Land Markets and Inequality: Evidence from Medieval England*

Cliff T. Bekar and Clyde G. Reed†

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Abstract

Between the eleventh and thirteenth centuries English peasants faced large income shocks relative to mean incomes. Innovations in property rights over land induced peasants to respond by trading small parcels of land as part of their risk coping strategy. The same period witnessed a substantial increase in inequality in the distribution of peasant landholdings, with many peasants becoming landless. We argue that these events are related. Recent work in development economics has explored the relationship between inequality and asset markets. When agents are able to trade productive assets to manage risk, the resulting dynamics may generate increasing inequality over time. We employ a simulation strategy to analyze the impact of land markets in generating inequality in thirteenth century landholdings. We find that the most significant factor contributing to the unequal distribution of land in the period was the interaction of land markets and population growth resulting from households with substantial land holdings producing multiple surviving heirs.

Keywords: economic history, land market, Hundred Rolls, Domesday, inequality, risk, poverty, asset markets, simulation analysis, economic development

JEL Classifications: N23, N53, O15, J11

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†Cliff Bekar: Department of Economics, Lewis and Clark College, 0615 SW Palatine Hill Road, Portland OR, 97213, USA. Email: bekar@lclark.edu. Clyde Reed: Department of Economics, Simon Fraser University, 8888 University Drive, Burnaby, B.C. V5A 1S6, Canada. Email: reed@sfu.ca.

1 Introduction

During the 12^{th} and 13^{th} centuries the English peasantry experienced large increases in inequality and poverty. The Domesday survey of 1086 indicates that the vast majority of free peasant households produced income levels above subsistence working their own holdings exclusively. In contrast, the Hundred Rolls survey of 1279-80 indicates that most free peasant households achieved subsistence only by supplementing harvest realizations with wage income. Dyer (2002, p. 183) notes that one of the most important aspects of this increased inequality was "the gap between those with landholdings adequate to feed a family, and those with insufficient land who needed income from wages or non-agricultural activities." This growing inequality strained medieval English society and threatened the survival of the poorest, "Those numerous villagers with a few acres or a cottage were dependent for their living on wage-earning...the purchasing power of the daily wage—the amount of food that a worker could buy after a day's work—shows that a very low point was reached in the 1270s...The danger of the proliferation of families attempting to live on small amounts of land was becoming all too obvious by the 1290s" (Dyer, 2002, p. 186).

We argue that peasant demand for insurance through land market transactions and the differential production of heirs (i.e., households with large landholdings, on average, produced many more children who survived to adulthood than did small landholding households) were necessary conditions for the observed change in the distribution of land. Peasants faced persistent subsistence risk that traditional risk coping strategies mitigated but did not eliminate. Demographic pressure throughout the twelfth and thirteenth centuries aggravated this risk. Late twelfth century land market reforms (Campbell, 2009) allowed free peasants to more easily trade land in response to bad harvest realizations, creating a sequence of increasingly unequal land holdings. The same reforms were not extended to peasants of unfree status as transactions in customary land continued to be confounded with rights over personal obligations. Consistent with our analysis, the aggregate distribution of customary land changed very little.

Land markets have long been central to the study of economic stratification within peasant communities. Early work focused on a "natural peasant land market" operating largely within manorial traditions.[1] Households with surplus family labor (early in their lifecycle) were natural buyers of land, households with deficient family labor (late in their lifecycle) natural sellers. More recently,

[1] For example, see Smith (1984a) for an overview of Postan's and Chayanov's theories of the peasant land market.

scholars with access to a wider range of data have found a complex mix of land trades motivated by traditional lifecycle concerns,[2] bequest motives,[3] risk coping strategies,[4] and investment possibilities.[5] Recent work in development economics has explored the specific relationship between inequality and asset markets,[6] including the role played by incomplete markets,[7] subsistence constraints,[8] and the interaction of market and non-market activities.[9] Twelfth century improvements in the market for freehold land, and the subsequent increase in inequality in landholdings, presents an opportunity to explore the empirical relationship between the introduction of asset markets and wealth dynamics.

We use simulation analysis to generate estimates of the quantitative impact of land trades motivated by periodic subsistence crises and population growth on the distribution of landholdings. Starting with estimates of the distribution of free peasant landholdings at the time of Domesday (1086), we benchmark the simulation by replicating aspects of the distribution of freehold land in the Hundred Rolls survey (1279-80) and population growth over the period. Our simulation analysis indicates that:

1. In the absence of land trades, population growth coupled with partiple inheritance rules explain roughly 20% of the observed increase in inequality.
2. In the absence of population growth, land trades explain roughly 5% of the observed increase in inequality.
3. The interaction between population growth, driven by the differential production of heirs, partible inheritance, and an active land market explains roughly 75% of the observed increase in inequality.
4. The development of land markets increased the absolute and relative size of the smallholder/landless category of peasants, forced the poor into dependency on the labor market, and reduced the consumption of the poor while increasing their subsistence risk.

In section 2 we report the data on the changing distribution of land between Domesday and the Hundred Rolls. In section 3 we review previous explanations and develop our own. In section 4 we present our simulation results. Section 5 summarizes our findings and sketches potential extensions.

[2]Faith (1984).
[3]See, for example Razi (1981), Williamson (1984), Campbell (1984), and Smith (1984b).
[4]Campbell (1984, 2009), Razi (1981), Schofield (1997), Smith (1984a).
[5]Blanchard (1984) analyzes the land investment strategies of early "industrials." On the economic, social, and political returns to investing in land see Schofield (2003).
[6]Fafchamps (2005), Dercon (2005), and Mookherjee and Ray (2001).
[7]Heaton and Lucas (1996), and Fafchamps (1999).
[8]See Carter and Zimmerman (2003), and Baland et al (2007).
[9]Croix and Doepke (2003), and Piketty (1997).

2 The Data

We assume a standard holding (virgate) of 30 acres. Peasants are categorized as largeholders (a full virgate or more), middleholders (one-half to a full virgate), or smallholders (less than one-half virgate).

Dyer (1989, pp. 117-18) describes the economic circumstances of each group. Largeholders rarely faced subsistence crises, even during bad harvests, and could expect to produce a relatively large surplus in an average year after paying for hired labor. Middleholders could expect to "have broken even in normal years" working their own land exclusively, relying on alternative sources of income during bad harvests. Smallholders were unable to make a living on their own holding and led "a precarious existence relying on wages because of the small contribution that their land made to their income." Smallholder households worked from one-third to one-half the year for others even during good harvests.

Razi (1981, pp. 87-88) describes how each group typically responded to harvest shocks. Largeholders "suffered losses along with everyone else in the village when the harvests failed, but they were able to sustain these losses better than other villagers. During these crises they not only succeeded in feeding their families, but were able to lend money and corn to their poorer neighbours and to buy and lease their lands." Middleholders, "when the harvests failed, as they often did in the pre-plague era...could not make ends meet...often they had no choice but to sub-let or sell land." Among the poorest families, "The incomes which cottagers and smallholders obtained from their land or small workshops were too low to satisfy the needs of their families. In order to subsist, poor villagers had to supplement their incomes by working on the demesne or on the farms of better off villagers."

2.1 Changing distribution of peasant land, 1100 to 1300

Data from individual estates, tax records, royal surveys, and court rolls have been summarized and analyzed in Miller and Hatcher (1978), Dyer (1989, 2002), Hatcher and Bailey (2001), and Britnell (2004). All comment on the increasing inequality and fragmentation of holdings between the eleventh century and the end of the thirteenth. Three sets of observations present data on the distribution of English land holdings over this period: (i) the Domesday survey of 1086;[10] (ii) Postan's (1966)

[10]The Domesday survey includes all the counties of England except for Northumberland, Durham, Westmorland, Cumberland and the northern parts of Lancashire, which were apparently not surveyed. Volume I (Great Domesday) contains the summarized record of all the counties surveyed except Essex, Norfolk, and Suffolk. Volume II (Little Domesday) contains the full return for the "eastern circuit." An early draft of the southwestern circuit (Exon

sample of 104 manors drawn from the late twelfth and thirteenth centuries; (iii) the Hundred Rolls of 1279-80.[11]

Estimates for the distribution of land holdings at the time of Domesday for "unfree" peasants are derived as follows. We start with the size of the population categories: villani (i.e., large and middleholders of unfree status), 109,000, 41% of rural population, held 45% of land; bordari and cottars (smallholders of unfree status), 87,000, 32% of rural population, held 5% of land); liberi hominess and sokemen (peasants of free status), 37,000, 14% of rural population, held 20% of land); servi (almost always landless, "full-time workers on the land of their lord"), 28,000; and, "a few minor groups of small moment" (Miller and Hatcher, 1978, p. 22). We then allocate land among villani using estimates from Middlesex Domesday (Miller and Hatcher, p. 24): 1/3 held between 1 and 2 virgates, 2/3 held between half and 1 virgate. The most meaningful comparison between Domesday and the Hundred Rolls would focus on the distribution of landholdings in Middlesex. While observations for Middlesex itself are not included in the Hundred Rolls, the Hundred Rolls data is drawn from directly adjacent counties in central England.

Table 1 compares the distribution of customary holdings (i.e., land held by unfree peasants) at the time of Domesday with the distribution at the time of Hundred Rolls. The comparison shows only a slight increase in inequality for customary landholdings.

Table 1: Distribution of land, unfree tenants

Source (Date)	Largeholders	Middleholders	Smallholders
Domesday survey (1086)	19%	37%	44%
Postan (late 12^{th} & 13^{th} cent.)	22%	33%	45%
Hundred Rolls (1279-80)	22%	31%	47%

Measuring the change in landholdings among free tenants is more difficult. While the Hundred Rolls reveals a detailed distribution for freehold land, the Domesday survey does not. Nevertheless, observations from the Domesday survey in combination with other data from the 11th century constrain the distribution of freeholdings. Miller and Hatcher (1978, pp. 22-3) contrast differences between peasants as follows: "[some held] a fair amount of land... enough to live on or more" [and

Domesday) also provides detailed data. Useful summaries of the Domesday data are found in Britnell (2004), Darby (1952-67), Darby (1977), Lennard (1959), and Miller and Hatcher (1978).

[11]The surveys of vills contained in the Hundred Rolls yield data on both large ecclesiastical manors and small knightly manors. The area covered was biased towards the highly manorialized vills of central England and includes Cambridgeshire, Huntingdonshire, Warwickshire, and some of Oxfordshire. The Hundred Rolls resulted from government commissions attempting to establish rights of the crown and other lords. Previous to Kanzaka (2002) the standard reference was Kominsky (1956).

Table 2: Distribution of land, free tenants

Source (Date)	Largeholders	Middleholders	Smallholders
Domesday survey (1086)	50%	40%	10%
Hundred Rolls (1279-80)	18%	12%	70%

others worked holdings so small that they] "must have relied on supplementary earnings for some part of their daily bread... Very roughly the line of division corresponds to that between villani, liberi homines and sokemen on the one hand and bordars and cottars on the other—but only very roughly. There were bordars with half a virgate (around 15 acres); there were sokemen and freemen with the tiniest holdings." Postan (1966, p. 611) notes that there were likely more freemen than unfree in "the topmost layer of village society, i.e. among the few villagers with holdings of two or more virgates." In sum, the distribution of land among free peasants appears similar to that of villani, but with relatively more largeholders and some smallholders. We propose the following distribution of land among free peasants at the time of Domesday as the starting point for our simulation exercise: 50% greater than one virgate, 40% between one-half and one virgate, and 10% less than one-half virgate. Table 2 compares this estimate with the Hundred Rolls distribution from Kanzaka (2002).[12]

At the time of Domesday around 10% of peasants were classified as servi. These peasants did not hold land and instead worked exclusively for the lord of the manor. They are not included in tables 1 and 2 for two reasons: the comparison surveys do not include landless peasants, and servi probably disappeared soon after the Domesday survey (Miller and Hatcher, 1978, pp. 24-5). At the time of the Hundred Rolls, however, many peasants had become landless. Since the Hundred Rolls only reports peasants with positive landholdings, estimating the number of landless in 1279-80 with precision is not possible. It is well accepted, however, that the number of landless increased over time. From Miller and Hatcher (1978, p. 55), "The impression from every quarter of the land... is that the number of landless or near landless men grew steadily in the ensuing generations [after the Domesday survey in 1086], even though no small proportion of them are screened from our view." They provide the example of Wotton Underwood in early 14th century: the village population included 22 tenants of land and also "31 valetti who appear to be landless." Razi (1981, p. 5) finds

[12] At the time of Domesday freeholders (liberi homines and sokemen) constituted roughly 14% of rural landholders and held about 20% of the land (Miller and Hatcher, 1978). In the Hundred Rolls survey, freeholders constituted roughly 50% of landholders, and held a little more than 50% of the land (Kanzaka, 2002, table 2, p. 599). The estimated number of "free" peasants is significantly higher at the end of the 13th century if landless peasants are taken into account (see table 3).

that in a roughly 50 year period (Halesowen from 1270 to 1320), 30% of landed families became landless. Over the period 53 of 174 landholding families lost the entirety of their holdings, with 0% of wealthy families becoming landless, 10% of middling families becoming landless, and 65% percent of the poor families becoming landless.

Table 3 provides estimates of the distribution of freehold land by combining the Kanzaka data for the Hundred Rolls with alternative assumptions about the percentage of landless peasants. Assuming that 20% to 40% of free peasants were landless, the target of our benchmark simulation becomes 11%-15% largeholders, 7%-9% middleholders, 76%-82% smallholders.

Table 3: Distribution of land, free tenants (smallholders include landless)

Source	Largeholders	Middleholders	Smallholders
Domesday	50%	40%	10%
Hundred Rolls			
20% Landless	15%	9%	76%
30% Landless	12%	9%	79%
40% Landless	11%	7%	82%

3 Peasant Landholdings

A wide range of factors impacted the distribution of peasant landholdings in the middle ages. We focus on two sets of factors widely discussed in the historical literature.[13]

One set of factors tended to produce more equal landholdings. Labor sharing across households (formal or informal) involved high transaction costs due to induced shirking and high monitoring costs. As a result, static efficiency implied limiting each household's exposure to the labor market by allocating land such that most households were fully employed on their own holding.[14] Additional factors tending to equalize holdings included the desire of manorial lords to keep traditional holdings together in order to minimize administration costs, familial solidarity, and community norms.[15]

Another set of factors tended to produce more unequal landholdings. Dominant in the literature are population growth (coupled with partiple inheritance) and the peasant land market. Additional factors are suggested by the fact that: (i) the percentage of smallholdings were highest in areas characterized by commercial development, freehold tenure, and recent assarts; (ii) the percentage of

[13]For summaries of existing explanations see Miller and Hatcher (1978), Dyer (1989, 2002), Hatcher and Bailey (2001), Britnell (2004).

[14]See Fenoaltea (1975), North and Thomas (1973), and the Chayanov thesis (see Smith, 1984). We interpret Dyer's (1989, Chapter 5) discussion of the "normal" workings of the peasant land market in this light.

[15]See Campbell (2005), Dyer (1989), Hilton (1978), Razi (1981).

smallholdings was lowest in traditional manorial areas characterized by strong lordship (Dyer, 1989, pp. 119-20).

Biddick (1990, p. 629) notes that "Regionally, social structure varied as much as farming practices. The size of peasant holdings and their tenure varied from the extremes in Norfolk, where over 50 percent of the population held less than five acres of land, to the north of England, where the majority of peasants held more than ten acres of land...Recent studies have highlighted the futility of searching for simple relationships between inheritance customs, size of holdings, assarting, and demographic growth to explain such differences. A complex, but not well understood, interplay of institutional factors mediated regional social structure and demography." In addition, there are theoretical reasons for why the direct effects of the most emphasized variables, population growth and partible inheritance, might be expected to be relatively small. First, while population growth would reduce the average size of landholdings (all else equal), it is unclear why it should increase inequality. Second, since every surviving heir inherits land, partible inheritance cannot easily explain an increase in landlessness. Third, population growth resulted from wealthy families having large numbers of surviving children, while smallholders as a group were not able to produce enough surviving children to replace themselves (Clark and Hamilton, 2006; Dyer, 1989, p. 134). Thus while partible inheritance might explain why there were so few families farming very large holdings, it has difficulty explaining the proliferation in holdings of less than an acre. Finally, there is evidence that vills similar in all respects other than inheritance rules produced similar levels of inequality. Medieval peasants could and did distribute bequests of land to their children prior to dying.[16] It seems that preferences for egalitarian bequests were not overly constrained by formal inheritance rules.[17]

[16]Dyer (1989, p. 124) notes that "...in villages where the custom of impartible inheritance prevailed, fathers were anxious to provide for their non-inheriting sons and daughters. Custom allowed them to give away land that they had acquired in their own lifetime." From Razi (1981), "where impartible inheritance was practiced, parents usually endowed non-inheriting children with land. The commitment to do so was so strong that parents did not hesitate, if they failed to acquire additional land during their lifetime, to reduce the size of the original landholding given to the heir, in order to provide the non-inheriting siblings with land." Examples of egalitarian inheritances to daughters through dowries are documented and analyzed in Botticini (1999) and Botticini and Siow (2003).

[17]Williamson's analysis of Norfolk manors finds that Gressenhall and Martham (areas of partible inheritance) showed no more fragmentation than Sedgeford (an area of impartible inheritance). Williamson (1984, p. 103) notes "... in their effects on peasant holdings there was less difference between partible and impartible inheritance in the thirteenth century than a bare description of the two systems would suggest... Whatever the letter of the local inheritance law, tenants generally seem to have used their land to provide for as many of their immediate family as possible."

3.1 The impact of land markets on inequality

The nature of property rights in land at the time of Domesday hindered transferability, rendering land trades an expensive (and therefore seldom used) form of risk coping relative to traditional means that included diversification through scattered landholdings, storage, charity, and pooling.[18] Throughout the early 12th century traditional risk coping mechanisms came under stress from population growth and commercial development. Such developments were offset by the strength of informal tradition and the implementation of new formal rules, including harvest by-laws, long term relationships between wealthy and poor peasants (the former exchanging food in bad times for secure labor in good times), increased gleaning rights for the poor, and an increased commitment to the elderly (Dyer, 2002, p. 185). Dyer (2002, p. 185-86) notes that by the late 12th century England entered a period that "favored individual initiative, but the peasants who showed these entrepreneurial and selfish tendencies were still contained within highly cohesive communities. No doubt some individuals were held back by the restrictions of common agriculture, but many more welcomed the security that came from belonging to a group with many shared interests."

The picture that emerges is one of traditional risk coping mechanisms being overwhelmed by changing economic conditions and evolving social norms. It was in this context that the reforms of Henry II (1160 to 1170) separated land title for freehold land from personal obligations.[19] This innovation in property rights lowered transaction costs in the land market, rendering land trades relatively more attractive as a risk coping strategy. By the thirteenth century there is ample evidence that peasants used land markets to manage consumption risk. Schofield (1997) finds that land market activity is correlated with years of dearth, consistent with the findings of Dyer (1989, p. 113), Jordan (1996, pp. 102-06), Razi (1981) and Duby (1968, pp. 254-57). Bekar and Reed (2003) demonstrate that the buying and selling of small parcels of land was an effective method for peasants to mitigate subsistence crises relative to traditional forms of insurance, and that land market activity reflected this fact. Specifically, in English medieval land markets: (i) transactions were dominated by the frequent and extensive exchange of small parcels of land; (ii) bad harvest years were correlated with

[18] In this connection Dyer (1989, p. 257) stresses the critical role of "networks of neighbors and friends" for avoiding widespread starvation. For a general discussion of the concept of reciprocal exchange see Kranton (1996), for its application to medieval history see Kimball (1988), and Reed and Bekar (2003).

[19] We take developments in the land market as exogenous to our model. For an analysis of factor market developments in this period see Campbell (2009), for his discussion of land market reforms see pp. 88-91. This changing relationship between peasants and their land is summarized by Harvey (1984, p. 12), "in 1100 the lord of a manor was the lord of men who held lands of him; in 1200 he was the lord of lands that were occupied by tenants...In 1100 the tenant's holding could be viewed simply as a standard share in the vill's resources; by 1200 it was far more likely to be viewed as precisely defined in its area of land and other rights."

high levels of land market activity; (iii) land transactions were dominated by sales between families, not within families; (iv) land transactions were dominated by transfers of arable land.

Campbell (1984, p. 112-14) finds that many small plots of land were offered for sale to finance food purchases, and "whereas the propensity of individuals to sell land was increased by bad [harvests], it was reduced by good harvests. Furthermore, the effect of successive bad harvests appears to have been cumulative." Razi (1981, 37) finds that "Lean years are reflected in the court rolls by a rise in the number of pleas of debt, of inter-peasant land transactions and of illegal gleaners. The reason for the rapid quickening of the inter-peasant land market during periods of economic crises is that smallholders and to a lesser extent half yardlanders had to sub-let and to sell land either to remit debts or to pay rents and fines and to buy food, seed corn, and livestock." Further, he finds that during these lean years it was the largeholders who typically entered the market as buyers or to take up vacated holdings (Razi, 1980, p. 96, tables 18 - 19). Campbell (2009, p. 92) finds that the land market became a "buffer against hard times," and that "As a last resort, tenants could raise the cash they needed to survive by selling off tiny parcels of land, in the hope of recouping those losses when better times came."

The central idea linking land transactions to inequality in landholdings is straightforward. Agents who sell land in period t (the unlucky) are more likely to be sellers in period $t + n$, since their diminished land position today increases the probability of a subsistence crisis tomorrow. Agents who buy land in period t (the lucky) are more likely to be buyers in $t + n$. Over time this dynamic can be expected to lead to increased inequality and poverty as peasants whose land benefits from positive productivity shocks accumulate land at the expense of their less fortunate neighbors. The dynamics of the process are far from straightforward however when one includes the interactions between risk coping through land sales, the differential production of heirs by landholding, and inheritance practices. To understand these complex dynamics we adopt a simulation strategy.

4 Simulation Strategy

Our simulation focuses on demographic variables and distress land trades resulting from heterogeneous land holdings and harvest realizations to explain the high levels of inequality in freehold land and poverty observed in central England at the end of the thirteenth century. We employ our simulation to estimate counterfactual distributions of landholdings in order to rank the relative

importance of the demographic effect, the land market effect, and their interaction. We recognize that our model abstracts from many additional historical factors that may have played a role in determining land inequality and poverty: capital markets, strength of manorial tradition, strength of lordship, proximity to market centers, intensity of sheep husbandry, etc.

To establish the credibility of our simulated estimates we employ historical observations, benchmarking exercises, and robustness testing. First, we constrain our parameter values and behavioral assumptions to comply with accepted historical data and analysis. Second, we require our parameter values and behavioral assumptions to reproduce critical aspects of the distribution of freehold land in the Hundred Rolls conditional on starting with the historical Domesday seed. Third, to test the sensitivity of our simulation to possible errors in specification and parameterization, we reproduce the same aspects of the Hundred Rolls' distribution with a range of alternative parameter values, initial seeds, and rule specifications. While our simulation's predictions change on the margin the changes are small and, critically, the implications for inequality and poverty remain unchanged

4.1 The simulation[20]

Each peasant's consumption sequence $\{c_1 \dots c_t\}$ is a function of their harvest sequence $\{H_1 \dots H_t\}$, which is in turn a function of their landholding sequence $\{L_1 \dots L_t\}$. One way to solve for the evolution of a peasant's landholdings would be to maximize their expected utility of consumption in every period t, allowing them to optimally substitute between different risk coping strategies (i.e., rates of storage, effort levels, etc.) in a forward looking manner. The limit of this approach is that while relevant production parameters can be estimated (see below), data is lacking for key behavioral parameters (e.g., degree of risk aversion, rate of time preference, etc.) and market parameters (e.g., the elasticities of demand and supply in the land and labor markets, etc.). Further, there is a large literature on whether and to what extent medieval communitarian impulses may have constrained an individualistic maximizing calculus, and whether and to what extent the increasing penetration of markets may have changed this calculus. In the face of these concerns we employ a different approach.

We simulate an agent based model in which decisions regarding pooling, saving, labor supply, and land transactions are rule based. We propose rules reflecting period specific concerns: (i) peasants

[20]The simulation is coded in Java and employs the Recursive Porous Agent Simulation Toolkit (REPAST) libraries developed at the University of Chicago and Argonne National Laboratory. The simulation source code can be found at www.lclark.edu/~bekar/Research.htm.

sell parcels of land[21] only when facing a subsistence crisis and all other methods of risk coping have been exhausted,[22] (ii) agents bequest all surviving heirs with an equal portion of the family holding, (iii) agents participate in the labor market only when their own holding no longer fully absorbs their own labor supply.[23]

Agents are initially endowed with an exogenous landholding.[24] Each period each agent draws a harvest realization from a random normal distribution transformed by the requisite mean and variance.[25] Harvests are independent across agents and through time.[26] Agents pool and save out of current harvests.[27] Smallholders work in the labor market and largeholders hire labor.[28] Incomes are compared to a subsistence consumption bundle.[29] An agent facing a subsistence crisis with a positive land position offers a parcel of land for sale. If an agent is still below subsistence after depleting all landholdings the agent experiences a subsistence crisis.[30] An agent sufficiently above subsistence (one half standard deviation) purchases parcels offered for sale. Population growth occurs continuously. Agents produce heirs as a function of their landholdings, with largeholders producing more heirs than smallholders.[31] Agents with more than one heir have their holdings divided equally

[21] Agents buy and sell in $\frac{1}{4}$ acre fragments. In each period the price of land (p_l) is starts at a 10 year purchase price (9.16 units of output per $\frac{1}{4}$ acre) and declines until the market clears**.** Peasants typically bought and sold very small parcels of land. While smaller parcels are observed in the literature, $\frac{1}{4}$ acre is a defensible average (see Bekar and Reed, 2003; Harvey, 1984; Smith, 1984).

[22] This rule is consistent with the view that peasants appreciated the intertemporal nature of the risk environment (selling land today increases subsistence risk tomorrow) as reflected in the tradition of "familial land." Razi (1981, p. 6) notes that "despite the legal situation which allowed landholders to alienate their farms, they had a strong moral obligation to their families which prevented them from doing so."

[23] Britnell (2004, p. 172), Dyer (1989, p. 117), Razi (1981), and Kitsikopoulos (2000) all find a significant increase in labor market activity when holdings fall below one-half the standard holding. Dyer (1989, p. 255) notes, "What happened to those without property or with smallholdings? They could make the maximum use of the labour market, by sending their children out to work at the earliest opportunity, and by working as late in life as possible. . . "

[24] Land is homogeneous in quality. Assarting occurs annually with two acres of arable land being added to the land supply (see Miller and Hatcher 1978, and Britnell, 2004).

[25] We use the production parameters from the literature on open fields (McCloskey 1975a, 1975b, 1976, and Bekar 2001) to parameterize our simulation, a mean standardized harvest produces 110 units of grain with a standard deviation of 48.4.

[26] In section 4.3 we test the sensitivity of our results to the assumption of idiosyncratic risk by modeling common shocks.

[27] Agents pool (ρ) 2.5% of their income, the costs of administering pooling arrangements (δ_p) absorbs 20% of the pool's value each period. Agents store (s) 2.5% of their harvest net of subsistence, facing a 20% rate of depreciation (δ_s) (see Kimball, 1988 and Bekar & Reed, 2003).

[28] When a peasant holding falls below 15 acres that peasant works as a wage laborer; when a peasant holding exceeds 35 acres that peasant hires wage laborers. Labor demand is assumed perfectly elastic at the given wage (ω).

[29] A subsistence harvest (z) is 55% of output on a standard virgate (Bekar, 2001; McCloskey 1975a).

[30] Note, a subsistence crisis does not mean "death" in our simulation. We define it in the spirit of McCloskey (1976) as a significant consumption event that produces increased hunger, disease, and stress on the household, an event that peasants had a strong incentive to avoid.

[31] On the differential production of heirs in 14^{th} century Halesowen Razi (1981, p. 143-44) finds that "The rich peasants, who had in this period large holdings of a virgate or more, had 33 percent more children per family than half yardlanders and 53 per cent more children than smallholders and cottagers...". Clark and Hamilton (2006) provide evidence on completed family size and levels of wealth. Smith (1984) provides actuarial estimates of the probability of producing more than a singe heir based on survivability (probability a child survives to the death of father) and number of children. See also Dyer (1989). Combining these estimates, and following Razi (1981, see table 30, p. 142) we assume: smallholder fertility is below replacement (mean sons = .7); middleholders only rarely produced two heirs

among all offspring, those producing no heirs have their holdings added to the land supply.

The peasant's consumption stream (c_t) therefore evolves as follows, [32]

$$c_t \leq H_t + \ell_t + w_t + k_t + \rho_t$$

with,

$$H_t = F(L_t) + \varepsilon_t$$

$$L_t = L_{t-1} + l_{t-1}$$

and,

$$\ell_t = [p_l l_t]\,(1 - \delta_l)$$

$$w_t = G(L_t)$$

$$k_t = H_t - z + (1 - \delta_s)k_{t-1} \qquad \text{if } H_t < z$$

$$k_t = s(H_t - z) + (1 - \delta_s)k_{t-1} \qquad \text{if } H_t \geq z$$

$$\rho_t = \frac{\sum_{n=1}^{N} p(H_t - z)}{N}(1 - \delta_p) \qquad \text{if } H_t < z$$

$$\rho_t = -p(H_t - z) \qquad \text{if } H_t \geq z$$

Where H is the peasant's current harvest income as a function of their landholdings L, z subsistence consumption, ℓ their income/spending from land sales/purchases ($l < 0$ if agent buys land, $l > 0$ if agent sells land), w their wage income, k their store of grain, ρ their contribution/transfer from pooling, and N the number of pooling agents (all in the appropriate period t).[33]

4.2 Benchmarking: simulating history

The simulation is seeded with a population of 50 agents distributed according to table 2 (25 largeholders, 20 middleholders, 5 smallholders) and iterated 180 years (the period between Domesday and the Hundred Rolls). For the first 60 years it is assumed that peasants only have access to traditional risk coping mechanisms (storage and pooling), for the last 120 years they gain access to land trades. The simulation is run 100 times. The mean estimates by landholding category are presented in table

(mean sons = 1); largeholders would produce two heirs with some regularity (mean sons = 1.5). Fertility parameters produce historically consistent population growth rates. Titow (1961) reports an annual growth rate of 0.85% from 1209-1311, simulated annual population growth rates are 0.78%. The simulation predicts a little more than a doubling of the population from Domesday to the Hundred Rolls, consistent with reported changes from Wrigley et al (1997).

[32] Campbell (2009) convincingly argues that early capital markets were important complements to developing land markets. Their absence in our model could introduce some predictable biases into our results. First, since agents are not able to borrow to finance land purchases our model biases land purchases towards largeholders and the lucky (i.e., those able to finance purchases out of current harvest income). Second, to the extent that distress loans were part of a peasant's risk-coping strategy our model will tend to over predict distress land sales.

[33] Parameters: p = rate of pooling out of current harvest, p_l = price of land, l_s= land sales/purchases, s = rate of storage, δ_s = cost of storage, δ_p = cost of pooling, and δ_l = cost using the land market.

4. Compared to the Hundred Rolls, our simulation predicts a smaller share of largeholders, a larger share of middleholders, and the identical share of smallholders/landless.[34]

Table 4: Simulating the Hundred Rolls, Aggregate Comparisons (smallholders include landless)

Source (Date)	Largeholders	Middleholders	Smallholders	Gini
Historical				
Domesday	50%	40%	10%	.135
Hundred Rolls	11%-14%	7%-9%	76%-82%	.638 - .645
Simulated				
Hundred Rolls	11%-15%	11%-18%	63%-79%	.635 - .693

Data from the Hundred Rolls allow us to disaggregate further. Table 5 reports the central estimate for each of Kanzaka's landholding categories, the standard deviation around that estimate, and the number of standard deviations separating the simulated results from historical estimates.

Table 5: Simulating the Hundred Rolls, Disaggregated Comparisons

Holding (in acres)	Historical (20%-40% Landless)	Simulation (μ, 100 runs)	Range (+/- 1 σ)
0-1	46% - 66%	62%	58%-66%
1-6	13% - 21%	2%	1%-3%
6-10	3% - 6%	5%	4%-6%
10-15	2% - 3%	6%	4%-8%
15-20	4% - 7%	5%	3%-7%
20-30	1% - 2%	7%	4%-10%
30-40	4% - 7%	5%	4%-6%
40+	5% - 8%	8%	7%-9%

While the landholding categories in table 4 (small-, middle-, and largeholders) are the most relevant categories for measuring inequality and poverty, the more granular data in table 5 provide additional precision to the benchmarking exercise. The simulation produces estimates with relatively small variances that for the most part fall within the historical range. However, the simulation vastly underestimates the percentage of households in the the 1-6 acre category (2% predicted, 13%-21% historically). The most likely reasons for this discrepancy are that the model lacks a capital market and assumes effort is exogenous (i.e., agents do not work harder as their land position dwindles). Both supplying additional labor effort and borrowing in the capital market were mechanisms that peasants relied on to forestall becoming landless, especially when their diminished landholdings made

[34] As a point of comparison, Otsuka et al (1992) report gini coefficients on land ownership from South America and Africa in the 1970s running from .420 (Bangladesh) to .910 (Columbia). The average gini coefficient from all twelve countries reported was .642. Sussman (2006, p. 20) reports urban income gini coefficients of .700 for London in 1292, .750 for Paris in 1292.

landlessness a strong possibility in the near future. Other discrepancies include overestimating the percentage of households in the 10-15 acre category (6% predicted, 2%-3% in reality) and the 20-30 acre category (7% predicted, 1%-2% in reality).

4.3 Robustness: simulating alternative rules and parameters

Data from Domesday constrains our initial seed, but is subject to potential errors and regional variation. We test the model's sensitivity to errors in the initial seed by considering three possible alternatives. Specifically, we simulate the Hundred Rolls with a more unequal seed with a rightward skew (more largeholders), a more unequal seed with a leftward skew (more smallholders), and a more equal seed with no skew. Table 6 reveals that the initial seed matters in determining the final distribution, but only on the margin. The simulation's simple behavioral rules produce a relatively stable dynamic. Initially land markets increase inequality, but at some point the simulation reaches an equilibrium in which largeholdings are accumulated by the lucky but eventually broken up via higher fertility. In other words, consistent with Dyer (1989, p. 124), we find that bad harvests tended to concentrate land ownership but that "large accumulations of land were constantly being broken up to add to the numbers of smallholdings," and over the longer run the land market "both prevented and caused the parcellization of holdings." This equilibrium is approached from a range of historically plausible seeds.

Perhaps the simulation's most important parameters concern the peasant's production and risk environment. One measure of peasant risk is their "distance from disaster:" how many standard deviations from a subsistence disaster/crisis was the average peasant in a normal year? The distance from disaster is determined by the variance of the harvest around its mean and the subsistence consumption bundle. Choosing a distance from disaster is equivalent to choosing a probability of disaster for agents possessing a standard holding (in the baseline simulation middleholders are 1.13 standard deviations from subsistence and will therefore experience a harvest crisis about once every 12 years, with consumption crises being rarer due to consumption smoothing). Combining what we know about the observed pattern of harvest failures and seed yields leaves a range of 1 to 2.5 standard deviations from subsistence.[35] A distance from disaster less than 1 predicts almost constant harvest failure, greater than 2.5 predicts a harvest far more stable than the historical record. The simulations

[35] On the historical distribution of harvest failures see Hoskins (1964), Jordan (1996), Schofield (1997), and McCloskey (1975, 1976). Bekar (2001) employs seed yield data and historical observations on harvest failures to calculate estimates for distance from disaster.

are robust across this range of risk. Only when harvest failure is almost completely absent for middleholders (i.e., distance from disaster > 4), and therefore land trades almost completely absent, does the simulation fail to produce a historically recognizable distribution.

Another important consideration is the type of risk faced by peasants. To this point we have modeled idiosyncratic risk exclusively. Much of the risk in agricultural settings results from aggregate shocks (i.e., bad weather, crop disease, etc.) and is thus shared by all agents. We test the sensitivity of our simulation to this assumption by adding aggregate shocks to the model. Hoskins (1964) estimates the distribution of common harvest shocks using 15^{th} century price data. He finds that 25% of harvests were deficient, 33.5% were average, and 41.5% were abundant (p. 30). While Hoskins analysis concerns a later period, the results are broadly consistent with the pattern of earlier harvest failures and there is little reason to suspect a systematic difference in aggregate shocks relative to our time period (further, to the extent that lower population densities or improved agricultural technologies made later harvests more stable we have already demonstrated that our results are relatively robust to increases in risk).

Table 6: Robustness of Simulation (assuming 20% to 40% landless)

Hundred Rolls	**Large** 11 - 14%	**Middle** 7 - 9%	**Small** 76 - 82%
Base simulation	**10%**	**11%**	**79%**
Alternative initial seeds			
Unequal seed, rightward skew (more rich)[a]	10%	15%	75%
Unequal seed, leftward skew (more poor)[b]	10%	11%	79%
Equal seed, no skew (equal poor and rich)[c]	8%	10%	82%
Alternative rule specifications and parameters			
Sim #1: Increase harvest risk[d]	15%	10%	75%
Sim #2: Decrease harvest risk[e]	11%	16%	73%
Sim #3: Aggregate shocks	13%	8%	79%

a. 60% largeholders, 30% middleholders, 10% smallholders. ***b.*** 30% largeholders, 30% middleholders, 60% smallholders. ***c.*** 20% largeholders, 40% middleholders, 20% smallholders. ***d.*** Distance from disaster = 2.5. ***e.*** Distance from disaster = 1.

In addition to these tests we have run a range of other robustness tests on the simulation's parameters (e.g., rate and cost of storage, rate and cost of pooling, wage rates, peasant land budgets, endogenous provision of effort etc.) and find that our relatively simple behavioral rules are robust to a wide range of parameters. In sum the simulation: (i) reproduces the historical distribution of landholdings relatively well (tables 4 & 5); (ii) is consistent with the pattern of aggregate pop-

ulation change; (iii) is robust to alternative starting values, behavioral rules, and common versus idiosyncratic shocks.

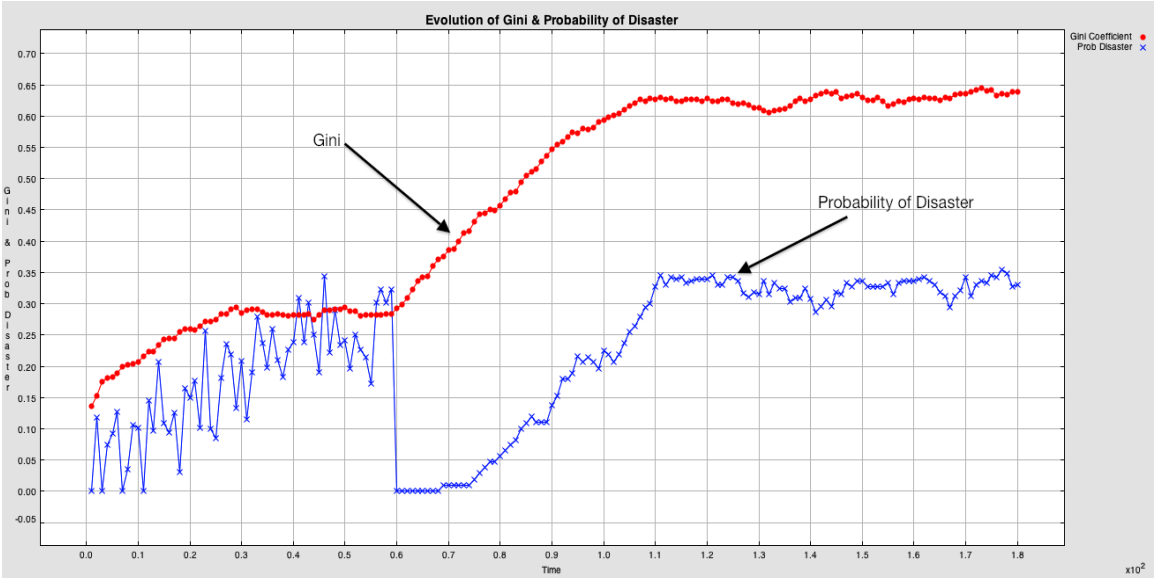
5 Simulation Results

We now employ our baseline simulation to analyze the introduction of land markets and their effect on the population, inequality, risk, and consumption.

5.1 Introduction of land markets: inequality and risk

Figure 1 shows the evolution of the gini coefficient and the probability of disaster over a typical run of the simulation.

Figure 1: Inequality and Risk, Land Market Introduced at t = 60

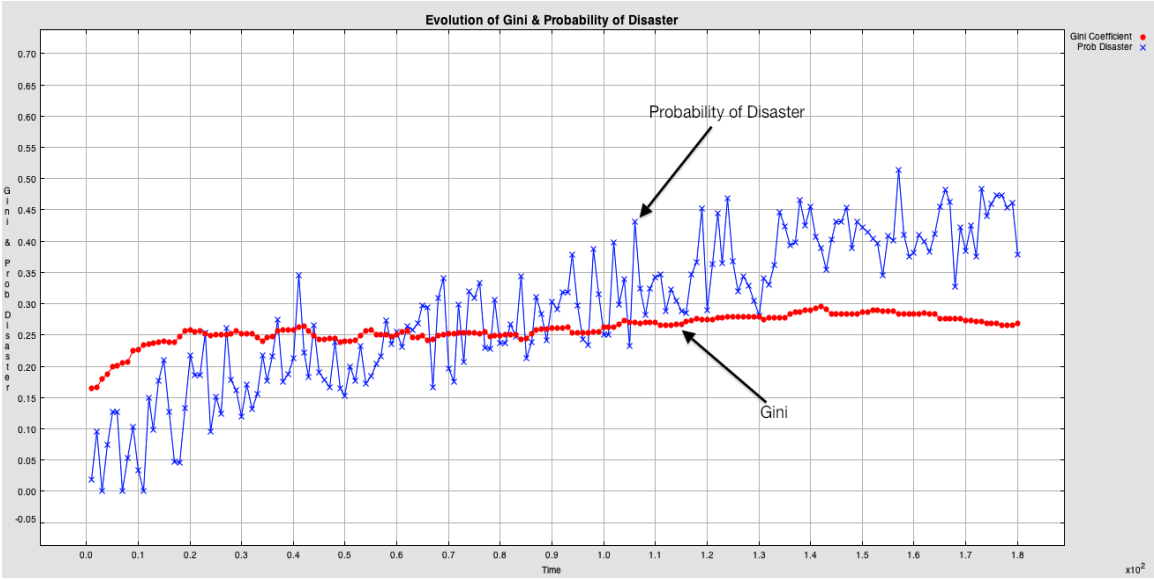


For the first 60 periods (years), in the absence of land trades, the distribution of land is mostly stable (the gini ticks up initially but is then constant). Consistent with the historical literature, however, population growth starts to overwhelm traditional risk coping strategies, driving up the frequency of subsistence crises. The introduction of land markets at year 60 eliminates subsistence risk for the village as a whole for roughly twenty years, it slowly returns to its previous level over the next 40 to 50 years. Given the dramatic reduction in subsistence risk, less than perfectly foresighted peasants would have faced a strong incentive to add land trades to their portfolio of risk coping

strategies in the shortrun. By 1250 or so, 60 years after the land market reforms, the vill has transitioned from an egalitarian high-risk equilibrium to an inegalitarian high-risk environment.

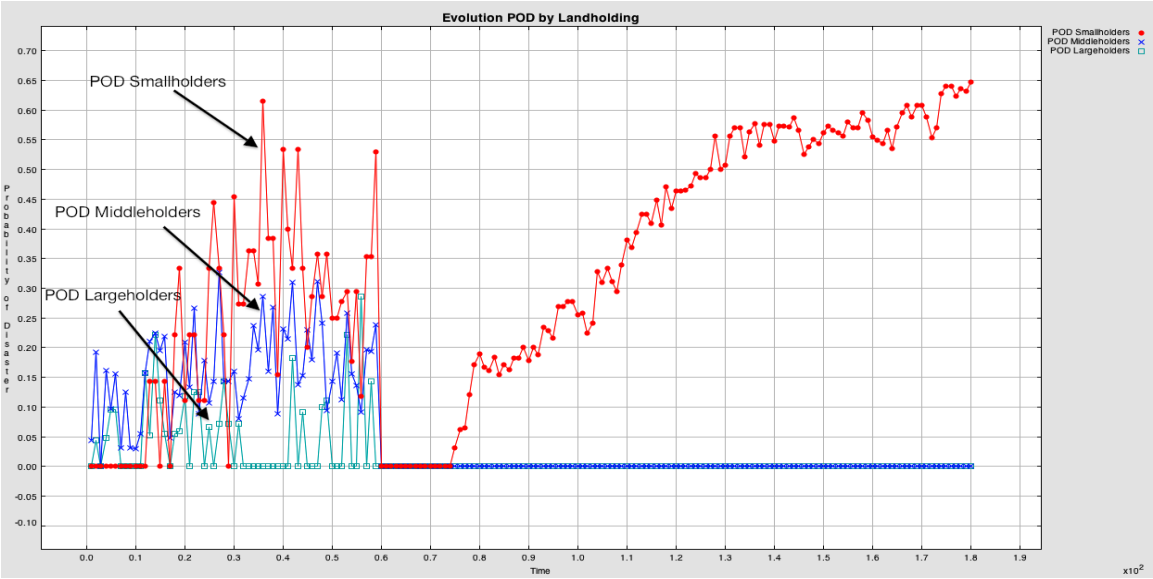
Consider a counterfactual history in which land market reforms are never enacted (see figure 2). In the absence of land trades the vill persists in an egalitarian but increasingly risky equilibrium.

Figure 2: Inequality and Risk, No Land Market



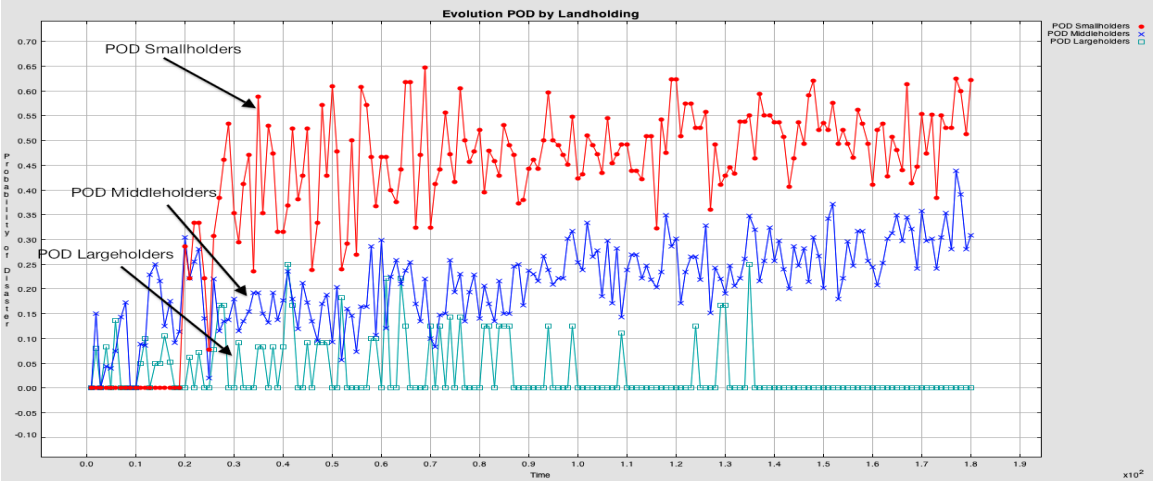
The introduction of land markets dramatically reduces the risk faced by the vill in the shortrun. However, the new equilibrium is not high-risk for everyone. Prior to the introduction of land trades smallholders face the most risk, largeholders the least, with middleholders somewhere in between (figure 3). The introduction of land trades permanently eliminates subsistence risk for largeholders and middleholders. In contrast, land trades dramatically increase subsistence risk for smallholders (who come to expect subsistence crises almost annually).

Figure 3: Probability of Disaster by Landholding, Land Market Introduced t = 60



In the absence of land trades all landholders continue to share subsistence risk (figure 4).

Figure 4: Probability of Disaster by Landholding, No Land Market

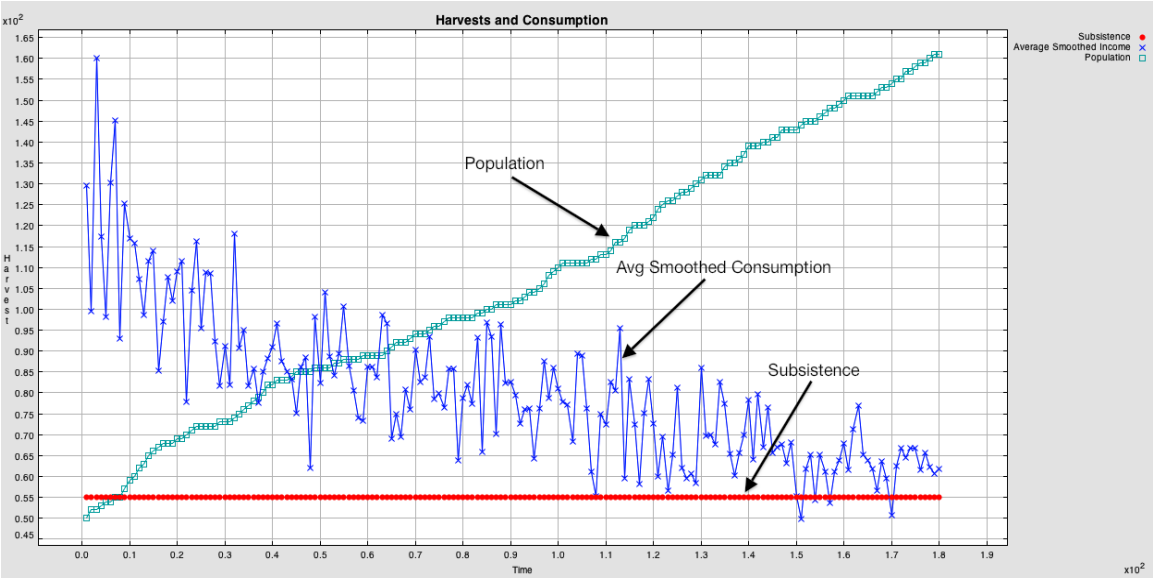


5.2 Introduction of land markets: population and consumption

Figure 5 plots population levels and the village's smoothed consumption (which is always less than the aggregate harvest since agents "lose" part of their harvest to pooling costs, storage, and depreciation on stores) in the absence of any land market. While consumption smoothing reduces the variance of consumption relative to that of the harvest, population growth eventually drives

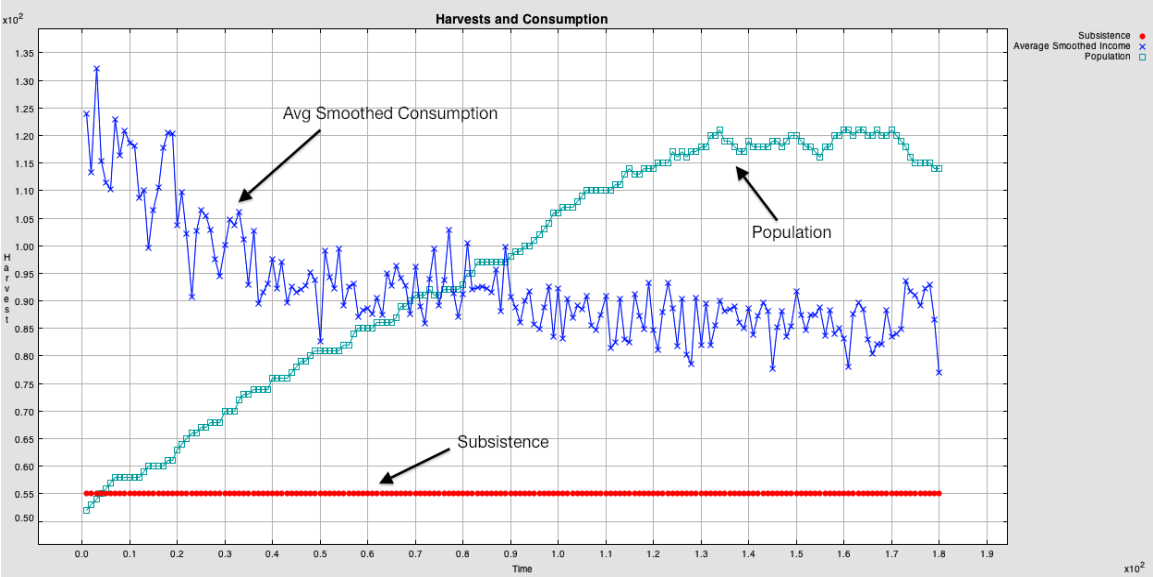
consumption towards subsistence.

Figure 5: Harvests and Consumption, No Land Market



The introduction of land trades stabilizes the consumption of the village (figure 6). It does this by shifting the distribution of consumption (from smallholders to middle- and largeholders), slowing the rate of population growth, and allowing largeholders to accumulate extensive stores.

Figure 6: Harvests and Consumption, Land Market Introduced t = 60



Our simulation demonstrates that the introduction of land markets produces a transition from

an egalitarian risky equilibrium to a inegalitarian risky equilibrium. As their share of the harvest dwindles smallholders eat less and worry more while largeholders eat better and worry less.

5.3 Simulating effects of land markets and demographics

A sequence of harvests determines a sequence of landholdings through two channels of effect:

1. **Land Market Effect**: Distress land trades tend to increase the size of largeholdings while breaking up small- and middleholdings.
2. **Demographic Effect**: The differential production of heirs by landholding tends to decrease the size of largeholdings and create more small- and middleholdings.

The land market and demographic effects interact. By facilitating the accumulation of larger holdings, land markets tend to increase population fertility, strengthening the demographic effect. Population growth, through partible inheritance, breaks up largeholdings,[36] producing more small and middleholdings, exposing them to increased distress sales.[37]

We estimate the discrete impact of the land market and demographic effects by "shutting off" one off the relevant effects, seeding the simulation with the Domesday distribution, and iterating for 180 years. We hold all parameters and rule specifications (from section 4) constant in each case. Table 7 presents the results for both channels of effect.

Table 7: Channels of Effect (assumes range of 20% to 40% landless)

Hundred Rolls Target	**Large**	**Middle**	**Small**	**Gini**
	9 - 18%	6 - 12%	70 - 85%	.638-.645
Base Sim	10%	11%	79%	.625
Demographic Effect (no land market)	2%	16%	82%	.232
Land Market Effect (no pop. growth)	68%	22%	10%	.161

In the absence of land trades population growth and partible inheritance produces a 71% increase in inequality from Domesday to the Hundred Rolls (the Gini increases from .135 to .232), 20% of the observed increase. The resulting distribution of landholdings is tightly clustered around a middleholding (71% of peasants hold from 0 to 10 acres, 29% hold 11 to 20 acres). All peasants

[36] From Razi (1981, p. 9) "[Halesowen] court records show clearly that kulaks usually accumulated land from their unfortunate neighbours. Yet...the size of their holdings remained remarkably stable. This happened because the rich villagers who had usually more than one adult child to provide for used the additional land they had acquired to endow their non-inheriting siblings."

[37] In the context of land hunger a "brisk land market reinforced rather than reversed" a process of downward mobility as the wealthy colonized "lands held by the poorer and weaker members of the community whose unfavorable economic conditions pushed either up to heaven or out from their holdings..." Razi (1981, p. 97).

hold at least 1/4 virgate and would participate in the labor market only on a part time basis, while one-third of peasants would not participate in the labor market at all.

With no population growth, land trades alone produce a 19% increase in inequality (the Gini increases from .135 to .161), 5% of the observed increase. The resulting distribution of landholdings is skewed dramatically towards large holdings (80% of all peasants hold more than 20 acres, 66% hold more than a virgate, 40% more than 40 acres). Only 12% of peasants would be forced into the labor market, of those half would be part time.

The pattern of inequality produced by each effect is consistent with the historical distribution of customary and freehold land. The simulated land market effect produces inequality through the accumulation of very large holdings, producing a right skewed distribution of landholdings. A common finding in empirical studies of 13th century landholdings is that the the distribution of freeholdings (more exposed to the land market effect) are right skewed relative to the distribution of customary holdings. For example, in 1289 in Redgrave Smith (1984b, p. 143) finds that free tenants were five times as likely to possess a largeholding as customary tenants.[38]

The simulated demographic effect produces inequality by breaking up standard holdings and creating a large group of homogenous smallholders. In his analysis of customary holdings (less exposed to market dynamics) Campbell (1984, pp. 103-106) finds that population growth in the late 13th century created a proliferation of smallholdings and pushed tenants "into a single class of impoverished smallholders." In our simulation we find that roughly 35% of landholders would hold less than 2 acres; in late 13th Coltishall 67% of landholders held less than 2 acres (Campbell, 1984, p. 105), in Redgrave 43% (Smith, 1984b, p. 143). Consistent with our simulations, both studies find that less than 2% of landholders held more than a virgate.

We conclude that:

1. Land markets alone explain roughly 20% of the observed increase in inequality.
2. Population growth alone explains roughly 5% of the observed increase in inequality.
3. Neither the demographic or land market effect alone can explain the large rise in observed poverty (demographic effect explains 0% of landlessness, the land market effect roughly 10%), labor market participation, or the shape of the distribution of landholdings.
4. In the context of our simulations, it is only possible to explain the nature and extent of the observed increase in inequality, polarization and poverty by modeling the interaction of land

[38]For more evidence of rightward skew in freeholdings see Campbell (1984), and Kanzaka (2002).

trades and the differential production of heirs which explains roughly 75% of the observed increase in inequality as well as the extent of rural poverty.

6 Concluding Remarks

Farming communities in England experienced a dramatic increase in the inequality of peasant landholdings between the 11^{th} and 13^{th} centuries. Our explanation focuses on the role of risk reduction through land transactions and the differential production of heirs. Institutional innovations in the 12th century lowered the cost of operating in the land market, motivating free peasants to include land purchases and sales in their portfolio of risk coping strategies. At the same time large holdings were broken up due to the combination of partible inheritance and the relatively large families of wealthy peasant households. As a result, many households found themselves working holdings that were increasingly vulnerable to harvest risk, further shrinking their holdings through time. This dynamic created a sequence of increasingly unequal landholdings, landlessness, and poverty over time. The distribution of land for unfree peasants, whose access to the land market was far more restricted, remained relatively unchanged.

Our analysis contributes to the literature exploring polarization and poverty in pre-plague peasant communities by providing quantitative estimates for the size of the land market and demographic effects. Aspects of our results may also contribute to a deeper understanding of increasing inequality when agents use asset trading to mitigate consumption risk.[39] Economists have long argued that a prerequisite of modern economic growth is the development of more efficient markets and institutions.[40] In the shortrun we find that land markets increased the vill's aggregate consumption and reduced its aggregate consumption risk. They did so, of course, by shifting who bore the risk (to smallholders) and who claimed the harvest (to middle- and largeholders). So while improved land markets may have brought dynamic efficiency gains, they certainly created a dynamic that was unambiguously welfare decreasing for a large portion of the medieval peasantry.

Contemplating the introduction of land markets Schofield (2003, p. 76) concludes that "it is easy to imagine the splintering of communities, divided along lines of vested interest, with the wealthy promoting an active market through their various machinations including economic and

[39] Fafchamps (2005, pp. 101-2) notes that, "From an equity point of view, there might therefore be a rationale for shutting down certain asset markets, i.e., those for which supply is finite. This is because allowing accumulation is likely to result in polarization. This conclusion applies primarily to land, manpower, mineral resources, and the environment."

[40] See for example Campbell (2009), Greif (2006), and North and Thomas (1973).

political pressure exerted upon lord and village community alike, while the poor offered resistance in whatever form that presented itself." These complex distributional issues are central to the literature on the weakening of traditional manorial norms and customs. For example, Dyer (2002, p. 183) notes that "In many ways the rise in population and commercial activity threatened to weaken the community. Many of the changes of the period, such as the growth of the land market, encouraged selfishness among a minority, who took advantage of their poorer neighbors." It is possible that in vills where wealthy peasants maintained a commitment to their less prosperous neighbors, the distributional cost of land markets might have been somewhat mitigated, "rather different views of the efficacy of a free market in land are likely to have arisen, a unanimity of purpose within the village community could only be maintained if the wealthier members of the community were prepared to be constrained by their perceived social obligations to the poorer members" (Schofield, 2003, pp. 75-76).

While our simulation strategy abstracts from some of these issues, and is applied specifically to central England in the Middle Ages, the dynamics we identify speak to the aggregate increases in inequality in the distribution of land and increased poverty that historians see occurring throughout most of England in the later 13th and early 14th centuries.

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