Ties That Bind: The Political Economy of Coerced Labor*

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Abstract

This paper develops a game theoretic model of coerced labor, with particular applications to serfdom in Late Medieval Europe and slavery in the antebellum United States. Two of the more prominent explanations for the abrogation of this institution in Western Europe are critically examined. The model predicts that reductions in population are generally associated with less coercion, in accordance with the population-based Malthusian theory. More profitable outside opportunities for laborers and price inflation, in some cases, decreases coercion as well, which is interpreted as evidence in favor of the market-based commercialization theory. The theory also provides explanations for why these same factors did not bring about the demise of serfdom in Eastern Europe, a puzzle posed in the famous Brenner debate. Because greater coercion increases output per laborer, the model also accords with the Fogel and Engerman (1974) finding that slave labor was productive in the antebellum United States.

JEL codes: B15, C72, D02, J47, N53, P14

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1 Introduction

A fundamental assumption implicit throughout traditional economic theory is that of perfect and costless enforcement of property rights. Yet the foundational insights garnered from the Arrow-Debreu model of competitive general equilibrium, for example, remain salient only if one assumes that agents can bargain over scarce resources free from coercion, forceful appropriation or the threat thereof. A review of recorded human history illustrates that the majority of labor market transactions across the globe exhibited precisely these characteristics. Forced labor was common practice in labor markets in several ancient civilizations including Egypt, Greece, Rome and Japan (see Melzter (1993), for example). In the feudal era, restrictions on labor mobility and the various customary labor services serfs were obliged to provide landlords, for example the *Gutswirtschaft* in Germany, were a defining feature of the "ties of dependence"[1] that characterized European serfdom.[2] During the European colonial era, slavery was an integral component of plantation economies formed in the Caribbean, parts of Brazil and Colombia[3] and, of course, in the United States.[4] Coercion was also an important factor in the organization of labor in mining operations, encomiendas, as well as the later hacienda system that persisted throughout much of Latin America well into the post-colonial era.[5]

More strikingly, the United Nations' International Labor Organization estimates that there are roughly 21 million forced laborers worldwide today, the vast majority residing in the developing world.[6] In Pakistan, for example, underdeveloped capital markets preclude easy access to credit, forcing sharecroppers dependent on short-term liquidity to seek it from opportunistic landowners.[7] In newly industrialized Brazil, lucrative opportunities afforded by black market economies create a demand for labor, often satiated by duplicitous means, while negating traditional avenues for legal recourse. For instance, windfall profits from illegal logging in the Brazilian Amazon incentivize the activity of *gatos,* who entrap laborers in debt bondage by promising jobs and then demanding repayment for transportation, meals and tools.[8] Moreover, globalization, and the attendant labor market displacements that occur as a result of weakening barriers to capital mobility, have led to a massive increase in the supply

[1]Bloch (1964).

[2]See Hagen (1985) for discussion of these labor dues in the case of 16th century Brandenburg.

[3] Curtin (1990).

[4]Fogel and Engerman (1974), Ransom and Sutch (2001).

[5]Lockhart and Schwartz (1983).

[6]"Forced Labour, Human Trafficking and Slavery," *United Nations International Labour Organization*, accessed September 2014, http://www.ilo.org/global/topics/forced-labour/lang–en/index.htm.

[7]"Bonded labor in Pakistan and India almost certainly accounts for the largest number of forced laborers in the world today" Khan (2009, p. 51).

[8]Sakamoto (2009, p. 27).

of migrant workers. The UNILO estimates that there are currently 175 million such laborers across the globe, and it is well documented that many of these transients toil under dubious conditions.[9]

This paper develops a game theoretic model to investigate the underlying incentives behind coerced labor, with a particular emphasis on feudalism in Late Medieval Europe and slavery in the antebellum Southern United States. The model is used to rigorously evaluate two of the more prominent theories for the eventual disappearance of serfdom in Western Europe: a demographic theory which posits the radical reduction in European populations as a result of famine and the Black Death, and a commercialization theory which posits greater market integration due to reduced transportation costs. In general the theory accords with the demographic theory, in that a smaller laboring population will lead to less coercion. However, under an alternative specification of the model in which communal institutions are taken into account, such as the village commune which prevailed throughout much of Eastern Europe and Russia, coercion increases as the population shrinks. Moreover, the model illustrates that the success of the commercialization theory hinges critically on whether the landowner's demands for labor are curtailed by the ability of laborers to flee the manor for more profitable opportunities. When such non-manorial opportunities are limited, coercion increases as the price of agricultural output increases. Conversely, when outside opportunities for laborers are more profitable, the ability of landlord's to appropriate their labor is restricted and therefore coercion will decrease. Lastly, the model predicts that, when non-manorial opportunities are limited, coercion will increase as the institutional environment becomes more biased in favor of landowners.

The theory contributes to the existing literature by evaluating the relative strengths and weaknesses of these competing theories, while explicitly accounting for the resistance efforts put forth by laborers in these contexts. Such an exercise may be viewed as a logical extension of the famous Brenner Debate, in which Robert Brenner forcefully criticized the aforementioned theories because they did not account for the inherently coercive nature of property relations predominating in Late Medieval Europe.[10] This paper explicitly formalizes these relationships through the use of a contest-success func-

[9]In large part this results from the fact that visa status is almost exclusively determined by employment status, creating a relationship between employer and employed characterized by what James Taylor (1977) terms "contrived dependence"; the former, by virtue of their ability to restrict the outside opportunities afforded to the latter, is able to impose more deleterious working conditions, perhaps by coercively extracting greater effort. See Subramanian and Hedge (1997), Lim (2003).

[10]Brenner (1976, p. 31) argues that "...such attempts at economic model-building are necessarily doomed from the start precisely because, most crudely stated, it is the structure of class relations, of class power, which will determine the manner and degree to which particular demographic and commercial changes will affect long-run trends in the distribution of income and economic growth- and not *vice versa*."

tion, and is the first to model "labor extraction" as a contest.[11] In addition, the model offers formal explanations to an important, unresolved puzzle put forth by Brenner in his critique: why did serfdom persist into the 19th century in Eastern Europe (its abolishment in Russia, for example, did not occur until 1861), while in Western Europe it was all but eradicated by the turn of the 16th century, though both regions experienced greater market integration and reduced populations in the Late Medieval period? The analysis suggests that the prevalence of communal institutions in Eastern Europe, as well as relatively smaller urbanization rates and therefore less profitable non-manorial opportunities for laborers, are potential explanations for these disparate responses.[12]

The theory also predicts that greater coercion necessarily leads to increased output per laborer, and in this vein adds to the extensive scholarship on the viability of American slavery on the eve of the Civil War. Fogel and Engerman (1974), Genovese (1972, 1989), Ransom and Sutch (2001), David and Temin (1979) and several others, with varying degrees of acrimony, have weighed in on this important issue. If in the language of Fenoaltea (1989, p. 304), this debate may be termed a "Great War", then a crucial battlefield is the issue of slave-labor productivity. Some historians have argued that slave labor was of such poor quality and given so reluctantly that the plantation system was too inefficient to be viable (see, for example, Genovese (1972, 1989) and Cairnes (1863)), while Fogel and Engerman (1971a) argue that plantations employing slave-labor were more productive than free farms in the North. The model implies that coerced labor can indeed be productive, and thus offers a potential explanation for the findings of Fogel and Engerman (1971a, 1974).

Despite the prevalence of coercive labor markets throughout historical time and space, scholarship on this topic remains limited. Seminal works include Domar (1970), Fogel and Engerman (1974) and Ransom and Sutch (1977). More recently, Naidu and Yuchtman (2013) highlight the inherently coercive nature of labor relations in a time and place normally considered to be at the genesis of modern labor relations: nineteenth

[11] It is often recognized that the work of Haavelmo (1954) was the first to investigate the basic trade-off between production and appropriation inherent in the use of these functions. Later contributions include Tullock (1980), Hirshleifer (1988) and Skaperdas (1992). Skaperdas (1996) and Jia (2008) provide derivations of variants of the functional form employed in this paper, the former via an axiomization approach and the latter using stochastic methods, in which the determination of a "winner" in the contest is noisy. Bowles (1985) and Bowles and Boyer (1988) apply a "labor extraction function", complete with supervision costs, to determine labor effort in an industrial organization setting, but the form of this function is not specified and the primary means through which employers guarantee higher worker exertion is through the threat of unemployment. In this sense the work of Bowles and Boyer is closely linked to the seminal contribution of Shapiro and Stiglitz (1984), in which involuntary unemployment is shown to be an equilibrium outcome. An important commonality between each of these papers and my own is the importance of outside opportunities, captured by workers' reservation utilities, in specifying worker exertion.

[12] See Acemoglu et al. (2005) and Anderson (1996) for a discussion of the dearth of cities in Eastern Europe, and Carsten (1954) and Blum (1957) for how this manifested itself in the conflicts between peasants and landlords.

century industrial Britain. Master and Servant laws which existed in Britain until 1875 made it a criminal offense for employees to breach contracts entered into with their employers, and the resultant restriction on labor mobility had the ambiguous effect of decreasing wages, but also lessening their volatility.[13]

That said, the contribution of Acemoglu and Wolitzky (2011), which is in turn heavily inspired by Chwe (1990), is most directly similar to my own. In their paper the authors develop a principal-agent model of coerced labor and derive general equilibrium implications regarding the intensity of labor extraction and scarcity that seem to confirm the influential theory of Domar (1970). Yet an important distinction remains, as Acemoglu and Wolitzky do not employ a labor appropriation function as in this paper, and instead model coercion as a reduction in the reservation utility of laborers. Although the ability of landowner's to force laborers into accepting unfavorable labor terms is certainly a feature of coerced labor, the *direct* mechanisms by which coercion manifested themselves in both the feudal and slavery settings cannot be overlooked. It is this distinction in my paper that leads to the varying predictions regarding Eastern and Western Europe. In addition, accounting for the myriad forms of resistance put forth by serfs and slaves appears important, especially given the cost imposed by investments in quelling unrest and outright rebellion, as well as guaranteeing effort.[14] Indeed such costs were often a feature of the debates over the viability of American slavery described above.[15]

The organization of the paper is as follows: Section 2 expounds on the explanations for the eradication of serfdom at the core of the Brenner Debate, Section 3 delineates the model primitives, Section 4 derives candidate equilibria, Section 5 characterizes these equilibria through a comparative statics analysis, Section 6 describes a calibration and numerical optimization exercise to determine various welfare effects and Section 7 closes with final thoughts.

[13]This contribution broadens a strand of literature which has typically focused on "labor tying", and the ability of landlords to force peasants into unfavorable contracts, in a purely agricultural context. For example, Genicot (2002) develops a theoretical model in which agrarian peasants benefit from a legal ban on bonded labor agreements because this creates incentives for the development of alternative credit institutions. Similarly, Conning (2004) provides further rigor to Domar's (1970) agrarian model and generates implications regarding landlords' ologopolistic market power in the context of a standard general equilibrium trade model.

[14]The historiography of peasant and slave resistance is quite rich. In the case of serfdom, see Hilton (1990), Freedman and Bourin (2005), Kosminsky (1956), Bloch (1962), Postan (1937, 1972) and Kolchin (1987). In the case of slavery, see Aptheker (1963), Kilson (1964), Morgan (1975, 1998), and Genovese (1972, 1989).

[15]In particular, see Genovese (1989, p. 43). "The economic backwardness that condemned the slaveholding South to defeat in 1861-1865 had at its root the low productivity of labor, which expressed itself in several ways. Most significant was the carelessness and wastefulness of the slaves. Bondage forced the Negro to give his labor grudgingly and badly, and his poor work habits retarded those social and economic advances that could have raised the general level of productivity."

2 Commercialization and Demographic Theories

Forceful extraction of labor from direct producers by a landed nobility which specialized, either directly or through contractual ties of dependence, in the use of violence was the hallmark of European serfdom. Nevertheless, it is widely recognized that a necessary condition for the economic development witnessed by early modern Western Europe was the abrogation of this coercive institution. The creation of a free-flowing labor force dependent on the market for subsistence and the proliferation of a tenant wage-earner labor structure via commutation, precipitated an era of manorial production characterized by large-scale land ownership, the elimination of principal-agent issues associated with effort in landlord-serf "contracts", incentives for fixed investment and enhanced agricultural productivity.[16] Moreover, labor mobility allowed for intra-regional specialization and interdependence, further stimulating competitiveness and efficiency (e.g., Brenner (1982, 2001)). Yet despite a broad consensus on the importance of the eradication of serfdom in unfurling Europe's economic potential, there is far less agreement as to why this important transition took place. The debate is as old as it is contentious, but this paper will focus on two popular theories which attribute the supplantation of the manorial system to factors such as demographic contraction and commercialization. Due to their importance in interpreting the results of our model, each will be briefly delineated.

The demographic model finds its inspiration in the theory of Thomas Malthus (1798), and although first espoused by such eminent historians as M.M. Postan (1960) and Emmanuel Le Roy Ladurie (1966) more than half a century ago, continues to garner broad consensus today.[17] In its simplest rendering the theory argues that the rampant demographic downturn, a form of Malthusian "phase B", which plagued much of the European continent during the 14th century dramatically altered relative factor scarcities and, consequently, the distribution of income between landlords and peasants. Faced with falling agricultural prices and rents, as well as a drastically reduced labor supply,[18] landlords were compelled to compete for productive tenants. This competition resulted in the reduction of peasant-borne levies, such as *tallage*, *merchet* and *heriot*[19], and culminated in the abolition of serfdom in large, contiguous areas in England, France and much of Western Europe.

[16]See, for example, North and Thomas (1995, 1981) and Brenner (1982, 2001). On the stunting impact of labor obligations on peasant investment in England, see Postan (1960) and Fussell (1968). For principal-agent issues associated with serfdom see Fenoaltea (1975). Relatedly, Ogilvie and Dennsion (2007) discuss the tendency for social capital formation to be hindered by vertical hierarchies such as serfdom.

[17]For example, primitives of the Malthusian model are assumed in the theory of Voigtländer and Voth (2012), which attempts to explain Europe's escape from the "Iron Law of Wages".

[18]Tilly (1992) estimates that in some areas rural populations declined by over 40%.

[19]See Schofield (2003, p.15) for a description of the various customary dues borne by peasants.

A second popular explanation for the abrogation of serfdom in late medieval Europe posits the rise of trade, in conjunction with the integration of competitive markets, as the underlying causal factor. This "commercialization" theory was perhaps first popularized by Marc Bloch (1962), and has recently been reinvigorated by the contribution of Acemoglu, Johnson and Robinson (2005a), but its economic and philosophical underpinnings are clearly evident in the work of Adam Smith (1776).[20] Its foundational premise is that markets induce producers to maximize profits through specialization, cost-cutting and productivity-enhancing investments *inter alia*, and, through a Coase-like mechanism, bring about the demise of institutions which are at odds with these incentives.[21] Viewed through this lens the eradication of serfdom in Europe was a result of the precipitous rise in intra-European trade in the wake of reduced transportation costs and frequency of war concomitant with the late medieval period; in particular, between the grain-producing East and states which possessed nascent, urban manufacturing sectors, as in the Italian city-states and Flanders.

3 Model

The model parsimoniously depicts two distinct but inter-related contexts: the archetypal European feudal manor, and the slave plantation endemic to the antebellum Southern United States. On the former, cultivable land was divided between the *demesne* and tracts with customary tenure subdivided between peasant families. Landlords held exclusive property rights over the *demesne*, including the right to appropriate all agricultural output accumulated therein, which was almost exclusively produced through coerced labor.[22] Peasants populated the latter, and the agricultural production from these plots, or "strips", satisfied subsistence requirements, with any remaining surpluses sold in fairs or the local town for private revenue.[23] Identical productive and appropriative relations obtained on Southern slave plantations, with slaves toiling roughly 5 days per week in the service of their owners, the remainder of which could be put toward production on family garden plots.[24]

[20] See Shiue and Keller (2007) for an empirical examination of this market-based theory, and its ability to explain the comparative economic history of Western Europe and China in the period leading up to the Industrial Revolution. Kelly (1997) formalizes the proposition that specialization brought on by trade and market integration can yield a take-off in growth.

[21] This is an example of the "efficient institutions view" described by Acemoglu et al. (2005).

[22] Andersen (1996) and Duby (1978, p. 224-6) note that common practice was for peasants to work 2-3 days each week (unpaid) on the lord's *demesne*.

[23] Although there is of course variation in the organization of production exhibited by feudal manors throughout time and space in Medieval Europe, Postan (1972, p. 89-94) notes that "this bilateral composition of the manor and of its revenues was the true hallmark of the typical manor."

[24] See, for example, Ransom and Sutch (2001, p. 83), Fogel and Engerman (1974, p. 127), Covey and Eisnach (2009, p. 73-5) and Morgan (1998, p. 186). Fogel and Engerman (1977, p. 286) estimate

The foregoing structure of productive activities is presented as a sequential game in which all players are, by assumption, endowed with perfect recall and common knowledge, so that they may costlessly observe the history of play in choosing an optimal strategy.[25] The set of players is discrete, and consists of a single landowner and a set J of identical laborers, each of whom supply a given quantity of labor in homogenous quality. For simplicity it shall be assumed that the set of laborers has a cardinality of J (i.e., $|J| = J$), and that $J > 2$. The strategy set M of the landowner is compact, bounded by zero from below and an arbitrarily large, but finite, Δ from above so that his strategy consists of some $m \in [0, \Delta]$.[26] This choice, along with the resistance effort put forth by peasants, determines the quantity of labor the landowner is able to forcibly extract from the direct producers residing on his land. This variable may be imbued with a variety of concrete interpretations, but in each it represents a direct expression of force made possible by the absence of an interceding centralized political or legal authority, and thus a lack of inviolable, unalterable and sufficiently well-specified property rights in labor.[27] As such, m may represent the purchase of weapons, maintaining of mercenary forces or various supervisory efforts, such as the employment of overseers tasked with monitoring labor productivity.

The strategy space of laborer $j \in J$ consists of the unit interval, representing all possible choices of resistance effort, as well as the decision to *Flee* and earn a reservation utility or *Stay* and remain on the landowner's plot.[28] Thus, a complete strategy profile is a tuple from the cartesian product $[0, 1] \times [Flee, Stay]$. Each laborer $j \in J$ is

slaves toiled between 270 and 293 days out of the year on average. "By permitting families to have *de facto* ownership of houses, furniture, clothing, garden plots, and small livestock, planters created an economic stake for slaves in the system. Moreover, the size of the stakes was variable. It was possible for some families to achieve substantially higher levels of income and of *de facto* wealth ownership than others. The size and quality of houses and the allotments of clothes as well as the size of the garden plots differed from family to family" (Fogel and Engerman 1974, p. 127).

[25]There is often subtle differences in the manner in which these terms are employed in the game theory literature. The terminology employed in this paper is that of Fudenberg and Tirole (1991).

[26]In fact, given the structure of the landowner's utility function explained below, it can be shown that the optimal choice of m will always be finite, and thus the assumption of an arbitrary upper bound Δ is somewhat superfluous in ensuring the their strategy set is compact. This results from the assumptions of diminishing marginal product of labor and a constant, finite marginal cost of coercion, denoted μ below.

[27]Marc Bloch (1962) argues that hierarchical "ties of dependence" between those with varying degrees of political, military and economic clout arose as a mechanism by which social order and security could be maintained after the fall of the (western) Roman and Carolingian Empires. Fogel and Engerman (1974, p. 128) argue that plantation owners in the Southern United States enjoyed similar latitude in the interpretation and application of state law regarding the treatment of slaves. "Within fairly wide limits the state, in effect, turned the definition of the codes of legal behavior of slaves, and of the punishment for infractions of these codes, over to planters. Such duality of the legal structure was not unique to the antebellum South. It existed in medieval Europe in the duality between the law of the manor and of the crown..."

[28]This reservation utility may be interpreted as the Von Neumann-Morgenstern expected utility from stealing away to the city and earning a wage, for example.

endowed with one unit of a resource, say time or work-effort, the proportions of which, given the decision to *Stay,* are distributed between private production (λ_j), coerced labor conducted in the service of the landowner (β), and resistance to forced labor obligations ($r_j \in [0,1]$).[29] Condition (1) expresses this distribution of the peasants' resource:

$$\lambda_j + r_j + \beta(m, R) = 1. \tag{1}$$

Where $R \equiv \sum_{j \in J_s} r_j$ to represent the communal nature of resistance efforts and J_s is the set of laborers who choose *Stay.*

The choice variable r may also be given a number of historical interpretations. In the context of Late Medieval Europe, for example, it may represent the accumulation of military strength through the purchase of crude weapons, as well as the organization and training of a local militia; in such cases the credible threat of violence may have been sufficient to reduce customary dues to forward-looking lords.[30] At times a more effective alternative, r may represent costs, monetary or otherwise, associated with persuading religious and legal authorities to protect them from arbitrary exaction. For example, throughout this era religious "peace associations" were formed by prelates as a method to impose codes of conduct and morality, on peasants and nobility alike, in an era in which the Catholic church increasingly filled the void left by rampant political fragmentation. Such organizations relied on contributions from all segments of society, known as the *pezade* in France, and sometimes protected peasants from the abuses of "robber nobles."[31] In addition, it was not unheard of for non-manorial courts to rule in favor of the peasantry, as was the case in the altercations between the bondsmen of East Sussex and lord Harengod.[32] The collective nature of these forms of resistance, evident in the contest-success function detailed below, was catalyzed by the fact that much of

[29]Two remarks are warranted here. First, it should be noted that an alternative interpretation of λ_j is the proportion of laborers' time that may be devoted to leisure. Second, from the perspective of the peasant, direct appropriation of their resource through β and a contestable lump-sum tax on the private production elicited from λ_j would be identical. As a result, in terms of its effect on peasant decision-making, m may also be interpreted as costs associated with the collection of tallages, entry fines and death dues that were also a continuing source of contention in the late Medieval period (see, for example, Anderson (1996), Duby (1978)).

[30]The threat was indeed credible, over-zealous appropriation on the part of landlords was at the heart of bloody confrontations in Catalonia in 1486, culminating in the Sentence of Guadalupe, as well as the French *Grande Jacquerie* of 1358 and peasant revolts in Germany in 1525, England in 1381, Flanders in the 1320's and the convulsions of the Calabrian peasantry from 1469-75; and "these were only the major episodes of a continent-wide phenomenon, which stretched from Denmark to Majorca" [Andersen (1996, p. 203)].

[31]Bloch (1961, p. 412-420)

[32]As Searle (1973, p. 165) notes, "a jury once again recalled the history of their tenure, emphasizing that the tenants had never tallaged or paid merchet and that their services were certain. The court ordered the instigators, the prior Ralph Harengod, to gaol until they should repay and satisfy the me men they had attacked."

the land not expressly designated to landlords was shared among peasant communities, as was the case with scattered allods, pastures, meadows and forests.[33] As Robert Brenner notes,

> "...the peasant wars in both west and east Germany were largely a failure, as were most of the really large-scale peasant revolts of the later medieval period in Europe. What was successful, however, not only in Eastern Germany, but throughout most of Western Europe, was the less spectacular but ultimately more significant process of stubborn resistance, village by village, through which the peasantry developed its solidarity and village institutions."[34]

In terms of the antebellum slave plantation, r may represent what Peter Kolchin (1987) refers to as "silent sabotage", such as the maiming of draft animals or destruction of lands, tools and facilities, in which effort was expended to reduce the burden of difficult labor in the field.[35] Moreover, strikes and revolts were also a common form of resistance employed by slaves.[36]

Thus the model formalizes an inherent conflict over the distribution of slaves' time between forced labor obligations, and a residual which could be applied to gainful pursuits, the prosecution of which had important implications for the efficiency of American slavery. Its outcome was not a foregone conclusion, as concerted efforts by slaves could prove effective in curtailing infringements on norms governing what was considered a "fair day's work." As one South Carolina planter noted, emphasizing the aforementioned lack of clearly defined property rights,

> "The daily task does not vary according to the arbitrary will and caprice of their owners, and although it is not fixed by law, it is so well settled by long usage, that upon every plantation it is the same. Should any owner increase the work beyond what is customary, he subjects himself to the reproach of his neighbors, and to such discontent amongst his slaves as to make them of but little use to him."[37]

[33] Andersen (1996, p. 148).

[34] Brenner (1976, p. 59).

[35] Daniel Dennett (1849), editor of the *Planter's Banner* in Louisiana, spoke about his slaves as such: "On a plantation they can neither hoe, nor ditch, chop wood, nore perform any king of labor with a white man's skill. They break and destroy more farming utensils, ruin more carts, break more gates, spoil more cattle and horses, and commit more waste than five times the number of white laborers do." Moreover, an anonymous contributor to the *South-Carolina Gazette* reported, "Mr. James Gray who work'd his negroes late in his Barn at Night, and the next Morning before Day, hurried them out again, and when they came to it, found it burnt down to the Ground, and all that was in it" (quoted in Morgan 1998, p. 154-5).

[36] Aptheker (1963, p.142).

[37] Quoted in Morgan (1998, p. 184). Commenting on the planter's observation, Morgan states "the

The effectiveness of slave resistance, as well as its communal character to be formalized below, is also echoed in the detailed accounts of Eugene Genovese.

> "Thus, the slaves struggled to influence their own working conditions. Their actions did not challenge slavery *per se*, nor were they often meant to, any more than striking workers often mean to challenge the capitalist system. Yet, in an important sense the slowdowns and resistance to overwork contributed more to the slaves' struggle for survival than did many bolder individual acts that may have reflected a willingness to attack slavery itself. The slaves did make gains in their everyday living conditions...the collective from of this kind of resistance imparted a sense of community strength and taught the rudiments of organization..."[38]

If resistance proved futile attempted flight could be undertaken in the last resort, perhaps to pose as a self-hired slave in the nearest town or city.[39]

The timing of the game is as follows:[40]

Stage 1: The landowner chooses $m \in M$.

Stage 2: Each laborer $j \in J$ chooses *Flee* or *Stay*. Let J_s refer to the subset of laborers who choose *Stay* in this subgame. If the laborers flee, they receive a reservation utility $\pi \in (0,1)$, and the landowner receives $-\mu m$, where μ represents the constant marginal cost of coercion.

Stage 3: If previously laborer $j \in J$ chose *Stay,* they then choose $r_j \in [0,1]$. Letting $L(\beta)$ represent coerced labor, T land[41], P the price of agricultural output, A a Hicks-neutral productivity parameter and $F: \Re \times \Re_+ \to \Re$ a twice-differentiable production technology, the payoff functions, if Stage 3 is reached, may be written as:

$$U_{j \in J_s}(r_j, m) = \lambda_j = 1 - r_j - \beta(m, R),$$

$$U_L(r_j, m) = PAF(L(\beta)), T) - \mu m.$$

requirements of the task system were hammered out just as much in conflicts with the workforce as in the supposedly inevitable march of technological progress" (Ibid, p. 184).

[38] Genovese (1972, p. 621).

[39] "It was a unusual planter who could boast that none of his slaves had absconded during a given year. In fact, the vast majority admitted just the opposite, and some complained about 'habitual' runaways, or those who ran off two, three, and four times each year. Traveling through the southern states during the 1850s, Frederick Law Olmsted noted that at virtually every plantation he visited masters complained about runaways" Schweninger (1999, p. 267).

[40] In the current setup the landowner is the first-mover. It should be noted that comparative statics results regarding the equilibrium choice of coercion are qualitatively robust to deviations in this formulation. That is, equilibrium coercion responds similarly to deviations in P, A, T, J and μ irrespective of whether the landowner or laborers move first.

[41] It is assumed that the quantity of land endowed to the landowner is determined exogenously and utilized costlessly.

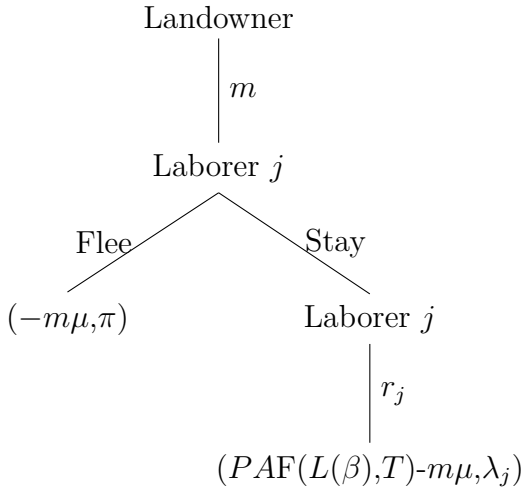

Figure 1: Extensive Form Representation With a Single Laborer

Where $U_{j\in J}$ and U_L refer to the payoffs of laborers and the landowner, respectively. The extensive form representation of the game for a single laborer $j \in J$ is shown in Figure 2.1 above. Therefore a laborer in stage 2, having observed the choice of the landowner $m \in [0, \Delta]$, will only choose *Stay* if $\lambda_j(R, m) \geq \pi$.[42]

Thus the utility laborer $j \in J_s$ receives in stage 3 is equal to the proportion of their resource which can be devoted to their private production or leisure. The payoff the landowner receives in stage three is equal to the revenue garnered from agricultural production, which takes as inputs labor $L(\beta)$ and land (T), less the costs associated with coercion. F is assumed to be a prototypical neo-classical production function, satisfying positive marginal products, strict concavity in its arguments, positive cross partial derivatives, smooth dependence on its parameters and constant returns to scale. That is:

$$\frac{\partial F}{\partial L} > 0, \quad \frac{\partial F}{\partial T} > 0, \quad \frac{\partial^2 F}{\partial L^2} < 0, \quad \frac{\partial^2 F}{\partial L^2} < 0, \quad \frac{\partial^2 F}{\partial L \partial T} = \frac{\partial^2 F}{\partial T \partial L} > 0$$

$$F(0, T) = F(L, 0) = 0 \quad \forall\ L,\ T, \quad \text{and}$$

$$F(\rho L, \rho T) = \rho F(L, T) \quad \forall\ \rho \geq 0.$$

Lastly, the total quantity of labor the landowner is able to forcibly extract from all $j \in J_s$ depends on the contest-success function $\beta(m, R)$, which is borrowed from the economic literature on conflict:

[42]It is assumed that laborer $j \in J$ chooses *Stay* if $\lambda_j(m, r_j) = \pi$.

$$L(\beta) = \beta(m, R) * J_s = \frac{cm}{cm + (1-c)\sum\limits_{j \in J_s} r_j} J_s) \qquad \text{for } m + R > 0 \text{ and } c \in (0, 1). \quad (2)$$

As the functional form for $\beta(m, R)$ plays a critical role in the following analysis, it is worth a brief discussion. It states that the proportion of labor appropriated by the landowner from laborer $j \in J_s$ is a function of his individual contribution to coercion (m), the combined level of resistance on the part of laborers $(\sum r_j)$ and the parameter c which, perhaps via norms, laws and tradition, determines the relative efficacy of repression versus resistance.[43] $\beta(m, R)$ may be considered a conflict technology, markedly distinct from those generally encountered in economic theory in that its inputs are combined *adversarially* in the "production" process, so that if both total resistance and monitoring efforts are doubled, the "output" remains constant. The fact that $(\sum r_j)$ is an argument of β is meant to reflect the communal nature of resistance discussed above, in which solidarity among the peasant and slave communities was crucial in countering the fluctuating demands of landlords.

Lastly, the parameter c is critically important in determining the relative power between the landowner and laborers. For example, note that when $m = \sum\limits_{j \in J} r_j > 0$, $\beta = c$; and thus the conflict becomes increasingly unbalanced in the landlord's favor as c approaches 1. As mentioned above, c may represent the influence of norms regarding the definition of a "fair" day's work on Southern plantations. Or c may signify a bias on the part of legal and religious authorities adjudicating disputes between lord and peasant.[44] Finally, less invasive mechanisms of slave control in cities *vis-a-vis* plantations, often posited as an important factor in the decline of urban slavery in the antebellum may be represented by a smaller c.[45] Lastly, in order to ensure the existence of best-response functions, it shall be assumed that $\beta(0, 0) = 0$; in other words, if the landowner chooses not to attempt to appropriate labor and, conversely, laborers decide not to resist such efforts, then no labor is extracted.

[43] More specifically, it is the *ratio* of coercion to combined resistance that determines β. This can be mostly clearly seen by assuming $c = \frac{1}{2}$, which yields $\beta = \frac{m}{m + \sum r_j}$. Also, it will be assumed that $\beta(m, R) = \beta(0, 0) = c$.

[44] Bogart (2013) gives a similar interpretation of this parameter in discussing the success of river navigation improvements in the British Parliament following the Glorious Revolution.

[45] For a detailed discussions see Wade (1964) and Goldin (1976).

4 Equilibria

The solution concept employed throughout this paper is that of subgame perfect Nash equilibrium (SPNE). Such a solution will require a Nash equilibrium to be played in each subgame, and thus will give a strong prediction to the course of play. Given the primitives of the game a pure-strategy SPNE is guaranteed, but to first narrow down the candidate strategy profiles, an immediate result is useful.

LEMMA 1: *Suppose their exists an* $m \in [0, \Delta]$ *that induces the decision "Stay" by laborers. This* m *endows the landowner with a strictly higher payoff than an* $m' \in [0, \Delta]$ *which induces the decision "Flea" by laborers.*

PROOF: Consider a strategy $m_f \in (0, \Delta]$ that induces laborers to choose *Flee*, and a strategy $m_s \in (0, \Delta]$ that leads to the choice *Stay*. Suppose by contradiction that the payoff to the landowner from m_f is greater than the payoff from m_s :

$$\mu(m_s - m_f) > F(\beta(m_s, R), T) \geq 0.$$

But because $\lambda_j(m, r_j)$ is decreasing in $m \; \forall \; r_j > 0$, it must be the case that $m_f > m_s$, and thus the above statement is a contradiction because the left hand side is negative.

Given this equilibrium condition, the left-hand side of the tree diagram in Figure 1 may be disregarded, and an SPNE will be derived by employing the method of backward induction, beginning with optimal choice r_j, given that *Stay* was played in the previous proper subgame. The optimality problem of the laborer in stage 3, having observed this history of play, is :

$$\underset{r_j \in [0,1]}{\text{Max}} \; \lambda_j(m, r_j), \tag{3}$$

$$s.t. \; \beta = \frac{cm}{cm + (1-c)\sum\limits_{j \in J_s} r_j}.$$

There are a multiplicity of equilibrium resistance efforts, $r(m)$, which satisfy the first-order condition to this problem, as only the *total* level of resistance by laborers is important in β. As a result, the symmetric strategy profile in which each laborer devotes an equal proportion of their resources to resistance shall be chosen. That is, it will be assumed:

$$\sum_{j \in J_s} r(m) = J_s r(m). \tag{4}$$

Note that equation (3) is a linear combination of concave functions, and is thus itself concave; this combined with the fact that $m > 0$ in equilibrium ensures that the solution $r(m)$ is a unique, global maximizer. Utilizing the laborer best-response function yields an immediate result that will be used throughout the text:

LEMMA 2: *If $m < m_f$, as m increases the proportion of laborers' time devoted to the landlord (β) increases.*

PROOF: Follows directly from substituting the laborer best-response function into $\beta(m, R)$.

Lemma 2 implies that greater coercion necessarily increases the time or work-effort devoted by laborers to the landlord, and therefore output per laborer, regardless of the resistance effort put forth. This result is in accordance with the argument of Fogel and Engerman (1974) that the productivity of slave labor in the antebellum United States was actually quite high relative to wage labor in the North. This has topic has been the subject of intense, and often acrimonious, debate, and figured prominently in the "ongoing Great War between the Central Empires of Fogel and Engerman and the Allied Powers of near everybody else"[46]

Having obtained $r(m)$, and established that any candidate strategy profile must induce the decision *Stay* by peasants, backward induction proceeds by next solving for the optimal landowner strategy m^*. In order for peasants to be incentivized to remain on the manor, or for slaves to remain on the plantation, any equilibrium strategy m must satisfy:

$$\lambda_j(m, r(m)) \geq \pi. \tag{5}$$

As one would expect, condition (5) places an upper bound on m in equilibrium, which will henceforth be referred to as γ in the text. The optimality problem of the landowner can thus be summarized as:

$$\underset{m \geq 0}{\text{Max}} \; (PA) \cdot F(L(m, r(m)), T) - \mu m, \tag{6}$$

$$\text{s.t. } m \leq \gamma \quad \text{and}$$

$$\text{s.t. } L(m, r(m)) = \beta(m, r(m)) \cdot J_s.$$

Differentiation yields the Kuhn-Tucker conditions:[47]

[46] Fenoaltea (1989, p. 182).

[47] Note that because the restriction is linear in m, the constraint qualification associated with the Kuhn-Tucker formulation is automatically satisfied.

$$PA(\frac{\partial F}{\partial L})(\frac{\partial L}{\partial m}) = \frac{J}{2}PA(\frac{\partial F}{\partial L})\left[\frac{c}{m(1-c)}\right]^{\frac{1}{2}} = \mu + \phi \tag{7}$$

$$\phi(m - \gamma) = 0 \tag{8}$$

$$\phi \geq 0 \tag{9}$$

$$m \leq \gamma \tag{10}$$

Cursory examination of these conditions reveals the possibility of two distinct cases, each to be discussed in turn: an equilibrium in which constraint (5) binds and one in which it does not.

4.1 Binding Equilibrium

Simply put, a binding equilibrium is one in which the returns to the landowner from extracting coerced labor are high enough that they will employ coercion up until the point where laborers are indifferent between fleeing and staying on the manor. Thus, $m^* = \gamma$ and the Lagrange multiplier ϕ, which may be interpreted as the shadow price of coercion, is positive, as the landowner would be willing to pay a nonzero sum in order to accrue the benefits from a slackening of constraint (5). Re-arranging equation (8) lends insight into the conditions under which this equilibrium may arise:

$$\phi = PA(\frac{\partial F}{\partial L})(\frac{\partial L}{\partial m}) - \mu > 0. \tag{11}$$

Landowners may wish to increase m, and intensify villein or slave labor to the point where laborers are indifferent between fleeing and remaining on the manor, if the marginal cost of m is sufficiently low, or if the price they receive for their output and the productivity of their production technology is sufficiently high. If one interprets m as an armament expenditure, a possible explanation for a low marginal cost (μ) is the technological and organizational advances in utilizing weaponry that were a by-product of the incessant warfare characteristic of medieval Europe.[48] Indeed such technological advancements may have also created spillover effects which enhanced the efficiency of productive technologies, an effect captured by a larger A. In each of these scenarios the marginal revenue garnered from increasing m would surpass its marginal cost. Thus a candidate SPNE of the game in which (5) binds is the strategy profile:

[48] See Hoffman (2013).

$$\left\{m^* = \gamma, \left(Stay \text{ if } \lambda_j(m^*, r(m)) \geq \pi, Flee \text{ otherwise}; r(m) = \text{Max}\left\{\frac{2\theta^{\frac{1}{2}} - \theta}{4J}, 0\right\} \text{ if } Stay\right)\right\}$$

$$where \quad \theta \equiv 2(J-1)\left[J - 1 - \left[(J-1)^2 + 4J(1-\pi)\right]^{\frac{1}{2}}\right] + 4J(1-\pi).$$

4.2 Non-binding Equilibrium

As a converse to that described in the previous section, a non-binding equilibrium obtains if the returns to the landowner from employing coerced labor are sufficiently low. Such a situation may arise if the marginal cost of m is sufficiently high, or if the price of agricultural output and the Hicks-neutral productivity of the production technology is sufficiently low. Such conditions may have been characteristic of Medieval Europe before the economic and demographic expansions of the 12th and 13th centuries, in which efficiency improving techniques such as advanced husbandry and the 3 field system had yet to be adopted, and intra-regional trade had yet to have an inflationary effect on agricultural output. In regards to the antebellum South, μ may have been relatively higher before the advent of organizational improvements in the extraction of labor, such as the gang and task systems, which took advantage of scale economies in supervision. From the complementary slackness condition (equation 9 above) this implies that $\phi = 0$, and from equation (8) an implicitly defined reaction function for the landowner may be derived:

$$PA(\frac{\partial F}{\partial L})(\frac{\partial L}{\partial m}) = \frac{PAJ}{2}(\frac{\partial F}{\partial L})\left[\frac{c}{m(1-c)}\right]^{\frac{1}{2}} = \mu. \tag{12}$$

This yields the familiar condition that, in equilibrium, the landowner will calibrate his strategy so that the marginal benefit accrued from coercion is equal to its marginal cost.

Thus, an SPNE in the case where constraint (3.3) does not bind is given by:

$$\{m^* \text{ defined by } (13), (Stay \text{ if } \lambda_j(m^*, r(m)) \geq \pi, Flee \text{ otherwise}; r(m) = \text{Max}\{\eta, 0\} \text{ if } Stay)\}$$

$$where \quad \eta \equiv \frac{cm^*\left[\left(\frac{1-c}{cm^*}\right)^{\frac{1}{2}} - 1\right]}{(1-c)\,J}.$$

5 Comparative Statics

The properties of these equilibria, specifically how the laborers' and landlord's equilibrium strategies respond to marginal changes in parameter values, will be discussed presently. To simplify the following exposition m_b^* and m_n^* shall refer to the equilibrium choice of coercion in the binding and non-binding equilibria, respectively, where $m_b^* \equiv \gamma$. The analysis is somewhat complicated by the fact that, in contrast to simultaneous games, fluctuations in parameters that do not enter directly into the peasant utility function may, as a result of a deviation in the landlord's strategy, nevertheless induce an altered laborer best response. This section is organized according to the main theories discussed in the Introduction.

5.1 Commercialization Theory Comparative Statics

Recall that this theory poses the entrenchment and expansion of markets, for example those associated with grain, woolens and viticulture, as the fundamental causal factor in explaining the decline of serfdom and, ultimately, the adoption of more efficient means of agricultural production. The potential gains from trade realized through specialization and the division of labor, as well as economies of scale and agglomeration, necessitated a freely mobile labor force and thus an abandonment of the feudal organization of production. Two parameters within the model most directly capture the growing commercialization that was characteristic of Medieval Western and Southern Europe in the 12th and 13th centuries: P and π.

In regards to P, a number of historians have highlighted the inflationary impact of market integration on agricultural output, as reductions in transport costs and specialization stimulated urban demand, both home and abroad. As Robert Brenner notes, "Ultimately the growing shift of population into industrial employments, supplemented by a powerful demographic upturn, determined a long-term increase in the demand for agricultural products, leading to a rise in food prices" Brenner (1982, p. 87). Moreover, Slicher van Blath writes

> "The changes which took place in the second half of the twelfth century and during the thirteenth century are well illustrated by the tremendous rise in cereal prices. Although information about prices in this period is scarce, the movements of English wheat prices between 1160 and and 1339 are symptomatic of the economic development of all western Europe. In about one hundred years the price of wheat increased almost threefold, an increase comparable to that of the price revolution of the sixteenth century."[49]

[49] Slicher van Blath (1963, p. 132-3). North and Thomas (1995, p 48) and Farmer (1988, p. 716-733)

Thus, between the 12th and 14th centuries increases in the price of agricultural output were symptomatic of deepening trade and commerce, an effect captured by a larger P in the model.

In regards to π, recall that this parameter represents the non-manorial opportunities afforded to laborers. Suppose π represents the Von Neumann-Morgenstern expected utility of escaping to the local city and earning a wage in the nascent urban manufacturing center. That is, suppose $\pi = P^e w$, where w refers to such a wage, P^e the probability of attaining employment and it is assumed that peasants are risk-neutral. As has been noted by a number of historians of the era, an important effect of the rise of intra-European trade in medieval Europe was to catalyze urbanization, and thus opportunities for urban employment. As North and Thomas note in their description of the preeminence of the Italian city-states,

> "Improvements in productivity were probably greater in the Italian cities than in Northern Europe. Their ability to support the described population densities suggests an efficiency in economic organization well surpassing that exhibited by Northern Europe...The extension of international specialization and division of labor...allowed those areas to capture the gains from trade. Their ability to reap the benefits from an extensive commerce is the underlying factor in the precocious development of the Italian cities."[50]

More recently, Paul Krugman (1980, 1991) has illustrated that in a context of reduced transportation costs, such as that resulting from the assartation and colonization of new lands in response to population pressure,[51] the ability of manufacturers to take advantage of increasing returns to scale in urban markets may produce a self-reinforcing cycle of urbanization. Essentially in line with the logic of Say (1803), the concentration of production creates its own demand. As a result, a key effect of commercialization in late Medieval Europe was to tighten the individual rationality constraint faced by landlords on the manor. In the model the mechanism through which this effect is manifested is the probability of finding urban employment and, due to the adoption of productivity improving technologies, the wage rate. The sum of these effects is to increase π.

Having established the manner in which commercialization manifests itself in the model, Propositions 1 and 2 below detail the effect of marginal increases in P and π on equilibrium strategies and the quantity of labor extracted by the landowner in the binding and non-binding equilibria.

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similarly note an inflationary effect on agricultural products in England during the economic expansion of the 13th century.

[50] North and Thomas (1995).

[51] North and Thomas (1981, p. 132) note this phenomenon.

PROPOSITION 1:

In a binding equilibrium:

1. *An increase in P has no effect on the landlord's coercive effort, the total or individual resistance effort by laborers, or the proportion of laborers' time devoted to the landlord (β).*

2. *An increase in laborers' outside opportunities (π) will decrease coercive effort and β, but will have an ambiguous impact on resistance effort.*

PROOF: statement 1 results directly from Lemma 1 and the laborer best-response function. Part 2 results directly from Lemmas 1, the fact that γ is decreasing in π, and the observation that π only *indirectly* affects $r(m)$ through its impact on m^*.

PROPOSITION 2

In a non-binding equilibrium:

1. *An increase in laborers' outside opportunities (π) has no effect on the landlord's coercive effort, total and individual resistance efforts, or β.*

2. *An increase in the price of output will increase coercive effort and β, but will have an ambiguous impact on resistance effort.*

PROOF: The first statement is straightforward: if m_n^* is the coercive effort that brings the marginal benefits and costs of coerced labor into equality, in the most extreme case an increase in the peasants' outside opportunities will cause constraint (5) to bind, and peasants to now be indifferent between stealing away and remaining on the manor. However, as noted previously, it is assumed that peasants will choose *Stay* under such circumstances, and thus there does not exist a profitable deviation from m_n^* for the landowner. As a result, the laborer best response will also remain unchanged. The second statement follows from total differentiation of the landowner best-response function, Lemma 2 and the observation that P only *indirectly* affects $r(m)$ through its impact on m^*.

If one interprets $m^*$and $\beta(m^*, R(m))$, which move in the same direction in response to parameter shifts, as metrics for the severity of serfdom, then clearly the success of the commercialization theory rests on whether a binding or non-binding equilibrium obtains. In a binding equilibrium, changes in the price of agricultural output have no effect on equilibrium strategies and payoffs, but an increase in outside opportunities (π) forces landowners to reduce their employment of coercion, and thus the severity of labor

obligations, in order to prevent laborers from fleeing to the city. In the non-binding case an increase in π has no effect, but an increase in P will result in increased coercive efforts by the landowner due to the greater revenue that can be accrued from their output. In a binding equilibrium inflation of agricultural prices will have no effect, but more lucrative outside opportunities for peasants will force a reduction in m_b^*, and thus a reduction in the coercive efforts associated with serfdom. This prediction accords well with the historical record of Western Europe during this period, in which traditional manifestations of seigneurial power such as forced labor obligations had largely been weakened. As North and Thomas note:

> "By the dawn of the thirteenth century the political and economic structure of Western Europe had fundamentally changed from what it had been in the tenth century. In summary: population and commerce had expanded together; technological changes, if still limited in occurrence, had been widely adopted throughout the areas; and the methods of agriculture had been adjusted to new conditions. And the net result was both manorialism and feudalism had undergone irreversible change" North and Thomas (1995, p.35).[52]

Moreover, the effect of urbanization in undermining the ability of landlords to "squeeze" their peasantry is also noted by Perry Anderson.[53] Referring to the seigneurial reaction to the crisis of the 14th and 15th centuries, in which landlords in the West attempted to resurrect feudal institutions in the face of falling incomes, he writes:

> "The existence of urban municipal independence and power of attraction, even in a diminished form, was a manifest obstacle to the coercive imposition of a generalized serfdom on the peasantry: it has been seen that it was precisely the objective 'interposition' of cities in the overall class structure that blocked any final intensification of servile bonds as a response to the crisis in the West" Anderson (1996, p. 253).

The effects of urbanization and inflation in a non-binding equilibrium, however, are markedly different, and run contra to the predictions of the commercialization theory. Although an increase in π has no effect on equilibrium strategies and payoffs, inflation in the price of output increases the marginal return to employing coercion, and leads landowners to further entrench serfdom through more burdensome labor dues. These disparate predictions of the binding and non-binding equilibria may be

[52] As a more specific example, the authors also note "Serfdom, where it had existed, had disappeared in most parts of Flanders and Brabant in the course of the twelfth and thirteenth centuries. The rise of the market, typified by Bruges, made vassalage inefficient" North and Thomas (1995, p. 142-3).

[53] Similar arguments are also given in North and Thomas (1995, p. 30)

helpful in explaining the divergent reactions to commercialization exhibited by Eastern and Western Europe, and the fact that in the former serfdom was to continue, in certain areas, well into the 19th century. First of all it is noted above that γ is decreasing in π, and therefore a non-binding equilibrium is more likely in a scenario in which vibrant non-manorial opportunities for laborers are not extant. As Anderson notes, this was precisely the case for peasants in Eastern Europe.

> "It was fundamentally this weakness of towns that allowed the nobles to adopt a solution...that was structurally barred to them in the West: a manorial reaction that slowly destroyed all peasant rights and systematically reduced tenants to serfs, working on large seigneurial demesnes" (Andersen 1996, p. 252).

Moreover, fewer cities in Eastern Europe meant less urban demand for agricultural products, and therefore a lower P. Equation (12) implies that this will also make a non-binding equilibrium more likely.

In addition, Hoffman (2013) notes that military technologies progressed at a slower rate in Eastern Europe, in large part because military engagements were often conducted against invading nomads from the Asian steppe, in which traditional cavalry and archer tactics remained effective. As a result, it is likely that, due to the technological and organizational spillovers associated with military advancements, civilian productive technologies in Eastern Europe also progressed at a slower rate. The combined effects of high marginal cost of coercion (μ), lower productivity (A) and lower urbanization rates (π) would make a non-binding equilibrium more likely in Eastern Europe. The presence of a non-binding equilibrium, coupled with a vibrant grain export market, particularly in Eastern Germany, in the 15th and 16th centuries,[54] would have led commercialization to the entrenchment of serfdom in Eastern Europe during this period, colloquially termed the second serfdom.[55]

5.2 Demographic Theory Comparative Statics

The merits of the demographic explanation for the eradication of serfdom in Western Europe shall now be assessed in the context of the model, in which population growth is modeled as an increase in the peasant population J.

[54] see Anderson (1996), footnote 19.

[55] A more expansive interpretation would posit the sign of $\frac{dm_n^*}{dA}$ as contradictory to the commercialization model as well. For as North and Thomas note, "The growth in towns facilitated local and regional exchanges, and the expansion of these markets made it profitable to specialize functions, to introduce new technologies, and to adjust the production processes to altered conditions" (North and Thomas [1995, p. 26]). Thus a more vibrant trade environment led to greater productivity, an effect captured by an increase in A.

PROPOSITION 3

In a non-binding equilibrium, under linear and Cobb-Douglas production technologies, as well as Constant Elasticity of Substitution (CES) production with a restriction on the land-labor ratio, if the laboring population (J) increases:

1. *Equilibrium coercion effort (m_n^*) increases.*

2. *The proportion of laborers' time devoted to the landlord (β) increases.*

PROOF: See Appendix A.

PROPOSITION 4

In a binding equilibrium, under linear and Cobb-Douglas production technologies, as well as Constant Elasticity of Substitution (CES) production with a restriction on the land-labor ratio, if the laboring population (J) increases:

1. *Equilibrium coercion effort (m_b^*) increases.*

2. *The proportion of laborers' time devoted to the landlord (β) increases.*

PROOF: Part 1 follows from Proposition 3 and the fact that $\gamma(c, J, \pi)$ is increasing in J. Part 2 follows from Part 1 and substitution of the laborer best-response function into $\beta(m, R)$.

If once again one interprets m^* and $\beta(m^*, R(m))$ as metrics for the trenchancy of serfdom, Propositions 3 and 4 align with the predictions of the demographic theory, despite the fact that conflict over property rights in labor are explicitly accounted for as Brenner recommends. Recall this theory portends that a population contraction will induce a ratcheting-down effect on seigneurial appropriation. Such was the case in 14th and 15th century Europe, in which disease, incessant warfare and famine were so deleterious to European populations that landlords were forced to, in the face of falling rents and increased peasant bargaining power, alleviate customary dues in order to attract what remained of a dramatically reduced labor supply. Conversely, in the 12th and 13th centuries, when the introduction of new technologies and more vibrant trade markets allowed for agricultural output to sustain a growing population, peasants were on the receiving end of intensified villein labor.

Moreover, a common effect of demographic pressure was the accumulation of more lands under the lord's *demes*ne, as serfs engaged in the assarting of wastelands and forests or the colonization of frontier lands in an effort to safeguard their livelihood in the face of parcellization. Such efforts may be captured by an increase in T, the effect of which is summarized in Proposition 5.

PROPOSITION 5

In a non-binding equilibrium, if the quantity of arable (T) increases then:

1. *Equilibrium coercion effort (m_n^*) will increase.*

2. *The proportion of laborers' time devoted to the landowner (β) will also increase.*

PROOF: Part 1 follows from total differentiation of the landlord best-response function and the assumption of positive cross partial derivatives in the production technology. Part 2 follows from Part 1 and by substituting the laborer best- response function into $\beta(m, R)$.

Thus the aggregation of lands also increased the profitability of coercive labor extraction by landlords, adding further support to the demographic theory.

5.3 Extension: Communal Laborer Utility

Although to this point the model has provided evidence in favor of the demographic theory, the question of why Eastern and Western Europe exhibited radically disparate responses to the bubonic plague and famine remains unresolved. Why was it the case that massive reductions in the population led to the abrogation of serfdom in the West, but a "second serfdom" in the East? A potential answer may lie in the degree to which peasants were able to organize and coordinate their activities in resisting the demands of landowners. Given the recent work of Ogilivie (2005), Dennison (2011) Dennison and Ogilvie (2007), it is clear that the village communes of Eastern Europe, particularly in Bohemia and Russia, played an important role in facilitating collective action among peasants against the opportunism of landowners. Ogilvie (2005, p. 71) writes, "per-industrial European communes are also believed to exemplify the closely knit and multi-stranded 'social networks' which, according to some modern social scientists, created a 'social capital' of shared norms, information transmission and collective action that benefited society at large and hold lessons for modern less-developed countries." Moreover, and importantly for the model, communes often represented the interests of the entire peasant community in dealings with landowners over the determination of labor obligations.

The current specification of the laborer optimality problem, together with the selection of a symmetric equilibrium, trivially implies that when J_s increases individual contributions to the resistance effort will lessen, a manifestation of the familiar free-rider problem. Given the foregoing discussion, however, it seems reasonable to investigate an alternative formulation of the model in which each laborer $j \in J_s$ maximizes the utility of the *entire* laboring population. Thus, suppose instead that the optimality problem of laborer $j \in J_s$ in Stage 3, having costlessly observed the history of play is:

$$\underset{r_j \in [0,1]}{Max} \sum_{j \in J_s} \lambda_j(m, r_j) = \sum_{j \in J_s} \{1 - r_j - \beta(m, r_j)\}, \tag{13}$$

$$s.t.\ \beta = \frac{cm}{cm + (1-c)\sum_{j \in J_s} r_j}.$$

Comparative statics results regarding the parameters P, A, T, c and π remain precisely the same as those described above. The effect of an increase in J, however, is more interesting. It can be shown that under this alternative setup the total level of resistance will indeed respond positively to an increase in the laboring population, and therefore the proportion of laborers' time devoted to labor dues (β) will decrease. Proposition below summarizes the effect of a population expansion under this alternative formulation in a non-binding equilibrium.

PROPOSITION 6

In a non-binding equilibrium, under linear and Cobb-Douglas production, as well as CES production with a restriction on the land-labor ratio, if the laboring population (J) *increases:*

1. *The total level of communal resistance* R^{*c} *will increase.*
2. *Coercive effort* m_n^* *will increase.*
3. *The proportion of laborers' time devoted to coerced labor* (β) *will decrease.*

PROOF: Part 1 results directly from the peasant best-response function. It can be shown by total differentiation that the necessary and sufficient condition for Part 2 to hold is identical to that required in Proposition 3, described in Appendix A. Part 3 follows from differentiation of $\beta(m_n^*, R^*)$.

Thus, this alternative formulation yields markedly different predictions regarding the effect of population growth on the severity of labor obligations. While the equilibrium coercive effort of the landowner still increases as the peasant population swells, the fact that total peasant resistance also increases ensures that the net effect is a reduction in forced labor obligations. This offers a potential explanation for why Eastern Europe, where a non-binding equilibrium was more likely, witnessed a general increase in peasant labor obligations in the wake of extreme population reduction brought on by famine and the Black Death.

5.4 The Role of Institutions in the Seigneurial Reaction

Investigating the role of institutions which arbitrated the conflictual relationship between laborers and landowners offers another potential explanation for the disparate responses to the massive demographic contraction witnessed by Eastern and Western

Europe in the Late Medieval period. As a number of authors have noted, landowners throughout Europe met falling rents and agricultural prices with a "seigneurial reaction" in which more onerous labor dues were placed on peasants in order to maintain profits.[56] These measures were typically codified into law, as was the case with the English Statute of Labourers of 1351, legislation passed by the Catalonian *Corts* in the early 14th century, and the various measures employed by the Junkers throughout much of Prussia.[57] As mentioned above, the parameter c may be interpreted as an institutional parameter which determines the relative efficacy of coercion versus resistance, and as such, represent aspects of the legal code pertaining to labor disputes between landowners and serfs. Therefore, the seigneurial reaction manifests itself in the model as an increase in c. Propositions 6 and 7 summarize the effect of such a parameter deviation on the equilibrium level of coercion.

PROPOSITION 7

In a non-binding equilibrium, under linear and Cobb-Douglas production, as well as CES production with a restriction on the land-labor ratio, if institutions become more biased in favor of the landowner, that is, as c increases, equilibrium coercion (m_n^*) and the proportion of laborers' time devoted to the landowner (β) increase.

PROOF: this follows from total differentiation of the landowner best-response function and by substituting the laborer best-response function into the contest-success function (β).

PROPOSITION 8

In a binding equilibrium, if institutions become more biased in favor of the landowner, that is, as c increases, equilibrium coercion (m_b^*) decreases.

PROOF: This follows directly from Lemma 1 and the fact that $\gamma(c, J, \pi)$ is decreasing in c. The logic here is intuitive. In a binding equilibrium, *ceteris paribus,* an increase in c will enhance the effectiveness of the landowner's attempts at extracting labor, and consequently must be accompanied by a drop in ${m_b}^*$ in order to prevent the laborers from profitably deviating to *Flee*.

Thus, as is the case with many of the parameters previously discussed, the effect of greater institutional bias in favor of landowners hinges on whether a binding or non-binding equilibrium obtains. It has been previously discussed that a non-binding equilibrium was more likely in Eastern Europe, and as a result Proposition 6 is most appropriate. Aided by a legal system favorable to their interests, landlord's in Eastern

[56]See Brenner (1982), Jones (2000), Hilton (1990), Blum (1957).
[57]See Melton (1994) and Hagen (1985).

Europe could increase their coercive efforts and extract more labor from a peasantry which did not possess viable opportunities off the manor. In Western Europe, however, a binding equilibrium was more likely, and therefore landlords could not wantonly increase labor dues for fear that this would lead to a mass exodus of their labor supply.[58]

6 Numerical Examples

This section details the results of numerical simulations aimed at illustrating the welfare effects of various parameter deviations, as well as the propensity for constraint (5) to bind in equilibrium. With regard to the latter, an important result that is immediately garnered from these simulations is that extreme parameter values are required for (5) *not* to bind. As is evident from the discussion above, lower and higher values for c and μ, respectively, decrease the returns to the landowner from applying coercive efforts, and thus should make such an eventuality less likely. Nevertheless, considered in isolation, a binding equilibrium obtains even when $c = .13$ (which would imply that only 13% of the laborers' time was spent toiling for the landowner if both chose equal efforts), and $\mu = 10$, that is, if the marginal cost of production was ten times its price. Moreover, the availability of outside opportunities for laborers should diminish the landowners' ability to wantonly extract additional labor dues, but a binding equilibrium results even for values of $\pi < .01$. In the context of Late Medieval Europe, this result seems to accord well with the historical record of Western Europe, as the restraining effect of cities on the coercive efforts of landlords is explicitly corroborated in the scholarship of the period.[59]

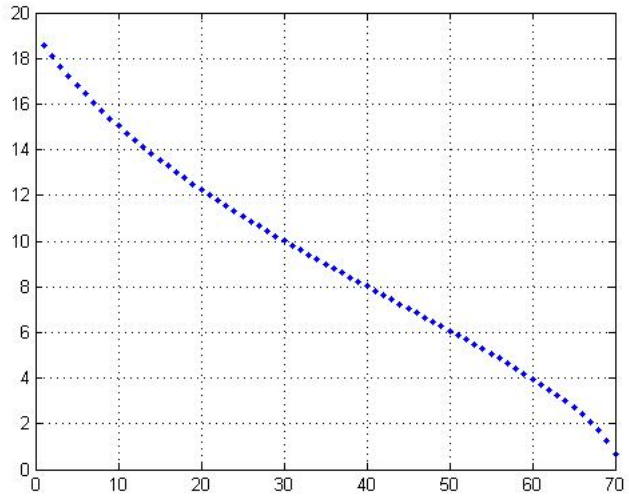
This insight has salient implications for the comparative statics delineated in Section 5.1. Recall these results cast doubt on the commercialization theory, as it was shown that under a non-binding equilibrium coercive efforts on the part of the landowner increase in response to inflation in agricultural prices, interpreted as the macroeconomic effect of a rise in demand from burgeoning cities, or perhaps trade. However, simulations in which *both* P and π are incrementally augmented reveal that the expected profitability from escape is an effective deterrent to coercion, and that the efforts of the landlord (m) and the proportion of labor extracted (β) both unambiguously fall under such a scenario. Moreover, if one accepts the view espoused by Douglas North

[58] This observation has been noted by a number of authors. See for example Hatcher and Bailey (2001).

[59] According to North and Thomas (1995, p. 30), "The lord or seigneur was the logical person to settle disputes and in the last resort to enforce local law or customs; thus the provision of justice was added to his role of protector. The lord's power to exploit serfs, however, was not unlimited, but constrained (in the extreme case) by the serf's ability to steal away to seek illegal asylum..." Note that this observation further supports the case for a bias in the valuation of c described in Appendix B.

(1981) and M. M. Postan (1937) that the relative income of peasants and landowners was an important factor in determining the course of bargaining over feudal customary dues, it is also important to note that the indirect utility of a single peasant, in both absolute terms and relative to that of the landowner, rises as a result of these parameter deviations. The landowner's indirect utility increases initially as a result of the enhanced profitability of agricultural production, but this effect is eventually swamped by an inability to secure a greater supply of labor in the face of more profitable outside opportunities for peasants. Qualitatively these results are robust to changes in J and T by three orders of magnitude. Figure 4 below, which plots $\frac{landowner\ indirect\ utility}{individual\ peasant\ indirect\ utility}$, illustrates that although the income of the landowner was initially just under 20 times that of a peasant, by the end of the simulation this advantage is reduced to less than a factor of 2, and is cut in half when $\pi = .69$ and $P = 1.34$.

Figure 4: Relative Income, Landowner vs. Entire Peasant Community



However, it should be noted that when *only* P is increased, the income of the landlord relative to the entire peasant community *increases*. Thus if commercialization is posited as the underlying causal factor in the decline of serfdom, and bargaining power between landlords and serfs its mechanism, then it must occur in a context of inflation *and* increasing outside opportunities for serfs.

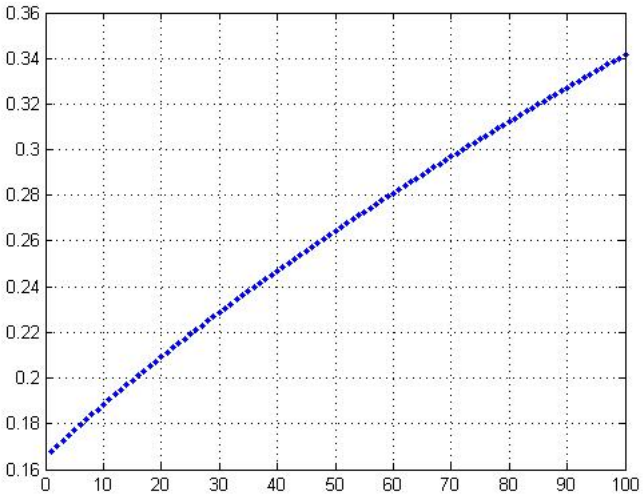
Simulations in which J and P are simultaneously increased also yield welfare implications which accord with the Malthus-inspired demographic model. As Postan (1937, p. 171) states, "the fluctuation of labour service requires no other explanation than that which is provided by the ordinary interplay of supply and demand - demand for villein services and supply of serf labor." Thus, as the peasant population swelled in Western Europe in the 12th and 13th centuries, and relative factor scarcities increasingly tipped the balance in favor of landowners, their augmented incomes could be

leveraged to extract more burdensome labor obligations from the peasantry.[60] Simulations to test this hypothesis illustrate that as the laboring population increases, and subsistence requirements apply upward pressure on agricultural prices, the expected utility of the landowner indeed rises relative to that of a single peasant, and relative to the peasant community en masse. Although the indirect utility of an individual peasant is increasing under these dynamics, that accruing to the landowner increases much more apace; in fact, so much so that the share of total income enjoyed by the landowner increases despite the expansion of the peasant population.[61] This insight, in conjunction with the comparative statics of Section 5.1, corroborate the predictions of the demographic model. In the context of Medieval Europe, one may point to the omission of rental payments made by peasants in return for use of the land as an important variable missing from the model; however, assuming that these payments would be a decreasing function of the land/labor ratio, their inclusion would only strengthen this result. Once again, qualitatively these welfare implications are immune to changes in the values of J and T by three orders of magnitude. Figure 5 below, which plots $\frac{landowner\ indirect\ utility}{total\ peasant\ indirect\ utility}$, illustrates that while initially the share of total income accruing to the peasant community collectively is 85%, this figure steadily drops even as the peasant population (J) expands and the price of output rises, so that by the conclusion of the simulation ($J = 147$, $P = 1.48$) this number has been reduced to 74%.

Figure 5: Relative Income, Landowner vs. Entire Peasant Community

[60] Douglas North also lends weight to the demographic model by arguing its converse, ascribing the eventual abrogation of serfdom in Western Europe to the population contractions of the 14th century. "The plague in 1347 became endemic, returning again and again so that probably population fell for a century...In the agricultural sector there was a return to an era of abundant land and scarce labor...The relative bargaining strength shifted from the lords to the peasants. The opportunity cost of peasants improved as escape to towns (which resulted in freedom after a year and a day) offered an alternative to the oppression of the local lord. Despite repeated efforts to regulate maximum wages, competition among landlords led to increasingly liberal terms for tenants as well as to rising wages; as a consequence, the master-servant aspect of serfdom gave way to recognition of copyhold rights and an end to servile obligations..." North (1981, p.134-5).

[61] This result is altered slightly when *only* J is increased. As is the case when both J and π increase, both the landowner and laborer utilities are increasing. The landowner's income relative to a single laborer increases as well, with that of the former being over 30 times that of the latter by the conclusion of the simulation. However, as the size of the peasant population swells, the relative income of the landowner versus the entire peasant community decreases, in contrast to Figure 5 above.



7 Conclusion

A focus of this paper has been to investigate the relationships of labor extraction extant on slave plantations in the antebellum Southern United States. Numerical optimization methods imply that, given the macroeconomic conditions which prevailed in that period, slave-labor productivity was on the rise. Though these arguments are tentative at best, we hope that further investigation will help inform the longstanding debate over the long-run viability of the peculiar institution. A second focus of this paper has been to illuminate and sharpen some of the more popular explanations for the abrogation of serfdom in Late Medieval Europe. It has been shown that our theory matches the predictions of the demographic model quite well, despite formalizing the character of property relations as prescribed by Brenner (1982, 2001). In the face of population expansion the efforts brought forth by a landowner in extracting the labor of direct producers will be reduced in both a binding and non-binding equilibrium. Moreover, collective resistance from laborers, whether through the petitioning of legal or religious organizations, or through day-to-day acts of "silent sabotage", will also be muted if the institutional framework is sufficiently biased in favor of landowner interests. Movements in the indirect utilities enjoyed by players also corroborate these findings. Interpretations regarding the commercialization model of European economic development are more mixed, though numerical analysis implies that a binding equilibrium is a likely eventuality. In a binding equilibrium, increases in the price of agricultural output and the laborer reservation utility, each of which may be interpreted as a sign of market integration, will lead to less coercive efforts on the part of the landowner. In a non-binding equilibrium, however, an increase in P, and therefore the marginal revenue amassed from labor, will induce a ramping-up of such efforts, and therefore an

entrenchment of the coerced labor associated with serfdom. Once again, the best response of the peasant community in the face of intensified labor obligations will depend on the leanings of the institutional framework adjudicating peasant-landlord disputes.

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Appendix A: Proof of Proposition 3

Part 1

Total differentiation of the landowner best-response function yields:

$$\frac{dm_n^*}{dJ} = \frac{2\sqrt{m_n^*}\left\{\left(\frac{\partial F}{\partial L}\right) + J\left(\frac{\partial^2 F}{\partial L^2}\right)\beta\right\}}{J\left\{\frac{1}{\sqrt{m_n^*}}\left(\frac{\partial F}{\partial L}\right) - J\left(\frac{\partial^2 F}{\partial L^2}\right)\left(\frac{c}{1-c}\right)^{\frac{1}{2}}\right\}} \tag{14}$$

Cursory inspection reveals that, given diminishing marginal product of labor, the denominator must be positive, and thus a positive numerator is necessary and sufficient for $\frac{dm_n^*}{dJ} > 0$. Because m_n^* is positive, we need only to determine the sign of the bracketed term, which requires specifying the production technology. It is straightforward to verify that $\left(\frac{\partial F}{\partial L}\right) + J\left(\frac{\partial^2 F}{\partial L^2}\right)\beta > 0$ under a linear specification. Suppose instead Cobb-Douglas production given by $F(L,T) = L^\alpha T^\gamma$, where for simplicity the productivity parameter A is omitted and $\alpha, \gamma > 0$. This yields:

$$\left(\frac{\partial F}{\partial L}\right) + J\left(\frac{\partial^2 F}{\partial L^2}\right)\beta > 0 \Longleftrightarrow \frac{\alpha T^\gamma}{(\beta J)^{1-\alpha}} + \beta J\left[\frac{\alpha(\alpha-1)T^\gamma}{(\beta J)^{2-\alpha}}\right] > 0 \Longleftrightarrow \frac{\alpha}{(\beta J)^{1-\alpha}} > 0 \quad \blacksquare$$

Lastly, suppose a CES production technology given by $F(L,T) = k(c_1 L^{-a} + (1 - c_1)T^{-a})^{-\frac{1}{a}}$:

$$\left(\frac{\partial F}{\partial L}\right) + J\left(\frac{\partial^2 F}{\partial L^2}\right)\beta > 0 \Longleftrightarrow \frac{T}{L} > \left(\frac{a(1-c_1)}{c_1}\right)^{\frac{1}{a}} > 0$$

This requirement on the land-labor ratio is necessary and sufficient for $\frac{dm_n^*}{dJ} > 0$. It should be noted that this restiction is in line with the theory of Domar (1970), which predicts a greater degree of coerced labor in settings where the land-labor ratio is high, as in 16th century Russia, for example.

Part 2

Follows from Part 1 and substituting the laborer best response into $\beta(m, R)$.

Appendix B: Calibration Procedure for Numerical Analysis

In the above simulations the price of agricultural output P is normalized to unity, and in accordance with a perfectly competitive benchmark the marginal cost of production, μ, is assigned the same value. Following Voigtländer and Voth (2012), the amount of arable land available to the landowner (T) is also set to unity, but it should be noted that the ensuing analysis is extremely robust to the value assigned to this parameter, even when augmented by three orders of magnitude. The production technology is assumed to be Cobb-Douglas, and the assumption of constant returns to scale is retained. Also in accordance with Voigtländer and Voth (2009, 2012), both of which investigate the effect of European demographic trends in the Late Middle Ages under a similar calibration and simulation paradigm, the output elasticity of labor is set to .6.[62] In regards to the antebellum South, the existence of increasing returns to scale in slave production has been the subject of mcuh debate and empirical scholarship[63], but because an overwhelming consensus on this important technical issue has yet to be reached, the assumption of constant returns is retained as a useful starting point. Fogel and Engerman (1971a) also employ an output elasticity of slave labor of .6 in their efficiency computations, and thus this parameter is kept constant throughout the analysis of both Medieval Europe and the antebellum Southern United States.

Given the politico-economic aspects of the contexts described in this paper, and the interpretation of c as the institutional power of the landowner *vis-a-vis* laborers, a value of $c > .5$ seems most appropriate. This follows from the fact that in medieval Europe legal disputes regarding peasants were exclusively adjudicated in manorial courts, absent any recourse to an over-arching legal authority, in which the lord himself would often serve as judge and jury.[64] As previously noted, Fogel and Engerman (1974) make an identical claim concerning the discharge of justice on slave plantations within the antebellum South. In their analysis it is also contended that planters self-interestedly promoted stable nuclear slave families as a means of increasing both fertility and labor productivity, despite the fact that slave marriages were forbidden under state law. "While the existence of slave marriages was explicitly denied under the legal codes of the states, they were not only recognized but actively promoted under plantation codes" (Ibid., p. 128). Thus, in order to recreate the discretion afforded landowners in the application of justice in both contexts, and maintain a realistic efficacy of resistance, c is set to .6.

[62]The authors note that this estimate similar to that used in Crafts (1985), and is in line with the average of Stokey's (2001) calibrations.

[63]cf. Fogel and Engerman (1974) and Metzer (1975) for arguments in the affirmative. Russell (1966) provides conflicting evidence.

[64]Bloch (1962), North and Thomas (1972).

The sweeping chronological and spatial scale of this exercise clearly precludes a value of J that is appropriate in all contingencies. Dennison (1987) observes that even restricting the unit of analysis to a single estate in 19th century Russia, the Voshchazhnikovo given to the Sheremetyev family following its patriarch's service in the Great Northern War, allows for ample heterogeneity in the number of peasant households per village. For example, Popovo was populated by only 3 households while eponymous Voshchazhnikovo was endowed with 201.[65] Similarly, Peter Kolchin estimates that while 71.9% of American slaveowners in 1860 owned between 1-9 slaves, 2.6% owned between 50-199, and 2.4% of slaves toiled on plantations with more than 199 slaves.[66] Though its techniques are summarily denounced by Fogel and Engerman (1971a), the assumption of 50 slaves per landowner used in Sydnor (1933), as well as a number of other articles in this period which attempted to quantify the profitability of a "representative plantation", will be utilized. Once again, however, the arbitrariness of this designation is mitigated by the robustness of our results to the value ultimately assigned. More specifically, the direction of changes in landowner and laborer indirect utility in response to parameter fluctuations, as well as the type of equilibrium obtained (binding or otherwise) is robust to changes in J by 3 orders of magnitude.

The reservation utility of laborers,π, is calibrated to reflect estimates of the amount time laborers were forced into the service of their landowner each week under both slave and villein labor, given in footnote 9. Using the midpoint between the roughly 5 days supplied under the former, and the 3 supplied under the latter, a value of .42 for π seems most appropriate. Lastly, the parameter A has been omitted from the analysis, (i.e., set equal to 1) both out of a desire for parsimony and because a reasonable estimate could not be gleaned from extant econometric studies.

[65] Dennison (1987, p. 31).
[66] Kolchin (1987, p. 54).