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Land Markets and Inequality: Evidence from Medieval England*

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Abstract

The 13th century witnessed a substantial increase in inequality in the distribution of peasant landholdings relative to the distribution of the late 11th century. Innovations in property rights over land in 12th century England induced peasants to include the trading of small parcels of land as part of their risk coping strategy. We argue that these events are related. Recent theoretical 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 13th century landholdings. We find that the dominant factor contributing to the unequal distribution of land was the interaction between emerging land markets and population growth driven by high fertility rates in households with large landholdings.

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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1 Introduction

During the 12th and 13th centuries the English peasantry experienced large increases in inequality and poverty. 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." 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, "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 the primary variables responsible for the substantial increase in inequality in landholdings in 13th century England were population growth and land market transactions. We are not the first to stress this connection, demographic change and the expansion of the land market are traditional explanatory variables for increases in inequality in this period.[1] We differ from the tradition in several important ways. First, we find that the independent contributions of population growth and land markets to inequality were modest. The most significant contributor to inequality was the interaction between these variables. Second, we incorporate new research that finds that population growth was primarily driven by the large household sizes of peasants with large holdings. Smallholders had so few surviving heirs that their households often could not replace themselves.[2] Third, the land market effect on inequality and poverty was the result of free peasants incorporating land sales into their risk coping strategy. Putting this together yields the following dynamic: (i) population growth coupled with egalitarian bequest motives broke up large holdings into middle and small sized holdings; (ii) late 12th century land market reforms specific to freehold land (Campbell, 2009) motivated middleholders and smallholders to sell land in response to frequent crisis-level harvest realizations. These distress land sales resulted in middleholders becoming smallholders, and smallholders becoming landless.

Recent work in development economics has explored the relationship between inequality and

[1] For example, see Hilton (1978), Dyer (1989, 2002), Britnell (2004).
[2] Clark and Hamilton (2006), Clark (2007), Razi (1980).

asset markets,[3] including the role played by incomplete markets,[4] subsistence constraints,[5] and the interaction of market and non-market activities.[6] 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 the Domesday survey (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. Counterfactual runs of the benchmarked simulation indicate 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 describe our simulation strategy, and in section 5 we detail our simulation results. Section 6 summarizes our findings and suggests potential extensions.

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).

[3]Fafchamps (2005), Dercon (2005), Mookherjee and Ray (2001).
[4]Heaton and Lucas (1996), Fafchamps (1999).
[5]Carter and Zimmerman (2003), Baland et al (2007).
[6]Croix and Doepke (2003), Piketty (1997).

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 subsistence income 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 (1980, 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 11^{th} century and the end of the 13^{th}. Three sets of observations document the changing distribution of English land holdings over this period: (i) the Domesday survey of 1086;[7] (ii) Postan's (1966) sample of 104 manors drawn from the late 12^{th} and 13^{th} centuries; (iii) the Hundred Rolls of 1279-80.[8]

[7]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 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).

[8]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).

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 (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 & Hatcher, 1978, p. 22). We then allocate land among villani using estimates from Middlesex Domesday (Miller & Hatcher, p. 24): one-third held between one and two virgates, two-thirds held between one-half and one virgate.

Table 1 compares the distribution of customary holdings at the time of Domesday with the distribution at the time of Hundred Rolls, revealing only a slight increase in inequality.

Table 1: Distribution of land, unfree tenants

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

Since 12^{th} century land market reforms were not extended to land held by peasants of unfree status, potential transactions in customary land continued to be confounded with rights over personal obligations. Selling land in response to poor harvests remained a difficult option for unfree peasants. Thus the fact that the distribution of customary landholdings changed very little between the 11^{th} and 13^{th} centuries offers some support to our 'risk coping through land sales' hypothesis as applied to freeholders. In our view, however, the difference in 13^{th} century inequality outcomes for freehold land compared to customary land was only partially due to the change in the legal environment that made property rights in freehold land more easily transferable through land markets. Additional factors included insurance against poor harvests that was often part of the manorial lord/customary tenant relationship, and the fact that manorial lords had more direct control over the allocation of customary land.

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 manorial surveys from the 11^{th} 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 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).[9]

Table 2: Distribution of land, free tenants

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

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 & Hatcher, 1978, pp. 24-5). Estimating the number of landless in 1279-80 with precision is not possible since the Hundred Rolls only reports peasants with positive landholdings. It is well accepted, however, that the number of landless households increased dramatically by the time of the Hundred Rolls, "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" (Miller & Hatcher, 1978, p. 55) 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) finds that in a roughly 50 year period (Halesowen

[9] At the time of Domesday freeholders (liberi homines and sokemen) constituted roughly 14% of rural landholders and held about 20% of the land (Miller & 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).

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. 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.[10] 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.[11]

Another set of factors tended to produce more unequal landholdings. Population growth (coupled with partiple inheritance) and the peasant land market are the dominat variables stressed in the literature.[12] 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 smallholdings was lowest in traditional manorial areas characterized by strong lordship (Dyer, 1989, pp. 119-20).

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

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

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

The large variation in inequality in landholdings across geographical regions has prompted some historians to question the applicability of simple explanations.[13] A prime example of a simple causal hypothesis, often implicit in the historical literature, is that population growth/partible inheritance and land markets contributed independently to inequality. For theoretical as well an empirical reasons, such a hypothesis is difficult to support.

While population growth could reasonably be expected to reduce the average size of landholdings (all else equal and assuming constraints on bringing new land under cultivation), it is unclear why it should increase inequality. Also, since every surviving heir inherits land, partible inheritance cannot easily explain an increase in landlessness. Additionally, population growth resulted from wealthy families having large numbers of surviving children. 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.[14] It seems that preferences for egalitarian bequests were not overly constrained by formal inheritance rules.[15]

3.1 The impact of land markets on inequality

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.[16] Households with surplus family labor (early in their lifecycle) were natural buyers of

[13]From Biddick (1990, p. 629), "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 the conclusion we offer some suggestions, based on our analysis, for thinking about possible explanations for the widely different inequality outcomes that characterize some areas of England in the 13th century.

[14]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).

[15]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."

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

land, households with deficient family labor (late in their lifecycle) natural sellers. More recent scholarship has found a complex mix of land trades motivated by traditional lifecycle concerns,[17] bequest motives,[18] investment possibilities,[19] and risk coping strategies.[20]

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.[21] Throughout the early 12th century traditional risk coping mechanisms came under stress from population growth and commercial development. These were at least partially 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 stressed by changing economic conditions and evolving social norms. It was in this context that the reforms of Henry II (1160 to 1170) separated title for freehold land from personal obligations.[22] 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 13th 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 (1980) and Duby (1968, pp. 254-57). Bekar and Reed (2003) demonstrate that

[17] Faith (1984).

[18] Razi (1981), Williamson (1984), Campbell (1984), and Smith (1984b).

[19] Blanchard (1984) analyzes the land investment strategies of early "industrials." On the economic, social, and political returns to investing in land see Schofield (2003).

[20] Bekar (2001), Bekar and Reed (2003), Campbell (1984, 2009), Razi (1980), Schofield (1997), Smith (1984a).

[21] 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 applications to medieval landholding and consumption smoothing see Kimball (1988), and Reed and Bekar (2003).

[22] 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."

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 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, pp. 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 (1980, 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 better understand these complex dynamics we adopt a simulation strategy.

4 Simulation Strategy

We simulate counterfactual distributions of landholdings in order to rank the relative importance of the demographic effect, the land market effect, and their interaction. Our model abstracts from many additional historical factors that may have played a role in determining inequality and poverty: capital markets, strength of manorial tradition, strength of lordship, proximity to market centers, and the intensity of sheep husbandry. To establish the applicability of our model we: (i) constrain the parameter values and behavioral assumptions with accepted historical data and analysis, (ii) require that the parameter values and behavioral assumptions reproduce critical aspects of the distribution of freehold land in the Hundred Rolls conditional on starting with the historical Domesday seed, (iii) test the sensitivity of our simulation to possible errors in specification and parameterization.

4.1 The simulation[23]

A 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 in a forward looking manner. The limitation of this approach is that while relevant production parameters can be estimated, data is lacking for key behavioral and market parameters (e.g., rate of time preference, the elasticities of demand and supply in the land and labor markets, etc.). Further, a large literature considers 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.

Decisions regarding pooling, saving, labor supply, and land transactions are rule based: (i) peasants sell parcels of land[24] only when facing a subsistence crisis and all other methods of risk coping have been exhausted,[25] (ii) agents bequest all surviving heirs an equal portion of the family

[23]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 http://college.lclark.edu/faculty/members/clifford_bekar/research.php.

[24]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).

[25]This rule is consistent with the view that peasants appreciated the intertemporal nature of the risk environment

holding, (iii) agents participate in the labor market only when their own holding no longer fully absorbs their own labor supply.[26]

Agents are initially endowed with an exogenous landholding. Assarting occurs annually.[27] Each period each agent randomly draws a harvest realization from a normal distribution transformed by the requisite mean and variance.[28] Harvests are independent across agents and through time.[29] Agents pool[30] and save out of current harvests.[31] Smallholders work in the labor market and largeholders hire labor.[32] Incomes are compared to a subsistence consumption bundle.[33] 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.[34] An agent sufficiently above subsistence (one half standard deviation) purchases parcels offered for sale. Population growth occurs annually. Agents produce heirs as a function of their landholdings, with largeholders producing more heirs than smallholders.[35] Agents with more than one heir have

(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."

[26]Britnell (2004, p. 172), Dyer (1989, p. 117), Razi (1980), 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. . . "

[27]Two acres of homogenous land are added each period to the vill's initial 1225 acres. The vill's arable therefore grows by 360 acres over the 180 periods of the simulation, a 30% increase in arable land. Campbell (2000) estimates the English arable increased by 31% over the period. As Britnell (2004) and Miller and Hatcher (1978) point out, the variance around any estimtate of assarting must be significant since it displayed much regional and legal heterogeniety. Established vills in the core grew little, newer vills extensively. Assarts were established as commons, as desmene, and as freehold, often they contained land with multiple types of title. The simulated distribution of landholdings is robust to a range of assarting rules.

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

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

[30]Agents contribute (ρ) 2.5% of their income, net of subsistence, to a income sharing pool. The administration of pooling arrangements (δ_p) absorbs 20% of the pool's value each period. Assets in the income sharing pool are distributed exclusively to agents experiencing consumption below subsistence.

[31]Agents store (s) 2.5% of their harvest net of subsistence, facing a 20% rate of depreciation (δ_s) (see Kimball, 1988, Bekar & Reed, 2003).

[32]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).

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

[34]We define the Probability of Disaster (POD) as the annual probability an agent experiences a subsistence crisis. A subsistence crisis does not mean "death," but a significant consumption event that produces increased hunger, disease, and stress on the household. The rules describing peasant behavior are consistent with a safety first logic (i.e., they do not trade off mean consumption against changes in its variance but instead seek to minimize their POD). This definition of disaster and that peasants might act to minimize their POD was first formalized by McCloskey (1976).

[35]On the differential production of heirs in 14$^{\text{th}}$ century Halesowen Razi (1980, pp. 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 (1980, see table 30, p. 142) we assume: smallholder fertility is below replacement (mean heirs = .7); middleholders only rarely produced two heirs

their holdings divided equally 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, [36]

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

with,

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

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

$$k_t, l_t \geq 0$$

and,

$$\ell_t = p_l l_t (1 - \delta_l)$$

$$w_t = G(L_t)$$

$$k_t = \begin{cases} H_t - z + (1-\delta_s)k_{t-1} & if\ H < z\ and\ k_t > 0 \\ s(H_t - z) + (1-\delta_s)k_{t-1} & if\ H_t \geq z \\ 0 & otherwise \end{cases}$$

$$\rho_t = \begin{cases} (H_t - z) & if\ H_t < z\ and\ \rho_t > 0 \\ p(H_t - z)(1-\delta_p) & if\ H_t \geq z \\ 0 & otherwise \end{cases}$$

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 to the pool[37] (all in the appropriate period t).[38]

(mean heirs = 1); largeholders would produce two heirs with some regularity (mean heirs = 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).

[36] Campbell (2009) argues that early capital markets were important complements to developing land markets. Their absence in our model may introduce 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.

[37] With N agents in the vill, the total value of the pool is $\sum_{n=1}^{N} p(H_n - z)\ \forall\ H_n > z$.

[38] 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.

4.2 Benchmarking: simulating history

The simulation is seeded with a population of 50 agents distributed according to table 2 (25 largeholders, 20 middleholders, 5 smallholders). The fertility behavior of agents is constrained to reproduce known population growth (see footnote 34). The simulation is run from Domesday to the Hundred Rolls (180 iterations). For the first 60 years it is assumed that peasants have accessonly only to traditional risk coping mechanisms (i.e., storage, pooling, and diversification), 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 4. Compared to the Hundred Rolls, our simulation predicts a similar share of largeholders, a larger share of middleholders, a slightly smaller share of smallholders/landless, and similar Gini coefficients.

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

Source	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 plus or minus one standard deviation.

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 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. Discrepancies between our simu-

lated estimates and the historical record include overestimating the number of households holding 10-15 acres and 20-30 acres. More serious perhaps is the simulation's underestimate of households holding 1-6 acres. Most likely this discrepancy results from the absence of possible peasant smoothing strategies (intensification of family labor, expansion of garden plots, gleaning rights, etc.), the absence of capital markets (agents are not able to borrow against their land), and the lack of endogenous effort levels (agents are unable to work harder as their land position dwindles). Both borrowing in the capital market and supplying additional labor effort were mechanisms that peasants could be expected to use in order to forestall becoming landless, especially as landlessness became a strong possibility. Data constraints preclude adding these elements to the simulation.

4.3 Robustness: simulating alternative rules and parameters

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 outcome is approached from a range of historically plausible seeds.

The simulation's most important parameters concern production and risk. Recall that our model's measure of risk is the annual probability of a subsistence disaster (POD). The probability that a peasant experiences a disaster level harvest is determined by the number of standard deviations between the mean harvest and subsistence consumption. The probability that a bad harvest in turn causes a consumption crisis is determined by the efficacy of peasant risk coping strategies. When mean harvests are less than 1 standard deviation from subsistence peasants experience almost constant harvest failure; when mean harvests are more than 2.5 standard deviations from subsistence harvests are far more stable than the historical record.[39] The simulations are robust

[39]The parameters in the baseline simulation (middleholders are 1.13 standard deviations from subsistence and

Table 6: Robustness Tests

Hundred Rolls Target	**Large** 11 - 14%	**Middle** 7 - 9%	**Small** 76 - 82%
Base simulation	**10%**	**11%**	**79%**
Production Parameters: 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%
Production Parameters: Risk			
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.

across this range (see Sim #1 and #2 in table 6).[40] 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. Our results are not sensitive to the addition of aggregate shocks[41] (see Sim #3 in table 6).

In sum, the simulation is only marginally sensitive to changes in key parameters and specifications. In all cases, the implications for inequality and poverty are unchanged.

5 Simulation Results

5.1 Simulating land markets: causes of inequality

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

experience a harvest crisis roughly every 12 years) are estimated from the literature on harvest failures and seed yields. 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.

[40]Only when harvest failures, and therefore distress land sales, are almost completely absent for middleholders–i.e. when harvest failures are more than 50 years apart–does the simulation produce distributions of land ownership substaintially different from that in Table 4.

[41]Hoskins (1964) estimates of 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. 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.

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,[42] producing more small and middleholdings, exposing them to the threat of increased distress sales.[43] Historically this dynamic produced a highly unequal population (i.e., a Gini coefficient between .638 and .645)[44] dominated by smallholdings.

We estimate the discrete impacts of the land market and demographic effects by "shutting off" one of the relevant effects, seeding the simulation with the Domesday distribution, and iterating for 180 years. We hold all parameters and rule specifications (from section 4.1) constant in each case. Table 7 presents the results for both channels of effect.

Table 7: Channels of Effect

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 - 10 acres, 29% hold 11 - 20 acres). All peasants hold at least 1/4 virgate and only participate in the labor market on a part time basis; 1/3 of peasants hold at least 1/3 of a virgate and do not participate in the labor market at all.

[42] 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."

[43] 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 them either up to heaven or out from their holdings..." (Razi, 1980, p. 97).

[44] 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.

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.

We conclude that neither the demographic nor 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. 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 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.

5.1.1 Inequality and risk

Figure 1 plots the evolution of the vill's Gini coefficient and POD[45] over a typical run of the simulation assuming no land market reforms. In the absence of land trades the vill remains relatively egalitarian over time (relatively constant Gini coefficients) within an increasingly risky environment (higher PODs).

[45]For any given year, the vill's POD is equal to the number of peasants experiencing a subsistence crisis in that year divided by the vill's population.

Figure 1: Inequality and Risk, No Land Market

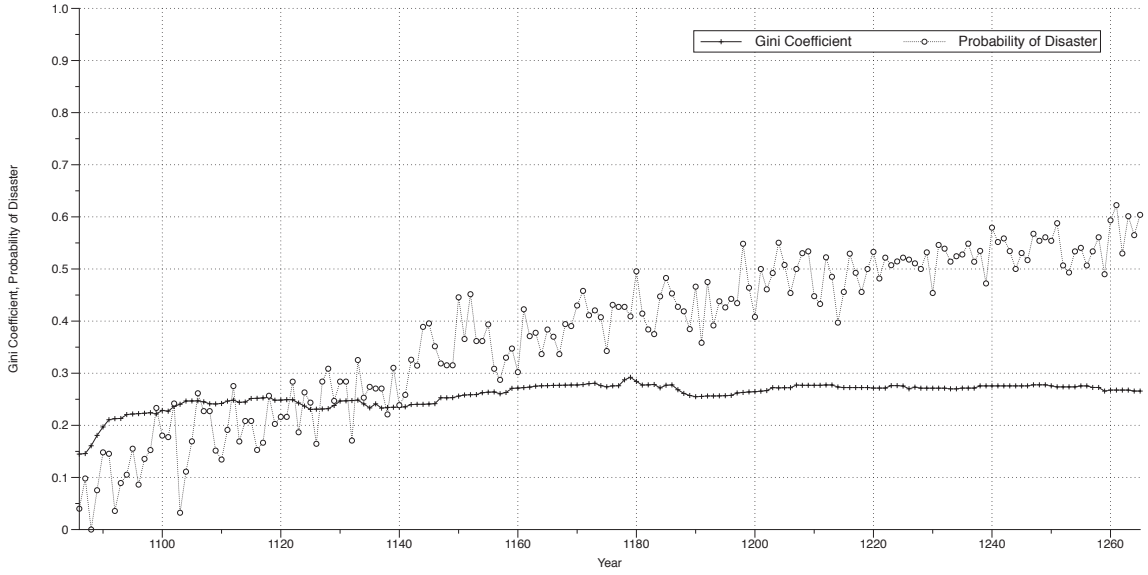
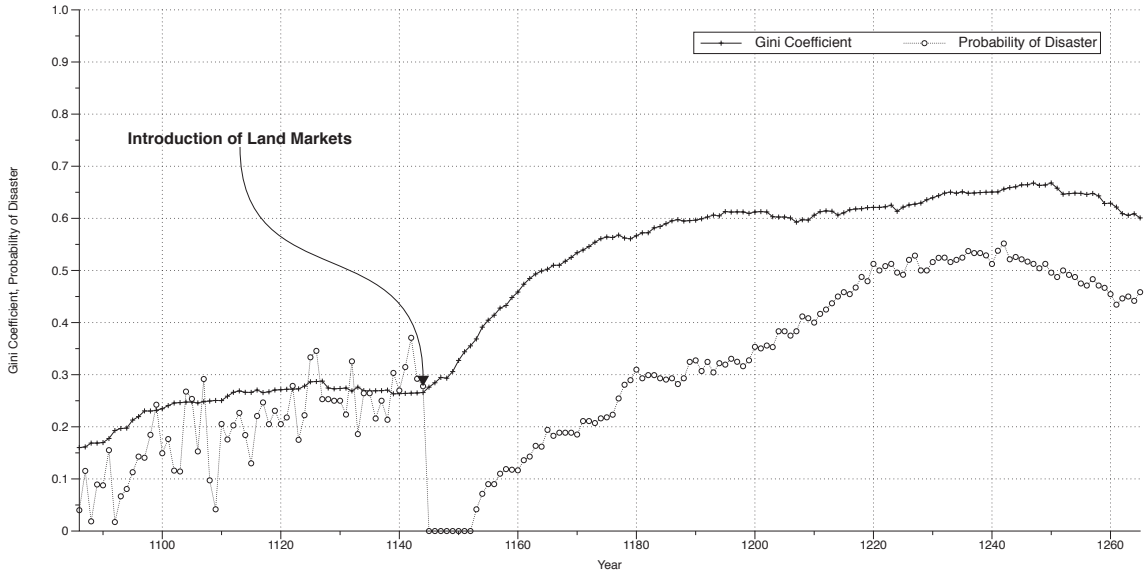


Figure 2 plots the evolution of the vill's Gini coefficient and POD over a typical run of the simulation assuming land market reforms are enacted in year 60. The introduction of land markets eliminates subsistence risk for the vill for 10 to 20 years. As smallholders and some middleholders are pushed to liquidate their landholdings over the next 40 to 50 years, subsistence risk in the vill rises again until almost doubling (from a POD of around .25 to around .50). Peasants faced a clear incentive in the shortrun to add land trades to their portfolio of risk coping strategies. However, while inequality is mostly stable in the first 60 years in the absence of land trades, it more than doubles with the introduction of land markets.

Figure 2: Inequality and Risk, Land Market Introduced in 1146 (t = 60)



The introduction of markets in land therefore transitions the vill from a relatively egalitarian risky equilibrium to an inegalitarian higher-risk environment. While land markets reduce the risk faced by the vill by close to 20% (POD of around .60 without land markets compared to a POD less than .50 with land markets), it does so by dramatically shifting who was exposed to consumption risk.

5.1.2 The distribution of risk

Dissagregagting our estimates of POD by land landholding category reveals that the introduction of land markets shifts consumption risk away from middle- and largeholders onto smallholders. Figure 3 plots the evolution of POD by landholding category (with a quadratic best fit line) assuming no land market reforms. In the absence of land trades risk is shared, to varying degrees, by all landholders.

Figure 3: POD by Landholding, No Land Market

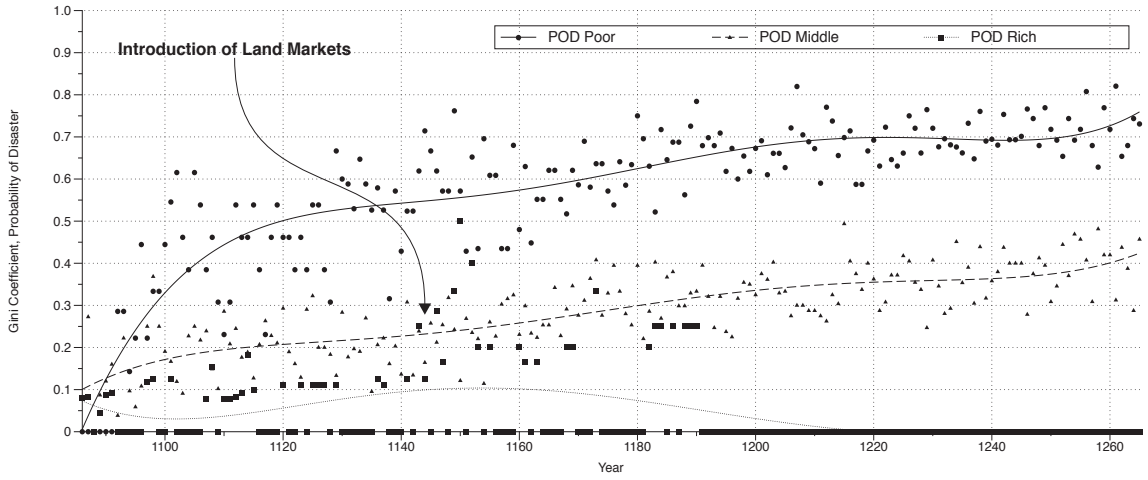
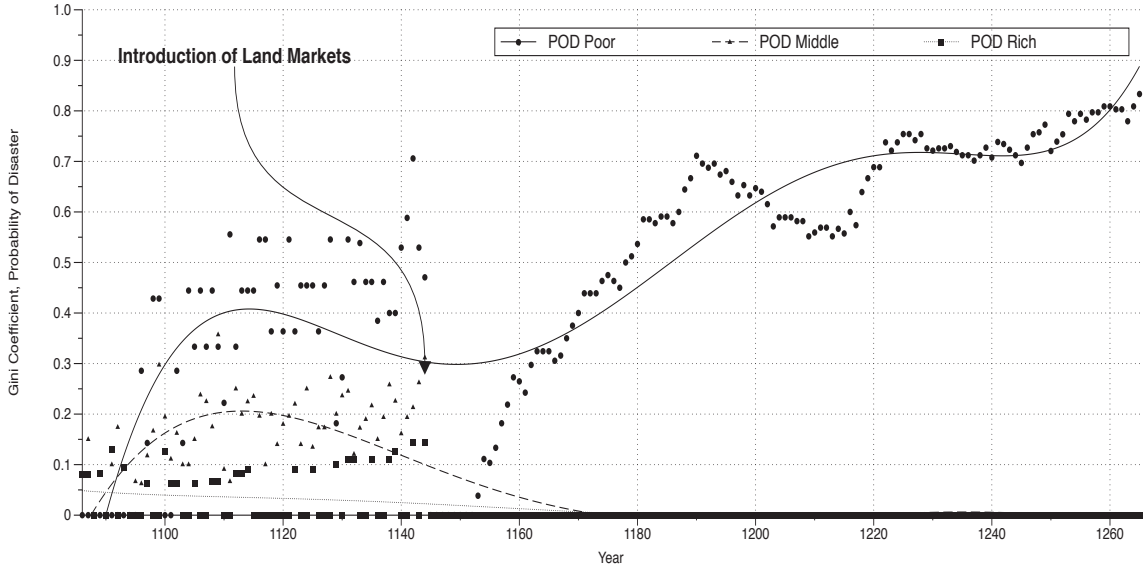


Figure 4 plots the evolution of POD by landholding category (with a quadratic best fit line) assuming land market reforms in year 60. The introduction of land trades permanently eliminates subsistence risk for largeholders and middleholders and dramatically increases the subsistence risk of smallholders. By the time of Domesday smallholders come to expect a consumption crisis almost annually (their POD approaches unity by 1260).

Figure 4: POD by Landholding, Land Market Introduced 1146 (t = 60)



6 Concluding Remarks

Rural communities in England experienced a dramatic increase in the inequality of peasant landholdings between the 11^{th} and 13^{th} centuries. Our empirical focus is on the areas of central England for which data are available from the Domesday survey of 1086 and the Hundred Rolls survey of 1279. Our explanation focuses on the role of risk coping through land transactions and the differential production of heirs. Institutional innovations in the 12^{th} 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 egalitarian bequest motivatives and the large family sizes characteristic of wealthy peasant households. As a result, more households were forced to work smaller holdings that were then vulnerable to risk induced land sales and thereby reduced further in size. This dynamic created a sequence of increasingly unequal landholdings and poverty over time.

While our data are drawn from the heavily manorialized regions of central England, our analysis suggests an approach to understanding the observed differences in distributions of land ownership across England as a whole towards end of the 13^{th} century. The core of our story is that harvest shocks motivated many freehold peasants to sell land in order to avoid subsistence crises, ultimately resulting in large numbers of smallholders and landless peasants. We would expect less severe increases in inequality in: (i) areas in which harvest shocks were smaller and less frequent (whether due to less climate variability, capital improvements, and/or better farming technologies); (ii) areas with more extensive pooling arrangements (while difficult to detect in the historical record, variables that would correlate with effective pooling arrangements include stable populations, homogeneous populations, lower levels of urbanization, and idiosyncratic harvest shocks); (iii) areas with a high ratio of customary land to freehold land.

Economic historians have long argued that a prerequisite of modern economic growth is the development of more efficient institutions.[46] In the short run we find that improved land markets increased the vill's aggregate consumption and reduced its aggregate consumption risk. They did so 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 also created a dynamic that was unambiguously welfare decreasing for a large portion of the medieval

[46] See for example Campbell (2009), Greif (2006), and North and Thomas (1973). For an overview of the broader literature on institutions and growth see Acemoglu et al (2005).

peasantry. Our findings are also suggestive of the role that emerging asset markets might play in terms of inequality, polarization, and poverty in developing economies. Our results are consistent with Fafchamps' (2005, pp. 101-2) argument 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." In general, aspects of our results may contribute to a deeper understanding of the impact on inequality when agents use asset trading to mitigate consumption risk in a range of environments.

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