The Road from Serfdom: Property Rights and the End of the Feudal Economic System*

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Abstract

What were the causes of the transformation of feudalism to capitalism? How do changing market conditions affect economic institutions? I examine the disappearance of the feudal economic system and the formation of modern land property rights in the Kingdom of Hungary during the 19th century. The separation of the landlord and serf economies and the division of the commons finalized the abolition of the serfdom and created stable land property rights that were a prelude to modern agricultural production. I investigate this in the context of the economic integration (customs union and the construction of railroads) of the Habsburg Empire. I find that an improvement in market access increased the probability of the partition of landlord and serf economies. My results suggest that potential returns on secure property rights were important, but transaction costs played an important role in delaying their development.

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1 Introduction

The modern property rights are considered central to economic development, but it is less understood how this economic institution emerged. Feudalism was the dominating economic system in Europe for centuries and its disappearance marked the emergence of capitalism and modern property right system. According to North (1981), the most controversial characteristics of the feudal economic system were the serfdom, the labor service and the scattering of strips in the open fields. While there are several definitions, and the institution varied in time and space, (Ogilvie, 2014), serfdom usually meant some kind of bondage of the tenant peasant to his hereditary (usufruct) land and to his landlord. Hence the limited property rights in one's own labor and land were central features in pre-modern Europe that still common in developing country settings today. Researchers were puzzled by the fact that, while serfdom slowly disappeared in Western Europe after the Black Death, the strict control of the landlord over the peasants' labor and the traditional production structures reemerged in Eastern Europe during the 16th and the 17th century. In the Eastern part of the continent, the process of the abolition of serfdom started in the 18th century and lasted until the mid-19th century. Legally, the emancipation of the serfs often happened instantly, by a decree, but the disappearance of the feudal economic system and the emergence of modern property right institutions took much longer and it was more continuous in nature. The dismantling of this system meant separating the landlord and peasant economy: the end of the feudal in-kind payments and labor services, but the last step was often the separation of peasant and landlord properties and the partition of the common lands (forests and pastures), hence creating secure and transferable property rights.

My paper examines what were the economic forces that contributed to the break-up of the feudal economic system and to the emergence of modern property right regime in the 19th-century Hungary. I argue that market integration and improved market access, through increasing the value of secure property rights, decreased the attractiveness of the feudal economic system and contributed to the development of a modern property right regime and hence the structural transformation of agriculture.

As marketing opportunities improved, the value of agricultural surplus increased. At the

same time, the expansion of the demand for agricultural output raised the relative price of land, the more inelastic input. Hence, as trade costs decreased, eventually, the benefits of better property rights in land and more efficient production methods became larger than the costs of separating landlord and peasants economies and giving up the cheap but inefficient labor service. Since these are the bases of the feudal production methods, this process gave way to a more modern form of agricultural production.

To examine the process of the partition of the landlord and the peasant agricultural production, I have digitized village level data on 3,000 land settlements (úrbérrendezés) that separated landlord and peasant lands and divided the commons (pastures and forests) in a village. This process started in the early 19th century but it sped up after the revolution and the emancipation of serfs in 1848. These land settlements were the final, de facto step in disassembling the feudal production system.

During this time, there were two major changes that could potentially affect the market access of Hungarian villages. First, in 1850, the Habsburg emperor created a customs union between the Kingdom of Hungary and the other lands of the Habsburg Empire (Figure 1). While the internal customs had been abolished between the German and Slavic lands of the Empire earlier, but tariffs and lengthy administrative processes were applied at the borders of Hungary. The trade liberalization decreased the tariffs paid on the most important staple goods exported by Hungary[1], and it also eliminated the administrative burden of customs inspections. The customs union, however, affected regions differently depending on the how close they were to the Austrian markets. Villages closer to Vienna - the capital and the primary market for Hungarian products - benefited more from the customs union than villages farther away.

Since I observe the land settlements before and after the trade barrier was lifted, I use Difference-in-Difference analysis to estimate the effect of the change in market access on the probability of land settlements. I ask the question whether we can see an increase in the probability of land settlements as a consequence of the customs union among villages closer to the Austrian markets compared to villages farther from them? The Difference-in-Difference estimation shows that in the group of villages closer to Vienna than the median, the customs union

[1]For example, the tariff on wheat decreased from 7% to zero as a consequence of the decree. However, contemporaries found the administrative burden of the customs border inhibited trade more than the tariffs themselves.

increased the probability of land settlement by one percentage point. The Dynamic Difference-in-Difference results show that the role of distance to Vienna is insignificant before 1850 and it gains explanatory power during the customs union about five years after of the policy change. For comparison, according to the linear probability model, moving from the 25th to the 75th percentile of the distance to Vienna, increased the probability of land settlements by 17 percentage points during the period between 1850 and 1864.

In my second approach, I focus on the period after the customs union and I make use of the fact that more than 2000 kilometers (1300 miles) of railroads were built during this period that affected the market access of the villages in the country. To address the potential endogenity bias, I use an instrumental variable approach to address this concern. In my cross-sectional estimation, my proposed instrument is the Roman road network built around 1500 years before the land settlements have started and also several hundreds years before the emergence of the feudal institutions in the region. Roman roads can provide a plausibly exogenous source of variation in the railroads built in the middle of the 19th century. I find that a decrease in the distance to the closest railroad by 10 kilometers (6.2 miles) increased the probability of land settlement in a village by about 4 percentage points.

I also consider the fact that my data has a survival model structure, where the failure date is the year when the land settlement happened in a village. I am taking advantage of the panel nature of the data and I re-estimate the model in survival analysis setting. Because of the scattered construction of railroads, the distance to the closest railroad varies during this time, hence I can use time-dependent covariates in the survival model as well. The results of the survival analysis are in line with the previous results: villages closer to Vienna and those that experienced a larger improvement in railroad-accessibility exhibit a higher hazard rate of land settlement.

Furthermore, to learn about the role of the potential benefits and the coordination costs in land settlements, I conducted heterogeneity analyses. These show that the effect of market access was larger in villages with better soil quality for wheat production and with fewer landlord owning serfs in the village.

My paper contributes to the long scholarly debate on what forces contributed to the emergence, persistence and the eventual disappearance of serfdom. These views can be categorized

to be either related to resource endowment (geography), efficiency, or conflict of distribution (Ogilvie and Carus, 2014). One of the earliest explanations, made by Domar (1970), follows the resource endowment view. He argued that labor scarcity could be an explanation for emergence of serfdom in Russia. Because of the high land-labor ratio, serf labor was more valuable than land and since serfs often fled to the frontier area with less labor obligations, the feudal lords had the incentive to restrict the free movement of the serfs. Boserup (1965) also pointed out that the large, freely available land areas can make it difficult for the landlord to retain labor force without restricting mobility. But she argued that as population increases, labor shortage becomes less of a problem and the relative value of land increases compared to labor that creates an incentives to establish secure property rights in land.

Moreover, in their theoretical model, Acemoglu and Wolitzky (2011) argue that both observations may have their merits since higher labor scarcity can increase the return on coercion, but at the same time it can also increase the bargaining power for the peasants. The empirical relevance of the land-labor ratio was tested by Klein and Ogilvie (2017), who use data on serf villages in Bohemia from the mid-18th-century in Bohemia, also part of the Habsburg Empire. They find that higher land-labor ratios increased coercion measured by tax collected from serfs.

While large population shocks did not happen in the observed time period in Hungary that could explain the sudden disappearance of the feudal production system, to address the role of resource endowment, in my estimations, I control for the size of the serf land and the total number of serfs in a village using an earlier census of the rural population. I find that villages with higher historical serf population were less likely to go through land settlements, while villages with larger serf (urbarial) land had a higher probability to do so. After including these variables, however, the improvement of market access still has explanatory power.

Another explanation of the existence of serfdom is that it was actually efficient in maximizing output under the given circumstances (Ogilvie and Carus, 2014). North and Thomas (1973) argue that it was a rational decision from the side of both the landlord and the serfs. Transaction costs were high because of the underdevelopment of markets. Hence landlords could achieve their optimal consumption bundle easier using labor service in exchange for hereditary land use of the serfs than money payments of the tenants.

Acemoglu and Wolitzky (2011) argue that higher value of output increased the return on

labor coercion, hence it could be a motivating factor in the emergence or reemergence of serfdom. Since the landlords weight the value of the output from labor coercion against the cost of exercising it, whenever the first exceeded the second, they were willing to take action to repress labor. In their model, however, they don't consider the costs and inefficiencies of the feudal economic system. In my paper, I argue that even when an institution is not optimal anymore, changing the status may be costly and exogenous shock to costs and benefits may be necessary to trigger institutional reforms.

Several empirical papers look at how trade shocks affecting the return on agricultural production could shape imperfect labor markets. Naidu and Yuchtman (2013) use the British Master and Servant Law in 19th-century Britain to show that a positive labor demand shock increased the number of prosecutions against workers who breached their contract with their employer. The role of the value of output in labor institutions was also examined by Dippel, Greif and Trefler (2020), who connect labor coercion (low wages) to the export opportunities faced by Caribbean sugar plantations and the outside options of the workers. They argue that the high prices for sugar made the coercion of local population profitable but once export opportunities deteriorated, the coercive institution faded away. The connection between the export opportunities and serfdom was examined by Raster (2019). He observes the number of days of corvée labor on Estonian estates in the 18th century. He argues that labor coercion is stronger on estates closer to export ports. That is, landlords increased the number of corvée labor in order to take advantage of the better export opportunities of their goods.

My analysis provides an extension of this research, since I look at the effect of a trade shock on the dismantling of the feudal economic system, especially on the separation of serf and landlord economies. Since the large share of the land settlements took place after the legal emancipation of serfs, my analysis help us to understand what role the landlord's market power in land played in the feudal economic system. In this sense, my paper contribute to empirical understanding of connection between labor coercion and market power in land as argued by Conning (2004) and Binswanger, Deininger and Feder (1995).

My paper is also related to the literature on common property regimes and the disappearance of the open-field system. Hoffman (1975) argues that beside technological changes, it was the penetration of markets to rural areas that made it clear that the intensification of agriculture

and the market-based rationalization would be complicated under the open-field system. At the same time, McCloskey (1975*b*) argues that the system of scattered plots served as an insurance because it helped mitigating the effect of natural disasters. Technological development, however, decreased yield-volatility and the penetration of the markets to rural areas helped peasants to diversify away from agriculture. Because of this, an improvement in market access could contribute to the disappearance of the open-field system.

More specifically, my research is also related to the literature on the evolution of property rights. Beside North and Thomas (1973), Demsetz (1967) also emphasized the role of incentives in the development of property rights, that is, when the benefits from creating private property rights exceed its cost, communal land-use will be replaced by private ownership. Alston, Libecap and Schneider (1996), for example, examined the land titling process in the Brazilian frontier. They find that the proximity to the market center increases land values and the demand for title. Perego (2019) finds that higher agricultural prices increased the demand for land titling among farmers in Uganda, and the effect is larger the better a region's connection is to markets.

Finally this paper is closely related to that of Ashraf et al. (2020), who also examine the process of the peasant-landlord settlements that ended the feudal relationship in Prussian counties. They differentiate between "de jure" emancipation (the law that emancipated the serfs) and "de facto" emancipation (the actual agreement between peasants and landlords on the compensation of landlords for their loss). They argue that since human capital was necessary for industrial production, landlords whose initial level of capital on their estate was high were willing to emancipate serfs. They use the number of water mills in a given county as a measure of this proto-industrial capital, and they find that the number of water mills explains "de facto" serf emancipation. My paper extends Ashraf et al. (2020) in multiple ways. First, I observe settlements on village level, while they use county and district level emancipation rates. Second, I observe the timing of these land partition settlements from the early 19th century (the earliest in 1805) until 1864 in each year, while they use a cross-section of data for the counties and panel data only for the district level. On the other hand, my approach is complementary to theirs. The role of proto-industrial capital and the capital-skill complementary should be more prevalent in regions with better marketing opportunities.

The rest of the paper is organized as follows. In the next section, I briefly describe the feudal economic system in Hungary in the first half of the 19th century and the process of land settlements. In section three, I describe the data collected and used in the paper. In section four, I present the results, while in section five, I conduct heterogeneity checks. The last section concludes.

2 Historical Background

2.1 The Serfdom in Hungary

In the Kingdom of Hungary, the long list of legislative measures that restricted the life of the serfs started in 1514, after a peasant rebellion and a decade before the Ottoman Empire occupied large area of the Kingdom. Under these circumstances, the restrictions on peasant mobility were difficult to enforce, especially at the frontier regions of the country and in areas that came under Ottoman control. Hence, the enforcement of feudal dues and the exploitation of the serfs became stronger only after the occupied territories had been reconquered under the leadership of the Habsburgs at the end of the 17th century.

The problems of the feudal economic system became more apparent from the mid-18th century, when frequent wars increased the fiscal demand of the Habsburg emperors. Since serfs and their lands were the bases of taxation, the state took measures to protect the serfs and prevent their eviction from their land. In 1767, the ruler, Maria Theresa decided to regulate the landlords-serf relationship. This code, the *Urbarium*, set a maximum limit on the days of labor service and on other duties that the serfs owed to their landlords. This regulation also involved documenting the number of serf plots and the size of the serf land in each village. The empress also tried to limit the landlords' opportunity to evict the serfs from their lands (Felhő, 1970). The decree of her son, Joseph II in 1785, codified the rights of the serfs to move away from their landlord's estate if their feudal duties were paid, and they also gained right to learn any trades without the prior permission of their landlords. While the rulers realized the inefficiency of the feudal economic system, further steps toward emancipation were not made, mostly because of the resistance of the nobles.

then in the early 19th century, it was the group of progressive landlords that expressed emerging necessity to regulate the serf-landlord relationship. The legislation of 1836 was the first that regulated partition landlord and serf lands, the division of commons and redemption of peasants' feudal duties, although settlements happened sporadically even before this date.

The legal emancipation of the serfs, however, only happened in 1848 during a revolution and independence war against the Habsburg emperor. While the revolution failed, the legal emancipation remained in effect. The ruler, finally, having a political edge over the nobility, started to disassemble the remnants of the feudal economic system.

The legal emancipation, however, did not mean the end of the feudal relationship between the former serfs and the landlords. Land settlements and the partition of lands and commons continued after the emancipation on a village-by-village basis, as before. In 1853 the emperor issued another decree to help the process of land settlements. The legal infrastructure was expanded with the creation of specific courts to handle the disputes of the land divisions.

2.2 The Feudal Land Property Right System

The basis of the feudal economic system was the manorial economy. The manor consisted the land under the direct ownership of the landlord, the so-called demesne (or allodium in Hungary) and the land (called urbarial land) used by the serfs as tenants according to feudal law. In the feudal legal system, the serfs held usufruct rights to use these urbarial lands and their children could inherit it but they did not have private property rights, that is, they couldn't sell it or mortgage it and the landlord had the rights to evict them although under limited circumstances from the late 18th century. In exchange of their tenure, the serfs owned payment in-kind, money or labor service to the landlord. As a consequence of the regulation of the landlord-serf relationship by the Urbarium of Maria Theresa, the amount of feudal dues were directly related to the size of the landplot used by the serf.

The land owned directly by the landlord, the demesne, was either under the landlord direct cultivation or was similarly rented out to peasants. Often, otherwise landless serfs cultivated part of the demesne land as tenants. The length of these leases varied, often set for decades and were renewed for the next generations of the serf family.

While, the urbarial and the tenant-cultivated demesne land may seem to be similar, their legal status were different. Tenants cultivating demesne land did not own taxes to the state and the dues owed to the landlord was also often lighter than that of paid by the urbarial serfs. The differences between the two kind of lands became important, however, after the emancipation of the serfs. Those who held urbarial lands had become the owner of their plots after 1848, gaining full property rights. Demesne lands, however, whether they were used by the landlord or rented out to tenants remained the property of the landlord. That is, serfs who rented plots from the landlord did not gain property rights. They continued to owe rent payment (in-kind, money or labor service) to the landlord and they faced eviction if they denied these services (Für, 1965).

The most important factor that made the emancipation of serfs in Hungary different from that of the other Eastern European cases is that it was the state that compensated the noble landlords for their loss of urbarial land. The funding for this came from a new tax. Hence serfs using urbarial lands didn't have to compensate the landlord, and they gained full property rights of their land. Serf who leased land on the demesne got the option of pay redemption fee to the landlord if they wanted to become the owner of their plots, but the government did not contribute to this compensation. Hence, during the land settlements, the most important question became whether the land plot cultivated by a serf belonged to the demesne or was urbarial lands (Für, 1965).

2.3 Land Settlements

The process of land settlements included the surveying of the village and determining the exact location and size of the demesne and the urbarial lands before the partitioning. The next step then involved the creation of larger, continuous blocks of the landlord's property and dividing of the common pastures and forests. An example of the outcome of a land settlement is illustrated in Figure 2.

The first land settlements happened at the beginning of the 19th century but the process sped up after the emancipation of serfs in 1848 (Lónyay, 1865). The most important question related to the land settlements were the actual size of urbarial land and the divisions of common

pastures. As a result of the emancipation of the serfs, those who cultivated urbarial lands became the owner of their plot with the state compensating the landlords for their loss. Hence, the proof of the status of their land was essential for the peasants. Furthermore, common pastures and forests were divided between the landlord and the former serfs based on the amount of urbarial land. (Für, 1965). At the same time, lot of serfs cultivated land with similar terms as those owning urbarial plots. These tenancy relations also often stretched over several decades and generations. If the cultivated land was, however, part of the landlords' demesne, these tenancy contracts were considered private in nature. Even after the emancipation, the serfs did not gain property rights of these plots. The peasants had to compensate the landlord for these lands if they wanted to keep them, but mostly it was the landlord's discretion to accept the compensation.

While serfs were emancipated in 1848, this did not mean automatically that peasants economies became separate from the manor. In order to speed up the process of land and to avoid long legal battles between the landlords and the serfs, the emperor issued a decree (urbéri pátens) in 1853 to give guidance on how to define the size of the urbarial land and how to separate the common forests and pastures. The decree used the 1767-1773 survey of serf land (the Urbarium) as the basis for these decisions. At the lowest level, the county authorities were responsible to facilitate the process. If the landlords and the former peasants could not agree and the local authorities were not successful in the mediation, the case moved to regional authorities and then to the central authority. In order to ease the burden on the counties, in 1856, the state also created a system of special courts with the primary role to handle the land settlements.

The land settlement put administrative burden on both sides. Legal documents that could prove the urbarial or non-urbarial status of a land must have been collected. Engineers had to be hired to survey the land of the villages. Lawyers represented both the landlord and the peasants during the process. Since the land settlement were mostly initiated by the landlords, they bore a large part of the administrative burden (Simonffy, 1960). Moreover, to convince the serfs to accept the offer of settlements, the landlords often offered better quality land to the peasants (Tilkovszky, 1961). The land settlement sometimes happened in a few years but if the sides could reach an agreement, it could last for decades. This happened if the peasants argued that the size of the urbarial land is larger than what was find by the surveyors of the landlord.

The serfs often argued that they paid more tax to the state than the size of the offered land would suggest. Other times, the sides couldn't agree on the partition of the common pastures or forests. In the end, the lengthy legal process meant that property rights on the lands could not be established and it often halted any attempt to invest in the land.

Figure 10 and 11 show the villages where the land settlement happened by 1850 and where it happened by 1864, the end of my sample period.

2.4 Change in Market Access: Customs Union and Railroad Construction

The Kingdom of Hungary differed from other Eastern European regions in the sense that it didn't have good connection to Western European markets. Unlike Poland, Prussia and the Baltic regions, it didn't have easy access to seaports and its rivers flow from the West and North to the East and to the South. Documents on the Hungarian exports in the 1780s show that the largest part of the Hungarian trade to the Austrian lands was animals (cattle and sheep), while grain export was much less important (Szántay (2014) and Berlász (1993)).

The circumstances changed little until regular steamboat transport started in 1831 on the Danube river between Vienna and Pest[2] and when the first railroad line was constructed in 1846 between Pest and the town of Vác, however, the railroad construction only sped up after the revolution, decreasing the transport cost of regions with previously bad connections to larger markets (Figure 3 and 4)[3].

In October 1, 1850 customs union was created between Hungary and the Austrian lands by an imperial decree (Figure 1). As a consequence, tariffs were abolished at the border between the Kingdom of Hungary and the other parts of the Empire. On wheat, for example, the tariff rate decreased from 7-8% to zero per cent. As a consequence of the customs union, however, the administrative burden of customs inspections were also eliminated ,that contemporaries found more important in hindering trade between the two parts of the Empire.

Regions were, however, differently affected by the policy change. Areas closer to the border were affected more because the actual tariff and the non-tariff barriers composed a higher

[2]Budapest was created in 1873 by the unification of Buda, Óbuda, and Pest.

[3]For the 19th-century maps of railroads, rivers and villages, I used the GISta Hungarorum Database (GISta Hungarorum (OTKA K 111766) that can be found at https://www.gistory.hu/g/en/gistory/otka

percentage of their trade costs with the Empire. The importance of the customs union in the development of the Hungarian economy was debated by Komlos (1983), but Alix-Garcia et al. (2018) found evidence that the customs union contributed to the decrease in the forested area in Hungary right after its creation. My research contribute to the understanding of their findings as well, since as we saw before, the land settlements were the preconditions for the forest-clearing. The sides could only clear new areas of forests, once the land settlement was finished and property rights were established in the former commons.

My paper is also relevant in understanding Komlos (1983) argument that the abolition of serfdom did not increase the productivity of Hungarian agriculture. Labor obligations were only one aspect of the feudal economic system that was considered as an obstacle to higher productivity. The communal agriculture (open-field system) and the lack of clear property rights are also often cited as institutional settings that hinder development. Hence the slow process of land settlements could explain why the increase in agricultural productivity occurred only decades after the customs union. My dataset gives the opportunity to evaluate these effects on a disaggregated level.

2.5 Inefficiencies in the feudal economic system

Because of the high transport cost and the lack of proximity to harbors grain export to Western Europe was less important in Hungary than in the Baltic region until the early modern period. In the mid-16th century 93% of the export from Hungary to Austria was animal (Ember (1988), p. 201) but the role of wheat in the Hungarian export increased during the 18th century.[4]

Since animal husbandry was more important under these circumstances, common pastures, forests and even demesne lands were used for grazing animals. In most estates, labor service was less important, while huge portion of the income of an estate came from the in-kind payment of the serfs to the landlord. For example, landlords marketed huge quantity of wine that was provided by serfs in exchange of the lease of the vineyards. Under these economic circumstances, the feudal economic system faces less challenges. However, once the landlord wanted to start a more intensive agricultural production, he faced the fundamental problems of the

[4]Even in 1783 the value of exported wheat was 584.000 forints while that of the cattle export was 2.272.000 forints (Horváth (1868) p. 254.).

feudal land system. The labor service of the serfs were of low efficiency, while using them in some agricultural activities like in vineyards, did more harm than good (Felhő, 1970).

On the other hand, demesne and serf lands were scattered around each other in the estate, that made it especially difficult to use efficient technologies and protect the output. In the crop rotation system used in manorial economies, part of the land - the fallow - was left resting regularly to regain its fertility. Fallows were also often used to graze animals. A more efficient way of using fallows could have been planting legumes or fodder crops that could have helped the soil to regain the nutrients. Abandoning fallows, however, was difficult in the feudal land system, since the grazing animals of the serfs could destroy the crops on the landlord's land before the harvest. In his seminal writing, the Hitel (Credit, 1830), the famous progressive Hungarian estate owner, István Széchenyi emphasized that a landlord can expect rewards for his efforts only from lands that owned by himself alone; otherwise, the the profit is uncertain (cited by Tilkovszky (1961)). This riskiness of the return on agricultural investment shows that landlords faced uncertainty of their property rights regarding their land, and as Besley and Ghatak (2010) show the chance of expropriation, or in this case the destruction of income can decrease the incentives for investment in agriculture.

The transformation of agricultural production, however, (enclosing of the commons, hiring wage labor instead labor service, and the dismantling of the open-field system) was still a slow process. The separation of the landlord and the peasants economies did not happen everywhere at the same time. One possible explanation is that changing the existing institutional settings had large transaction costs. The landlords faced administrative and financial burden of the lengthy legal process and coordination problems. In this circumstances, low or uncertain demand and limited marketing opportunities could decrease the incentives of the landlord to invest in better production technologies and property rights. These imply that an endogenous change in the institutional settings would require a shift in the potential benefits or the costs of setting up secure property rights (Demsetz, 1967). Better market access, however, could increased the value of the lost output, that eventually became greater than the fixed cost of land settlement and land partition with the serfs. When it happened, landlords initiated the settlement or were willing to agree to more favorable terms with the serfs and were willing to accept temporal losses in exchange for the future increases in profits (Tilkovszky, 1961).

A conceptual framework to further motivate the empirical analysis can be found in the Appendix A.1.

3 Data

3.1 Land Settlements

In 1864, the Statistical Department of the Hungarian Academy of Science requested information from the government on the process of land settlements. This information was collected and subsequently published by Lónyay (1865) in the new annual Statistical Review of the Academy. The digitization of this data consists the main outcome variable I examine in this paper. I observe the year when the land settlement was finished in a given village up to 1865. In most of the cases, the data give the information whether the settlement happened by "peaceful agreement" between the landlord and the peasants or as a result of a court trial.

The earliest agreement in the datasets is from 1805, while the latest agreements are from 1864. Several cases were in progress in this year. The process of land settlement has been started or finished in 3000 villages by this year. Figure 5 shows the number of property settlements in a given year and the cumulative value of them, while Figure 7 shows the cumulative percentage of villages where land settlement happened.

The map of Figure 6 shows the area of townships (villages and small towns) that are in my sample. The missing townships are non-feudal villages (like housing projects around a mining site), or royal villages and other privileged areas like the autonomous territory of the Jászság and the Kunság.

3.2 Control Variables

Queen Maria Theresa issued the regulation of the landlord-serf relationship, the so-called *Urbarium*. This maximized the feudal duties (money, in-kind payment and labor service) that the landlords could request from their serfs. Since both the feudal duties and the state tax paid by the serfs were based on urbarial serf plots, the regulation included a survey (between 1767

and 1774) of the number of serfs and the number and size of urbarial serf land in each village. The survey included the number of villeins (serfs with land), the number of landless serfs with a house (inquilinus), and landless serfs without even a house (subinquilinus). The number of serf plots and area of these plots are also recorded in every village that was included in the survey. This data on village-level was published in Fónagy (2013). The number of villages in this survey is around 9000. Several municipalities might have not been included in this survey. Royal cities and other municipalities with privileges were excluded. Other villages did not exist at this time and had been settled by peasants after the survey. Other villages had different, non-feudal relationship with their landlord.

I have also collected data on whether a given village was owned my the ruler at the end of the 18th century using the Historical Atlas of Municipalities (Magyarország történeti helységnévtára), a publication of the Hungarian Statistical Office.[5]. For some counties, this dataset is not available, hence, I collected information on whether a village was owned by the ruler from the book of Vályi (1796-99).

The survey of 1667-1774 also contains information on the landlords in almost every cases. I use this information to differentiate between villages owned by one or multiple landlords.

I also use data on soil quality of the World Soil Information system from the International Soil Reference and Information Centre[6]. The variable is the probability that a soil is Chernozem, a black-colored fertile soil that is considered to be the best for cereal production.

Data on terrain ruggedness is from Nunn and Puga (2012), while the data on elevation is from the Land Processes Distributed Active Archive Center[7].

3.3 Market Access

My main explanatory variables are those that measure the market access of a given village related to the main consumer markets. In most cases, I use a village's straight-line distance to Vienna. This can be seen in Figure 8, where darker shading shows a larger straight-line distance from Vienna. I also created a measure of market access using the average population

[5] *Magyarország történeti helységnévtára. (Historical register of Hungarian municipalities)* (1987-2004)
[6] https://www.isric.org/
[7] https://lpdaac.usgs.gov/products/srtmgl1v003/

of the five largest cities in the Habsburg Empire in 1850 outside Hungary weighted by their distance to each village. It is calculated in the following way:

$$MA_i = \sum_j \frac{pop_j}{dist_{ij}}$$

Where the five most populous cities are: Vienna, Prague, Brno, Venice, and Krakow according to 1850 population.

Since according to Glósz (2014), the largest part of export was conducted on rivers, I also measured the distance of each village to the Danube, the largest river of the Empire and the only one in Hungary that provided direct river-connection to Vienna (Figure 9). Finally, in some analysis I also use the measure of the straight-line distance to the Danube and then along the Danube river to Vienna. Table 1 summarizes the dataset on the the dependent and explanatory variables.

4 Empirical Analysis

To test the role of market access in land settlements, first, I look at the relationship between the straight-line distance of each village to Vienna and the probability that the land settlement happened in a given village by 1864. Since the largest share of trade costs at this time was the cost of transporting goods to the market, villages closer to Vienna had an advantage the marketing of their agricultural products.

4.1 Probit and Linear Probability Model

To look at the relationship between the distance to Vienna and the probability of land settlements, I estimate both a probit and linear probability model. Hence, in my first estimated regression I use the whole time period and the main explanatory variable is the logarithm of the straight-line distance of a village from Vienna. The dependent variable takes the value 1 if the land settlement happened by 1864, and zero otherwise. With this estimation, I examine whether there is any relationship between market access and land settlements in the whole

sample. I estimate both linear probability model and probit model.

The regression of the linear probability model has the following form:

$$Land\_Settlement_i = \alpha + \beta\ log(distance\ to\ Vienna_i) + X_i\delta_c + u_i \quad (1)$$

X_i shows the covariates I use from the survey of Maria Theresa: number of villeins and the size of the urbarial land in acres. While the probit estimation has the following form:

$$Pr(Land\_Settlement_i = 1|X_i,\ log(distance\ to\ Vienna_i)) = \\ \Phi(\alpha + \beta\ log(distance\ to\ Vienna_i) + X_i + \delta_c + u_i) \quad (2)$$

Where Φ is the normal cdf, δ_c is the county fixed effect. In all regressions, the standard errors are clustered at the district (járás) level. In Table 2 the first three columns report the marginal effects of all major variables in the probit model, while the forth to sixth column show the respective coefficients of the linear probability model. We can see that the coefficients on the log distance from Vienna is significant in the first two specification of both models, but when all the explanatory variables are included, the coefficients on the log distance from Vienna becomes insignificant. The coefficients of the control variables, however, are significant. They show that the larger is the size of the urbarial lands, that is lands cultivated by the serfs and the smaller is the number of serfs in the village, the higher the probability of land settlement in a village.

In 1850, the customs borders between Hungary and the rest of the Empire were abolished, so next, I use the same measure of market access, but I conduct two estimations to see whether this effect is different in the periods pre-1850 and post-1850. In the first estimation, I use the dependent variable that takes the value 1 if the land settlement happened by 1850 and zero otherwise. That is, the value of the dependent variable for all the villages where settlement happened after 1850 is zero. In the second estimation I run the regression on a smaller sample that includes villages where land settlement did not happen until 1850, that is, I use the same dependent variable as in the very first estimation but on a smaller sample. Estimating the probit model, I find that land settlements didn't happen with higher probability in villages closer to

Vienna before the customs union, but after the trade barriers were lifted, the distance to Vienna became a significant explanatory variable as can be seen in Table 3. The result remains similar if additional variables and county fixed effects are included in the estimation.

To check, whether the results are robust, I estimate a logit model a linear probability model and they also show a significant negative coefficient for the distance from Vienna after the year 1850 4. If I reestimate the probit and the linear probability model using levels (kilometers) instead of logarithms the result remain similar. (See Appendix B). The point estimate in column 4 implies that moving from the 25th to the 75th percentile of the distance to Vienna, increases the probability of land settlements by 17 percentage points between the period 1850-1864.

To learn about the role of the customs union in the accessibility of export markets, I repeat the estimation with other measures of the treatment intensity, the composite market access measure, the straight-line distance of a village to Vienna along the Danube river. Table 7 show that the measure of the distance to Vienna along the Danube river behaves similarly to the main measure, the composite market access does not. Again, the market access measure uses the average population of the five largest cities in the Habsburg Empire in 1850 outside Hungary weighted by their distance to each village. This measure has a higher value with larger market access, hence one would expect a positive sign after 1850. I find that according to this variable, market access negatively affected the probability land settlement, however, this effect decreased after 1850.

To handle the possible problem of spatial correlation I cluster the standard errors at district (járás) level, but in Table 5 I also report standard errors clustered at a higher, county level. As a different clustering strategy, using the methodology of Bester, Conley and Hansen (2011), I cluster instead on a series of 0.5degree-by-0.5degree grid squares that completely cover the examined area. The results from this estimator can be also seen in 5. Finally, in Table 6,I use Conley (1999)'s estimator that allows for serial correlation within a given radius around each observation. In Table I show the result for different - 20, 25, 30 and 50 km - cutoffs.

4.2 Difference-In-Difference Estimation

In some villages, the process of land settlement happened before 1850 (the customs union in the Empire), but after that year, we can see an increase in the number of places where land settlements were finished. The customs union could be potentially important factor in the change of market access, because this decreased both the tariff and non-tariff barriers to trade between Hungary and the the other provinces. It eliminated the tariffs and abolished the administrative burden of customs inspections that contemporaries found more important in hindering trade between the two parts of the Empire. Villages, however, were affected to a different degree by this policy, depending on how much they could take advantage of the end of the tariff and non-tariff barriers. Beside the custom borders, the other relevant factor of trade costs at this times were the transport costs. Intuitively, tariffs were a smaller share of the total trade costs for agricultural producers who were farther away from the potential consumers.

Taking advantage of the panel nature of the data, I can also address the potential bias coming from omitted variables and I use difference-in-difference estimation to examine whether access for export markets had an effect on land settlements. I use the straight-line distance to Vienna the define the treatment group as villages that are closer than the median to Vienna. We could expect that being closer to Vienna became more advantageous once the customs border were removed and both tariff payments and customs inspections were abolished. I estimate the regression of the following form:

$$Land\_Settlement_{it} = \alpha_c + \beta treat_i + \gamma treat_i \times after_t + \lambda_t + u_{it} \tag{3}$$

where $Land\_Settlement_{it}$ is the dependent variable that takes value 1 if the property settlement and land partition happened in village i in year t or before. α_c is the county fixed effect, and λ_t is the year fixed effect. The $after_t$ dummy indicates the year 1850 and years after that, while the $treat_i$ is an indicator of some measures of market access.

To examine the robustness of my results, I use different measures for the intensity of the trade liberalization and the change in market access. First, as I mentioned above, I use the simple straight line distance of a given village from Vienna. Second, I use a market access measure that takes the average population of the five most populous cities in the Habsburg

Empire outside Hungary weighted by their inverse distance to each given village. Third, I am using the straight-line distance to the Danube, the largest and most important river connecting Hungary to Vienna.

The treatment group in the first case is the collection of villages that are closer to Vienna according to the straight-line distance measure than the median village. Similarly, for the *Market Access* measure, a village is in the treatment group, if the value of its market access is above the median. While for the third case, a village is in the treatment group if its distance to the Danube river and then along the Danube to Vienna is less than the median.

Table 8 shows the treatment effect on land settlements. The coefficient of the dummy of being closer to Vienna than the median distance of villages has the expected positive sign, that is, the probability of land settlement increased more in villages with higher market access after the customs union, while in the control group the removal of trade barriers did not have large effect. I estimate that the customs union increased the probability of land settlement by 1 percentage points among the villages closer to Vienna than the median. The explanatory variables are also statistically significant and have similar coefficients as in the previous estimations.

I get similar results if I use other measures of market access. Using the composite market access variable, I also find that the probability of land settlement increased in villages in the treatment group. Using the distance to the Danube river and then along the Danube to Vienna I get similar although less robust results. Once explanatory variables are included, the coefficient on this variable becomes insignificant.[8]

4.3 Dynamic Difference-In-Difference Estimation

After this, using the fact that annual data is available, I look for systematic differences between the compared groups in terms of their proximity to Vienna in the years, when the customs borders still existed. Using event-study analysis, one can show the absence of pre-trends between the treatment and the control group. To get year-wise difference-in-difference coefficients, I estimate the following event-study regression

[8]To check the robustness of the results to spatial correlation, similarly to the Probit estimation, I cluster the standard errors at district (járás) level, butI also report standard errors clustered at the county level and based on the 0.5degree-by-0.5degree grid squares. The results are Table 17 in Appendix show the results.

$$Land\_Settlement_{it} = \alpha_c + \sum_{j=1836}^{1864} \beta_j treat_i \times 1.(year = j) + \lambda_t + u_{it} \quad (4)$$

where, again, $Land\_Settlement_{it}$ is the dependent variable that takes value 1 if the land settlement happened in village i by year t. α_c is the county fixed effect, and λ_t is the year fixed effect. The coefficients β_j's capture the average difference in the new land settlements between the two groups in year j relative to the reference year 1850. The $treat_i$ is an indicator of some measure of market access. I restrict the sample to start from 1836, when I have larger number of observations for a given year.

Figure 12 and 13 show the result from the estimation of this equation when the treatment is assigned by the straight-line distance and the composite market access measure, respectively. The figures show that there are no preexisting differences between the compared groups in terms of land settlements. The coefficients on β_j's insignificant before 1850, but become large and significant after that. The coefficients, however, start to be significant only five years after 1850, although, the estimated values of the coefficients increase.[9] There are a few possible explanations for why the customs union didn't affect the land settlements right-away. Regarding my dependent variable, I observe the year when the land settlement concluded in a given village and not the beginning of the process. Reaching an agreement usually took from one to a a few years, and in case of a trial the process could last several years or a decade. Hence, one would expect that the effect of a change in access to export markets should show up with a few years lag. Since most of the cases, I have information whether the land settlement happened through agreement or trial I can compare the effect of the customs union in these two groups. In the heterogeneity analysis, I indeed find the distance to Vienna is a more important explanatory variable in case of villages where the land settlement happened through agreement and not through trial.

Another explanation is that there were lot of uncertainties at the early years about the process of serf emancipation. Landlords might have waited for the decision on the emperor regarding the property rights of demesne and urbarial lands. It was in 1853 when the emperor

[9]The estimation when the treatment is assigned by the distance to Vienna along the Danube river show very similar results and can be found in the Appendix.

issued a decree with detailed instruction regarding the process of land settlements and in 1856 when special court system was created to handle the cases of land partitions. These changes decreased uncertainty and could speed up the process by decreasing the costs of land settlements.

It is also a possible explanation is that the railroad construction altered the importance of straight-line distance to Vienna as a proxy for market access in the years after the customs union when approximately 1200 miles of railroads were constructed. Hence, in the next section, I look at the role of railroads in explaining market access.

4.4 The Role of Railroad Construction

One could argue that other changes might have happened at the time of the customs union that could also potentially affect the probability of the land settlements. Although I control for several related variables, to address the possibility of other factors potentially coinciding with the customs union, I restrict my sample to the data from 1850 to 1864. While there was no further trade liberalization during this period, the railroad construction during this time could arguable affect the market access of the villages in Hungary.

Between 1850 and 1864, almost 2,000 kilometers (around 1,200 miles) of railroad was constructed that potentially decreased trade costs agricultural producers faced at this time. Figures 3 and 4 show the evolution of railroad network in the sample period. Next, using map of railroad lines constructed at this period, I estimate the effect of the change in distance to the closest railroad on the probability of land settlements between 1850 and 1865.

I estimate the following equation:

$$\Delta Land\_Settlement_{50\_64i} = \alpha_d + \beta_i \Delta Railroad\_dist_{50\_57i} + X_i + u_{it}$$

where $\Delta Land\_Settlement_{it}$ takes value 1 if settlement happened in village i between 1850 and 1865, α_d is the district fixed effect, β_i is the coefficient of interest: the effect of the change of the the distance to the closest railroad, and X_i are additional covariates.[10]

[10]The estimations related to the railroads are in levels and not logs. The results of the estimations if I use logs are very similar and can be found in the Appendix.

I restrict the sample to start from 1850 - after the customs union was created and hence ask the questions: what is the probability of land settlement in a village between 1850 and 1864? Table 9 shows the results of the estimation. I find that a larger decrease in the distance to the closest railroad indeed increased the probability of land settlement: a decrease in the distance to the closest railroad by 10 kilometers (6.2 miles) increased the probability of land settlement in a village by about 2.45 percentage points.

In this model, I don't use the information on neither the years of the land settlement and nor the years of the railroad construction, but I pool the all the years after 1850. Hence assuming that the railroad construction do not affect land settlements in the same year as we have seen in the Dynamic Difference-in-Difference estimation, I have restricted the year of railroad construction in the explanatory variable to the years from 1850 to 1857. Results for considering different years of land settlements (1850-1860 and 1850-1864) can be found in the Appendix.

One could also expect that the role of railroads in transportation should be more relevant in areas that previously did not have access to navigable rivers. To examine this, I redo the OLS estimation for two subsamples: for villages closer to the Danube than the median villages and those farther away. The results are in line with the expectations. The coefficient on railroads are larger for villages that did not have good access to the Danube river. The results can be found in Table 20 in the Appendix.

To properly assess the effect of railroads, I have to consider whether railroad construction could be endogenous to land settlements. First, it is possible that missing variables may drive both new railroad construction and land settlements. For example, railroads could have been built to connect the most fertile lands with the export markets, while landlords in a fertile region might have more incentives to partition their lands from the peasants. Hence, I use an instrumental variable approach to address this concern. My proposed instrument is the Roman road network built around 1500 years before the land settlements have started. I instrument the accessibility of railroads by the distance to the closest Roman roads. This approach is similar to that of Martincus, Carballo and Cusolito (2017), who use the Inca road system as an instrument for present day road construction. Figure 15 shows the original Roman road system.

It is a good instrument, if it can predict the expansion of the railroads in the middle of the

19th century. The location of the Roman roads could be correlated with the placement of the railroads, because road construction in general follow natural boundaries, like rivers, and areas where construction requires only minor changes in the landscape.

On the other hand, it is important that it should be uncorrelated with the error term. We can expect it to be the case, first, because the Roman roads were built long before the emergence of feudal institutions in Hungary and around 1500 years before the land settlements have started. Furthermore, only the so-called western part of the region that later became the Kingdom of Hungary was part of the Roman Empire. Hence, these roads were not built in order to transport grains from the region.[11] Finally, Transdanubia was the part of the Roman Empire around the same time and approximately for the same length as Britain and as Michaels and Rauch (2016) show, the Roman network of cities did not survive into the Middle Ages in England.

Table 10 show the result of the 2SLS estimation. The results have the same sign as the OLS estimation, but the coefficients are larger: a decrease in the distance to the closest railroad by 10 kilometers (6.2 miles) increased the probability of land settlement in a village by about 12 percentage points.

4.5 Survival Analysis

Since the outcome variable is a dummy that takes the value 1 if land settlement happened in a village by a given year, one could argue that survival analysis would fit this data structure better. In order to analyse whether the results are sensitive to this feature of the data, conduct a survival analysis as well.

To visualize the path of the survival rates in the treatment and the control group, first, I look at the Kaplan-Meier graph. Figure 14 shows the Kaplan-Meier survival rates for villages with above and below the median distance to Vienna. Similar to the Dynamic Difference-In-Difference estimation, we can see that the survival rates moves very close to each other before the customs union, and they started to diverge around 5 years after the policy change. After that, villages closer to Vienna had a lower survival rate, that is, a higher hazard rate of land settlement than those farther away.

[11] The most important sources of grain for the Roman Empire were Egypt and Sicily.

Since the Kaplan-Meier estimator doesn't allow to control for a a wide range of covariates, I also estimate a parametric model. Taking advantage of the longitudinal data structure, I estimate an exponential hazard function such that the hazard rate at time t is

$$h(t) = exp(\beta_1 log(distance\ to\ Vienna_i) + X_i) \tag{5}$$

The panel data estimation shows that the distance from Vienna decreases the hazard rate of land settlement happening in a given village if we use the whole sample, although the coefficient is not significant. I also look at whether the effect is stronger after the creation of the customs union. I re-estimated the model using an interaction term of the variable of the distance of a village from Vienna and the post-1850 dummy, that takes the value zero before 1850 and one after that:

$$h(t) = exp(\beta_1 log(distance\ to\ Vienna_i) + \beta_2 after_t + \beta_3 after_t \times log(distance\ to\ Vienna_i) + X_i) \tag{6}$$

where $after_t$ takes the value 1 if time is after 1850. In this case, we expect the coefficient on the interaction term of the distance and *after* dummy to be significant and less than 1. As Table 11 shows, the interaction term is statistically significant, that is, the distance from Vienna became a significant factor after the customs union was created. Hazard rates are lower for villages with greater distance to Vienna after 1850.

In order to compare the results from the earlier estimation related to the role of railroads, in the final step, I take advantage of the panel nature of the railroad data, and I re-estimate the model using time-dependent covariates in the survival model. Table 12 shows the results: the larger the decrease in the distance to the closest railroad, the larger is the hazard rate of land settlement in a given village. That is, villages that gained better access to railroads between 1850 and 1857 had a higher hazard rates of land settlements than villages that did not gain as much market access from railroad construction.

5 Heterogeneity Analysis

5.1 Settlements: Trial versus Agreement

The process of land settlement often happened through a peaceful agreement between the landlord and their former serfs, but if the landlords and the former peasants could not agree and the local authorities were not successful in the mediation, the case moved to regional authorities and then to the central authority. If the landlord and the peasants could agree, settlement could happen in a year or two years. In case of disagreement and if the court had to be involved in the process, the settlement could take several years or more than a decade. Hence one could expect that we should see a stronger connection between the timing of land settlements and the change in market access in case of agreements. Table 13 shows that indeed, we see a stronger and more significant effect in case of villages where the settlement happened through agreements.

Since I do not observe the start of the process of the land settlements, only the year when it concluded, it can potentially explain why I observe a few years lag in the reaction of the process to the customs union. One could expect that an improvement in market access could incentivize a landlord to initiate a land settlement, hence I could see a larger effect if my outcome variable would be the year of the start of the land settlement. On the other hand, the process of land settlement could last for several years after the start and final property rights security could have not been achieved without finishing it. Hence, an increase in market access could also incentivize landlords to conclude the agreements by making more generous offers to the serfs.

Using the Kaplan-Meier graph 16 to examine a sample that excludes villages with trials, we can see that in this subsample, villages closer to Vienna still had a land settlement with higher probability but this difference occurs much earlier than in the whole sample. This result suggest that the costs of disagreement and trial could explain part of the delay in land settlements.

5.2 One versus Multiple Landlords

Villages differed based on whether they were owned by one or multiple landlords. It was common that more than one landlord owned both serfs and land in a given village. The number

of their landlords could go as high as 30 sometimes. When there were lot of landlords in a village, usually, it meant that they were not wealthy nobles and they might have owned only a few, one or two serfs.

Since the high number of landlords could pose coordination problem during the negotiations of land settlements, I also examined whether there were any difference in how "one-landlord" and "multiple-landlord" villages reacted to the customs union. Furthermore, the high number of landlords could also be a proxy for the limit of the potential benefit from land partition. Hence, land settlement in villages where there were multiple landlords could be delayed. Estimating the Difference-in-Difference equation separately for villages with one and multiple landlords, Table 14 shows that only villages with one landlord reacted to the customs union in the treated group. The probability of land settlement did not change for villages with more than one landlord.

5.3 Soil Quality

If the demand for property rights depends on the potential return from the land, then the expected return should be also related to the expected yield. Hence one can expect that, land quality should be positively related the investment in property rights. To test this relationship, I used the soil classification data of the World Soil Information system. The variable is the probability that a soil is Chernozem, a black-colored fertile soil that is considered to produce high agricultural yields. Unlike measures of soil suitability it might have changed less since the mid-19th century. Figure 17 show the distribution of Chernozem soil in the area under examination, where darker green indicates higher probability of this type of soil. Re-estimating the Difference-in-Difference equations, Table 15 shows that indeed, we see a stronger and more significant effect of the customs union in case of villages that were in area with soil type above the median productivity. To compare the results to the survival analysis I re-estimated the Kaplan-Meier survival curve. Graph 18 shows that there is a large increase in the hazard rate of land settlements in case of villages that were both closer to Vienna and had better quality soil. At the same time areas with better quality soil but farther from Vienna or in areas closer to Vienna but with lower quality soil the survival rate is not significantly different.

5.4 Terrrain

One can expect that terrain should be related to the land settlements. First, ruggedness affects market access as more rugged terrain should impose higher transport costs. Second, other features of terrain, like elevation, can be correlated with soil quality beside also affecting transport costs. (McCloskey, 1975*a*) argues that insurance was an important motivation for the open-field system, hence villages with more rugged terrain might have had more incentives to maintain the system. (Simonffy, 1960) cites cases where the serfs were against the land settlements because of the ruggedness of the terrain would have made it difficult to have land for each serfs in one block with similar quality. Table 16 shows that both elevation and ruggedness affected land settlement after 1850. Villages on more rugged terrain or at higher elevation had a lower probability of land settlement. 100 meters (about 330 feet) higher elevation is associated with a 16 percentage points lower probability of land settlement after 1850.[12]

6 Conclusion

Serfdom was the dominant social and economic institution in Europe for centuries, hence, the process that led to a disappearance of this economic system is crucial to understand modern economic development. While legislation was important, economic changes also played a significant role in dismantling the feudal system. Using village-level data, I examined the role of market access in the separation of landlord and serf economy and the formation of modern land property rights in the Kingdom of Hungary during the 19th century. The partition of the landlord and serf lands and the division of the commons finalized the abolition of the serfdom and created stable land property rights that were a prelude to modern agricultural production. I find that an improvement in market access increased the probability of the partition of landlord and serf economies. My results suggest that potential returns on secure property rights were important, but transaction costs could delay the process of land settlements.

Using Difference-in-Difference analysis, I estimate the effect of the establishment of the cus-

[12]I have also reestimated the OLS model on the effect of railroad construction on land settlements. The coefficients of elevation and the ruggedness are significant and have the expected sign but the inclusion of the new variables does not change the previous results. The table of this estimation can be find in the Appendix.

toms union on the probability of land settlements. I find that villages closer to Vienna, the primary market for Hungarian grain, went through land settlement with higher probability after the establishment of the customs union. The Event Study analysis confirms the role of distance to Vienna in explaining the land settlements. Examining the role of the railroad construction during this period I also estimated their effects on separating landlord and serf economies and found that a decrease in the distance to the closest railroad increased the probability of land settlements. To address potential endogeneity concerns, I apply an instrumental variable approach using the Roman road network as the proposed instrument and the 2SLS results confirm the previous estimates. Moreover, after reestimating the model in survival analysis setting, the results are in line with the OLS estimates: villages closer to Vienna and those that experienced a larger improvement in railroad-accessibility exhibit a higher hazard rate of land settlement.

Traditional customary property rights are common in developing countries even today and they have a large role in determining the form of economic activity. Land titling is still an on-going process in several countries. Moreover, policies supporting trade liberalization and infrastructure development were common features in developing countries recently and they are expected to be continued. Hence, the findings of this paper may be important in giving some insights on how the integration of the developing regions into the world economy could affect the institutional structure of these countries. Understanding these mechanisms can be important to address problems emerging from insecure property rights and can help creating policies to align incentives with development goals.

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7 Tables and Figures

7.1 Figures

Figure 1: The Habsburg Empire in 1815. Grey is the Kingdom of Hungary. Dark grey is Transylvania and Croatia, light grey is the area of examination. The map also shows the location of Vienna (black).

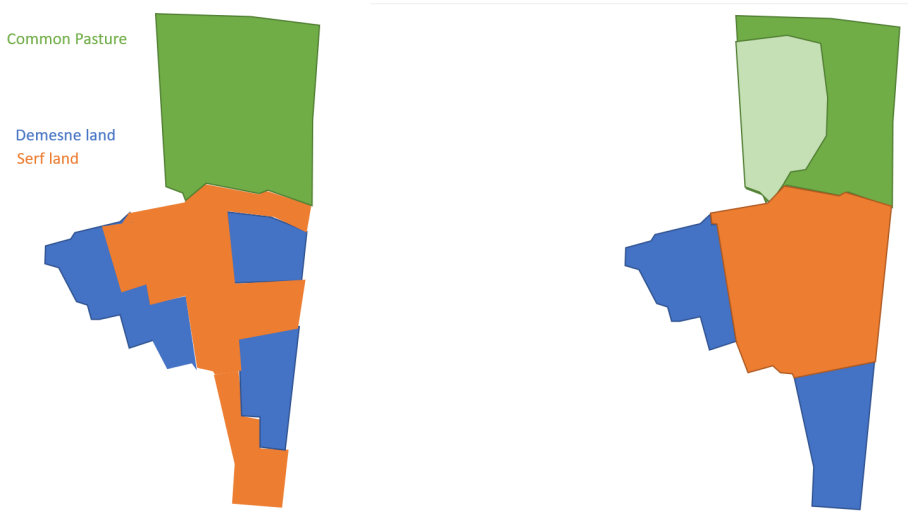

Figure 2: Landownership in the village of Homok before (left) and after (right) the land settlement of 1836 (based on Tilkovszky (1961))

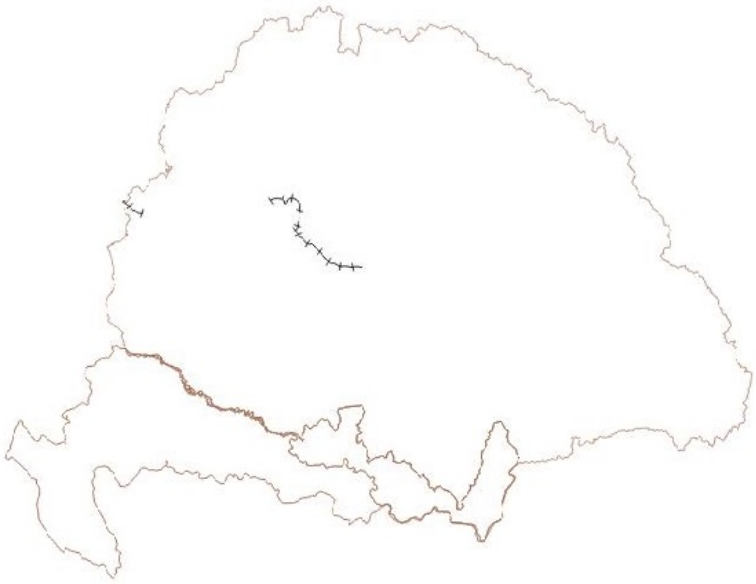

Figure 3: Railroads built in the Kingdom of Hungary by 1850

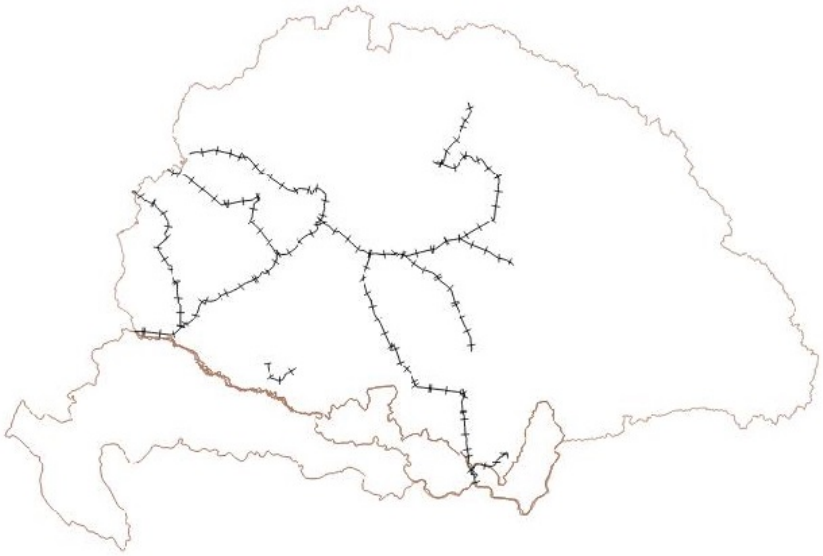

Figure 4: Railroads built in the Kingdom of Hungary by 1865

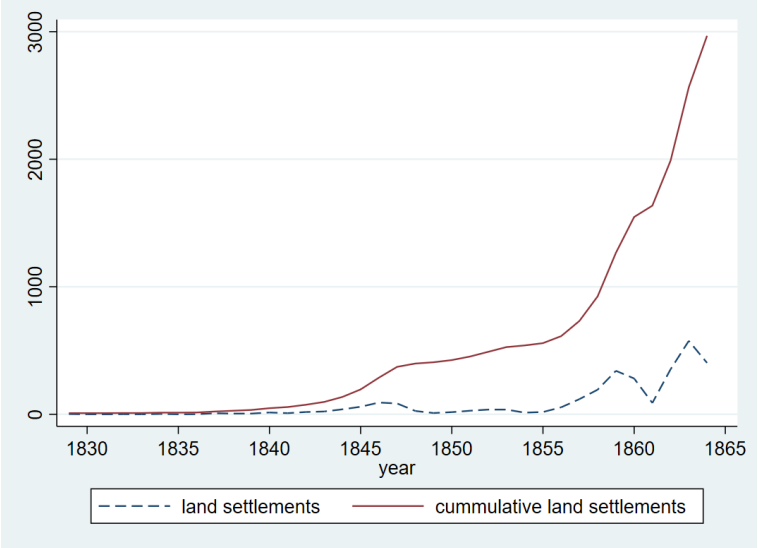

Figure 5: Number of land settlements in each year and cumulatively between 1828-1865

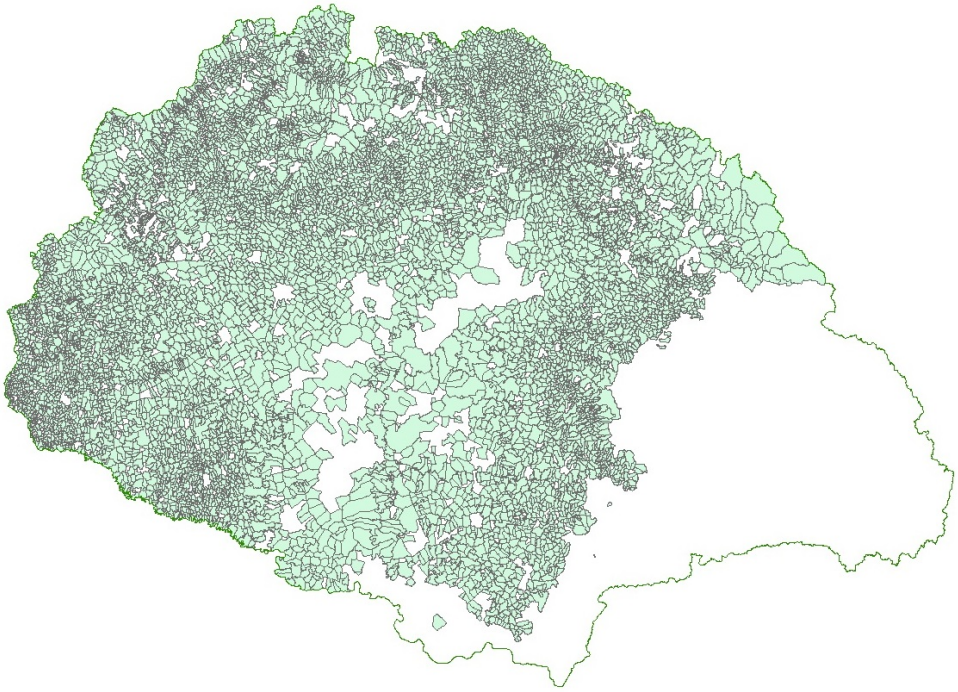

Figure 6: Area with townships in the whole sample Missing townships are royal towns, non feudal villages or privileged regions plus Transylvania.

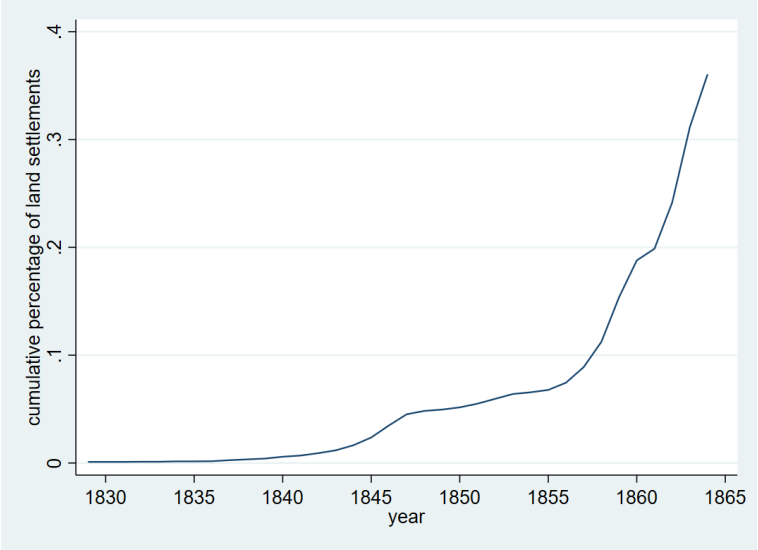

Figure 7: Percentage of villages with land settlements cumulatively between 1828-1865

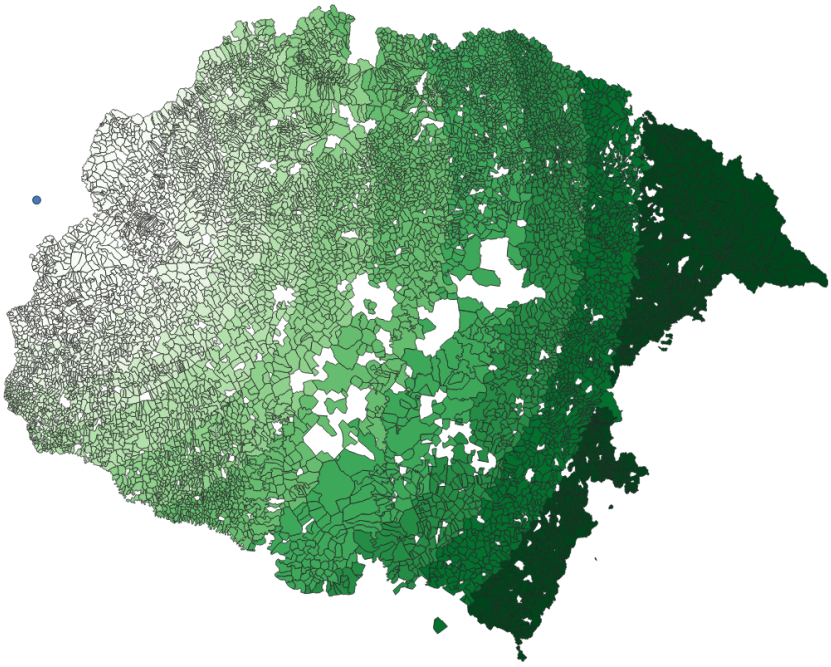

Figure 8: Straight-line distance to Vienna, where darker shading shows a larger straight-line distance from Vienna (blue dot).

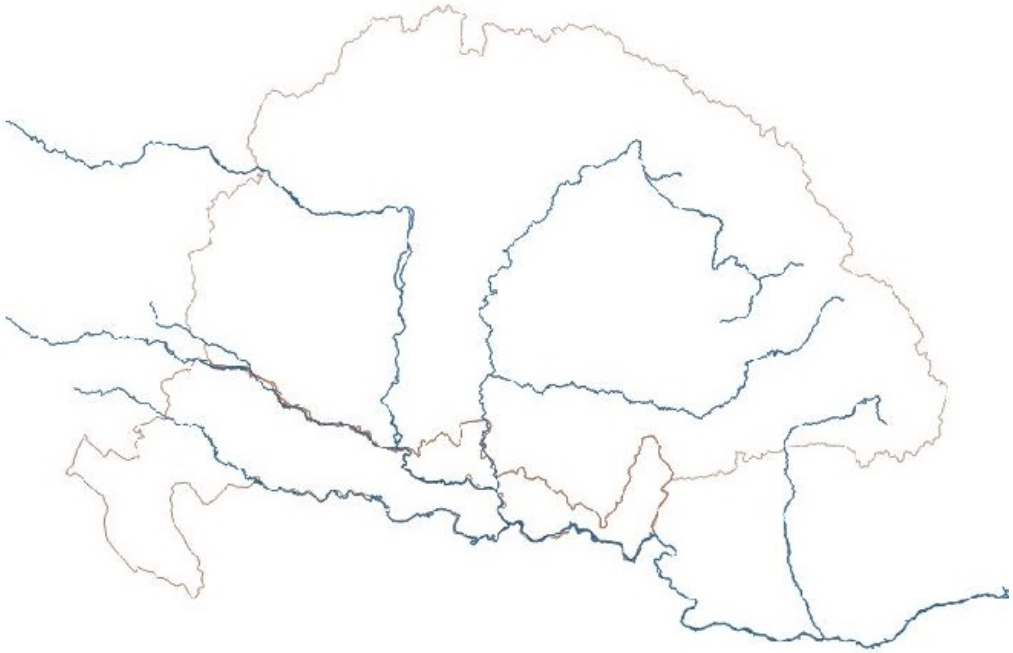

Figure 9: Main navigable rivers of the Kingdom of Hungary

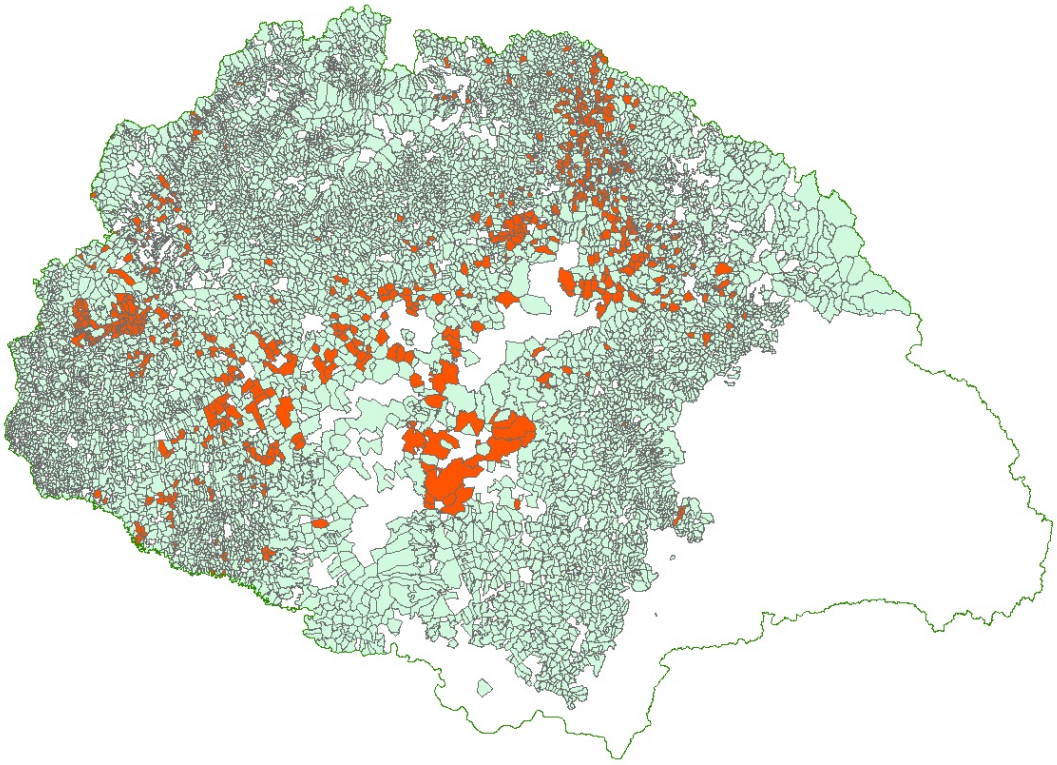

Figure 10: Villages where the land settlement happened by 1850

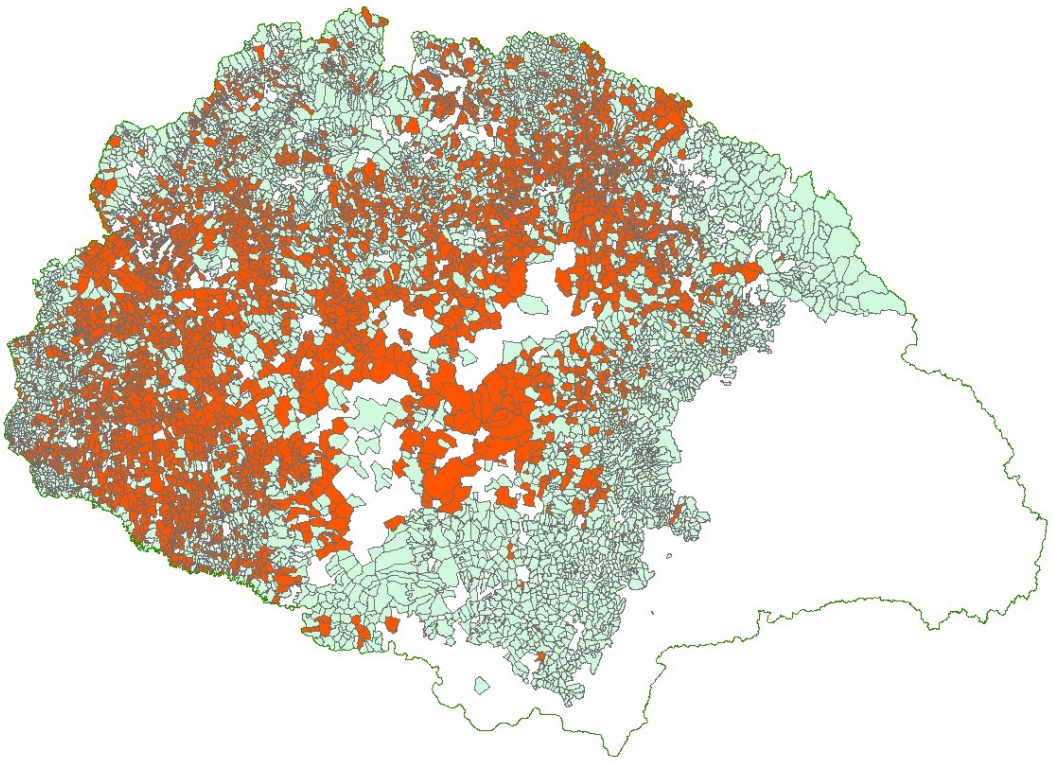

Figure 11: Villages where the land settlement happened by 1864

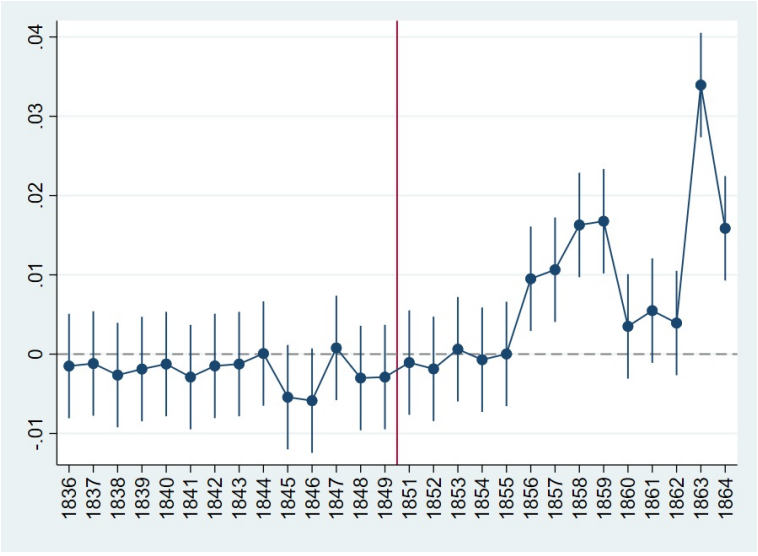

Figure 12: Difference-in-Difference coefficients, below vs. above average log distance from Vienna

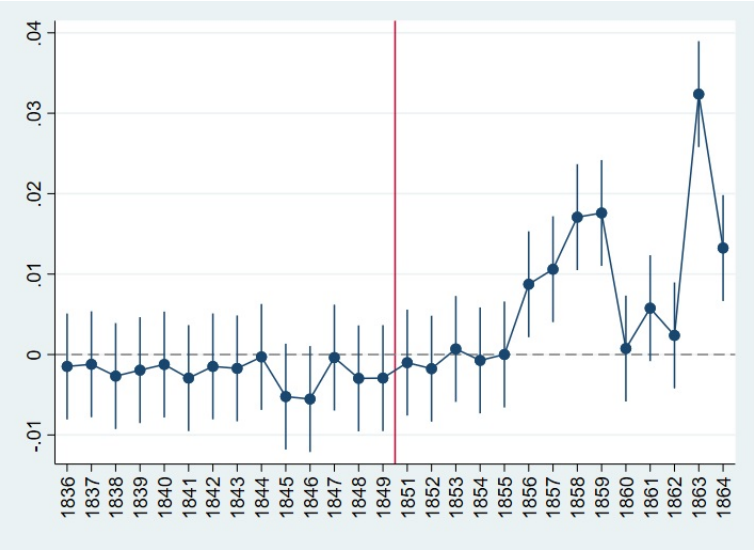

Figure 13: Difference-in-Difference coefficients, below vs. above average market access

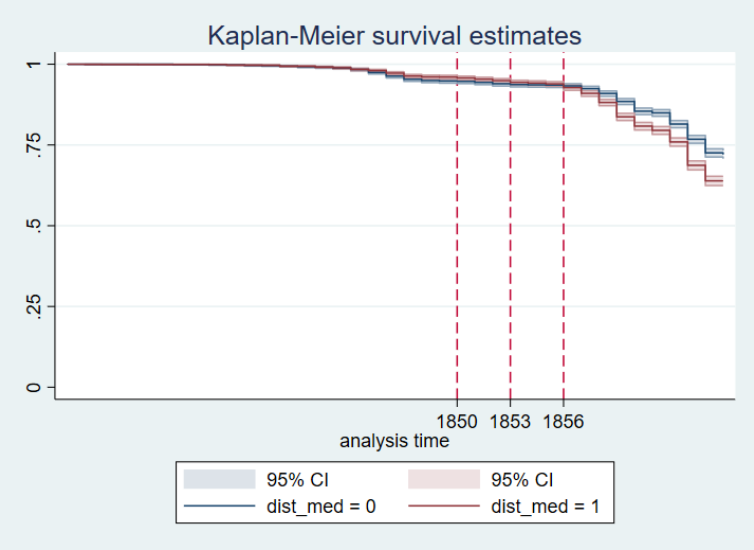

Figure 14: Kaplan-Meier survival estimates by above and below median distance from Vienna

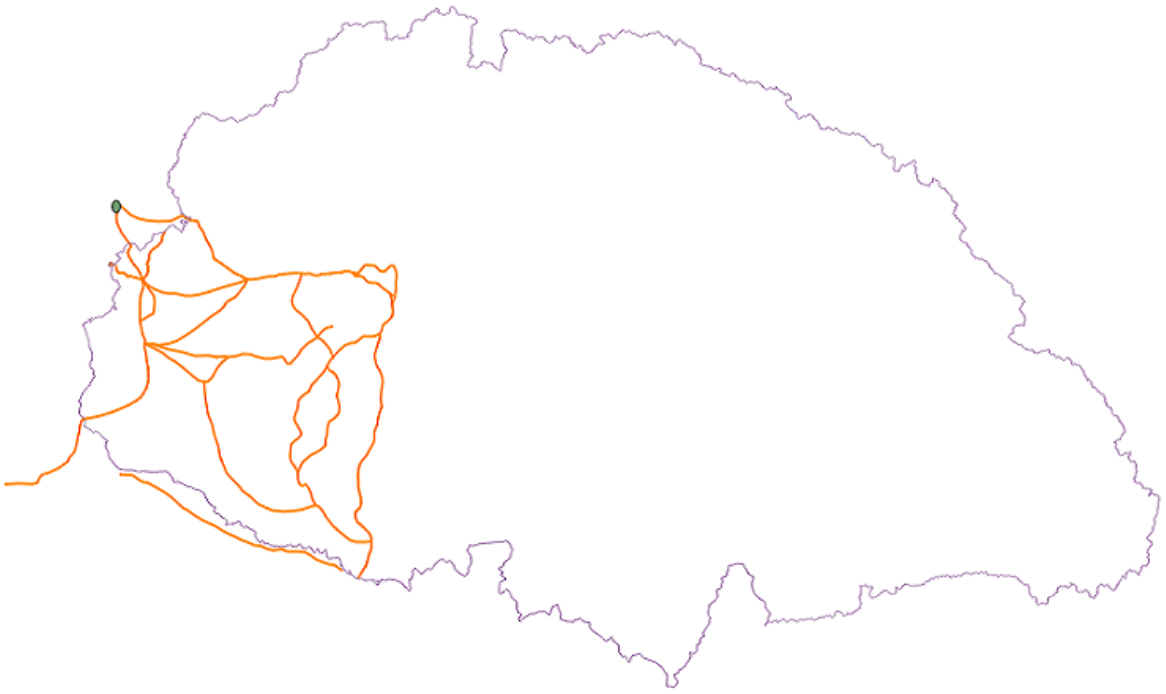

Figure 15: Roads in Pannonia province of the Roman Empire on the area of the later Kingdom of Hungary

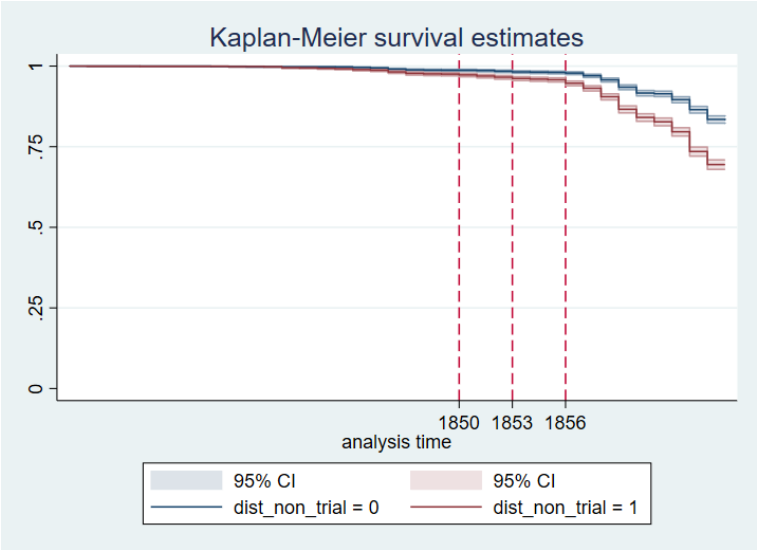

Figure 16: Kaplan-Meier survival estimates by above and below median distance from Vienna excluding villages where the land settlement happened through trial

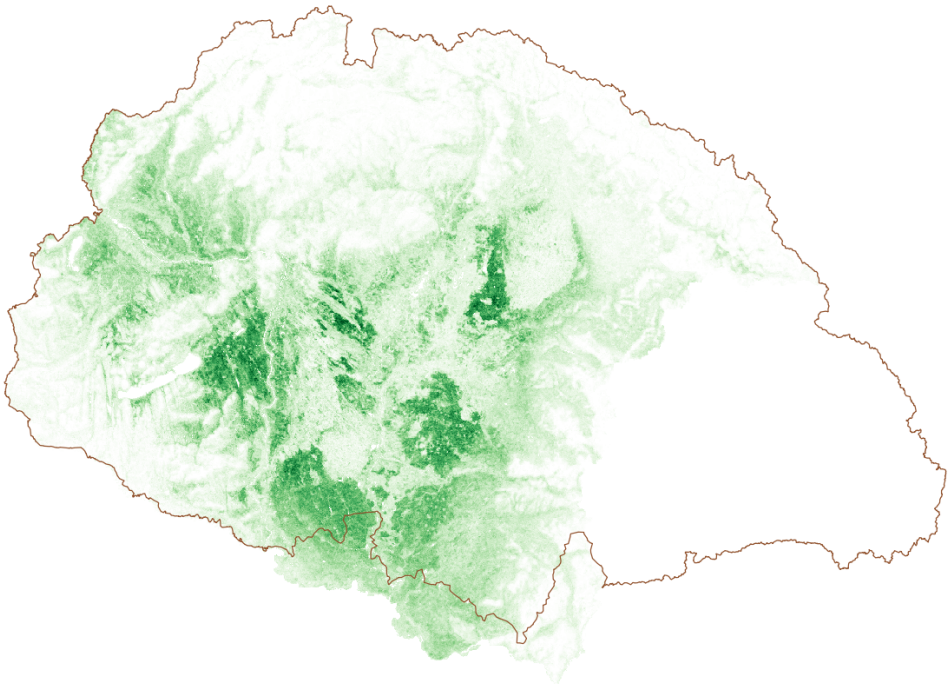

Figure 17: The distribution of Chernozem soil

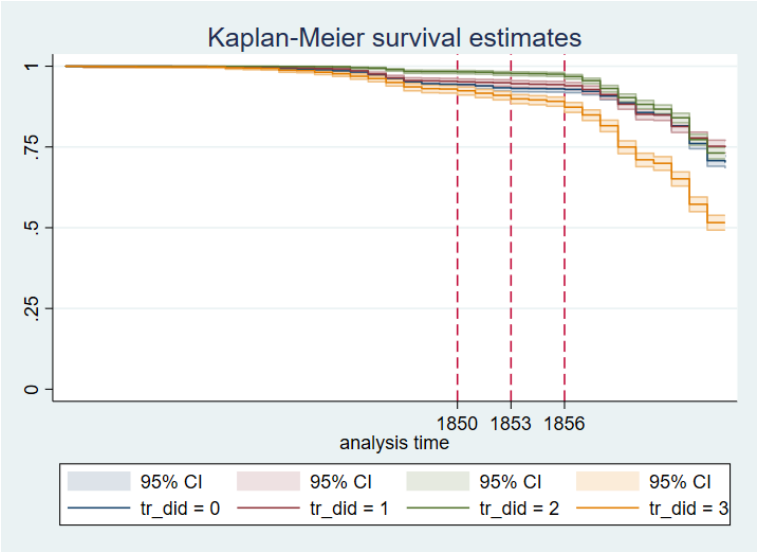

Figure 18: Kaplan-Meier survival estimates: 0: above the median distance from Vienna, below the median soil quality, 1 above the median distance from Vienna, above the median soil quality, 2 below the median distance from Vienna, below the median soil quality, 3 below the median distance from Vienna, above the median soil quality

7.2 Tables

Table 1: Summary Statistics

	Control	Treatment	Total
land settlement happened by 1864	.311	0.466	0.388
	(0.463)	(0.499)	(0.487)
land settlement happened by 1850	0.141	0.0640	0.0847
	(0.348)	(0.245)	(0.279)
number of serf plots in village	15.13	23.66	21.37
	(36.19)	(48.32)	(45.54)
size of total serf plots in acre	639.3	750.6	720.8
	(1338.5)	(911.3)	(1044.2)
acres per serfs	16.20	17.47	17.13
	(12.18)	(10.28)	(10.83)
number of total serfs	56.35	67.07	64.20
	(82.75)	(76.44)	(78.32)
share of landless serfs	0.293	0.272	0.278
	(0.236)	(0.215)	(0.221)
distance to Vienna in km	443.5	201.6	266.4
	(43.43)	(76.53)	(127.6)
Observations	4,251	4,252	9,043

Standard deviations in parentheses. Treatment: distance to Vienna is less than the median distance of the whole sample, 280 km

Table 2: Relationship between market access (distance to Vienna) and land reform settlements by 1864

Dep. variable: dummy -land reform by 1864	(1) Probit	(2) Probit	(3) Probit	(4) OLS	(5) OLS	(6) OLS
log distance from Vienna	-0.421***	-0.126	-0.357	-0.159***	-0.0485	-0.114
	(0.0857)	(0.0855)	(0.245)	(0.0318)	(0.0329)	(0.0849)
log(acres of serf land)		0.263***	0.163***		0.101***	0.0539***
		(0.0452)	(0.0361)		(0.0162)	(0.0116)
log(total serfs)		-0.255***	-0.230***		-0.0977***	-0.0763***
		(0.0570)	(0.0463)		(0.0210)	(0.0151)
Constant	2.050***	-0.0287	1.506	1.273***	0.486**	0.959**
	(0.481)	(0.517)	(1.381)	(0.181)	(0.201)	(0.480)
county FE	No	No	Yes	No	No	Yes
Observations	8973	6582	6559	8973	6582	6582
Adjusted R^2				0.033	0.023	0.194
Pseudo R^2	0.025	0.018	0.153			

Notes: Standard errors in parentheses, clustered at the district (járás) level. Model 1-3 show the results of the Probit, while model 4-6 show the results of a Linear Probability Model. County fixed effects are included in model 3 and 6. log distance from Vienna is the logarithm of the straight-line distance of each village from Vienna in kilometers. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 3: Relationship between market access (distance to Vienna) and land reform settlements before and after 1850 (Probit estimation)

	(1) before 1850 - no controls	(2) before 1850	(3) after 1850 - no controls	(4) after 1850
log distance to Vienna	-0.0693	0.611	-0.465***	-0.589***
	(0.129)	(0.394)	(0.0858)	(0.209)
log(acres of serf land)		0.148***		0.143***
		(0.0517)		(0.0371)
log(total serfs)		-0.191***		-0.197***
		(0.0693)		(0.0469)
Constant	-1.060	-5.548**	2.162***	2.776**
	(0.734)	(2.260)	(0.484)	(1.186)
county FE	No	Yes	No	Yes
Observations	8973	4211	8306	5951
Pseudo R^2	0.001	0.173	0.031	0.147

Notes: Standard errors in parentheses, clustered at the district (járás) level. County fixed effects are included in model 2 and 4. log distance from Vienna is the logarithm of the straight-line distance of each village from Vienna in kilometers. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 4: Relationship between market access (distance to Vienna) and land reform settlements after 1850

Dep. variable: dummy -land reform by 1864	(1) Probit	(2) Probit	(3) LPM	(4) LPM	(5) Logit	(6) Logit
logdistance from Vienna	-0.465***	-0.589***	-0.167***	-0.195***	-0.743***	-0.962***
	(0.0858)	(0.209)	(0.0306)	(0.0696)	(0.140)	(0.353)
log(acres of serf land)		0.143***		0.0460***		0.237***
		(0.0371)		(0.0118)		(0.0639)
log(total serfs)		-0.197***		-0.0645***		-0.329***
		(0.0469)		(0.0151)		(0.0809)
Constant	2.162***	2.776**	1.270***	1.402***	3.448***	4.535**
	(0.484)	(1.186)	(0.176)	(0.397)	(0.787)	(2.016)
county FE	No	Yes	No	Yes	No	Yes
Observations	8306	5951	8306	6011	8306	5951
Adjusted R^2			0.038	0.189		
Pseudo R^2	0.031	0.147			0.030	0.147

Notes: Standard errors in parentheses, clustered at the district (járás) level. Model 1-2 show the results of the Probit, model 3-4 show the results of a Linear Probability Model, while model 5-6 show the results of a Logit Model. County fixed effects are included in model 2, 4 and 6. log distance from Vienna is the logarithm of the straight-line distance of each village from Vienna in kilometers. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 5: The effect of market access on land settlements after 1850 - Clustered at different levels

	(1) Probit - county	(2) Probit - rectangle	(3) OLS - county	(4) OLS - rectangle
log distance to Vienna	-0.589**	-0.589***	-0.195**	-0.195***
	(0.283)	(0.207)	(0.0932)	(0.0688)
log(acres of serf land)	0.143**	0.143***	0.0460**	0.0460***
	(0.0608)	(0.0349)	(0.0193)	(0.0112)
log(total serfs)	-0.197***	-0.197***	-0.0645**	-0.0645***
	(0.0755)	(0.0467)	(0.0245)	(0.0155)
Constant	2.776*	2.776**	1.402**	1.402***
	(1.643)	(1.186)	(0.544)	(0.396)
county FE	Yes	Yes	Yes	Yes
Observations	5951	5951	6011	6011
Adjusted R^2			0.189	0.189
Pseudo R^2	0.147	0.147		

Notes: Standard errors in parentheses. Model 1 and 3 are clustered at the county (vármegye) level. Model 2 and 4 are clustered at a 0.5degree-by-0.5 degree rectangle level. County fixed effects are included in every model. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 6: The effect of market access after 1850 - using Conley's estimator with different cutoffs

	(1) OLS	(2) 20 km	(3) 25 km	(4) 30 km	(5) 50 km
log distance to Vienna	-0.220**	-0.220**	-0.220**	-0.220*	-0.220*
	(0.102)	(0.104)	(0.110)	(0.115)	(0.130)
log(total serfs 1770)	-0.0653***	-0.0653***	-0.0653***	-0.0653***	-0.0653***
	(0.0150)	(0.0158)	(0.0174)	(0.0184)	(0.0209)
log(acres of serf land 1770)	0.0471***	0.0471***	0.0471***	0.0471***	0.0471***
	(0.0116)	(0.0125)	(0.0134)	(0.0141)	(0.0157)
Constant	1.951***	1.951***	1.951***	1.951***	1.951**
	(0.609)	(0.624)	(0.654)	(0.681)	(0.777)
Observations	6011	6011	6011	6011	6011

Notes: Standard errors in parentheses. Model 1 and 3 are clustered at the county (vármegye) level. Model 2 and 4 are clustered at a 0.5degree-by-0.5 degree rectangle level. County fixed effects are included in every model. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 7: The effect of different measures of market access on land settlements before and after 1850 (Probit model)

	(1) before 1850	(2) before 1850	(3) before 1850	(4) after 1850	(5) after 1850	(6) after 1850
log distance to Vienna	0.611			-0.589***		
	(0.394)			(0.209)		
market access		-9.614*			-3.764*	
		(5.139)			(2.194)	
log distance to Vienna along the Danube			0.0698			-0.114**
			(0.0610)			(0.0477)
log(acres of serf land)	0.148***	0.130**	0.166***	0.143***	0.123***	0.137***
	(0.0517)	(0.0513)	(0.0569)	(0.0371)	(0.0385)	(0.0378)
log(total serfs)	-0.191***	-0.154**	-0.218***	-0.197***	-0.164***	-0.190***
	(0.0693)	(0.0690)	(0.0779)	(0.0469)	(0.0490)	(0.0472)
Constant	-5.548**	-2.112***	-2.750***	2.776**	-0.547***	0.497
	(2.260)	(0.312)	(0.629)	(1.186)	(0.207)	(0.500)
county FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4211	4211	4211	5951	5951	5951
Pseudo R^2	0.173	0.181	0.170	0.147	0.145	0.146

Standard errors in parentheses, clustered at the district (járás) level.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 8: Difference-in-Difference coefficients with different measures

	Straight Line	Market Access	Along the Danube	Straight Line	Market Access	Along the Danube
after	-0.00297*	-0.00266	-0.00170	-0.00340	-0.00319	-0.00151
	(0.00175)	(0.00173)	(0.00156)	(0.00218)	(0.00213)	(0.00206)
treated	-0.00608***	-0.00626***	-0.00216	-0.00417*	-0.00395*	0.0000597
	(0.00189)	(0.00173)	(0.00216)	(0.00229)	(0.00201)	(0.00254)
treated × after	0.0101***	0.00970***	0.00778***	0.00520*	0.00495*	0.00221
	(0.00202)	(0.00203)	(0.00207)	(0.00265)	(0.00262)	(0.00270)
log(acres of serf land)				0.00188***	0.00187***	0.00189***
				(0.000417)	(0.000416)	(0.000417)
log(total serfs)				-0.00226***	-0.00226***	-0.00226***
				(0.000484)	(0.000483)	(0.000485)
R^2	0.0287	0.0287	0.0285	0.0323	0.0323	0.0322

Notes: Standard errors in parentheses, clustered at the district (járás) level. Model 5-6 includes additional explanatory variables and county fixed effects. A village is in the treatment group if its straight-line distance to Vienna is less than the median distance to Vienna for column 1 and 4. A village is in the treatment group if its composite market access measure is larger than the median market access for column 2 and 5. Finally, a village is in the treatment group if its distance to the Danube and the along the river to Vienna is less than the median distance.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 9: Change in the Distance to Railroads and the probability of land settlements between 1850 and 1864

	(1)	(2)	(3)	(4)
change in the distance to railroads, 1850-57 (10km)	-0.00451	-0.0135***	-0.0245***	-0.0245**
	(0.00352)	(0.00459)	(0.00577)	(0.00930)
distance to Vienna (10km)	-0.00623***	-0.00409**	-0.0189***	-0.0189***
	(0.00136)	(0.00162)	(0.00442)	(0.00592)
total acres of serf land		0.0000617***	0.0000347***	0.0000347**
		(0.0000175)	(0.0000120)	(0.0000168)
total number of serfs		-0.000508***	-0.000482***	-0.000482***
		(0.000160)	(0.000122)	(0.000162)
Constant	0.449***	0.400***	1.254***	1.254***
	(0.0355)	(0.0402)	(0.158)	(0.195)
Observations	8485	6096	6096	6096
Adjusted R^2	0.027	0.022	0.193	0.193

Notes: Standard errors in parentheses, clustered at the district (járás) level for Model 1-3 and at the county level for Model 4. Model 3 and 4 includes county fixed effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 10: Instrumenting the change in the distance to the nearest railroad

	(1)	(2)	(3)	(4)
	IV-First Stage	2SLS	IV-First Stage	2SLS
distance to roman roads (10km)	0.312***		0.247***	
	(0.0613)		(0.0821)	
distance to Vienna (10km)	-0.480***	-0.0113***	-0.395***	-0.0203***
	(0.0445)	(0.00248)	(0.0579)	(0.00729)
change in the distance to railroads (1850-57) 10km		-0.0271***		-0.104**
		(0.00858)		(0.0481)
total acres of serf land			0.000124	0.0000166
			(0.000132)	(0.0000114)
total number of serfs			-0.000165	-0.000268**
			(0.00139)	(0.000135)
Constant	4.985***	0.450***	3.505***	-0.676
	(0.599)	(0.0414)	(0.609)	(0.657)
Observations	9411	9411	7003	6945
R-squared	0.573	.	0.452	0.100
F-statistic	237.7		86.88	

Standard errors in parentheses clustered at the district level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 11: Hazard Model Estimates - Exponential Model

	(1)	(2)	(3)	(4)	(5)
log distance to Vienna	0.692***	0.982	1.678***	1.459*	1.459
	(0.0200)	(0.0369)	(0.184)	(0.301)	(0.609)
log(acres of serf land)		1.537***	1.545***	1.228***	1.219***
		(0.0513)	(0.0518)	(0.0457)	(0.0589)
log(total serfs)		0.720***	0.717***	0.779***	0.787***
		(0.0261)	(0.0261)	(0.0318)	(0.0420)
after $\times$ distance			0.535***	0.483***	0.481***
			(0.0625)	(0.0601)	(0.135)
Constant	0.0235***	0.000102***	0.000000127***	0.00000397***	0.00000405**
	(0.0187)	(0.0000867)	(0.000000198)	(0.0000108)	(0.0000216)
Pseudo-Likelihood	-3373.6804	-2289.4413	-2273.8706	-1570.7425	-1566.8033

Exponentiated coefficients; Standard errors in parentheses
County Fixed effects in model 4 and 5.
Standard errors in parentheses clustered at the village level in model 1-4 and at county level in model 5.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 12: Hazard Model - Time Dependent Covariates: Minimum distance to the closest railroad

	(1)	(2)	(3)	(4)
log(minimal distance to railroad)	0.747***	0.786***	0.829***	0.828***
	(0.0137)	(0.0164)	(0.0254)	(0.0438)
log(acres of serf land)		1.490***	1.225***	1.215***
		(0.0491)	(0.0452)	(0.0584)
log(total serfs)		0.715***	0.779***	0.789***
		(0.0256)	(0.0319)	(0.0435)
Constant	0.000240***	0.000102***	0.000363***	0.000368***
	(0.000170)	(0.0000727)	(0.000263)	(0.000272)
Pseudo-Likelihood	-3336.3636	-2232.7575	-1573.7692	-1569.9335

Exponentiated coefficients
Standard errors in parentheses clustered at village level in model 1-3 and district level in model 4
County fixed effects in model 3 and 4
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 13: Settlements: Trial versus Agreement

	(1) Trial	(2) Agreement	(3) Trial	(4) Agreement
after	-0.000180	-0.00508***	0.00147	-0.00276*
	(0.00136)	(0.00111)	(0.00220)	(0.00166)
treated	-0.00399**	-0.00387*	-0.00300	-0.00189
	(0.00180)	(0.00203)	(0.00219)	(0.00238)
treated × after	0.00143	0.0103***	-0.00133	0.00517**
	(0.00141)	(0.00166)	(0.00210)	(0.00208)
log(acres of serf land)			0.00118***	0.00167***
			(0.000267)	(0.000450)
log(total number of serfs)			-0.00115***	-0.00216***
			(0.000358)	(0.000498)
R^2	0.0182	0.0257	0.0204	0.0297

Standard errors in parentheses clustered at the district level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 14: Settlements: One landlord versus Multiple

	(1) multiple landlords	(2) one landlord	(3) multiple landlords	(4) one landlord
after	0.000835	-0.00570***	0.000799	-0.00321
	(0.00248)	(0.00166)	(0.00250)	(0.00287)
treated	0.00283	-0.00972***	0.00223	-0.00785***
	(0.00287)	(0.00186)	(0.00308)	(0.00236)
treated × after	0.000614	0.0140***	0.000717	0.00844***
	(0.00316)	(0.00209)	(0.00316)	(0.00319)
log(acres of serf land)			0.00111**	0.00234***
			(0.000515)	(0.000528)
log(total serfs)			-0.00187***	-0.00252***
			(0.000617)	(0.000608)
R^2	0.0334	0.0280	0.0341	0.0325

Standard errors in parentheses, clustered at the district level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 15: Soil Quality and Settlements

	(1) Above Median (1)	(2) Below Median (1)	(3) Above 3rd Quartile (2)	(4) Below 3rd Quartile (2)
time	0.00790**	0.00487*	-0.00227	0.0107***
	(0.001)	(0.027)	(0.370)	(0.000)
treated (dist. to Vienna)	-0.00851***	-0.00114		
	(0.000)	(0.567)		
treat × after	0.0154***	0.00536***		
	(0.000)	(0.000)		
treated (market access)			0.000484	-0.00259
			(0.896)	(0.170)
treat × after			0.00302	-0.00161
			(0.281)	(0.259)
Observations	109765	126817	53563	183019

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 16: Terrain ruggedness and Elevation

	(1) before 1850	(2) after 1850	(3) before 1850	(4) after 1850	(5) before 1850	(6) after 1850
log distance to Vienna	0.602*	-0.469**	0.700**	-0.395*	0.703**	-0.381*
	(0.322)	(0.225)	(0.332)	(0.209)	(0.334)	(0.214)
log(acres of serf land)	0.0939**	0.0927**	0.104**	0.105***	0.103**	0.0942**
	(0.0477)	(0.0381)	(0.0466)	(0.0383)	(0.0466)	(0.0382)
log(total serfs)	-0.112*	-0.147***	-0.120*	-0.132***	-0.119*	-0.126**
	(0.0661)	(0.0481)	(0.0687)	(0.0491)	(0.0680)	(0.0490)
log(ruggednes)	-0.185***	-0.163***			0.0146	-0.0547*
	(0.0382)	(0.0311)			(0.0456)	(0.0313)
elevation (100 meters)			-0.353***	-0.189***	-0.365***	-0.162***
			(0.0426)	(0.0308)	(0.0482)	(0.0309)
Constant	-3.569*	3.939***	-5.544***	1.980*	-5.695***	2.475**
	(1.827)	(1.248)	(1.895)	(1.187)	(1.906)	(1.161)
Observations	4291	6140	4296	6143	4287	6136
Pseudo R^2	0.182	0.149	0.206	0.158	0.206	0.159

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

A Appendices

A.1 Conceptual framework

In this section, to motivate the empirical analysis, I investigate how change in market access affects the landlords decision to partition its economy and land from that of the peasants, that is how it induces transition from feudal to modern property right regimes. The landlord produces agricultural goods according to the following production function

$$Y = F(q_{it}, T_i, L_i)$$

where q is land quality, T is the land used and L is the labor employed. The landlord aims to maximize its profit from the manorial economy. It faces costs of labor that we will take as given. The landlord owns the land hence it didn't pay rent. The feudal land system, however, causes uncertain property rights in lands: the exact size and location of the urbarial and demesne lands is uncertain, fallows cannot be cultivated without the danger of the peasants animals the crops. Property right uncertainty inhibit the use of demesne land for collateral. These inefficiencies and losses are represented by τ, where the τ ($\tau \in [0, 1]$) share of the output is lost. The landlord can invest in the protection (P), that is transition from feudal to private property rights, land partition to decrease $\tau(P)$, that is $\tau^{'}(P) < 0$. Land partition is costly: the landlord had to hire a lawyer, and an engineer to survey the land and occasionally convince the peasants to agree to the partition with disadvantageous land swap. The cost of protection is $C_{it}(P_{ct})$ is increasing in P. In order to examine the effect of market access, I include d, the trade cost the landlord faces to market its agricultural output. The landlord maximizes:

$$d^{-\sigma}(1 - \tau(P_{it}))F(q_{it}, T_i, L_i) - wL - RT - C_{it}(P_{ct})$$

The first order condition with respect to P is:

$$-d^{-\sigma}\tau'(P_{it})F(q_{it}, T_i, L_i) = C_{it}^{'}(P_{ct})$$

The marginal cost of protection is equal to the marginal increase in total ouput that is kept. Hence, for smaller trade costs, smaller d, the optimal level of protection is higher.

A.2 Tables

Table 17: Difference-in-Difference coefficients with different clusters

	(1) district	(2) rectangle	(3) county	(4) district	(5) rectangle	(6) county
after	0.0409***	0.0556***	0.0559***	-0.00155	-0.00175	-0.00175
	(0.00419)	(0.00520)	(0.00805)	(0.00226)	(0.00259)	(0.00446)
treated	-0.00608***	-0.00678***	-0.00618**	-0.00417*	-0.00499**	-0.00431
	(0.00189)	(0.00206)	(0.00268)	(0.00229)	(0.00248)	(0.00347)
treated × after	0.0101***	0.0102***	0.0101**	0.00520*	0.00533	0.00525
	(0.00202)	(0.00261)	(0.00405)	(0.00265)	(0.00343)	(0.00602)
log(acres of serf land)				0.00188***	0.00190***	0.00194***
				(0.000417)	(0.000388)	(0.000602)
log(total serfs)				-0.00226***	-0.00235***	-0.00237***
				(0.000484)	(0.000465)	(0.000666)
R^2	0.0287	0.0287	0.0286	0.0323	0.0324	0.0322

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 18: Distance to Railroads and land settlements by 1865, logs

	(1)	(2)	(3)	(4)
log change in distance				
to railroad (km) (1850-57)	0.0150*	0.0343***	0.0353***	0.0360**
	(0.00856)	(0.00888)	(0.0111)	(0.0152)
log(dist. to Vienna)	-0.127***	-0.0721**	-0.175*	-0.175
	(0.0298)	(0.0306)	(0.0913)	(0.121)
log(acres of serf land)		0.112***	0.0590***	0.0611***
		(0.0145)	(0.0108)	(0.0138)
log(total serfs)		-0.0957***	-0.0680***	-0.0720***
		(0.0176)	(0.0122)	(0.0142)
Constant	0.949***	0.353**	1.476***	1.476**
	(0.156)	(0.165)	(0.531)	(0.685)
Observations	8309	5817	5817	5839
Adjusted R^2	0.017	0.041	0.194	0.195

Standard errors in parentheses clustered at the district level in model 1-3 and county level in model 4
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 19: Railroads constructed 1850-57, 1850-1860, 1850-1863

	(1)	(2)	(3)
change in the distance to railroads, 1850-57 (10km)	-0.0135***		
	(0.00459)		
change in the distance to railroads, 1850-60 (10km)		-0.0142***	
		(0.00470)	
change in the distance to railroads, 1850-64 (10km)			-0.0142***
			(0.00470)
distance to Vienna (10km)	-0.00409**	-0.00607***	-0.00607***
	(0.00162)	(0.00220)	(0.00220)
total acres of serf land	0.0000617***	0.0000667***	0.0000667***
	(0.0000175)	(0.0000176)	(0.0000176)
total number of serfs	-0.000508***	-0.000445***	-0.000445***
	(0.000160)	(0.000159)	(0.000159)
Observations	6096	6096	6096
Adjusted R^2	0.022	0.025	0.025

Standard errors in parentheses clustered at the district level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 20: The effect of railroad construction on land settlements depending on distance of a village from the Danube river

	(1) closer to the Danube than the median	(2) farther from the Danube than the median
[1em] change in the distance to railroads (1850-57) 10km	-0.0151*	-0.0338***
	(0.00766)	(0.0129)
distance to Vienna (10km)	-0.00555	-0.0353***
	(0.00821)	(0.00702)
total acres of serf land	0.0000442***	-0.0000284
	(0.0000145)	(0.0000197)
total number of serfs	-0.000583***	0.0000455
	(0.000149)	(0.000215)
Constant	0.0288	1.818***
	(0.179)	(0.250)
Observations	3639	2457
Adjusted R^2	0.200	0.177

Standard errors in parentheses clustered at district level.

County fixed effects are included.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 21: The effect of railroads and terrain on land settlements

	(1)	(2)	(3)
change in the distance to railroads (1850-57) 10km	-0.0160***	-0.0182***	-0.0142***
	(0.00536)	(0.00541)	(0.00532)
distance to Vienna (10km)	-0.0113***	-0.0137***	-0.0104**
	(0.00435)	(0.00434)	(0.00440)
total acres of serf land	0.0000236**	0.0000217*	0.0000174
	(0.0000118)	(0.0000115)	(0.0000117)
total number of serfs	-0.000394***	-0.000394***	-0.000373***
	(0.000121)	(0.000117)	(0.000120)
elevation (100 meters)	-0.0437***		-0.0299***
	(0.00762)		(0.00718)
log(ruggedness)		-0.0518***	-0.0342***
		(0.00904)	(0.00890)
Observations	5963	6088	5955
Adjusted R^2	0.211	0.203	0.214

Standard errors in parentheses clustered at the district level
County Fixed effects are included.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

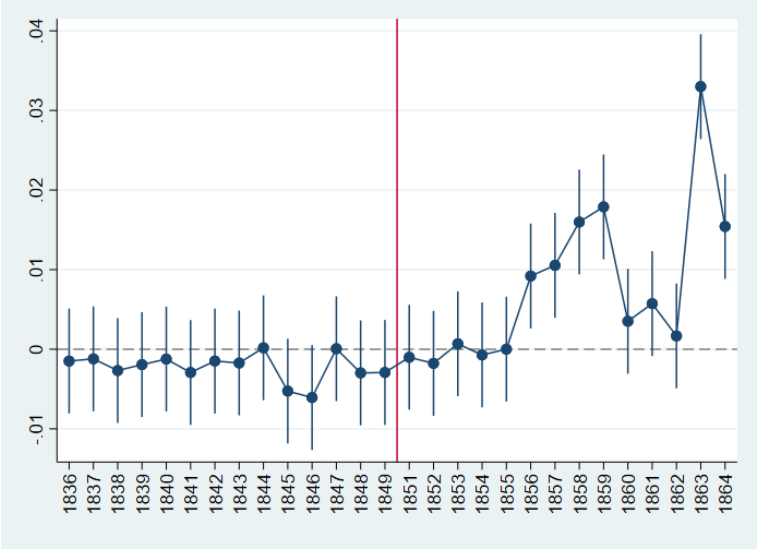

Figure 19: Difference-in-Difference coefficients, below vs. above median distance along the Danube river to Vienna