatic .[10] One of the underlying reasons may be that successful initial reforms do not unequivocally identify the areas on which subsequent efforts should focus.

The fact different Indian states have taken a variety of routes to improve the functioning of their land administration systems implies that similar study for other states, especially those with approaches significantly different from the one taken in AP, can provide insights on the magnitude and distribution of the economic effects to be expected from property rights interventions. Prime among these are efforts to

[10] The Indian Government has adopted a large national program of land records modernization that with a volume of US $ 0.5 bn. over the next 4 years but take-up by states has been low.

integrate land records and registries and to improve local access, e.g. through kiosks established in partnership with the private sector. Evidence from other states can also provide an opportunity to quantify and analyze effects of land administration reform on governance and corruption, an area that is of great importance in the Indian context empirically but on which little information was available in our case. Both the methodological and substantive lesson from this study could be of great relevance beyond India.

Figure 1: Timing of land registry computerization in Andhra Pradesh

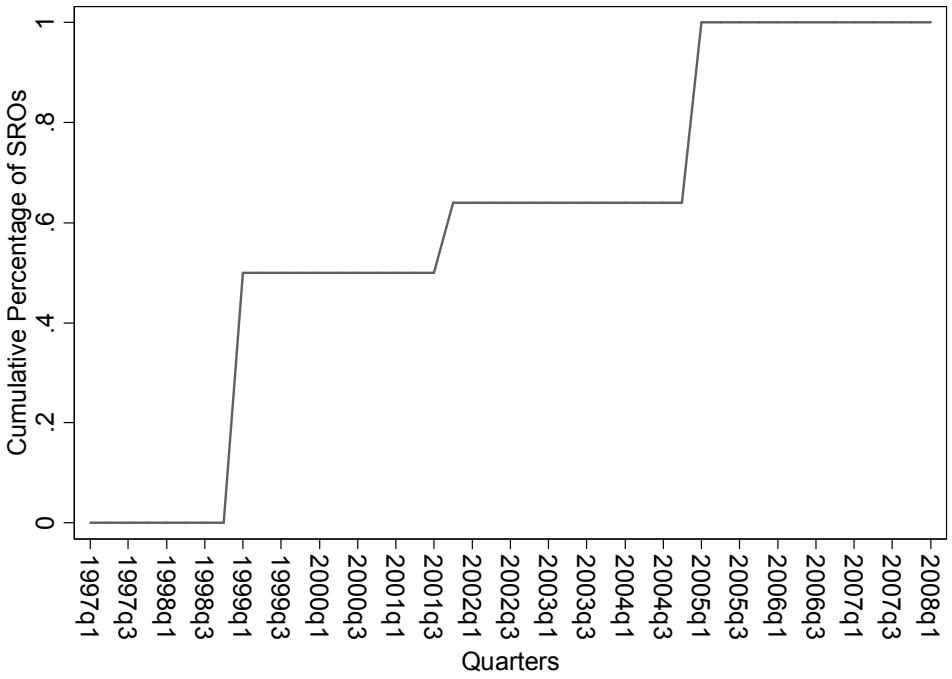

Figure 2: Evolution of retail credit and transaction volume in Andhra Pradesh, 1997-2007

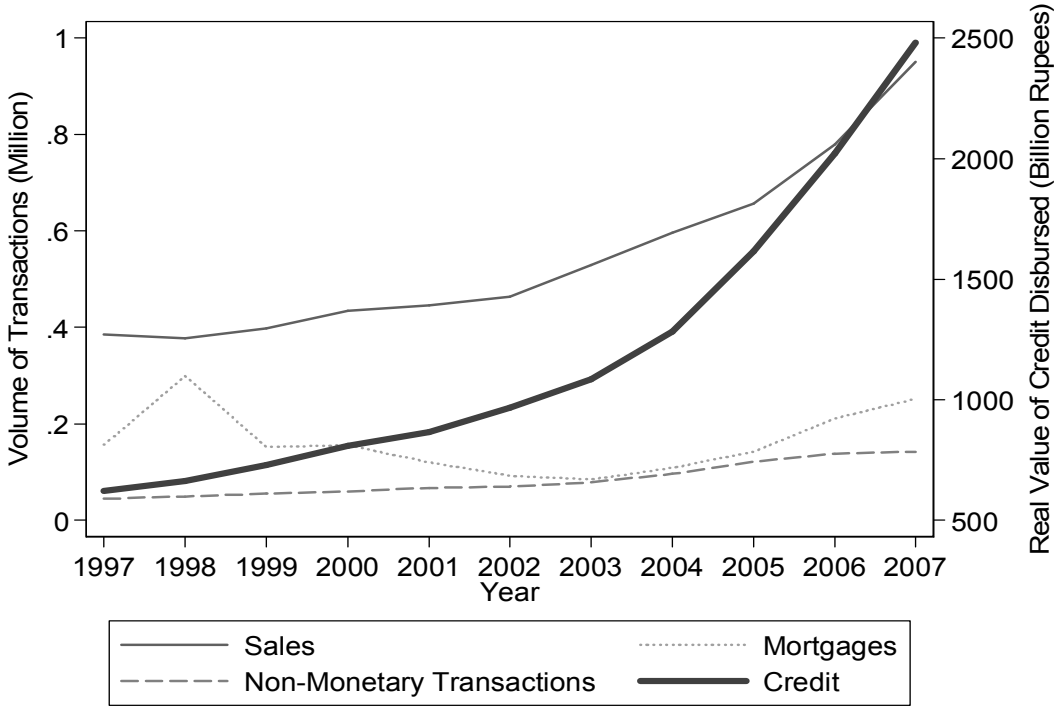

Table 1: Summary statistics

		All	Before Computerization	After Computerization
Total	Credit	0.24	0.10	0.35
	Sales	2207	1310	2818
	Mortgages	664	650	673
Rural	Credit	0.08	0.05	0.11
	Sales	1854	1203	2342
	Mortgages	637	631	644
Urban	Credit	2.00	1.00	2.37
	Sales	5815	3922	6244
	Mortgages	697	672	796

Note: Nominal values of credit are deflated using the RBI whole sale price index with 1993-94 as the base year. Credit is in billions of 1993 Rupees.

Table 2: Effect of computerization on credit access

	Dependent variable: log of credit disbursed by banks				
Computerization	0.981	0.471	-0.003	-0.013	
	[0.011]**	[0.015]**	[0.010]	[0.011]	
Computerization * Urban Share				0.151	
				[0.040]**	
Computerization * Q1-Q4					0.002
					[0.011]
Computerization * Q5-					-0.022
					[0.014]
Computerization * Urban *Q1-Q4					0.048
					[0.024]*
Computerization * Urban * Q5-					0.184
					[0.047]**
Quarter*Year Fixed Effects	No	Yes	Yes	Yes	Yes
Taluk Fixed Effects	No	No	Yes	Yes	Yes
Observations	47,871	47871	47,871	47,871	47,871
R-squared	0.21	0.42	0.97	0.97	0.97

Notes: *Taluk* and year*quarter fixed effects included throughout. Robust standard errors clustered at the *taluk* level.
* significant at 5%; ** significant at 1%

Table 3: Effect of computerization on volume of registered transactions

	Total Transactions			Sales			Mortgages		
Computerization	0.058	0.017		0.021	0.013		0.133	0.127	
	[0.037]	[0.036]		[0.035]	[0.037]		[0.086]	[0.090]	
Comp.* Urban Share		0.389			0.076			0.608	
		[0.083]**			[0.092]			[0.200]**	
Comp.* Y1-Y3			0.047			0.004			0.156
			[0.042]			[0.038]			[0.097]
Comp.* Y4 +			0.114			0.068			0.225
			[0.076]			[0.066]			[0.163]
Comp.* Urban * Y1-Y3			0.312			0.071			0.542
			[0.080]**			[0.089]			[0.203]**
Comp.* Urban * Y4 +			0.387			0.146			0.601
			[0.103]**			[0.118]			[0.238]**
Observations	2587	2587	2587	2587	2587	2587	2587	2587	2587
R-squared	0.82	0.82	0.82	0.89	0.89	0.89	0.58	0.58	0.58

Note: All regressions include year and SRO fixed effects. Robust standard errors clustered at the SRO level.
* significant at 5%; ** significant at 1%.

Table 4: Effect of computerization and stamp duty reduction on transaction volume

	Total		Sales		Mortgages	
Comp.	0.059	0.021	0.021	0.022	0.093	0.097
	[0.035]	[0.038]	[0.035]	[0.037]	[0.096]	[0.096]
Stampduty Reduction	0.512	0.496	0.531	0.518	0.173	0.198
	[0.048]**	[0.053]**	[0.051]**	[0.057]**	[0.115]	[0.125]
Comp.* Urban Share		0.38		0.052		0.709
		[0.081]**		[0.086]		[0.215]**
Stampduty Red*Urban		0.018		0.051		0.219
		[0.078]		[0.094]		[0.208]
Observations	2,587	2,587	2,587	2,587	2,587	2,587
R-squared	0.82	0.82	0.89	0.89	0.58	0.58

Note: All regressions include year and SRO fixed effects. Robust standard errors clustered at the SRO level.
* significant at 5%; ** significant at 1%.

Table A1: Regression of computerization timing on initial values and changes in credit and transactions

Panel A: Credit				
Credit in 1997	0.001		0.009	
	[0.001]		[0.005]	
Credit in 1998		0.001	-0.008	
		[0.001]	[0.004]	
Change in Credit 1998-1997				0.001
				[0.000]
Observations	387	387	387	387
R-squared	0.11	0.11	0.11	0.11
Panel B: Transactions				
Transaction Volume in 1997	0.002		0.002	
	[0.0003]**		[0.0004]**	
Transaction Volume in 1998		0.002	0.001	
		[0.0003]**	[0.001]	
Change in Transaction Volume 1998-1997				0.0003
				[0.0002]
Observations	242	242	242	242
R-squared	0.31	0.31	0.31	0.31

Notes: The dependent variable is 1 if a SRO computerized in 1999 and 0 if this happened in 2001 or 2005. Standard errors in brackets. Change in credit or transaction volume is the absolute change at SRO level. * significant at 5%; ** significant at 1%

Table A2: Effect of computerization on credit supply in subset of SROs

	Dependent variable: log of credit disbursed by banks				
Computerization	1.053	0.62	-0.003	-0.012	
	[0.015]**	[0.020]**	[0.013]	[0.013]	
Comp*Urban Share				0.143	
				[0.052]**	
Post0_4 Quarters					-0.005
					[0.014]
Post 5+Quarters					-0.015
					[0.017]
Post0_4 Quarters*Urban Share					0.058
					[0.033]*
Post 5+Quarters*Urban Share					0.167
					[0.060]**
Quarter*Year Fixed Effects	No	Yes	Yes	Yes	Yes
Taluk Fixed Effects	No	No	Yes	Yes	Yes
Observations	30,025	30,025	30,025	30,025	30,025
R-squared	0.14	0.21	0.97	0.97	0.97

Notes: *Taluk* and year*quarter fixed effects included throughout. Robust standard errors clustered at the *taluk* level.
* significant at 5%; ** significant at 1%

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