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Land Institutions, Investments, and Income Diversification

Pathways to Economic Development for Brazil's *Quilombo Communities*

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ABSTRACT

Efforts to distribute land titles to low-income rural Afro-Brazilian communities, known as *quilombos*, have been disappointing despite the provision of ample government resources. Until now, research on the implications of Brazil's land reform policies has not considered *quilombo* communities in an economic context. The unique case of the *quilombo* communities provides an interesting context to advance the understanding of the role of land titles in rural income generation. The impact of land tenure security in the cycle of assets, activities, and income is explored to identify the importance of institutions for land dependent agricultural enterprises. We find evidence of land titles contributing to desirable welfare outcomes through their impact on production and investment behavior. Income diversity from various production activities is found to positively contribute to higher income levels, particularly for producers earning more than the minimum wage, once conditioned on secure land rights and productive investments.

Keywords: Brazil, land tenure, institutions, property rights, assets, rural investment, diversification

JEL Classifications: D23;O12; P48; Q15

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1. INTRODUCTION

Poor households in developing countries are exposed to greater risks of income fluctuations and take up more measures to ensure against the detrimental effects of random shocks to their consumption. The most common ex post mechanisms of mitigating the risk of drastic reductions in consumption involve insurance schemes and inter-temporal consumption smoothing through savings and credit transactions. However, households in developing countries often rely upon informal insurance mechanisms of risk pooling, which has not been empirically found to be consistently efficient (Bardhan and Udry 1999). Furthermore, credit markets are often imperfect in developing countries and inaccessible to poor households. In the presence of incomplete credit markets, households will resort to liquidation of assets to smooth their consumption, which can have deleterious effects in the event that productive assets are used, and the ability to reaccumulate necessary assets is limited by investment disincentives (Carter and Barrett 2006). Hence, when ex post risk-coping mechanisms fail, households will undertake an ex ante strategy to reduce their risk of income fluctuations, such as diversifying their sources of income. Typically, income diversification has been attributed to either motivations of risk aversion or some cost-saving strategic complementarities between activities, respectively classified as *push factors* and *pull factors* (Barrett, Reardon, and Webb 2001). In either case, resource allocation decisions about the optimal combination of variable inputs and fixed assets will result in a diverse income portfolio but will be contingent upon the expectation of realizing the full return to the application of the resources. In an agricultural-based economy, this introduces the role of land institutions and land tenure security as a fundamental determinant for resource allocation, especially as it regards investments into fixed and/or maturing assets involved in the production process.

The importance of functioning land institutions in economic development can be further understood by examining the inherent connection among activities, assets, and subsequent income flows. A household's capacity to raise income through diversification into high-return activities (that is, responding to *pull factors*) is greatly influenced by its asset holdings (Barrett, Reardon, and Webb 2001). Income diversification is also an attractive *ex ante* approach to mitigating unbearable variance in income, especially when ex post mechanisms such as insurance or savings and credit fail to operate efficiently (Bardhan and Udry 1999). The effectiveness of the flow of resources channeled by the asset-activities relationship can indicate the level of development attained by a household, or even a country (Winters et al. 2009). Activities that promote the manufacturing of value-added goods or the provision of services typically coincide with forward-moving developing patterns and are typically better accommodated by the use of capital-intensive assets. For example, the set of assets required to engage in the manufacturing of value-added goods are quite distinct from those used in developing countries for annual cropping activities. Income from manufacturing is often higher and more stable than streams from raw agricultural products derived from annual crops. Closing gaps in accessing markets and engaging in activities that penetrate niche markets or secure advanced positions on the value chain also require substantial capital investments to meet quality-control standards and volumetric expectations for large market outlets that often provide better contract arrangements and higher returns for producers (Markelova et al. 2009). Hence, the capacity to operate in various productive activities will inherently engender a variety of income outcomes for the household that have direct implications for achieving welfare gains and poverty reduction.

This study examines income diversification as one of the mechanisms through which secure land tenure operates to contribute to economic development. We examine the way that land tenure security influences resource allocation across a portfolio of income activities, and we consider the role of increasingly diversified income streams on expected income levels. We frame the linkages among land tenure security, resource allocation, and more diversified portfolio choices by considering income diversification strategies requiring investments into fixed and/or maturing assets that are more likely to increase the stable earning capacity of households. The incentive to invest in these fixed assets is based on the land tenure security of each household, as measured by the ability of the land holding status to protect

against expropriation. Through this framework we address the following research questions: How does income diversity affect household income levels? Does secure land tenure lead to a more diverse income portfolio? Do the resource allocation incentives of secure land tenure lead to an income portfolio with an increased amount of fixed assets, reflecting increased investment demand? We approach this problem by utilizing a dataset that reflects the unique circumstances of *quilombola* (*quilombo* inhabitants) households situated in the middle of the implementation challenges associated with land reform policies in Brazil. Many *quilombola* households are awaiting definitive titles to their land and fall into several categories of land tenure based on their status in the Brazilian government's land titling process.

This work makes two principal contributions and addresses the ambiguity of the effects of land tenure, providing insight into economic channels that harness the benefits of land titles. First, we identify the positive role of functioning land institutions and land tenure security in enhancing the performance of *ex ante* risk-coping mechanisms. Previous studies have shown that credit worthiness and better access to credit can be enhanced by strengthening property rights over land, which correspond to the *ex post* mechanisms of risk mitigation. However, less attention has been given to the linkages among land security and institutions, their resource allocation incentives in *ex ante* mechanisms, and the benefits of the subsequent income diversification strategies. Second, we provide evidence of investment demand being stimulated by increased land tenure security and place the findings in the context of the interrelated functions of assets, activities, and income. Typically, studies of land security effects on investment demand deal with the investment response in isolation, which abstracts from the identification of the benefits of the investment. However, the current study enriches the understanding of the incentives of land security by using a framework that fits into the flow cycle of assets, activities, and income, which provides clearer implications for household welfare and economic development processes.

2. LAND REFORM IN BRAZIL AND ENTITLEMENT FOR *QUILOMBO* COMMUNITIES

The importance of functioning and secure institutions is a well-known contributing factor of sustainable economic development. Functioning land institutions promote and provide protection for investments in productive assets and ensure that agents can receive the full benefits of proper asset management in their productive activities. The accumulation of productive assets is essential to the economic security and empowerment of the poor, especially in developing countries (Carter and Barrett 2006). Failed institutions that do not provide security for assets remain an obstacle to the necessary investments required to transcend economic stagnation of the poor. Such impediments leading to suboptimal investment levels are often the result of inaccessible credit and capital markets as well as general investment disincentives due to high risk of asset loss in the absence of safety nets or enforcement policies (Conning and Udry 2005). In the developing world, the consequences of failed institutions may be most pronounced when considering informal property rights to land. Formalizing the informal property rights held by the poor is a key step in correcting certain structural failures that imply greater problems of governance, particularly in Latin America. Land comprises the principle component of the asset base of many households in developing countries, rendering land tenure a highly influential determinant in the composition of assets included in a poor household's portfolio (Carter and Olinto 2003). Reliable mechanisms that enforce property rights over land and provide equal access to resources and opportunities are essential elements for building a system of governance that more effectively facilitates economic development for the poor (Deininger 2003).

As the largest landmass in Latin America, Brazil has been subject to many disputes over land distribution. Stemming from its colonial past, inequality in the distribution of land has generally been a problem in Latin America, Brazil being no exception. In 1985 the Gini coefficient in land concentration was reported as 0.854 (Alston, Libecap, and Mueller 2008). This indicates that official land holdings have been concentrated in the hands of very few in Brazil. However, Brazil has recently implemented land reform initiatives enacted by its Constitution of 1988 that allow for the compensated expropriation of unproductive land. There have also been colonization programs initiated by the Brazilian government to populate unused public lands, especially in the Amazon region (Alston, Libecap, and Mueller 2000). This land redistribution policy has provoked many conflicts throughout Brazil and has thus spawned several land movements. For example, the MST (Landless Worker's Movement) has organized a campaign that has drawn international attention (Alston, Libecap, and Mueller 2008). Many of the conflicts arise due to the ambiguity in establishing concrete property rights, while others arise due to disputes over whether or not a parcel of land is being put to productive use.

Typically, these conflicts involve peasant farmers, or squatters, invading a parcel of land that may appear to be unused or unoccupied. Both land owners and squatters claim to be justified in their disputes. However, the point of complication is establishing clear ownership of land. For a landowner to oust invading squatters, he must prove that he has title to the land. Because of costs associated with the legal process of reclaiming invaded land, landowners often confront squatters and attempt to forcibly remove them. Another reason for direct confrontation with squatters in lieu of going to the courts is the trouble with proving that the land in question was under productive use by the landowner. The land may consequently be expropriated to squatters if it is determined that the land was not being used (Alston, Libecap, and Mueller 2000).

Informal Claims to Land

This mode of land reform can be quite problematic for landowners with informal claims to their land. In particular, the Afro-Brazilian communities known as *quilombos* are engaged in many land disputes because of the lack of formal land titles. This is largely due to the history of the formation of the *quilombo* communities. As explained by Silberling (2003), "The *quilombos* are inhabited by descendants

of Afro-Brazilian slaves who are either remnants of communities of escaped slaves, or communities of former slaves, who stayed on the land when it was abandoned by large landowners approximately 100 years ago . . .” In fact, some *quilombos* can trace their presence on the land they occupy as far back as 400 years (Universidade de Brasília 2004). In an attempt to reconcile land disputes over the legitimacy of land titles for the *quilombos*, the Brazilian government subtly included a clause in the Constitution of 1988. It states, “. . . survivors of *quilombo* communities occupying their lands are recognized as definitive owners, and the State shall issue them title to the land” (Do Rosário Linhares 2004), this clause was inserted when the Brazilian government believed that the *quilombolas*, or *quilombo* inhabitants, were small in number. In the year 2000, the Palmares Cultural Foundation reported the existence of 743 communities, with a population of 2 million, occupying 30.5 million hectares (Do Rosário Linhares 2004), more than 2,200 *quilombo* communities had been identified (French 2006). As of 2010, approximately 3,500 communities now identify themselves as *quilombos*. In Brazil, state governments along with the federal land reform agency, INCRA (the National Institute for Colonization and Agrarian Reform), are currently responsible for titling the *quilombo* lands.

These struggles for land title by the *quilombo* communities are not much different from the experiences of indigenous people across Latin America. However, in the 1990s, some Latin American countries included special protections for indigenous lands in their constitutions. This is believed to be a product of the International Labour Organization’s (ILO) Indigenous and Tribal Peoples Convention, No. 169 of 1989. This international effort to fight for the land titles of indigenous groups resulted in land provisions and ownership rights over natural resources on territories occupied by indigenous groups throughout the Latin American countries that ratified the convention (Plant and Hvalkof 2001).[1] In these regions, the rights of the indigenous groups are secured and extended to any territories traditionally occupied by them. This type of protection and respectful inclusion would be ideal in the case of the *quilombo* communities in Brazil. However, the international effort toward guaranteeing land titles and property rights are not as vehement for the *quilombolas*. The ILO’s Convention No. 169 is primarily targeted at indigenous groups, with very subtle implications for the communal land tenure regimes of black populations throughout Latin America.

The difficulty in obtaining land titles for *quilombolas* lies in the bureaucracy involved in the process itself. A *quilombo* community can present its petition for entitlement either to the local state government, if there is an active state agency administering legislation on land titles for *quilombolas*, or to the federal government via the national land grant agency INCRA. Upon opening a case for processing, the community must first be certified and registered as a *quilombo* by the Palmares Cultural Foundation, which is part of the national Ministry of Culture. Thereafter, the community must have a technical report of identification and demarcation (RTID) completed and published in order to be fully recognized by the Brazilian government as an authentic *quilombo* community with valid territorial boundaries. The RTID must include an anthropological report discussing the history of the community; a survey of the land within the claimed territory to identify historical and contemporary boundaries; a memorial description of the community; a registry of all the *quilombolas* families within the community; a survey of any conservation land, indigenous land, marine areas, and any other public lands owned by the government within the *quilombolas* territory; and valuation appraisal of the technical and legal area considered for titling.

Publishing the RTID is quite resource intensive and must be executed by government-authorized experts, including a professional anthropologist. *Quilombo* communities play a small role in the development of the RTID, which is essentially that of an informant. The cost of conducting the RTID, which can take up to six months to complete by the most efficient state agencies, is borne by the government. However, upon publishing the RTID, the case must undergo various levels of review, including litigation in the civil courts in case there is any contestation to the claim of some part of the territory by a third party living within the boundaries of the *quilombo* territory. In such a case, if the

[1] At the time of publication, the ILO’s Convention No. 169 had been ratified by Bolivia, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Paraguay, and Peru.

presence of the third party is judged to be invasive, there is an appraisal of the relevant land holdings and any improvements to the land made by the third party, and thereafter an indemnity payment is made to the third party for any lost property.

However, as resource intensive as the entire process is, the government is actually not utilizing all of the available funds allocated for titling *quilombola* lands. In 2009, 6.8 million Brazilian reais (R$) worth of funding dedicated to the recognition, demarcation, and entitlement process went unused, and out of R$28.3 million available for indemnity payments, only 6.52 percent of the funds were used (INESC 2010). *Quilombo* communities have a better success rate of receiving land titles from state governments over the federal government. Out of 24 titles distributed between 2008 and June 2010, the federal agency INCRA realized only two, with the overwhelming majority being granted by the local state government agencies. This disparity between state and federal government performance indicates that *quilombolas* must rely mainly on their local legislation to affect their processing. However, some states have a higher success rate and more interest in granting land titles to *quilombolas*, rendering the outcomes largely dependent on the location where the claim is being processed.

According to the Comissão Pró-Indio de São Paulo, there are currently 117 *quilombola* lands with titles, encompassing 202 communities.[2] Hence, there is still a long way to go before the full property rights of the *quilombolas* are recognized throughout Brazil. The implications of this protracted process of land rights distribution are underlined by the abject material poverty prevalent throughout many *quilombo* communities. A recent survey of *quilombo* living conditions reported to direct the national Programa Fome Zero (Zero Hunger Program) conducted by the Universidade de Brasília (2004) reported that more than 80 percent of their sample lived on less than US$1 per day. Furthermore, within the Fome Zero data sample, 63 percent of the households indicated agricultural production as the primary source of income, whereas only 32 percent of households earned income from some form of employment. Clearly, agriculture is a fundamental component of the way of life in the *quilombo* community. Hence, the importance of secure land as the primary resource generating a livelihood for *quilombolas*, and their most promising pathway to a better quality of life, cannot be underestimated.

Moreover, time spent observing *quilombo* communities and interviewing residents throughout Brazil's Atlantic forest region in 2010 brought a more vivid understanding of the way *quilombolas* live in the context of land rights claims. Many *quilombolas* are indeed engaged in agricultural production at some level. Some people work as small-scale farm managers, while others work as hired labor. In the community known as Ivaporunduva, located in the banana-producing region of São Paulo, a vertically integrated industry based on organic banana cultivation is developing. Producers are supplying organic produce to merchants as well as a processing facility located within the community where value-added products such as banana chips are made and packaged. In the Recôncavo region in the state of Bahia, a cooperative of *quilombola* producers is marketing honey from its apiculture projects. Therefore, despite poverty challenges there are *quilombolas* who are able to mobilize their local economies. However, the most promising projects observed throughout the various regions involved the use of some productive asset that is fixed to the land and requires a medium- to long-term time horizon to realize the full benefits of the operation. Furthermore, some of the most economically vibrant communities were observed to either already have land titles or be further along in the process compared to some of their counterparts, where economic activity was quite limited to subsistence farming operations and other small-capacity income activities.

[2] See www.cpisp.org.br/terras/asp/terras_tabela_print.asp.

3. REVIEW OF ECONOMIC IMPACT OF LAND TENURE SECURITY

Consistent with the limited success of the land title programs, there have been limited studies specifically addressing the case of the *quilombolas* in their land struggles and the subsequent economic implications. However, the importance of definitive property rights of land has been well established in economic studies of optimal resource allocation, especially in developing economies. Dependable and functional institutions are a vital component of an economic system seeking to evolve into a transparent and efficient mechanism of exchange (Deininger 2003). Feder and Feeny (1991) used a theoretical model to describe the losses in economic efficiency due to uncertainty in land tenure security and the adjoined disincentives to investment in resources that bring about the greatest benefit of the land for individuals, as well as for society. This result supports the general logic that suggests that with increasing land tenure security, investment demand will also rise and be met with a more abundant credit supply due to the ability to use the land as collateral.

However, the intuition behind this logic faces some complex challenges in practice. It is not necessarily a given that investment demand across various asset types will increase uniformly due to improved security of property rights to land. Using panel data from Paraguay, Carter and Olinto (2003) found that household liquidity constraints may lead to different investment decisions regarding the mix of fixed and movable assets due to changes in the status of land tenure security. Constrained households are found to substitute movable assets for fixed assets, while wealthier producers expand their complete portfolio as well as shift its composition. Maintaining a diverse set of income activities may not necessarily require the substitution of movable assets for fixed assets even for poor households, however, once tenure security is acquired and investment demand is stimulated.

Clear evidence of increased investment demand related to tenure security enhancements has also been very sparse in studies of African economies. There are very sensible theoretical reasons to expect a positive relationship between land tenure security and investment. Strong property rights to land are instrumental in ensuring claims to returns from investments; they increase access to capital markets; they facilitate the liquidation and sale of investments; and they provide the freedom to innovate or diversify the uses of the land (Fenske 2011). However, empirical findings have cast doubt on the strength of the positive effect of increased land tenure security on investment demand. Endogeneity of the land tenure variable is problematic in cases where land may transition from informal tenure and become titled as a result of investments made to indicate ownership (Brasselle, Gaspart, and Platteau 2002). Studies of land tenure in West Africa have also found that the duration of an investment makes an empirical difference, concluding that short-term investments such as labor, fertilizer, or insecticide use are less connected to land tenure security than are long-term investments such as irrigation systems, tree planting, and leaving land fallow (Besley 1995; Fenske 2011).

Furthermore, although the expected benefits of investments made in response to increased land tenure security theoretically correspond to improvements in agricultural productivity and higher incomes, empirical studies do not always find supportive evidence of this outcome (Place 2009). This is disconcerting, because the ultimate goal of effectively implementing land reform is to stimulate agricultural development and raise economic welfare through investment and other mechanisms. However, Smith (2004) found evidence that land tenure security in the form of land title positively contributes to fixed investments and that households with secure land holdings obtain the greatest portion of their income from high-return activities that make use of fixed investments. Such cases of coupling assets with certain types of activities can serve as a meaningful catalyst for reducing household poverty levels and securing income streams, especially when fixed assets prove to be adequately fungible (Winters et al. 2009). Hence, the complementarities among assets, activities, and income create a means of channeling the determinants of household decisions about livelihood strategies and enrich the understanding of how the feasible set of options can be improved, leading to increased welfare.

4. CONCEPTUAL MODEL

The conceptual model of income diversification is adapted from the standard model of inter-temporal household consumption in the presence of uncertain income in future periods as presented in Bardhan and Udry (1999) and incorporates a model of investment similar to that of Fenske (2010), where resource allocation decisions are made over two periods. First, consider the utility function of the typical household,

$$U_t = E_t \sum_{\tau=t}^{T} \beta^{\tau-t} u(c_t) \tag{1}$$

where $u(\cdot)$ is continuously twice differentiable, with $u' > 0$ and $u'' < 0$. U_t is the expected utility of a household over the remainder of its lifetime, c_t is the consumption level in period t, and β is the discount factor on the utility of future consumption such that $0 \leq \beta < 1$. The household can borrow or lend on a credit market at a certain interest rate r_t. At the start of the period t, the household's asset stock is A_t, which is positive if the household is a lender and negative if the household is a borrower. The household receives a random income y_t and must allocate its resources between consumption and net savings for the next period:

$$A_{t+1} = (1 + r_t)(A_t + y_t - c_t). \tag{2}$$

The household maximizes its expected utility subject to (2), non-negativity constraints on consumption, the transversality condition $A_{T+1} \geq 0$, and a liquidity constraint of the form:

$$A_t + y_t - c_t \geq 0. \tag{3}$$

In equilibrium, the transversality condition will bind such that the household can be a debtor in any period except the final period, implying that $A_{T+1} = 0$. Suppose producers are faced with a portfolio decision that involves the determination of how to diversify their income activities. Let income in period t be determined by the previous period portfolio choice x_{t-1}, where $y_t = y(x_{t-1})$.

A producer seeking to maximize his returns has an endowment of land and liquid capital to purchase variable inputs and fixed assets. Labor can be hired through the household, through external labor markets, or both. For each period t, there exists a feasible set of N portfolio choices $X_t = \{x_{1t},...,x_{Nt}\}$ such that for a portfolio choice i, $x_{it} = x_t(q_i,k_i)$, where q_i and k_i are the vector's variable inputs and fixed assets, respectively, which correspond to the resource allocation made for the portfolio choice. The technology of the producer is such that for every resource allocation corresponding to a portfolio choice, there exists a feasible set of M production functions such that $x_t(q_i,k_i) \rightarrow G(q_i,k_i):\{g_1(q_{i1},k_{i1}),...,g_M(q_{iM},k_{iM})\}$. For any production activity j, the corresponding production function g_j is increasing and concave in both of its arguments.

During the first period, the producer chooses some level of fixed investment k_i, with a positive and convex cost $h_{t-1}(k_i)$, to be allocated across productive activity j, constituting the portfolio choice that utilizes the fixed asset. The output of the production activity is realized after the second period. However, after the first period the producer faces uncertainty about whether he will retain his land, which is denoted by the probability $S(l, k_i) \in (0, 1)$. If the producer loses the land, he will not realize the return on his investment in the first period. S is considered to be security of the land holding, which is endogenous to the strength of land tenure l as is determined by the status of the property rights to the land. The subsequent value function can be stated as the following:

$$V_t(A_t + y_t) = Max\left\{u(c_t) + \beta E_t V_{t+1}\left[(1 + r_t)(A_t + y_t - c_t) + S(l, k_i)y(x_t)\right] + \lambda_t(A_t + y_t - c_t)\right\} \tag{4}$$

where applying the envelope theorem yields the expression

$$E_{t-1}\frac{dV_t}{dx_{t-1}} = E_{t-1}\left[\beta(1+r_t)V'_{t+1} + \lambda_t\right]S(l,k_i)\frac{\partial y}{\partial x_{t-1}}. \tag{4}$$

The value function is increasing in its arguments and the Langrange multiplier is non-negative, so for any non-zero value of Eq. (5), the sign will depend on the sign of $\partial y_t/\partial x_{t-1}$. This framework is useful in that it delineates the impact of the portfolio choice on the value of consumption. The assumption of separability between consumption and production holds in this setting and allows a more isolated characterization of the investment problem with more attention focused on the income component y_t as a function of the portfolio choice.

In this setup $S_l > 0$. If the producer retains his land after the first period, he chooses variable inputs to be used in the second period at a positive and convex cost $w_t(q_i)$ and solves the following problem:

$$y_t(k_i) = \underset{q_i}{Max}\left\{x_{t-1}(q_i,k_i) - w_t(q_i)\right\}. \tag{5}$$

By the envelope theorem and the first-order condition to Eq. (6), it is clear that

$$\frac{dy_t}{dk_i} = \frac{\partial x_{t-1}}{\partial k_i},$$

implying that the marginal effect of investment impacts income the same way it impacts the portfolio choice to diversify into more productive activities. A positive sign on the marginal effect of investment would indicate that diversification into additional activities is increased by the introduction of fixed assets, raising income; a negative sign would imply that the investments are concentrated into fewer productive activities, yielding less income than would a more diversified portfolio strategy. Given that income is increasing and concave in investment (that is, $dy_t/dk_i > 0$ and $d^2y_t/dk_i^2 < 0$), the sign will be positive. Such behavior is representative of a "pull" response to some factor, which raises income for households that are able to enter into new markets through the strategic investment into some fixed asset.

In the first period the producer selects the level of investment, where the expected return on investment is related to the strength of land tenure as depicted by the following program:

$$V_t(l) = \underset{k_i}{Max}\left\{S(l,k_i(l))y_t(k_i(l)) - h_t(k_i(l))\right\}. \tag{6}$$

By the envelope theorem, the expected value of the return on an optimal investment changes with the strength of land tenure by

$$\frac{dV_t}{dl} = \frac{\partial S}{\partial l}y_t(l) > 0.$$

Therefore, it is clear that the return on investment is dependent upon the strength of land tenure. Given the result that the optimal investment will be determined by the status of the property rights to the land, it is possible to restate Eq. (6) in terms of the strength of land tenure to illustrate the role of land tenure as a determinant of resource allocation in the portfolio choice decision to diversify. Reconsider the producer's second period problem as the following:

$$y_t(l) = \underset{q_i}{Max}\left\{x_{t-1}\left(q_i(k_i(l)),k_i(l)\right) - w_t\left(q_i(k_i(l))\right)\right\}, \tag{7}$$

where applying the envelope theorem once more yields the expression

$$\frac{dy}{dl} = \frac{\partial x_{t-1}}{\partial k_i}\frac{dk_i}{dl} = \frac{d\,x_{t-1}(k_i(l))}{dl}, \tag{8}$$

indicating that the marginal effect of strength in land tenure on income is equivalent to the marginal effect of land tenure on diversification. From the result of Eq. (6) above, it is clear that $\partial x_{t-1}/\partial k_i > 0$. Therefore, the sign of the marginal effect of land tenure on income diversification will have the same sign as the marginal effect of land tenure on investment (that is, $sign\{dx_{t-1}/dl\} = sign\{dk_i/dl\}$).

The central idea that motivates the conceptual model and the ensuing reduced-form empirical model stems from the fact that land tenure does not act directly upon income. Landholders and producers do not instantaneously receive a change in income upon receiving title to their lands. Rather, land tenure security operates through economic mechanisms that render an effect on income. Investment demand is stimulated by secure property rights, and investments are channeled through productive activities that generate income. The result of the conceptual model indicates that we can observe the causal effect of land tenure on income by observing the causal effect of land tenure security on the selection of an activity portfolio. And because of the interwoven relationship among assets, activities, and income, it is also possible to deduce the causal effect of land tenure security on the related investment decisions corresponding to the choice of productive activity.

5. DATA DESCRIPTION AND IDENTIFICATION STRATEGY

The data originate from the Secretaria da Agricultura Familiar DAP (Declaração de Aptidão ao PRONAF) database, sourced from the Brazilian Ministério de Desenvolvimento Agrário. The DAP database is comprised of administrative data submitted by agricultural households in application to the government's rural credit program, PRONAF. The program is structured to finance projects for agricultural households seeking assistance with harvest costs or upcoming expenses associated with investments in productive machinery, equipment, or infrastructure at a low interest rate. If the proposed project is approved for financing, the terms of the credit contract are specified based on the data entered into the DAP by the applicant. The DAP database is merely a registry of all applicants seeking a declaration of eligibility and does not indicate acceptance into the program. The dataset used in this study is constructed from a cross-section of the 4,013 *quilombola* applicants listed in the registry as of December 31, 2009. All data reported is a summarized account of the applicant's performance and activity during the fiscal period prior to the date of entry into the registry.

Quilombolas fall into one of four categories that are used as the measures of land tenure: *tenancy* applies to producers who operate the landholding under a rental contract; *occupancy* is applicable to cases where informal claims to the land are made and a land fee is paid to the government to indicate possession of the landholding; *resettlement* by the government's national agrarian land reform plan (PNRA) guarantees that the land cannot be expropriated and that the land title will be granted in the future; *definitive title* provides exclusive rights to the land.

Although investment demand is not directly observable in the dataset through a measure of investments, it is possible to identify whether investments have been made by separating out certain types of income-producing activities that require fixed and/or maturing assets. For example, instead of indicating whether a producer has planted a tree as part of an investment strategy, we indicate whether the producer earns income from fruit tree cultivation, and thereby it becomes evident that investments were made in the form of planting trees.[3] This process is carried out for all relevant production activities to create a binary variable of investment activities (that is, activities known to require fixed investments). The number of investment activities that each producer is involved in is counted to generate a variable measuring the extent of diversification into such activities. Investment activities include fruit cultivation, agro-industrial processing of goods, coffee, cacao, raising livestock for meat or dairy production (excluding poultry), rural tourism, and other permanent cropping/growing activities (for example, flowers and so on). A general measure of diversification is also constructed based on a more aggregate list of productive income activities included in the dataset. General activities include agricultural production, mining, forest excavation, and wage labor

Additional control variables include a gender identifier indicating whether the primary applicant listed in the DAP registry is a male or female. Because PRONAF is targeted to agricultural households, family size is included as well as a variable denoting the number of permanent employees hired by each producer to account for labor allocations. Also included is the natural logarithm of the land area operated by each producer to account for differences in the size of landholdings. We include an array of dummy variables indicating the highest level of educational attainment completed by the primary applicant: literacy, primary school, secondary school, technical school, superior school (that is, a specialized college degree). Social capital is characterized by a dummy variable denoting the primary applicant's membership in a cooperative and/or a *quilombo* association. And finally, unobserved local level effects are controlled for by the inclusion of a municipality index (that is, *municipio*) indicating the most disaggregate level available of where the applicant lives.

Table 5.1 reports the summary statistics for producers found in each category of land tenure. There is a large income disparity for *quilombolas* within each category of land tenure. Interestingly, the summary statistics fail to reveal that *quilombolas* with definitive land titles have either the highest mean

[3] Income earned as a laborer in an activity is not included in the variable construction of diversification in "investment activities."

or the highest median income. On the contrary, tenure security categories that provide weaker land rights, such as resettlement and tenancy, report the highest median and mean income levels in the sample, respectively. This counterintuitive outlook indicates that if indeed definitive title is the most welfare-enhancing tenure category, then there is a more systematic process through which it operates to provide the expected benefits to *quilombolas*. Furthermore, the largest and second largest median landholdings are respectively found among the resettlement and tenancy categories of tenure, while the largest and second largest maximum landholdings are respectively found within the occupancy and definitive title tenure categories. The average share of income derived from investment activities is the highest for the definitive title category at 26 percent, followed by the tenancy category at 24 percent. This may suggest that more investment occurs when a definitive title is held. However, a more critical analysis remains to be conducted to substantiate this claim.

Table 5.1—Summary statistics by land tenure category

Land tenure status	Statistic	Total income (R$)	Share of income from investment activities	Number of activities	Number of investment activities	Land area (Hectares)	Family size	Number of employees
Definitive title								
	Mean	6,260.76	0.26	2.72	0.76	1,105.12	4.43	0.54
	Std. dev.	15,973.64	0.34	1.70	1.02	22,986.38	2.07	0.50
	Min	1.00	0.00	1.00	0.00	0.00	1.00	0.00
	Med	2,740.00	0.00	2.00	0.00	5.00	4.00	1.00
	Max	347,260.00	1.00	9.00	6.00	600,000.00	14.00	1.00
	N	1,285	1,285	1,285	1,285	1,285	1,285	1,285
Settled by PNRA								
	Mean	6,813.80	0.10	3.57	0.17	31.90	3.31	0.04
	Std. dev.	2,587.98	0.28	1.20	0.48	37.33	1.30	0.21
	Min	480.00	0.00	1.00	0.00	3.00	1.00	0.00
	Med	7,200.00	0.00	4.00	0.00	25.00	3.00	0.00
	Max	19,250.00	1.00	10.00	3.00	240.00	8.00	1.00
	N	134	134	134	134	134	134	134
Occupancy								
	Mean	4,253.72	0.14	2.14	0.34	639.33	4.24	0.64
	Std. dev.	6,403.54	0.30	1.60	0.67	22,404.16	1.99	0.48
	Min	3.00	0.00	1.00	0.00	0.10	1.00	0.00
	Med	3,400.00	0.00	1.00	0.00	3.00	4.00	1.00
	Max	160,078.30	1.00	9.00	5.00	800,000.00	34.00	1.00
	N	1,275	1,275	1,275	1,275	1,275	1,275	1,275
Tenancy								
	Mean	9,007.90	0.22	1.90	0.43	19.73	4.18	0.58
	Std. dev.	21,136.70	0.35	1.10	0.63	33.92	2.03	0.50
	Min	80.00	0.00	1.00	0.00	0.60	1.00	0.00
	Med	2,045.00	0.00	2.00	0.00	7.10	4.00	1.00
	Max	220,000.00	1.00	6.00	3.00	240.00	11.00	1.00
	N	146	146	146	146	146	146	146

Source: Authors' calculations from the Declaração de Aptidão ao PRONAF (DAP) database.

The conceptual formulation of the portfolio diversification problem suggests an endogeneity problem with respect to influence of land tenure security on diversification. Recall that income is a function of the portfolio choice from the previous period and portfolio choice is a function of strength of land tenure, as depicted by

$$x_{it} = x_t(l, z) + v_t$$
$$y_{t+1} = y(x_t, z) + u_{t+1}, \quad (10)$$

where z is a vector of exogenous covariates representing producer attributes, v_t is the random error component of the diversification equation, and u_{t+1} is the random error term in the income equation. Portfolio choice is likely to be correlated with the error component of the income equation, which will yield biased estimates of the effect of diversification on income. Thus, we employ an instrumental variables specification for the income equation, using the land tenure measure and the exogenous variables found in z as instruments for the diversified portfolio choice variable. We identify the effect of land tenure security on diversification, and therefore investment, by estimating the coefficients for the land tenure measure in the first stage portfolio diversification equation (that is, Equation [9]). The effect of diversification, conditional on land tenure security, can then enter into the income equation. The estimated coefficient on the portfolio diversification variable in the income equation identifies the role of diversification on expected income (that is, $\partial y_t/\partial x_{t-1}$ from Equation [5]). The same procedure can be carried out to identify the effect of diversification on income variability, conditional on land tenure security.

However, caution is needed in the specification of the first stage regression on diversification. It is not suitable to apply a linear model to estimate the diversification equation due to the count structure of the variable (Cameron and Trivedi 1986). In fact, misspecifying the portfolio choice estimation results in erroneously accepting the assumption that portfolio diversification enters exogenously into the income equation. Table 5.2displays the results of the Wu-Hausman test for endogeneity of both the general diversification variable and the investment activity variable (Hausman 1978). Specifying a nonlinear count model for the diversification variable confirms that the endogeneity bias must be corrected.

Table 5.2—Wu-Hausman test for endogeneity

	General income diversification		Investment activity diversification	
	Linear model	Nonlinear model	Linear model	Nonlinear model
F-statistic	1.02	5.03**	1.65	4.96**

Source: Authors' calculations
Note **Significant at the 5% level

Because this study uses administrative data from the DAP database, at first glance, it is reasonable to expect there to be problems with self-selection bias (Heckman 1979). That is, some *quilombolas* in this dataset are seeking a means to invest by applying to PRONAF, in which case examining the effect of land tenure security on investment could be confounded by the inherent inclination to invest found within the sample. This would be problematic in that it would limit the universality of the results for *quilombola* producers outside of the sample, as well as any chance of extending the results to hold for all agricultural households. The presence of such sample selection bias would raise the magnitude of the effect of land tenure on investments and reduce the implications of the findings to apply only to a subset of *quilombolas* producers sharing the attributes that would lead them to select or be selected to participate in an agricultural financing program such as PRONAF.

However, the problem of self-selection bias is not a real concern in this analysis with the given data. The reason being that although the data originate from an administrative database, the data represent an accounting of activities and income generated for the period prior to selection into the program. The

analysis simply takes advantage of the available data that exhibit the household characteristics that relate to the intended measurable effect of land tenure. The data used originate from a sample that is collected at a point of preselection into the program. That is, the applicants have not chosen to participate nor been chosen to participate in the program at the point the data were collected. Therefore, investment behavior derived from the data used in this study is exogenous to the choice to participate in PRONAF, rendering self-selection bias irrelevant in this setting. Furthermore, the analysis utilizes data that describe the attributes of *quilombola* producers that would apply to PRONAF in order to achieve the means to invest, with the expectation of some gain from the process. Thus, the results of this study can be extended to all producers with the characteristics that would lead them to pursue financial assistance for agricultural projects, which is likely to cover many producers throughout the developing world.

6. EVIDENCE OF LAND TENURE SECURITY INFLUENCING DIVERSIFICATION AND INVESTMENT

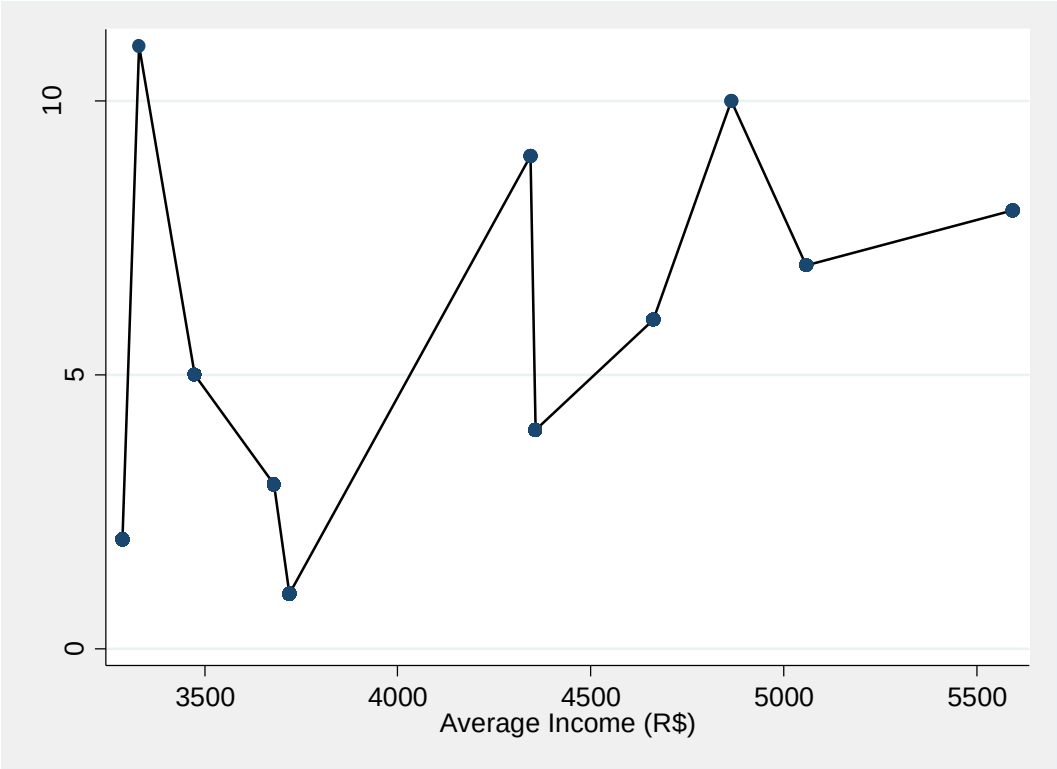
A Descriptive Analysis of the Data

Standard producer portfolio diversification theory posits that increased diversification of income reduces expected income (Bardhan and Udry, 1999). However, in some cases, producers may actually realize an increase in expected income from diversification. Producers motivated to further diversify their portfolios by pull factors would likely experience greater aggregate returns from new market activity. So-called pull factors driving diversification refer to the emergence of strategic complementarities in production across activities or a new ability to specialize due to the introduction of an advanced technology (Barrett, Reardon, and Webb 2001). In other cases, however, expected income may decline due to losses in productivity that occurs from spreading scarce resources across additional activities. Under such circumstances, diversification is likely to be driven instead by *push factors*. Enhanced competitive positioning due to fewer wealth constraints would allow more diversification into higher return markets and draw noticeable distinctions between wealthier and poorer producers. Ultimately, producers with greater liquid wealth can respond more readily to new market opportunities and take advantage of complementary advantages across productive activities.

Although observing initial wealth can indicate *a priori* the prospective types of diversification available to a producer, observing income streams ex post can signal the type of diversification a producer previously opted to engage in. Examining diversification in relation to income, as opposed to in terms of initial wealth, provides greater insight into the outcomes of producer choice and leads to greater clarity about how to distinguish between these two driving factors behind diversification. Figure 6.1 depicts the relationship between average income and different levels of diversification based on the general group of income activities.[4] It is apparent that while both poorer and wealthier producers diversify, there is generally more diversification apparent among producers reaching higher income levels. Where diversification is observed to be high among the low-income producers, it is reasonable to expect the observed diversification to be part of a risk-coping strategy, as opposed to the capitalization of some complementary advantage that allows entry into higher return markets. Additionally, the apparent gap in income among diversifying producers may further imply that there is some other characteristic beyond attained income or initial wealth that is associated with the performance of a diversified portfolio, indicating that diversification alone is not enough to raise income.

[4] See footnote 3 above.

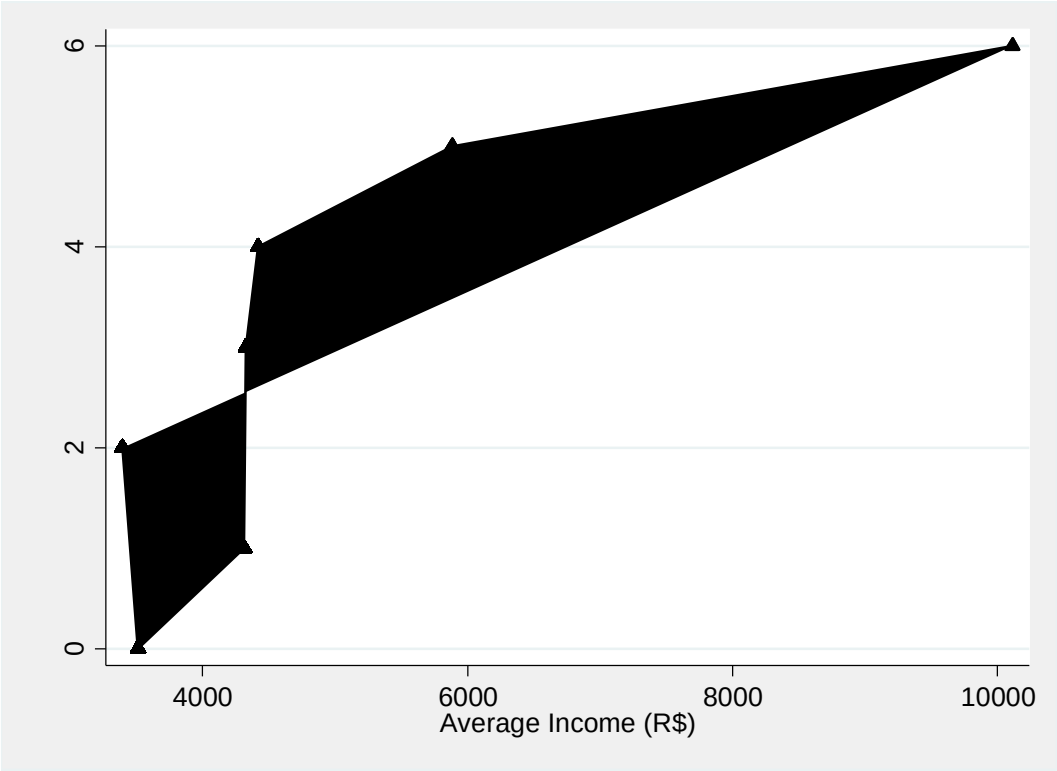
Figure 6.1—Aggregate activity portfolio size and income



Source: Authors' calculations from Declaração de Aptidão ao PRONAF (DAP) database.

The willingness and the ability to use long-term investments would certainly be a differential factor in determining the feasible production activities available to producers, with implications for the subsequent returns from these activities. The relationship between income and investments in activities requiring fixed assets is highlighted further in Figure 6.2. It is evident that diversification into such activities increases with average income, indicating that income is positively correlated with the type of diversification that involves activities utilizing fixed and/or maturing investments. Clearly, higher levels of wealth make investing in long-term assets more plausible, reinforcing the expectation that more investments are made by wealthier producers. Nevertheless, wealth and investment in fixed assets naturally work together to influence the type of diversification taken on by producers. Accumulated wealth and income are really outcomes of production decisions, whereas investment choices usually accompany or even precede decisions about income activities incorporated into the portfolio. Thus, there may be other institutional factors, such as land tenure security, that underlie the decision to make investments in assets that lead to certain productive activities and promote increased portfolio diversification. These cyclical connections among assets, their related activities, and the ensuing income streams from the respective activities constitute the foundation of the central hypothesis of this study: land tenure security does indeed promote investment in activities requiring fixed assets, and as a result, expected income is increased.

Figure 6.2—Investment activity portfolio size and income



Source: Authors' calculations from Declaração de Aptidão ao PRONAF (DAP) database.

7. EMPIRICAL ANALYSIS OF THE DATA

The implications of land tenure security are explicitly pronounced in the portfolio diversification equation. As previously mentioned, the structure of the diversification variable requires a nonlinear count model to properly fit the data. Typically, a Poisson model is the first candidate when searching for an appropriate count model (Hausman, Hall, and Griliches 1984). This model will be suitable if the mean of the dependent variable is equal to the variance, implying no overdispersion of the data (Cameron and Trivedi 1986). Table 7.1 displays the comparison of the mean and variance for both of the diversity measures and includes a measurement of the overdispersion found in the data. The general income diversification variable appears to be a good fit for the Poisson model, but there is too much overdispersion in the investment activity diversification variable. Therefore, we apply a negative binomial model to estimate the diversification equation for the investment activity variable.

Table 7.1—Validation of Poisson model

Variable	Mean	Variance	Overdispersion
Number of General Income Activities	2.429	2.463	0.005
Number of Investment Activities	0.500	0.664	0.657

Source: Authors' calculations.

Table 7.2 illustrates the count model regression results for the diversification variables and the marginal effects of the covariates. Given the varying spatial effectiveness of *quilombo* community mobility toward acquiring land rights, and the varying degrees of cooperation by the Brazilian government at the local level, it is possible that factors associated with the location of the producer enterprise may confound the effects of the covariate estimates due to the endogeneity of land tenure. Therefore, local level effects on land title are controlled for by incorporating a control function endogeneity correction that considers the effect of the location of the producer's residence, represented by the *municipio* index. There are not enough excludable exogenous variables to conduct the correction for all four of the land tenure measures, so the specification is identified by controlling the endogeneity on the definitive land title variable and excluding the remaining land tenure measures. Following the applicable Wooldridge (2010) approach for correcting omitted variable bias in a quasi-maximum likelihood estimator (QMLE) context, we regress the *municipio* index along with the exogenous covariates included in the count model on the definitive land title variable using a linear model. The residuals from the Ordinary Least Squares (OLS) regression are then included in the count model specification. If the estimated coefficient on the residuals is found to be statistically significant, there is endogeneity and it must be corrected by estimating the count model with the residuals from the previous OLS model. Wooldridge (2010) recommends a two-step bootstrap procedure to obtain the standard errors of the endogenity corrected specification, which is employed when appropriate in the current context.

Table 7.2—Average effect of land tenure on portfolio diversification

Dependent variable	Number of income activities		Number of investment activities	
	Poisson model	Marginal effects	Negative binomial model	Marginal effects
Definitive title	1.365***	3.322***	7.945***	4.026***
	(0.346)	(0.581)	(1.432)	(0.301)
Log of total area owned	0.033**	0.080***	0.035	0.018
	(0.011)	(0.018)	(0.048)	(0.009)
Cooperative member	-0.738***	-1.796***	-3.696***	-1.873***
	(0.200)	(0.338)	(0.808)	(0.167)
Association member	0.311***	0.757***	0.258	0.131***
	(0.032)	(0.060)	(0.142)	(0.028)
Male	-0.028	-0.069	0.018	0.009
	(0.028)	(0.051)	(0.123)	(0.026)
Family size	-0.010	-0.025	-0.070	-0.035***
	(0.009)	(0.014)	(0.037)	(0.007)
Number of permanent employees	-0.062*	-0.152**	0.111	0.056*
	(0.032)	(0.056)	(0.142)	(0.027)
Literate	-0.101*	-0.246**	-0.731***	-0.370***
	(0.047)	(0.081)	(0.209)	(0.040)
Secondary school	-0.049	-0.120	0.794**	0.402***
	(0.063)	(0.120)	(0.263)	(0.056)
Primary school	-0.139**	-0.337**	0.398	0.202***
	(0.050)	(0.104)	(0.225)	(0.047)
Technical school	0.493***	1.200	3.909	1.981***
	(0.149)	(1.101)	(7.928)	(0.322)
Superior school	0.072	0.176	2.234	1.132***
	(0.250)	(0.608)	(2.181)	(0.238)
Municipio correction term	-1.249***	-3.040***	-7.345***	-3.722***
	(0.348)	(0.583)	(1.431)	(0.298)
Constant	0.410***		-3.126***	
	(0.080)		(0.333)	
Ln(alpha)				
Constant			-1.506***	
			(0.250)	
# observations	3995	3995	3995	3995

Source: Authors' calculations from the Declaração de Aptidão ao PRONAF (DAP) database.
Notes: Bootstrapped standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Endogeneity testing indicates that the corrected specification should be employed, as Table 7.2 reports a statistically significant parameter on the *municipio* correction term. Therefore, the results are derived from the QMLE endogeneity correction model for both investment activities, and the more general class of productive activities. The estimation results reveal that the effect of land title is positive and statistically significant under both specifications of the diversification measure. Secure land tenure in the form of definitive title increases diversification within the general class of production activities by about three activities for *quilombolas*. Furthermore, definitive land title increases diversification within the class of activities requiring investment in fixed and/or maturing assets by about four activities for *quilombolas* producers. The increased diversification stimulated by secure land tenure is substantial enough to conclude that producers are making investments to accompany a more diversified activity portfolio. This is especially the case for the investment activities. Hence, it appears that portfolio diversification and investment demand are indeed increasing with the strength of land tenure, requiring firm property rights through land title.

The role of land tenure security in investment and diversification decisions is a key step in assessing the value of a diversified portfolio of income activities, but the implications for development are further identified by examining how these relationships affect expected income. Table 7.3 displays the regression results from the estimation of the income equation. The first two columns depict parameter estimates for the OLS model that assumes that portfolio choice is exogenous, and the last two columns portray the results from the instrumental variables (IV) specification to correct the endogeneity.[5] The coefficient estimates are statistically significant for both of the measures of diversification, but the IV model attributes greater magnitude to its effect on income. The OLS estimates an increase in income by about 5.01 percent for an additional activity included in a portfolio of the general class of production activities, whereas the IV estimation reports a 27.3 percent increase in income. Similarly, the OLS results indicate a 16.4 percent increase in income from adding an activity to the portfolio of investment activities, while the IV estimation yields a 58.6 percent increase in income by increasing diversification in investment activities. This indicates that there is a bias toward zero due to the endogeneity of the diversification variable and that neglecting the role of land tenure security in portfolio decisions underestimates the impact on income.

[5] The first stage of the IV/Two Stage Least Squares estimation involves a nonlinear specification to improve the estimation of the conditional expectation function associated with the portfolio choice beyond the capabilities of OLS. As such, it is improper to insert the prediction from the count model directly into the second stage income equation as is the convention with a linear first-stage model (Angrist and Pischke, 2009). Rather, the predicted value is included as an instrument for the observed portfolio size variable, which improves the efficiency of the second stage estimation if the count model is indeed more appropriate than the linear model (Angrist and Pischke, 2009; Newey, 1990).

Table 7.3—Average effect of diversification on expected income

	OLS		IV	
Dependent variable	**Log income**	**Log income**	**Log income**	**Log income**
Number of income activities	0.0501***		0.273***	
	(0.0110)		(0.0951)	
Number of investment activities		0.164***		0.586***
		(0.0206)		(0.0984)
Male	0.272***	0.259***	0.277***	0.227***
	(0.0330)	(0.0329)	(0.0345)	(0.0348)
Cooperative member	0.968***	0.955***	1.026***	0.956***
	(0.125)	(0.124)	(0.133)	(0.119)
Association member	-0.0740**	-0.0820**	-0.294***	-0.230***
	(0.0367)	(0.0356)	(0.103)	(0.0505)
Log of total area owned	0.114***	0.108***	0.0843***	0.0754***
	(0.0116)	(0.0116)	(0.0179)	(0.0150)
Literate	-0.258***	-0.261***	-0.284***	-0.283***
	(0.0362)	(0.0360)	(0.0390)	(0.0380)
Primary school	0.00673	-0.0257	0.0953	-0.0582
	(0.0621)	(0.0616)	(0.0772)	(0.0647)
Secondary school	0.0339	0.00429	0.113	-0.0260
	(0.0700)	(0.0695)	(0.0845)	(0.0775)
Technical school	1.440**	1.193*	1.382***	0.522*
	(0.725)	(0.721)	(0.506)	(0.280)
Superior school	0.928**	0.871**	1.066**	0.805**
	(0.363)	(0.361)	(0.441)	(0.361)
Number of permanent employees	-0.180***	-0.180***	-0.119***	-0.144***
	(0.0340)	(0.0337)	(0.0456)	(0.0377)
Family size	-0.00601	-0.00851	-0.0114	-0.0181*
	(0.00786)	(0.00783)	(0.00884)	(0.00924)
Constant	7.711***	7.788***	7.280***	7.735***
	(0.0557)	(0.0513)	(0.187)	(0.0579)
# observations	3995	3995	3995	3995

Source: Authors' calculations from the Declaração de Aptidão ao PRONAF (DAP) database.
Notes: Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

These results suggest that a more diverse portfolio increases expected income, and even more so when the institutional impact of land tenure is considered as it operates through the mechanism of investment and income diversification. However, it does not seem plausible to expect all producers to realize a nearly 60 percent increase in their income from diversification and investments stimulated by the effect of more secure land rights. Although the average effect of diversifying into activities that call for investments is large, the magnitude may be less for producers typically earning lower levels of income. To examine this possibility more closely, we divide the sample into quartiles conditioned on income level and measure the effects of land tenure for the first quartile, the inter-quartile range, and the fourth quartile.

Within the various strata of income, the effects of land tenure security on diversification and investment suggest less uniform implications for expected income. As depicted by the summary statistics in Table 7.4, there are 397 quilombola producers with definitive land title in the first quartile of the data where the median income level is R$800 compared to R$900 among the 605 producers without land titles in this income strata. Within the inter-quartile range the median income for the 537 producers with land title is R$2,900 and R$3,350 amongst the 1,471 producers lacking definitive titles. Furthermore, the median income for the 351 producers with land titles in the fourth quartile is R$8,735 compared to

R$7,650 for their 652 counterparts who are lacking titles. Therefore, only definitive land title holders among the highest 25 percent of income earners show a higher median income than their counterparts without land title in their same income group. This may imply that the welfare-enhancing effects of land title acting through diversification and investments that are observed for the average of the sample may not hold for the poorer *quilombolas* and may only benefit the wealthier producers.[6]

Table 7.4—Summary of income quartiles

		Total observations	Median income
First quartile			
	Definitive title = 1	397	800.00
	Definitive title = 0	605	900.00
Inter-quartile range			
	Definitive title = 1	537	2900.00
	Definitive title = 0	1471	3350.00
Fourth quartile			
	Definitive title = 1	351	8735.00
	Definitive title = 0	652	7650.00

Source: Authors' calculations from the Declaração de Aptidão ao PRONAF (DAP) database

The impact of land title on diversification and investments can be identified for each income group by estimating the same QMLE model for each respective activity portfolio.

[6] Based on the distribution of income in the sample, the set of "wealthier" producers are the *quilombolas* earning an annual income above or near the national minimum wage (that is, R$5,580 in 2009). Over 75 percent of the producers in this sample report an annual income below this level.

Table 7.5 reports the estimation results for the first income quartile of the sample. The effect of definitive title remains positive and statistically significant for both the general group of income activities and the investment group, but it is considerably less than the sample average effect. Definitive title increases the portfolio size within the first income strata by less than one activity for the general group of activities, compared to an increase of three activities for the sample average. For the investment group of activities, land title increases the portfolio size by nearly two activities, compared to four activities in the sample average. Source: Authors' calculations from the Declaração de Aptidão ao PRONAF (DAP) database.

Notes: Bootstrapped standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 7.6 reports the estimation outcome for the inter-quartile range of income. Again, the estimates are positive and statistically significant, with an estimated six activities added to a portfolio of general activities in this stratum, compared to three for the sample average. The portfolio of investment activities is increased by three activities within this income bracket, compared to four for the entire sample. Finally,

Table 7.7 provides the outcome of the estimation for the fourth income quartile. The estimates for both activity groups are statistically significant, but the general group yields a negative estimate while the investment group yields a positive parameter estimate. Within this income stratum, definitive title leads to a less than one unit decrease in general activity portfolio size and an increase of seven investment-oriented activities in a portfolio.

Table 7.5—Average effect of land tenure on portfolio diversification for first income quartile

Dependent variable	Number of income activities		Number of investment activities	
	Poisson model	Marginal effects	Negative binomial model	Marginal effects
Definitive title	0.189***	0.444***	5.268***	1.989***
	(0.0430)	(0.101)	(1.761)	(0.679)
Log of total area owned	0.0365**	0.0858**	0.188***	0.0709***
	(0.0143)	(0.0336)	(0.0454)	(0.0177)
Cooperative member	-0.673	-1.580	-16.60***	-6.269***
	(0.412)	(0.967)	(2.410)	(1.022)
Association member	0.308***	0.723***	0.475***	0.179***
	(0.0438)	(0.104)	(0.137)	(0.0526)
Male	-0.0776*	-0.182*	-0.657***	-0.248***
	(0.0428)	(0.100)	(0.203)	(0.0778)
Family size	0.00470	0.0110	-0.165**	-0.0623**
	(0.0111)	(0.0260)	(0.0660)	(0.0252)
Number of permanent employees	0.0538	0.126	0.818***	0.309***
	(0.0453)	(0.106)	(0.195)	(0.0745)
Literate	-0.154***	-0.362***	-0.975***	-0.368***
	(0.0449)	(0.106)	(0.247)	(0.0955)
Secondary school	-0.153	-0.359	-0.203	-0.0766
	(0.0984)	(0.231)	(0.226)	(0.0857)
Primary school	0.0529	0.124	-0.0657	-0.0248
	(0.0873)	(0.205)	(0.266)	(0.101)
Superior school	-0.465	-1.092	-16.84***	-6.358***
	(0.711)	(1.668)	(2.453)	(1.036)
Municipio correction term			-4.920***	-1.858***
			(1.756)	(0.676)
Constant	0.656***		-2.771***	
	(0.185)		(0.462)	
Ln(alpha)				
Constant			-1.175	
			(2.048)	
# observations	1002	1002	1002	1002

Source: Authors' calculations from the Declaração de Aptidão ao PRONAF (DAP) database.

Notes: Bootstrapped standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 7.6—Average effect of land tenure on portfolio diversification for inter-quartile range

Dependent variable	Number of income activities		Number of investment activities	
	Poisson model	Marginal effects	Negative binomial model	Marginal effects
Definitive title	2.611***	6.037***	5.755***	2.938***
	(0.285)	(0.665)	(0.525)	(0.295)
Log of total area owned	0.00928	0.0215	0.0544*	0.0278*
	(0.0117)	(0.0271)	(0.0287)	(0.0147)
Cooperative member	-1.971***	-4.556***	-4.400**	-2.246***
	(0.225)	(0.525)	(1.767)	(0.871)
Association member	0.413***	0.955***	0.497***	0.254***
	(0.0312)	(0.0735)	(0.0692)	(0.0364)
Male	0.182***	0.420***	0.449***	0.229***
	(0.0347)	(0.0806)	(0.0733)	(0.0379)
Family size	0.00917	0.0212	0.0327*	0.0167*
	(0.00626)	(0.0145)	(0.0194)	(0.00995)
Number of permanent employees	0.0978***	0.226***	0.0626	0.0320
	(0.0349)	(0.0808)	(0.0701)	(0.0359)
Literate	-0.116***	-0.269***	-0.349***	-0.178***
	(0.0401)	(0.0929)	(0.0906)	(0.0471)
Secondary school	0.0507	0.117	0.467***	0.238***
	(0.0705)	(0.163)	(0.142)	(0.0729)
Primary school	-0.100	-0.232	0.419***	0.214***
	(0.0654)	(0.151)	(0.110)	(0.0553)
Superior school	0.148	0.342	-15.59***	-7.960***
	(0.585)	(1.353)	(2.050)	(1.072)
Municipio correction term	-2.390***	-5.527***	-4.939***	-2.521***
	(0.287)	(0.668)	(0.531)	(0.291)
Constant	-0.191**		-2.984***	
	(0.0846)		(0.181)	
Ln(alpha)				
Constant			-1.999	
			(1.773)	
# observations	1992	1992	1992	1992

Source: Authors' calculations from the Declaração de Aptidão ao PRONAF (DAP) database.

Notes: Bootstrapped standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Table 7.7—Average effect of land tenure on portfolio diversification for fourth income quartile

Dependent variable	Number of income activities		Number of investment activities	
	Poisson model	Marginal effects	Negative binomial model	Marginal effects
Definitive title	-0.0974**	-0.269**	11.65***	7.266***
	(0.0421)	(0.116)	(1.039)	(0.755)
Log of total area owned	0.0221*	0.0609*	-0.266***	-0.166***
	(0.0129)	(0.0357)	(0.0579)	(0.0353)
Cooperative member	0.127	0.351	-3.743***	-2.334***
	(0.113)	(0.313)	(0.406)	(0.282)
Association member	0.353***	0.975***	-0.755***	-0.471***
	(0.0420)	(0.117)	(0.146)	(0.0947)
Male	-0.00153	-0.00422	-0.488***	-0.304***
	(0.0409)	(0.113)	(0.140)	(0.0898)
Family size	-0.00293	-0.00810	-0.144***	-0.0899***
	(0.00922)	(0.0255)	(0.0220)	(0.0145)
Number of permanent employees	-0.303***	-0.838***	-0.569***	-0.355***
	(0.0419)	(0.117)	(0.0963)	(0.0658)
Literate	0.177***	0.490***	-0.482***	-0.301***
	(0.0456)	(0.126)	(0.136)	(0.0866)
Secondary school	-0.182**	-0.504**	2.327***	1.451***
	(0.0821)	(0.227)	(0.210)	(0.150)
Primary school	-0.131*	-0.362*	0.452***	0.282***
	(0.0751)	(0.208)	(0.149)	(0.0945)
Superior school	-0.224	-0.619	2.685	1.674
	(0.292)	(0.805)	(2.575)	(1.645)
Municipio correction term			-11.15***	-6.954***
			(1.036)	(0.746)
Constant	0.972***		-2.772***	
	(0.0577)		(0.202)	
Ln(alpha)				
Constant			-2.119	
			(2.838)	
# observations	1001	1001	1001	1001

Source: Authors' calculations from the Declaração de Aptidão ao PRONAF (DAP) database.
Notes: Bootstrapped standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

From this analytical vantage point, it appears that land title still induces diversification in investment-oriented activities, but wealth constraints limit the involvement of *quilombola* producers in these activities. *Quilombola* producers at every income level become more engaged in investment-oriented activities when they have land titles, but the level of their involvement appears to be proportional to their income level. Equally as interesting is the role wealth plays in the decision to engage in multiple activities categorized in the general group. It seems that the poorest producers specialize in a small number of general cropping activities with a more muted diversification response into additional general activities. However, the poorest producers do seem to gradually move into more investment-oriented activities with secure land rights. The mid-level income producers appear to greatly expand their involvement in the general activities, implying that they utilize more of their available land when they have land titles. However, the wealthiest producers appear to move away from these general activities when they have land titles. This, combined with the more pronounced response for investment activities, suggests that wealthier *quilombola* producers are able to move into activities with higher returns that benefit from investments in fixed and/or maturing assets. These results enrich the outcome for the entire sample by revealing the intricate effects of land title on diversification and investment decisions as conditioned on the income or wealth level of the producer.

The functioning of land title on the mechanisms of diversification and investments may also lead to a different interpretation of the results for the income equation.

Table 7.8 reports the results from the estimation of the income equation for each income group. In the first quartile, there is no statistically significant effect on income from diversification into either the general activities or the investment activities. In the inter-quartile range, the effect on income is negative and statistically significant only for the general group of income activities. Increased diversification for *quilombola* producers in this income range reduces expected income by nearly 4 percent. The drop in income realized by this group of producers is consistent with the theoretical predictions made in the development literature dealing with *ex ante* risk-coping mechanisms. However, in the fourth quartile the effect of diversification on income is statistically significant only for the investment activities and is positive. Increased diversification into investment-oriented activities increases expected income for this income group by 51.5 percent. This considerable impact on income is consistent with the findings for the sample average and is likely to be the driving force behind the sample-wide effect of diversification into investment activities on income. Hence, diversifying an activity portfolio and making the related productive investments does not appear to have any notable effect on the poorest *quilombola* producers; it reduces expected income for middle-income producers; and it raises expected income substantially for the wealthiest producers.

Table 7.8—Average effect of diversification on expected income on income quartiles

Dependent variable	IV q25		IV iqr		IV q75	
	Log income	Log income	Log income	Log income	Log income	Log income
Number of income activities	-0.0457		-0.0381**		-0.104	
	(0.110)		(0.0175)		(0.121)	
Number of investment activities		0.127		-0.0665		0.515***
		(0.251)		(0.0464)		(0.0866)
Male	-0.00570	0.00749	0.0717***	0.0727***	0.194***	0.0597
	(0.0515)	(0.0501)	(0.0149)	(0.0148)	(0.0351)	(0.0418)
Cooperative member	0.623***	0.741***	-0.0319	-0.0274	0.833***	0.630***
	(0.237)	(0.219)	(0.0521)	(0.0495)	(0.141)	(0.158)
Association member	0.0118	-0.0622	0.0117	-0.0101	0.0684	-0.275***
	(0.118)	(0.108)	(0.0251)	(0.0219)	(0.129)	(0.0560)
Log of total area owned	0.122***	0.114***	-0.0119*	-0.0116*	0.0625***	0.0131
	(0.0212)	(0.0210)	(0.00673)	(0.00681)	(0.0148)	(0.0141)
Literate	0.0386	0.0668	0.0296*	0.0249	-0.159**	-0.345***
	(0.0602)	(0.0572)	(0.0171)	(0.0166)	(0.0669)	(0.0541)
Primary school	-0.0587	-0.0967	0.0397	0.0599**	0.132	0.0439
	(0.145)	(0.0861)	(0.0269)	(0.0250)	(0.113)	(0.0840)
Secondary school	-0.0928	-0.0366	-0.0108	0.00127	0.163**	0.0685
	(0.0926)	(0.143)	(0.0349)	(0.0339)	(0.0815)	(0.0789)
Superior school	0	0	-0.105	-0.105	0.842***	0.532***
	(0)	(0)	(0.0673)	(0.0665)	(0.177)	(0.158)
Number of permanent employees	0.183***	0.161***	-0.0183	-0.0218	-0.0416	0.163***
	(0.0543)	(0.0577)	(0.0159)	(0.0163)	(0.112)	(0.0477)
Family size	0.0113	0.00935	0.00347	0.00375	-0.0120	-0.0139
	(0.0131)	(0.0125)	(0.00340)	(0.00378)	(0.0113)	(0.00961)
Constant	6.311***	6.194***	8.080***	8.033***	9.251***	8.955***
	(0.238)	(0.1000)	(0.0350)	(0.0239)	(0.337)	(0.0539)
# observations	3995	3995	3995	3995	3995	3995

Source: Authors' calculations from the Declaração de Aptidão ao PRONAF (DAP) database.
Notes: Standard errors are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Although the findings for the sample average indicate that the theoretical predictions regarding the effect of secure land tenure working through the mechanisms of diversification and investment on income hold true, stratifying the sample of *quilombola* producers conditioned by their income level indicates that the prediction holds true only for the wealthiest group of producers. These findings suggest that this group of relatively wealthy producers typify a diversification strategy that is driven by pull factors that correspond with investments leading to better income-earning prospects. Conversely, the middle-income producers typify a diversification strategy that is motivated by risk reduction, or push factors. Although this group of producers may show a positive investment response to secure land rights, the benefits to investment appear to be truncated by the lack of specialization. The higher income producers are likely to be involved in numerous activities utilizing their investments and/or their land in a complementary way, which does not take away from their ability to manage multiple activities profitably. However, the middle-income producers appear to be spreading themselves thinly across many types of activities that do not suggest any complementary advantages. This mode of diversification does not allow them to fully harness the earning potential of the investments they are able to make, thus rendering their income portfolio less efficient, and almost nullifying the gains from investments.

8. CONCLUDING REMARKS

Using an administrative dataset of a unique set of agricultural households with varying degrees of land tenure security, this study identifies the effect of secure property rights on income diversity in certain activities that require the use of fixed and/or maturing assets. By considering investments as they operate through income activities, the analysis identifies the benefits of secure land tenure in terms of economic mechanisms and household welfare strategies, which may be better suited for understanding the implications of land tenure on household decision making. This cross-sectional approach serves as a lower bound for inter-temporal portfolio performance. The main results suggest that holding exclusive property rights in the form of definitive land title is shown to promote both general income diversification and participation in investment-related income activities for the average *quilombola* producer in the sample.

However, stratifying the producers in the sample into quartiles conditioned on income level reveals a more intricate story. *Quilombola* producers with definitive land titles strictly increase the level of diversification into investment-oriented activities, such as food processing, fruit tree cultivation, and raising livestock, as their income levels grow. Diversification into general types of income activities, such as seasonal cropping, mining, and wage labor, increases with income, peaking for middle-income producers and declining for the wealthiest producers. This implies that the asset portfolio, as well as the activity selection process, is connected to the strength of land tenure and is conditional on the level of wealth or income. Ultimately, the results suggest that increased security of land tenure increases the set of income generating activities and increases investment in fixed and/or maturing assets that enable producers with an annual income greater than or almost equal to the national minimum wage to yield higher returns from their selection of productive activities.[7]

Income diversity from various productive activities is found to positively contribute to higher income levels in the sample average. More specifically, engaging in productive activities that require fixed and/or maturing investments appears to be a key determinant in raising total income. *Quilombolas* living in communities with land titles appear to be more likely to engage in such activities, implying that long-term investments are more secure with land title and that income diversification using fixed and/or maturing investments is instrumental in improving welfare and reducing poverty. Hence, distributing definitive land title to *quilombolas* more efficiently and in greater number would engender a systematic process of development that allows greater benefits from the secured land and resources. Therefore, it would be highly beneficial to the Brazilian government's objective of poverty alleviation to title more *quilombola* land.

Through the previous framework, it is apparent that investment demand does indeed respond to increased land tenure security. However, land titling alone is not sufficient to raise income levels for these agricultural households. Although there is a positive investment response for households with land titles, the effect on income depends on the way investments are utilized. The way assets are used depends highly on the income level of the households. Identifying this multilevel linkage exemplifies the functioning of the assets, activities, and income cycle as highlighted by Winters et al. (2009) and identifies land institutions as a key underlying determinant in the cycle's operation. The importance of land institutions is not limited to the decision to make investments in productive assets, but continues onward through pivotal economic mechanisms that are expected to raise incomes and increase welfare. The promotion of investment through successful implementation of land institutions is observed to be channeled through income diversification. This study highlights the functioning of diversification as a mechanism that promotes increased returns to producers who can harness complementary advantages from their set of productive assets and become active in higher return activities that utilize fixed and/or maturing assets. Policy aimed at empowering underdeveloped components of an economy would do well to fortify land rights and other institutions that encourage investments in strategically aligned assets that enable producers to work more efficiently and reach higher return markets. To achieve the goal of sustainable development and poverty alleviation, policy should be informed by an analysis that considers the full cycle of impacts that will result from making changes to important institutions in the economy.

[7] See footnote 6.

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