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# The Economic Effects of the English Parliamentary Enclosures

Leander Heldring
James A. Robinson
Sebastian Vollmer

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**Abstract**

The re-organization and rationalization of rural property rights has been argued to be a key stimulant to agricultural productivity, potentially feeding into broader processes of development and structural change. In this paper we study the impact of one mechanism that created modern individualized property rights in England, "Parliamentary enclosure", initiated by Parliament between 1750 and 1830. In our main estimates we exploit a feature of the Parliamentary enclosure process as a source of exogenous variation and find that such enclosures were associated with significantly higher crop yields and land inequality. We also find that Parliamentary enclosures were connected to increased innovation, improved farming practices and infrastructure and a shift out of agriculture and towards industry. They also released labor which flowed primarily to northern industrializing regions. Our results do not suggest that previous systems of collective governance were able to efficiently manage commonly managed resources.

**Keywords**: Privatization, Productivity, Inequality, Structural Change. **JEL classification**: D02, N5, O43.

*Heldring: Northwestern University, Kellogg School of Management, 2211 Campus Drive, Evanston, IL 60208, USA; e-mail: leander.heldring@kellogg.northwestern.edu. Website: www.leanderheldring.com. Robinson: University of Chicago, Harris School of Public Policy and Department of Political Science, 1307 E 60th Street, Chicago, IL 60637, e-mail: jamesrobinson@uchicago.edu. Vollmer: University of Göttingen, Department of Economics, Platz der Göttinger Sieben 3, Germany; e-mail: svollmer@uni-goettingen.de. We would like to thank Daron Acemoglu, Robert Allen, Joshua Angrist, Mattia Bertazzini, Rui Pedro Esteves, Roger Kain, Steven Pincus and seminar participants at the Bonn/Cologne Workshop on Markets and Policy in History, briq Institute, Chapman University, Clermont-Ferrand, Göttingen, the NBER DAE Spring 2021 meeting, Northwestern, NYU, Oslo, Stanford, UBC, and the University of Chicago for helpful comments. We would like to thank Ann-Charline Weber and Parker Whitfill for providing outstanding assistance and feedback. Thanks are also due to Mariano Calderon, Santiago Castiblanco, Lauren Futter, Thiviya Kumaran, Daniel Lowery, Amol Pai and Meghana Nuthanapathi for their valuable research assistance.

# 1 Introduction

Many instances of economic development are anticipated by increases in agricultural productivity. This was true, for example, in the recent experiences of South Korea and Taiwan in the 1940s and 1950s and in China after 1978 (Lin, 1992; Brandt et al., 2002). A long tradition sees an agricultural revolution as almost a prerequisite for industrialization since, most basically, a labor force needs to be available and fed (Overton, 1996). A potential perturbation in the rural sector, clearly relevant in the East Asian cases, is changes in the form of property rights, since there is a great deal of evidence, for instance, that more collective systems of property rights are associated with inefficiency in agriculture (see Besley (1995), Deininger et al. (2008), Goldstein and Udry (1992), Deininger et al. (2011), Chen et al. (2023) for African evidence). It is therefore plausible that changes towards better defined individual ownership would boost incentives and productivity in the rural sector. This could then induce structural change more broadly. Potential mechanisms are that better incentives lead to the adoption of more productive technologies which creates spillovers by saving labor (Bustos et al., 2016) and shifting the labor force out of agriculture (Gollin et al., 2021), which would have positive development effects simply because industry is more productive than agriculture (Gollin et al., 2014).[1]

In this paper we examine the consequences of one of the most salient experiences of a change in the form of rural property rights - the English Parliamentary enclosures which began around 1750. Prior to this date much land was still collectively managed in "open fields" and commons, and also divided into widely scattered and fragmented individual private landholdings. Parliamentary enclosure took the form of an act to potentially divide up all the land of a parish[2] into individually owned consolidated private farms. In the process it not only potentially impacted farming techniques and technology adoption, but also created large numbers of externalities: for example facilitating the expansion and modernization of road networks. All these changes plausibly helped to induce what is called "the agricultural revolution" and potentially the industrial revolution (Overton, 1996).

We provide the first comprehensive estimates of the impact of Parliamentary enclosure on efficiency and distribution in agriculture. We also examine its downstream consequences on industrialization and structural change. With respect to the latter we provide the first estimates of the impact of enclosures on "primitive accumulation" as postulated by Karl Marx, who argued that enclosure as "the systematic theft of communal property was of great assistance ... in 'setting free' the agricultural population as a proletariat for the needs of industry" (Marx, 1990, p. 885-886).

In a new dataset we compare parishes that were enclosed via Parliament in the period (1750-1830), to parishes that were not enclosed by this method. We study the consequences of Parliamentary enclosure for efficiency and distribution around 1830 by measuring wheat yields and land inequality. We examine industrialization via the location of textile mills. For structural transformation we look at the distribution of the labor force between different sectors and the extent to which enclosure created migration towards industrial areas.[3]

[1] See Gollin (2021) and Deininger et al. (2022) for overviews of mechanisms and evidence.

[2] A parish is a local administrative unit typically coincidental with a village.

[3] In total there are 15,000 parishes and we have data for the entire population of Parliamentary enclosure acts, 5,383. However, our source of agricultural data to measure outputs is more restricted which means we work with a sample of around 3,641 parishes, 1,163 of which were enclosed by act of Parliament. When we examine the impact of enclosure on structural change and migration, however, we can use the full sample.

To investigate this empirically, however, it is important to recognize that in some places enclosure had already taken place by mutual agreement or in a piecemeal fashion prior to 1750 and the creation of the Parliamentary mechanism which allowed an entire parish to enclose with a parliamentary act if the owners of 3/4 of the land by value were in favor. Parishes where pre-parliamentary enclosure had occurred likely expected to gain less from Parliamentary mechanism. To some extent they would also already have realized the productivity improvements of enclosure. This would be true even though the historical evidence suggests that piecemeal enclosure was often inefficiently done and aspects of the Parliamentary mechanism, such as a definitive map of the new land settlement, were valuable even in parishes that were already to some extent, and even completely, enclosed. There is therefore a great deal of unobserved heterogeneity in the characteristics of different parishes influencing whether they decided to apply for a Parliamentary enclosure, a bottom-up process that began with a petition. Since this was costly, many of the costs had to be born upfront, and the process might not succeed, this was a significant decision.

To account for this type of selection and to establish a causal interpretation of the effects of *Parliamentary* enclosure we use two distinct and complementary identification strategies. The first exploits a feature of the Parliamentary process for approving a proposed enclosure as a source of variation in the likelihood that a parish would opt to enclose via Parliament. In particular, we construct an instrumental variable as follows: We use the fraction of enclosure petitions that pass in Parliament for a group of nearby parishes that would have had similar political representation had they petitioned to enclose, as a source of quasi-experimental variation in the probability of a left-out parish enclosing through Parliament.

Our approach is motivated by the fact that getting enclosed involved three steps. First, a parish petitioned Parliament in the form of a draft enclosure Bill. Then, a committee of Members of Parliament (MPs) was tasked with judging the quality of the Bill against a large number of legal requirements, called standing orders. Finally, a potentially amended Bill passed or failed in a vote. Because the recommendation of the committee was usually followed, Tate (1945) notes that a leading reason that "an enclosure bill failed" was "failure to comply in detail with the standing orders of the House" (Tate, 1945, p. 138-139). Since committees for parishes were typically composed of local MPs we posit that, if petitions were checked against the standing orders similarly in parishes that likely would have had similar committee composition, we can use the leave-one-out probability of passing in those parishes, conditional on petitioning, as an instrument for passing a Parliamentary enclosure Bill in the left-out parish. A significant advantage of this source of variation is that it is defined for both parishes that petition and parishes that never petition.

Because we condition on petitioning and compute the fraction of petitions that pass, rather than using the leave-one-out mean of realized Parliamentary enclosures across parishes, geographical 'common shocks' are unlikely to invalidate our strategy (Angrist, 2014).

There may still be unobservables at the level of the committee in Parliament in London that correlate with local economic outcomes. But to validate our strategy, we note that parishes were small relative to the constituencies their MPs represented, and electoral incentives for individual MPs were largely absent.[4] In addition, any involvement an MP may have had with a petitioning parish would be captured by removing the petitioning parishes. To empirically substantiate these assertions, we show that a number of variables

[4]About 85% of elections were uncontested, and less than 10% of the population was enfranchised. Considering that the average member of Parliament represented 387 parishes, it is very unlikely that a specific parish where enclosure might be more valuable would be able to to put electoral pressure on their MP to pass an enclosure bill.

that would plausibly correlate with the expected return to Parliamentary enclosure for the left-out parish are uncorrelated with our instrument.

Since parishes voluntarily petition Parliament for enclosure, and because our instrument induces variation in the likelihood of passing a Bill successfully through Parliament, our instrumental variable strategy estimates the Local Average Treatment Effect (LATE) for those 'complier' parishes that self-select into considering or taking the Parliamentary route to enclosure. Some parishes that were already enclosed piecemeal stood to gain so little that they would never consider the Parliamentary route for enclosure are 'never-takers' for this instrument, and are downweighted by our Two Stage Least Squares estimator (Imbens and Angrist, 1994).

Using our instrument, we find that Parliamentary enclosure leads to an increase in wheat yield of 45% and we show this is not driven simply by substitution from one agricultural activity into another. This estimated effect is in line with some simple 'before-after' comparisons of single parishes made in contemporary agricultural reports (Stone, 1808; Rudge, 1807). This estimated effect is, as we discuss later, also realistic considering the high costs of implementing Parliamentary enclosure. We find a 22 percentage point increase in the Gini coefficient of the value of plots of land in an enclosing parish (relative to a mean of 0.74). These results are unchanged when we use a 'donut' estimator in which we successively remove nearby parishes in the construction of our instrument to show that other patterns of geographical clustering, besides common shocks, do not explain our results.

In the Appendix we interpret our IV estimates through the lens of a recent literature on Marginal Treatment Effects which allows us to construct an estimated Average Treatment Effect (ATE) (Heckman and Vytlacil, 2005; Brinch et al., 2017). Since the IV, by estimating the LATE, downweights the 'never taker' parishes, a natural conjecture would be that the ATE should imply far smaller yields benefits of Parliamentary enclosure. This is for the intuitive reason that the never takers, which had considered Parliamentary enclosure but chose not to petition, would have had relatively little to gain and higher levels of yields. Indeed, we find that the ATE is 75 to 78 percent lower than the corresponding IV estimate. As we argue later, we believe this helps explain why our yield results are much larger than existing cross-sectional studies.

Our second identification strategy takes advantage of the plot level data on agricultural rents collected from the returns of the Charity Commissioners by Clark (1998). This data was originally assembled to investigate the management of assets, including land, held by various charities and contains multiple observations of land rents on different plots, as well as information on Parliamentary enclosure. We estimate difference-in-differences models of the impact of Parliamentary enclosure on land rents at the plot level. We find enclosure leads to significant and large positive increases in rents of about 25% of the mean.

In line with work we cited earlier, our results suggest that collective systems of property rights did lead to large efficiency losses. Through what mechanisms did Parliamentary enclosure increase yields? The literature has suggested several. First, the transactions costs involved in governing open fields and the commons reduced incentives to innovate and invest. Contemporary advocates of Parliamentary enclosure suggested that it promoted "improvement", by which they meant investment, innovation, and experimentation in new techniques. Second, the re-organization of property rights created positive externalities, allowing for the creation of new local public goods, like improved roads. Third, the fragmentation of plots

inhibited the exploitation of scale economies.

Our data allow us to measure the first two of these mechanisms. We measure innovation with data on the count of agricultural patents filed in a parish. To capture potential inefficiencies in governance we measure the acreage in a parish that was either sown with turnips or subject to four-course crop rotation. Both tasks, sowing turnips and crop rotation with nitrogen-fixing crops, were known to replenish depleted soils and improve output, but may not have been adopted because their implementation required coordination among villagers with disparate interests within commonly governed fields. Parliamentary enclosure gave everyone the freedom to implement best practices without the need for coordination. We measure the direct externalities from the reorganization of property rights by the quality of local roads. Parliamentary enclosure acts did not just re-distribute land rights they also took advantage of this re-organization to create new roads and revoke traditional rights of passage. These were likely important externalities from the process.

We find evidence that Parliamentary enclosure is associated with more innovation, improved agricultural practices and better infrastructure.

We finally examine the downstream effects of enclosure on structural transformation. Consistent with the recent literature, we find large positive effects. For example, enclosing via Parliamentary act leads to an increase in the share of the labor force in manufacturing in a parish by about 1/3. It is also associated with a close to 30% increase in the probability of having a textile mill.[5]

Perhaps the most radical externality associated with enclosure and structural transformation was postulated by Marx when he argued that it was a key part of "primitive accumulation". Using data from the 1851 census we therefore investigate the origin of individuals who migrated from the parish in which they were born. We find that migrants from parishes which were enclosed by Parliament were more likely to move to industrial areas than those from parishes which did not so enclose. However, migrants from enclosed parishes were not more likely to be working in manufacturing and this is true even amongst those who migrated to northern industrial areas. These results partially support Marx's argument. Enclosure did precipitate out migration to industrial areas but this seems to have been mostly because parishes that were thus enclosed tended to be in the midlands and the north and were therefore physically closer to industrializing areas.

Our paper contributes to an at least 250 year long debate (documented in the next section) on the economic effects of the English Parliamentary enclosures. This debated both the efficiency and distributional aspects, and their role in the industrial revolution. With respect to efficiency, we show that Parliamentary enclosure had a substantial positive effect on wheat yields and, with the data on rents, productivity. Though economic historians have examined aspects of this debate and studied some partial evidence, we study far more comprehensive datasets, bringing together novel data on yields and mechanisms. Our findings are consistent with the recent literature on misallocation of factors of production in collectively managed rural economies we cited earlier and also contribute to the broader debates on the role of the form of property rights in development. In particular they speak to whether or not local institutions could govern resources, particularly the commons, efficiently (see Hardin (1968) and Ostrom (1990)), in a case where

[5]Our mechanisms feed into this structural change. For example, Asher and Novosad (2020) find that the spread of rural roads in India facilitated the movement of labor out of the countryside. The positive effects of enclosures on roads we find may have had similar effects.

property rights were well-defined (Coase, 1960) and institutions could potentially change endogenously in an efficient way (Demsetz, 1967).[6] [7]

The debate on the distributional impact has been even more charged. Parliamentary enclosure involved an institutional process that allowed for small landowners who might have opposed it to be over-ruled. It was exactly this feature that led Marx (1990, p. 885) to claim it was a "form of robbery" (see also Hammond and Hammond (1911) and Thompson (1963)). The division of common lands may have been inequitable because some rights were far easier to establish than others and not all rights were compensated. Enclosure was also expensive and since capital markets were imperfect, liquidity constrained individuals might have had to sell out. Consistent with this, and a potential mechanism for large increases in land inequality, we find that Parliamentary enclosure is associated with significantly higher out-migration. Our results on innovation and structural change can also be interpreted as evidence for a link between enclosure and industrialization though perhaps through different mechanisms.

Though our analysis is solely in England, it is important to note that the English field system and the nature of agrarian institutions that enclosure eliminated were in no way unique. In fact, England had inherited them from the Germanic tribes and so they were characteristic of much of western Europe (see Hopcroft (1999) and DeMoor et al. (2002) for overviews of the facts). All of these societies enclosed in various ways in the early modern and modern period and though the ways in which this happened differed, we would argue that our results are informative of the likely economic consequences of enclosure in this broader set of countries.

The paper proceeds as follows. The next section discusses the relevant historical and institutional background, focusing on the process of enclosure, the political procedures in Parliament that led to a Parliamentary enclosure act being passed and the literature which has assessed enclosure's impact. We place the latter in the context of the broader development literature on the productivity and structural impact of changes in property rights regimes. Section 3 introduces our dataset. Section 4 introduces our first identification strategy and our estimation framework. Section 5 presents the Two Stage Least Squares estimates of the effect of Parliamentary enclosure. Section 6 then develops our second identification strategy. Section 7 discusses mechanisms. Section 8 examines the downstream consequences for structural change. Section 9 concludes.

## 2 Setting and context

In this section we provide the necessary background to extra-Parliamentary as well as Parliamentary enclosures.[8] We first give a picture of what parishes with pre-modern enclosure typically looked like. We then discuss how the process of Parliamentary enclosure was bottom-up and instigated by the parish landowners and subject to transactions costs which meant that, prior to the Parliamentary mechanism, an entire parish could only be enclosed by the unanimous agreement of all the landowners. This is more likely

[6] Indeed, both the commons and the open fields were governed by informal institutions and norms regulating usage and cooperation, which could be enforced both through social sanctions and in the manorial courts (Ault (1965) and Neeson (1993), chapter 5).

[7] Our results cannot be interpreted as the narrow efficiency effects of moving from common to private ownership, since as we mentioned, enclosure was a fundamental re-organization in property rights with many externalities, moreover some land in parishes that enclosed by Parliamentary act had already previously been enclosed by a different method.

[8] Standard works are Tate (1967), Yelling (1977), Turner (1980) and Mingay (1997)

in places with few landowners. Nevertheless, failing unanimity, various types of partial agreements and enclosures could and did take place. We next discuss the details of the Parliamentary process and show what this meant in practice in a parish. We finally provide an overview of the historical literature on the consequences of enclosure.

## 2.1 What did pre-modern property rights look like in England?

In some parts of England at the start of the period of Parliamentary enclosures, canonical versions of medieval strip farming systems persisted. The most famous version of this featured (usually) three "open" fields, like in Barton-upon-Humber which we show as Figure 1. The left panel shows the situation in Barton prior to Parliamentary enclosure. The defining feature of open fields is that farmers owned land which they had well defined property rights to, but this land lay scattered in strips in the three large fields. Barton also had various types of "common land" such as the Ings at the top left which were meadows leading down to the river Humber. It also had a marsh (known as 'waste') and cow and horse pastures and the 'common wolds' at the bottom of the map. These lands were not normally farmed. Instead, local inhabitants had all sorts of common rights, what Thompson (1963) calls "a dense cluster of claims and usages" (p. 239), to the use of these lands: The right to graze livestock on the three main fields after crops had been harvested, the use of meadow, common land, and woodlands. They also had the right of estover or the cutting of bracken and furze (gorse), and for the digging of building materials such as stone, clay, and sand. In addition, there was the right of turbary to cut turf for burning as fuel.

The bottom of Figure 1 also depicts "old enclosures" which in Barton were mostly part of the village area. Though the map of Barton is good for developing intuition, it is also somewhat misleading in that there were very few early or piecemeal enclosures in the parish. Enclosure didn't normally just divide up pristine open fields and commons, it was also "a frequent practice at enclosure for landowners to exchange small patches of old enclosed land for the new allotments in order to eliminate awkward detached pieces of their estates, and provision for this was normally included in the acts" (Chapman, 1987, p. 27). In Figure 2 we reproduce an 1838 map of Elmstone Hardwicke in Gloucestershire (from Yelling (1977, p. 75)) which is perhaps the more typical case of what parishes looked like before they enclosed via Parliament. Here one sees three large, enclosed farms (A, B, C) whose lands are depicted in the three different types of shaded areas. Though the owners had gradually managed to enclose land over time their properties were highly fragmented. At the same time the open fields persisted, and these enclosed farms also had holdings there. Manor farm (A), for example, was 72% enclosed implying that 28% of its land was still in the open fields or in claims on the commons (Yelling, 1977, p. 74). Importantly, parishes like Elmstone Hardwicke, which had not chosen to enclose via Parliament by 1838, are in our control group.

## 2.2 The Process of Enclosure

Enclosing a parish was a bottom-up process. Both before, during and after the period of Parliamentary enclosures, it started with negotiations between the landowners of a parish, who had to gain sufficient consensus for the process to move forward. The key distinguishing feature of enclosures prior to the institutionalization of the Parliamentary process is that for the whole parish to enclose there had to be unanimity amongst the landowners. Short of this, many types of partial and piecemeal enclosure, as in

Elmstone Hardwicke, were feasible. Moreover, Parliamentary enclosures did not always enclose the whole parish, either because some landowners managed to opt out, or because old piecemeal enclosures were left untouched. The case study literature suggests that an important determinant of whether the entire parish could enclose by unanimity was how concentrated landownership was. Parishes with one or very few landowners could reach an agreement more easily (see Kerridge (1969, p. 96-97), Chambers (1932, p. 142) and Slater (1907, p. 155)). Turner summarizes the consensus view when he notes "the fracture of landownership among a large number of small proprietors was a reason for delayed enclosure" (Turner, 1984, p. 66).[9] [10]

Though enclosure was facilitated by "the opportunity provided by the Parliamentary procedures to overrule opposition from small landowners" (Yelling, 1977, p. 113) it did so in contexts where, when parishes decided whether or not to use the Parliamentary mechanism, "very few had been left completely untouched by earlier piecemeal enclosure" (Turner, 1980, p. 137). Even while Parliamentary enclosure proceeded in the eighteen and nineteenth centuries, partially enclosed parishes weighted the costs and benefits. They sometimes opted for an act of Parliament, but sometimes they kept on trying the piecemeal approach. O'Donnell (2014, p. 110) notes that "non-parliamentary methods continued to be important after 1750" and the study of detailed local records in four southern counties by Chapman and Seelinger (2000) found non-Parliamentary enclosure agreements to be as common as Parliamentary acts in the eighteenth and early nineteenth centuries. The evidence of O'Donnell (2016) for Northumberland is similar and see the other evidence he cites, for example from Westmorland.

## 2.3 The Parliamentary Process

The institutionalization of the Parliamentary route to enclosure in the eighteenth century brought greater clarity to the process, and critically, it made it easier to fully enclose a parish because it provided rules which over-ruled opposition. To start the process, the parishioners had to petition Parliament with a draft enclosure Bill, which suggested a re-organization of property rights. When this was submitted to Parliament, the parishioners had to simultaneously present a "consent document" listing all the landowners in the parish, the value of their holdings, and their signatures as to whether they were in favor of the enclosure (Consent), against (Dissent), or indifferent (Neuter). No official figure was ever laid down for the proportion of these landowners who had to be in favor for Parliament to proceed. It was said to be 3/4 or 4/5 of landowners by value (though there are documented cases of parishes that were enclosed where less than 3/4 of the landowners were in favor (Mingay, 1997, p. 67). It was only in 1836, with the passage of the General Enclosure Act, that a 2/3 majority was specified.

Though negotiations began informally, parishioners would typically have a hired lawyer draw up a potential enclosure Bill, then there would be an open public meeting to discuss it. After they had done this, the petition had to be fixed to the church door for three summer Sundays prior to the next Parliamentary

[9] One of the themes of Gray (1915) and the subsequent literature, is that the variation in the timing of enclosure is related to idiosyncratic factors that created 'frictions' in the process of negotiating enclosure. For example, he contrasts the earlier timing of enclosure in Herefordshire compared to Oxfordshire noting that this could be explained by it being much easier to agree in the former because the size of townships were smaller Gray (1915, p. 153). See also Thirsk (1967) and Thirsk (1964, p. 23) for other related examples.

[10] Unfortunately extra-Parliamentary agreements to enclose are very poorly documented even when they were recorded, as some were, in the Court of Chancery (see Yelling (1977, p. 18) and Beresford (1961, p. 58)).

session. If there was sufficient agreement, the Bill would be presented to Parliament. The presented Bill would then typically form the basis of a Parliamentary enclosure act. In Parliament, the Bill was judged by a committee of Members of Parliament (MPs) against a large number of legal requirements, called the standing orders. If these were judged to have been satisfied, the committee would recommend that the Bill be subject to a vote on the house floor and enacted into law. We describe this process in detail in the context of our identification strategy in Section 5 of the paper.

The Bill specified the names of people who would become the commissioners, usually three, and the name of a surveyor. If the Bill became an act of Parliament, the commissioners undertook the division and re-organization of the lands. First, the surveyor would map the lands to be divided. Then, the commissioners would hold a series of meetings, where people would come forward to present their claims and try to establish their rights. As we noted, rights to the fruits of the commons were complex and often informal. The commissioners had to spend a long time soliciting evidence and interviewing multiple local residents to try to establish who used the commons and for what purpose. In the written Bill itself, considerable attention was paid to processes emphasizing transparency and the points at which people could protest decisions. When agreement was not possible, ultimately, appeals against commissioners' decisions could be taken to the local Quarter Sessions or the Chancery Court. Finally, the commissioners made the Award, which specified the division of the lands and an award map (see Kain et al. (2011) for a collection of the Award maps), placed it on the church door and had it read in public. Mingay (1997, p. 72-73) lays out all the events in the process from the first meeting of the commissioners on June 30, 1782 in Kingston Deverill to the final legal Award on August 23, 1785.

Parliamentary enclosure was a costly process. Leaving aside the value of all the time involved in making it happen, a lawyer had to be hired to make up the initial petition to Parliament. The landowners who wanted to enclose had to pay for the survey which would be the basis for the new land settlement, and they had to cover the costs of the commissioners who re-organized the land. In addition, Parliamentary enclosure involved the construction of new roads, replacing rights of way over the open fields, and the fencing of lands. The costs of these activities were divided between the landowners in proportion to the size of their holdings. Occasionally, the commissioners sold off portions of the newly enclosed lands to help pay some of these costs. See Stone (1808, p. 103) for a contemporary cost estimate for Barton. More generally, Turner (1984, p. 59-60) summarizing a great deal of evidence, argues that over the whole period of Parliamentary enclosures the total cost of enclosing was at least 12 pounds per acre on average (a "lower bound"). For a farmer owning 20 acres of land, the total cost of enclosure could be 240 pounds. This was almost five times the annual income of such a farm in the late 18th century (Mingay, 1997, p. 113). Since these costs had to be paid at the time enclosure took place this represented a serious problem for smallholders or liquidity constrained individuals.

## 2.4 The immediate consequences of Parliamentary enclosure

What happened when a parish was enclosed by Parliament? Mingay (1997, p. 7) defines a Parliamentary enclosure as involving

> the extinction of common rights which people held over the farmlands and commons of the parish, the abolition of the scattered holdings in the open fields and a re-allocation of holdings

> in compact blocks, accompanied usually by the physical separation of the newly created fields ... [and] by the erection of fences, hedges and stone walls.

This is more or less exactly what happened in places like Barton. The right panel of Figure 1 shows the map of Barton and the new consolidated farms after Parliamentary enclosure. All common lands have been eliminated and the large landowners who pushed for enclosure are clearly visible on the new map. These were Marmaduke Nelson Graburn, William Graburn, as well as the owners of the tithes, George Uppleby, Esq., and his wife Sarah (Ball, 1856, p. 69). After enclosure these three families owned 63% of the parish (Russell, 1968, p. 36). This map also shows a few of the other things that were packaged with Barton's enclosure. A new system of roads was built, and in the top right one sees lands "for tithe". When enclosure started in 1797, tithe incomes, which accounted for 10% of agricultural output, were usually in the hands of private people. In the process of Parliamentary enclosure, the tithe holder was often compensated for surrendering his right to the tithe in exchange for an enlarged landholding. Other similar types of compensation appear on the map. George and Sarah Uppleby also received land for "glebe" and Marmaduke Nelson Graburn and the Upplebys also each got a "corn rent allotment". These ancient rights were also frequently compensated with extra land.

## 2.5 The Literature

### 2.5.1 Parliamentary Enclosures

Parliamentary enclosures and their consequences received a great deal of comment at the time from politicians and intellectuals. No doubt the effects of enclosure were heterogeneous, as was the efficiency of the initial situation, so something more systematic than case studies is desirable. Many contemporaries made calculations suggesting that Parliamentary enclosure improved productivity and some modern assessments are similar with Overton simply stating: "Enclosure facilitated innovation and changes in land use because the constraints imposed by common property rights, the scattering of land, and collective decision making could be overcome" (Overton, 1996, p. 167). Overton regards the correlation between improved agricultural productivity, technological change, and Parliamentary enclosures to be so strong that a causal connection seems highly likely (Overton, 1996, p. 167). This conclusion is also reached by Clay (1984, p.133-134) and Bogart and Richardson (2009, 2011) all using very different methods than our own. We discuss other relevant case study evidence in Appendix 5.1.

Interestingly, contemporary commentators and "improvers" mostly suggested that the impact of Parliamentary enclosure were positive and large and a few of these studies used before and after comparisons of crop yields. Young (1808, p. 217) for example argued for a 50% increase in wheat yields.

On the other hand, Mingay (1997, p. 94) ends up arguing that "There can be no general conclusion that enclosure, by releasing farmers from the limitations of communal farming, inevitably led to general improvements." And Thirsk (1963, p. 99-100) concludes that the open field system was innovative and flexible (see Mokyr (2009, p.175) for a similar perspective). Indeed, the most sophisticated previous empirical work on enclosure, due to Allen (1982), finds very little effect. Allen's sample is of 231 farms, scattered mostly over the Midlands or different parts of northern England, extracted from a tour of England by Arthur Young between 1768 and 1770. He made a cross-sectional comparison of yields and (total factor) productivity between enclosed and open parishes and found no significant productivity differences and lower

yields in enclosed parishes.[11] It is unclear, however, how Young chose the sample with the only clue being that he met the farmers at York horse races and Turner specifically comments that "it is hard to maintain confidence in Young when we learn from Allen that grain yields were actually smaller" on enclosed land (Turner, 1984, p.44). In later work, Allen found a slight average increase of 1.9% in wheat yields in enclosed compared to open parishes (Allen, 1992, p.136). Turner (1984, p.40) cites several studies to conclude that crop yields increased by around 25.0% and elsewhere presents detailed evidence for a 26.4% increase (Turner, 1982, p.40). These studies make mostly cross-sectional comparisons and suffer from the same selection issue we face. Nevertheless, some modern scholars, like Daunton (1995, p. 114-117), accept this evidence as establishing that there were indeed few productivity effects of enclosure.

McCloskey (1989) bases her estimate on a selection of contemporary secondary sources which report the increase in rents associated with enclosure. The predominance of these studies suggest that rents doubled. She then multiplies the rent increase by the share of land in national income which, if wages and prices are constant, there are constant returns to scale and factors of production are paid their marginal products, gives an estimate of the change in total factor productivity correlated with enclosure. Taking a land share of 30% this leads to an estimated 30% increase in productivity, though she notes it could be as low as 6.5% with different estimates.[12]

Our own results on yields are closer to those estimated by Young and contemporaries than more modern economic historians. The fact that our yield estimates are significantly higher than those in the existing literature is likely because nobody has yet proposed a methodology for solving the inferential problem that Parliamentary enclosures were endogenous. Parishes that had already enclosed in a piecemeal fashion stood to gain less from Parliamentary enclosure than parishes that hadn't. Since potential gains from choosing Parliamentary enclosure for previously enclosed parishes are a counterfactual outcome, econometric techniques that allow us to estimate such counterfactual outcomes are necessary to estimate a more realistic treatment effect of Parliamentary enclosure. The natural alternative approach is to use before-after comparisons (which was Young's approach). We do so for a limited sample of plots for which data is available. We can use McCloskey's methodology to generate the implied increase in productivity induced by enclosure. Since we find small increases in rents they imply productivity increases of about 7.5% (using McCloskey's 30% estimate for the share of land in national income). Nevertheless, we prefer the yield estimates. The method of McCloskey rests on strong assumptions and also nets out the adjustment of factors of production to the institutional change. Though some of the changes wrought by enclosure clearly do concern productivity, others such as our innovation results, are about the induced response to enclosure. The yield estimates capture the total effect.

Just as contemporaries and scholars have debated the productivity impacts of enclosure, so they also discussed the likely impacts on distribution. The most famous nineteenth century hypothesis about the impact of Parliamentary enclosures was advanced by Karl Marx in Volume I of *Capital*. He argued that:

> the law itself now becomes the instrument by which the people's land is stolen ... The Parliamentary form of the robbery is that of 'Bills for Inclosure of Commons', in other words decrees

[11] As our discussion of piecemeal enclosure makes clear, there was really no such thing as a purely open or purely closed village, unless the latter was enclosed by Parliamentary act.

[12] An earlier attempt to use this methodology generated an estimate of a 7% increase in productivity (McCloskey, 1972, p. 35).

> by which the landowners grant themselves the people's land as private property, decrees of expropriation of the people. (Marx, 1990, p. 885-886).

In Marx's argument, Parliamentary enclosures were the process by which large landowners expropriated small landowners, leading to a large rise in land inequality and the creation of a landless population, who then migrated to work in the factories of the industrial revolution. His views were largely re-affirmed by famous 20th century studies such as those by Hammond and Hammond (1911) and Thompson (1963). Thompson states that "Enclosure ... was a plain enough case of class robbery, played according to fair rules of property and law laid down ... by property owners" (p. 237-238). Thompson, like Marx, emphasized the dispossession of small landowners and landless who, unable to survive anymore without access to the commons, became available for factory work. The consensus amongst scholars currently is that in fact there was little corruption in this process, so the words "stolen" and "robbery" are not accurate.[13] Nevertheless, Armstrong (1989, p. 722) notes "enclosure could be entirely legal in regard to respecting property rights and yet be inequitable" and thus consistent with significant increases in inequality. We discuss other relevant case study evidence in Appendix 5.2.

There is little systematic empirical work on this topic. Mokyr (2009, p.175) does note that "As a result of enclosures ... the size of the average agricultural holding increased" which is evident from case studies like Barton. To our knowledge there are no previous estimates of the impact of enclosure on land inequality though Allen (1982) interprets his findings of increased rents along with no change in productivity as indicating large increases in inequality. Chambers (1953) initiated a debate on the role of enclosure in providing an industrial labor supply, arguing that the evidence was inconsistent with it. This view was re-iterated by Landes (1969, p.115) amongst others. A lot of the debate focuses on the impact of enclosure on the size of population of enclosed parishes which is complicated by rapid population growth (see Daunton (1995, pp. 110-111)). The evidence presented by Crafts (1978) does lead him to conclude that "At the county level there was a small but perceptible positive association between parliamentary enclosure and ... out migration" (p. 182). He draws this conclusion from the 1841 census by finding that "a smaller fraction of of the population of parliamentary enclosed villages" was "born outside the county" (p. 181). He did not, as we do, look systematically at migrants to industrial areas. Allen (1992) attempts to do this but concludes about the south midlands, where his data is concentrated, that "the region did not supply a work force to the modern industries of the Industrial Revolution. The new factories were located mainly in the north of England, but southern labor did not flow there" (p. 243). This conclusion is correct, but by looking at the entire set of Parliamentary enclosures we show that it does not capture the broader pattern.

Ultimately then, the existing literature is inconclusive. One can make theoretical arguments about the efficiency of the open fields system (Townsend, 1993) and the usage of the commons (Ostrom, 1990), but one can also argue, on theoretical grounds, the opposite (Hardin, 1968; Samuelson, 1954). One can also argue that enclosure increased land inequality, the supply of labor to manufacturing industries and impacted industrialization and structural change through various channels. All the mechanisms emphasized make conceptual sense, but what is their quantitative significance? Our study is motivated by the salience of the

[13] Tate argued that the Parliamentary process tends to "show how very scrupulously and conscientiously the commissioners carried out their duties. They display almost an excessive regard for legality ... and a meticulous attention to the minutae of the business" (Tate, 1967, p. 173). The legality of the process is emphasized by virtually every study. For example, Mingay (1997, p. 57-58), Armstrong (1989, p. 721), Gonner (1966, p. 76-77).

question and the lack of systematic empirical studies.

### 2.5.2 The Development Literature

Outside of the specific literature on England, our results relate both to studies of agrarian reform and the impact of agrarian change on productivity and structural transformation. Most studies of reform, however, have studied government mandated land reforms. Some of these find positive effects, like Besley and Burgess (2000) and Montero (2022) with Kitamura (2022) and Galán (2022) specifically including structural change. Many find negative effects, e.g. Adamopoulos and Restuccia (2020), for example caused by the break-up of large farms reducing scale economies. These different findings reflect the great heterogeneity of the contexts and reforms. The English enclosures were different since the government simply provided a mechanism for facilitating private agreements. They did not stipulate what would happen. Libecap and Lueck (2011) study a natural experiment in the rationalization of field shape, which was much discussed as a benefit of Parliamentary enclosures at the time and find positive effects consistent with our results and Banerjee et al. (2002) show that tenancy reform which gave individuals more secure rights stimulated productivity.

A number of papers have researched the efficiency benefits of individualized private property rights. Besley (1995) does this in a rural setting and find large effects, more individualized rights leading to a 28 % increase in the probability of investment. Other studies also find positive effects but are of urban areas (Field, 2007; Galiani and Schargrodsky, 2010).

Studies of the connection between agriculture and structural change have tended to focus on the impact of specific innovations in technology or infrastructure, rather than re-organizations of property rights. In addition to the studies cited earlier Asher et al. (2023) examine the impact of the spread of irrigation in India. In common with our results these studies identify quite large effects (particularly Gollin et al. (2021)) but working through diverse channels. Our identification strategy does not allow us to estimate the causal effect of productivity, agricultural innovation or infrastructure on structural transformation, but our results are consistent with this literature.

# 3 Data

We use two samples to conduct our analyses. Our primary sample consists of parishes, and our secondary sample consists of an unbalanced panel of individual plots. In this section we introduce these unit of observation. We also introduce the main variables and discuss measurement. Table 1 presents summary statistics.

## 3.1 Unit of observation

Our main unit of observation in this study is a parish. There were about 15,000 parishes and parish-like units in England around 1830. At the time of the 1831 census, the average parish had 387 inhabitants.[14] Each enclosure act explicitly enclosed either a single parish or a field common to several parishes. The

[14] In southern England, the parish was the main unit of local administration. In northern England, parishes were historically larger, and were often composed of several hamlets. We use the hamlets as the local unit of observation in this case. Some data vary only at the parish level. In this case, we aggregate hamlets to parishes. The average population figure of 387 is the average after aggregating in this way. The largest parish in 1831 is Leeds with 85,287 inhabitants. Older and larger cities had their city centers split up into multiple parishes.

parish is therefore the natural unit of observation for studying enclosure.[15] We use a cross section of parishes prepared for the 1851 census as our unit of observation (Kain and Oliver, 2001). Using parish names, we then merge other data sources to our cross-section of parishes. The effective number of observations in our regressions depends on the geographical coverage of our outcome variables.[16] We remove London and other cities and towns from our sample throughout. Our secondary unit of observation is an individual agricultural plot. We restrict to plots available in the dataset of plots owned by charities introduced by Clark (1998) and we introduce this dataset below.

## 3.2 Enclosure

We measure Parliamentary enclosure from the *Domesday of English enclosure acts and awards* (Tate and Turner, 1978). This source lists each enclosure act passed during the Parliamentary enclosure period. In total it records 5,383 acts and covers the universe of Parliamentary enclosure. For each act we record the parish(es) it enclosed. Figure 3 shows the number of parishes enclosed over time via Parliamentary act. Appendix Figures 4 and 5 provide a photograph of an enclosure act and a bar graph of the number of parishes enclosed by county. We measure Parliamentary enclosure by an indicator equal to one if a parish was enclosed by an act of Parliament.

**Failed enclosure acts**. As described in section 2 of this paper, enclosure had to be proposed to Parliament. Often, these Bills failed and were not enacted into law. Failed acts are not in the database of realized enclosures of Tate and Turner (1978). We therefore expanded their database to include all failed enclosure acts as well. For acts proposed before 1800, we rely on Hoppit (1997), who records all failed acts in Parliament. For acts proposed after 1800, we read the *Journal of the House of Commons* which records Parliamentary proceedings. We recorded each instance of enclosure being proposed. By comparing the resulting list with the realized enclosures from Tate and Turner (1978), we identified enclosures that were proposed but did not pass.

In sum, for each parish we know whether it was enclosed by Parliament, the number of times enclosure was proposed, and whether a proposed enclosure passed. We use failed Parliamentary enclosures as part of our identification strategy, which we discuss below.

In our secondary sample, if a plot was enclosed, this fact - and its enclosure year - is recorded. The coding of Parliamentary enclosure was made by Clark (1998).

## 3.3 Outcome variables

For our primary sample, we measure wheat yield using data from Kain and Prince (1985), who study the records of the survey collected prior to the 1836 Tithe Commutation Act. In this process the commissioners measured wheat yields for a large number of parishes. We record wheat yield in bushels per acre in 1836

[15] That is not to say that all land in a parish had to be in common field. In some parishes, larger parts of the parish may already have been enclosed piecemeal. To capture this, each act recorded the acreage of *land* affected by the act, in addition to other stipulations, like road construction. In a robustness check we use this intensive margin variation.

[16] As we discuss in our section on outcome variables below, our data on yield and inequality come from agricultural surveys. The reduction in sample size from the total number of parishes to the effective number of parishes in our regression reflects this. For example, parishes in our sample are on average further away from London and more rural. For our data on wheat yield, our sample is further constrained by the fact that parishes would have to grow wheat for yields to be measurable.

from these returns. We focus on wheat, which has the most observations and was the most important staple crop around this time.

A complication of using this source is that, as we noted in the context of Barton, Parliamentary enclosure might lead to the commutation of the tithe. If this were the case in the entire parish, the commissioners typically did not record any yield information. As Kain and Prince (2000, p. 12) note: "About 2,200 enclosure acts passed before 1835 provided for the abolition of the payment of tithes in kind" (see also Ward (1965, p. 70) and Evans (1976, p. 111)). In 1,510 acts tithe holders were compensated with land, in 550 a combination of land and money and in 170 money only. However, "only rarely did commutations under enclosure acts extend over a whole parish" and "many parishes enclosed by act of parliament had not abolished their tithes" (Kain and Prince, 1985, p. 136,113).

Thus the tithe surveys therefore report data for parishes that did not enclose; which enclosed but did not commute their tithe at enclosure; and parishes that enclosed but only partially commuted their tithes at enclosure. In the latter case the situation is even more complicated since as Kain and Prince (1985, p. 136-137) observe "The tithe documents for ... partly commuted parishes rarely yield information on the enclosed lands, but only on those parts held in severalty before the enclosure act together with those parts still unenclosed at the time of the tithe survey." Therefore, depending on the nature of tenure, land which had been enclosed before the tithe surveys might nevertheless be surveyed.

The main issue that this raises for us is whether tithe commutation creates a selection problem - could it be, for example, that relatively unproductive parishes commuted their tithe at enclosure, biasing our sample of enclosures towards more productive parishes. In our main specification we use the entire sample of parishes for which we have Parliamentary enclosure data and data from the tithe surveys. In the Appendix we use three strategies to establish the robustness of these results and to show that selection is unlikely to be an issue.[17] In our secondary sample, described just below, we use data from a different data source that is unrelated to tithe commutation. Using this source, we find similar results.

To measure inequality we record, from the Tithe commissioners' records, the value of each plot in a parish. In total we have data on 8,333,558 plots, which gives us a dataset of 681,650 individuals who either own or farm one or more plots, and for whom we know the value of their holdings. On average, a parish with plot level agricultural data has 41 landowners that are in the tithe records. From this dataset we compute the land value Gini coefficient for each parish for which we have data, assigning zero land value to individuals who don't own any land but do rent a plot from someone else owning the land. To study mechanisms, we record several new measures of innovation and change in agricultural practices which we will introduce below.

Our secondary sample is taken from the Charity Commission returns, described by Clark (1998). Between 1818 and 1912, the Charity Commission of Parliament investigated the holdings of 28,800 charity

[17]The first is a simple one based on maps that Kain and Prince (1985, p. 11,65) draw. The first (p.11) uses a British Parliamentary Paper to plot the distribution of these parishes on a map and the second (p. 65) depicts a calculation of the proportion of land in different parts of England covered by the tithe surveys. The absent data comes mostly from the midlands. We use this latter map to drop all the counties for which a high proportion (greater than 60%) of the parishes have missing data. Secondly, we used the Parliamentary Paper on which the map on page 11 is constructed to document directly all the parishes where the tithe was commuted according to this source. We re-run our estimates dropping the parishes listed in this document. Finally, we construct a balance table to compare parishes enclosed by Parliament for which we do and do not have tithe data. Some variables do not balance, though quantitatively the differences are very small. We re-run our basic models controlling directly for variables which do not balance. Our results are also robust to all these exercises.

endowments. Such endowments were given to finance e.g. a school or a hospital. Since the endowments were often in the form of land, these records contain information on individual plots (sometimes observed at multiple points in time), and the rent in pounds per acre for each plot. Clark (1998) standardized these records and recorded whether a plot got enclosed through Parliament. We record rent/acre for each plot in the data in the resulting panel dataset. The dataset covers about 2% of all agricultural land in England, but we restrict to the subset of the dataset that has enclosure information as well as rent/acre information available. Appendix Figure 5 shows the distribution of observations per decade. The majority of observations are concentrated between 1800 and 1840. This data is our only source that admits a panel structure. We therefore describe our empirical strategy for the majority, cross-sectional, data sources and then introduce the empirical strategy for our panel when we come to those results.

Finally, we collect a large number of additional variables, which we introduce below as they become relevant in the empirical part of this paper.

### 3.4 Summary Statistics

In Table 1 we provide summary statistics of our main outcomes, split by an indicator equal to one if a parish experienced Parliamentary enclosure between 1750 and 1830. In a simple t-test we find that enclosed parishes have significantly higher yields and have a higher land value Gini. In the next sections we explore these patterns in detail.

## 4 Empirical strategy

As we outlined in our background section, all parishes potentially stood to gain from enclosure through Parliament. There was, however, heterogeneity in the returns to petitioning, and therefore in the decision to petition, and ultimately, in the probability of Parliamentary enclosure. Relative to the high costs of Parliamentary enclosure, it may not have been worth it for some, but profitable for others. This observation is the key empirical challenge of this paper. As parishes that had already (partially) enclosed likely already realized some of its effects, we expect to underestimate the true effect of Parliamentary enclosure if we rely on simple comparisons between parishes that enclosed through Parliament and those that did not. This is the main identification concern in our primary sample. In our secondary sample, identification requirements are different, and we discuss our empirical strategy for this sample below. In this section we introduce our primary empirical strategy, which focuses on estimating the treatment effect for those parishes that would potentially take up Parliamentary enclosure. This is the 'policy relevant' group: It is these parishes that the opening up of the Parliamentary route for enclosure was intended to benefit.

The core of our empirical strategy is the fact that after petitioning, enclosure Bills were judged by a committee in Parliament. This committee decided whether the Bill complied with legal requirements. We posit that there are differences between the committees who represented different parts of the country over our study period in the fraction of proposed Bills under their jurisdiction that passed. For parishes that did not petition, these differences would have been important had a committee been convened for a petition. These observations would allow us to use the fraction of proposed acts that passed locally as an instrument for a left-out parish. In the remainder of this section, we will discuss the historical background

for our empirical strategy, measurement, estimation, challenges to identification, and balance.

## 4.1 Parishes and Parliament

Each parish in England was part of a constituency, and each constituency sent two Members of Parliament (MPs) to Parliament. There were two types of constituencies, county, and borough. County constituencies were rural constituencies covering large parts of England. There were 40 such constituencies. In our dataset, an average county constituency covers 387 parishes. Borough constituencies covered medieval cities and were often very small.[18] Because we remove cities and towns from our analyses, we in practice restrict to county constituencies. In these constituencies, there were hundreds of parishes that had little control over the outcome of elections, unless they happened to be home to a large landlord or the MP himself.

## 4.2 The Parliamentary process for enclosure Bills

In section 2 we discussed the process that led to an enclosure act. Here we provide the relevant detail on the Parliamentary stage of the process.

Once a Bill was agreed upon in a parish, it was submitted to Parliament by a lawyer hired by the petitioning parish. In Parliament, it was subject to what was called the 'Private Bill procedure'.[19] Each Bill was judged by a committee of MPs. These committees were tasked with judging a Parliamentary by a large number of legal requirements, called standing orders. There were numerous standing orders for Private Bills, and additional standing orders for enclosure Bills in particular.[20] For example, these orders stipulated that a committee formed to judge a Bill should review the enclosure consent document and ascertain that the requisite majority of landowners, as well as all other stakeholders were adequately represented. To do this, committees were authorized to request documentary evidence, to call witnesses, and to require amendments to proposed Bills. After this, the committee was required to hear any 'counter-petitions' from stakeholders who felt disadvantaged by the proposed Bill. At the end, a committee made a recommendation and there was a vote by the Commons. After having been passed by the Commons, the Bill would move to the House of Lords where another vote occurred before a Bill was signed into law by the king.

Throughout these procedures, it was by no means guaranteed that a Bill would pass. For Oxfordshire, about a third of proposed Bills failed (Tate, 1949). For Nottinghamshire, the number is also about a third (Tate, 1942). In our database of all enclosure Bills, about 20 percent of Bills failed.

[18] The electorate in some boroughs was so small that they were called 'rotten', as a handful of voters elected two MPs, as many as were elected by the about ten thousand voters in Yorkshire.

[19] Any Bill in Parliament can either be public or private. Public pertains to the entire country, such as Bill on tariffs or war. Private pertains to local or individual issues, such as naturalization and divorce, but also from about 1700 on included local issues to do with property, like enclosure. Both types of acts were subject to separate procedures. We provide a step-by-step breakdown of the Private Bill procedure in the Appendix.

[20] The most important distinction between Public and Private Bills is that Private Bills were required to adequately represent all stakeholders' interests. Such requirements are of course impractical for public Bills but make sense for divorce and other private matters. By submitting enclosure Bills as Private Bills, petitioners ensured that the interests of all stakeholders were represented.

### 4.3 The committee in practice

We described so far the theoretical legal procedure. The formal procedure may of course differ from the de facto implementation of the law. As for the task of the committee, it is clear from contemporaries' descriptions of the process that its de facto mandate was the resolution of potential conflicts of interest in the Bill (May, 1844, p. 76):

> "a bill for the particular benefit of certain persons may be injurious to others; and to discriminate between the conflicting interests of different parties, involves the exercise of judicial inquiry and determination."

The members did so by applying the standing orders. In fact, Fisher (2009) notes:[21]

> "A private bill could not be introduced without confirmation that the standing orders had been complied with, and the committee's function was to establish whether this was so, and report its conclusions to the House."

In the Appendix, we provide a description of the full practical procedure from a contemporary lawyer's handbook. This handbook also lists in full text the standing orders an enclosure act was required to comply with (Ellis, 1802).

In principle, any MP could be assigned to be on a committee, but in practice the MPs representing the constituency from which a petition came, and MPs from surrounding constituencies constituted the committee formed to judge a Bill: "The members .. are usually the county members, or those from a neighboring constituency" (Tate, 1967, p. 95).

There was a committee for every Bill. For Private Bills, it is clear that MPs on the committee had a large degree of discretion over the rigor with which the standing orders were applied (Lambert, 1971). It stands to reason that there was variation across committees in what fraction of Bills within their jurisdiction passed.

When the committee reached a verdict, they "...report to the house that the Committee has gone through the Bill, and then they will order it to be engrossed" (Ellis, 1802, p. 89). The committee then went up to the speaker of the House to vote. Although formally every MP was allowed to vote, there is later, but probably representative, evidence from the 19th century "that routine business, whether public or private, was transacted round the speaker's chair, while the rest of the house chatted and moved about to speak to friends" (Lambert, 1971, p. 98).

In conclusion, a committee of MPs was required to formally judge a proposed enclosure against a large number of standing orders. At the end of the process, a law could be produced that enacted a Parliamentary enclosure. At this stage, as we saw in section 2, Parliament appointed commissioners and a surveyor that went to the involved parishes to document and map everyone's holdings and implement the actual enclosure.

[21] We consulted the online version of this book, available here: http://historyofparliamentonline.org/volume/1820-1832/survey/vii-procedure-and-business-house. Current as of 12/01/2020. The quotation appears on this page.

## 4.4 Measurement

We exploit the fact that enclosure Bills were enacted through Parliament in London, even though they usually pertained to an individual parish, and at most to a few parishes. Similar committees would receive petitions from the part of the country they represented, and whether a petitioning parish would enclose through Parliament was in part determined by the committee's decision. These facts allow us to use the leave-one-out mean of the number of petitions that passed over parishes that would plausibly have had a similar committee in our sample period.

There are two measurement challenges to this strategy. First, the precise composition of committees is not systematically recorded in the Parliamentary archives. Second, committees are not defined for those parishes that never petition. Our solution to both challenges is to identify a geographical area around a given parish which, we claim, captures the set of parishes for which committees would have been similar for. For parishes that did petition, this area captures parishes with similar committee representation to the petitioning parish. For parishes that did not, this area captures the representation they would have faced had they petitioned. We then compute the leave-one-out mean of the proposed enclosures that passed within this area, over our sample period. The reason to average over our entire sample period is practical. We do not know when a parish that did not petition would have, had they faced a committee that would have induced them to petition.[22] We hypothesize that this probability correlated with the probability of a Bill passing in the left-out parish. To operationalize the use of the leave-one-out mean petitions passing as an instrumental variable for Parliamentary enclosure, we proceed in several steps.

1. For each parish, we identify the $k$ closest parishes. In our baseline estimates, we set $k = 350$, and we vary $k$ in the Appendix. This area is intended to capture the area from which MPs would be selected to serve on the committee for a petitioning parish. For example, if a parish is near a constituency boundary, the committee would likely consist of MPs from both the constituency the parish is in, as well as the neighboring constituency. If a parish instead was in the heart of a large county constituency, the committee was typically staffed with the county constituency representatives as well as MPs from nearby boroughs within the constituency.[23] This way, the bandwidth $k$ identifies the likely composition of a committee, whether it was actually formed or not. We discuss an example that builds intuition below.

2. For parishes within $k$, leaving out the petitioning parish itself, we compute the fraction of petitions that were successful. If a parish petitioned twice, first unsuccessfully and subsequently successfully, we include it in this computation twice. To compute the instrument in the same way for enclosing parishes and parishes that never enclose, we compute this measure using enclosures over our entire sample period.

Figure 4 contains three maps that provide intuition for the construction of the instrument for the parish

[22] This of course implies that we include committees in the construction of the instrumental variable for parishes that did petition from before their petition happened. Because we intend to capture an aspect of the political representation in London that may or may not induce parishes to petition, we do not want to condition on any timing information we may have about Parliamentary enclosure. We would only be able condition this way for parishes that did in fact enclose through Parliament.

[23] Note that we drop parishes that are in such boroughs from our dataset, and the construction of our instrument does not take passed or failed enclosures from boroughs into account. It is still the case that rural parishes likely had MPs from nearby boroughs on the committees judging their petition.

of *Meldreth* in Cambridgeshire. The figure superimposed between subfigure (a) and (b) shows a bounding box to situate the case study within England. The extent of this box is the full extent of subfigures (a) and (b).

In subfigure (a) we show the extent of $k$. Note that $k$ spills into several neighboring constituencies, such as Bedfordshire and Hertfordshire county constituencies, and Cambridge and Huntingdon borough constituencies. This reflects our assertion that MPs from these constituencies were likely to be on the committee for Meldreth should it petition. In subfigure (b) we shade parishes within $k$ by enclosure status. Parishes in white never petitioned. Parishes in light gray successfully petitioned. Parishes in dark gray petitioned, but their petition failed at least once. We construct the value of our instrument for Meldreth by dividing the number of successful petitions by the total number of petitions within $k$.

Meldreth did in fact petition for enclosure on December 16, 1812. Although we cannot know the full composition of its committee, when a Bill was first assigned to a committee or when an MP returned with a Bill to the Commons, names of individuals were sometimes recorded in the Journal of the House of Commons. In the case of Meldreth for instance, after the petition was delivered, Lord Francis Osborne (MP for Cambridgeshire) and Lord Charles Manners (the second MP for Cambridgeshire) were charged to prepare the Bill for Parliamentary scrutiny and were made part of the enclosure committee. Later on, Thomas Brand (MP for Hertfordshire), who was a committee member, reported that the standing orders had been complied with. Hertfordshire is indicated in subfigure (b). Hertfordshire borders on Cambridgeshire, and Meldreth is close to their border.[24]

## 4.5 Challenges to identification

An important challenge to identification originates with the leave-one-out nature of the instrument. A now large literature points out that group means as instruments for left-out individual outcomes can produce a sufficiently strong estimated first stage even in the absence of a true first stage due to common shocks at the group level (Angrist, 2014). This would be a problem for us if we took the mean of an indicator for enclosure across parishes within $k$. Common shocks may affect the decision to petition for Parliamentary enclosure irrespective of what happens in Parliament, for example. We, instead, condition on petitioning, 'shifting' the construction of the instrument to Parliament in London.[25] It may still be the case that the pass rate of petitions correlates with local (un)observables in a way that in turn correlates with economic outcomes, violating the exclusion restriction. The most direct way this could occur is if, for example, MPs live in parishes with certain characteristics.[26] The behavior of MPs in Parliament in connection with enclosure has been studied extensively by William Tate (Tate, 1942, 1945, 1949, 1967). Tate (1949, p. 220) concludes:

> Enough evidence has been adduced to suggest strongly, though hardly to prove, that on occasion

[24] After a challenge to the petition due to some lands that were interspersed with neighboring parishes, the Bill was reported to have complied with all standing orders on June 3rd 1813.

[25] Because the role of a committee can be interpreted as judging the quality of a proposed Bill, our strategy is similar in spirit to 'examiner' designs, common in labor and public economics (e.g. Card et al. (2020) and Dahl et al. (2014); fundamentally, these strategies go back to Angrist et al. (1999)).

[26] For example, Sir Charles Mordaunt represented Warwickshire for 40 years, between 1734 and 1774. The first enclosure act that was proposed when he was in Parliament was for Wellesbourne Mountford, where he was the lord of the manor - the major local landowner. Note that in the construction of the instrument for Wellesbourne Mountford, this enclosure attempt would be omitted.

> members went out of their way to take part in enclosure proceedings for parishes where they or their friends, allies, or patrons had estates. But that this was done systematically, habitually, and upon a large scale is demonstrably untrue.

Our leave-one-out strategy addresses these concerns in principle by omitting the petitioning parish. In addition, we provide a number of balance checks below which support our assertion that parish characteristics are uncorrelated with our instrument. Finally, we remove nearby parishes from consideration when constructing the instrument, in a 'donut' strategy. This strategy has the additional benefit that it accounts for (local) spatial clustering of economic activity or soil conditions. We discuss spatial correlation in more detail below.

A more subtle challenge to identification is that the leave-one-out pass rate of petitions for Parliamentary enclosure may correlate with the probability that other Bills pass. There are two types of such legislation. The first type is national legislation. For this type, such as the Corn Laws, our concern is muted because they were uniformly implemented throughout the country, involving all MPs. The second type is other legislation that passed through the Private Bills procedure.[27] Of these the most important sub types were drainage, canal and turnpike Bills. Drainage Bills enacted embankment and subsequent drainage of local bodies of water, such as the Lincolnshire Fens, or drainage of waste lands. Since these were lands not previously farmed, we do not think that the fact that these Bills passed through the Private Bill procedure is a threat to our identification strategy. They also rarely failed. Between 1660 and 1800, only 30 drainage acts failed (Hoppit, 1997). Canal and turnpike Bills enacted the construction of canals and turnpike roads. From the perspective of an individual parish, such acts had much larger committees, as all MPs representing the involved constituencies typically sat on the committee for a canal or turnpike. For example, the famous Bridgewater Canal, built in the 1760s to link the newly industrializing cities of Lancashire with the coast, had a committee composed of 76 members when the Bill that allowed it to move forward went through the House of Commons in 1761-1762 (Williams, 1948, p. 36). In addition, a canal or turnpike going through a parish typically only involved the private sale of land for the canal or road, and not a complete overhaul of the parish, as was the case with Parliamentary enclosure. Taken together, drainage, canal and turnpike Bills are also not quantitatively important. Out of 11,029 Bills that passed through the Private Bills procedure 36 percent were enclosure Bills and only 4.5 percent were either drainage or turnpike Bills while 1.5 % were canal Bills. The largest remaining category is naturalization, divorce, and bequest Bills.[28] To empirically substantiate our assertion that drainage and turnpikes are unimportant for our results, we control for whether a turnpike passed through a parish and whether there was drainage infrastructure in the Appendix, and find that this does not explain our results (we ignore canals here since there were sufficiently few of them).

[27] This could be actual Private Bills of the types we described above, or from 1798 these could also be local acts. Local acts are subject to the same procedure as Private Bills but do not necessarily have to do with a private matter. For us what matters is that they were subject to the Private Bill procedure in Parliament.

[28] The Private Act calendar can be found here: https://www.legislation.gov.uk/changes/chron-tables/private/intro. The Local Act calendar can be found here: https://www.legislation.gov.uk/changes/chron-tables/local/intro (both accessed September 2021).

## 4.6 Estimation Framework

In this section we outline a simple framework that introduces our instrumental variable analysis. We provide a full framework starting from a Roy (1951) model in the Appendix. In this section we present a simplified version. We model the economic effects of enclosure as follows:

$$Y = \beta_1 E + X\beta_2 + V \tag{1}$$

Where $Y$ is an observed outcome, $E$ is an indicator for Parliamentary enclosure, $X$ is a vector of other variables potentially related to $Y$ and $V$ is a disturbance term. It will be useful to express our treatment effect of interest in two ways. We are interested in the treatment effect of Parliamentary enclosure. In Equation 1 this effect is captured by $\beta_1$. We now also express Equation 1 in terms of potential outcomes. Let $Y_0$ denote the potential value of $Y$ in the absence of Parliamentary enclosure and $Y_1$ denote the potential value of $Y$ in the presence of Parliamentary enclosure. Both $Y_0$ and $Y_1$ are random variables. We can then re-express Equation 1 as:

$$Y = Y_0 + (Y_1 - Y_0)E = \beta_1 E + X\beta_2 + V \tag{2}$$

With $\beta_1 \equiv Y_1 - Y_0$ and $V \equiv Y_0 - \beta_2 X$. This re-expression does not change the economic interpretation of any quantities from equation 1, $\beta_1$ still captures the treatment effect and $V$ still represents the disturbance term. Under the assumption that $Y_0, Y_1 \perp\!\!\!\perp E|X$, an OLS estimate of $\beta_1$ identifies $E(Y_1 - Y_0|X)$, or the Average Treatment Effect (ATE) (Angrist and Pischke, 2008, Chapter 2.3).

The fundamental problem we face is selection into treatment based on unobservables: Partially enclosed parishes stood to gain less from Parliamentary enclosure than unenclosed parishes. A standard way of modelling such selection, following Heckman (1979), is to suppose the existence of a latent index $U$. We observe the decision of petition for enclosure if:

$$E = 1\{f(Z) - U \geq 0\} \tag{3}$$

Here $Z$ captures observable factors that influence the decisions to enclose. Importantly, we assume that $Z = (\tilde{Z}, X)$, which includes both $X$ and an excluded instrument $\tilde{Z}$. $f$ is an unknown function. With such a conceptualization, for parishes that already enclosed partially, the unobserved index value $U$ may take a high value. This index is often referred to as the "resistance" to treatment (Brinch et al., 2017). In this terminology, parishes that stood to gain little from Parliamentary enclosure resist treatment, and have high values of $U$.

### 4.6.1 Estimating the LATE of Parliamentary enclosure

A natural choice for $f(Z)$ is a linear function in $Z$. In such cases we obtain a standard linear (first stage) probability model (Vytlacil, 2002). We now introduce the model we estimate:

$$E_p = \gamma_0 + \gamma_1 Z_p + X_p \gamma_2^{'} + s + \varepsilon_p \tag{4}$$

Where $E_p$ equals one if parish $p$ is enclosed by Parliament at any point between 1750 and 1830, and

zero otherwise. $Z_p$ is our instrument. $X_p$ is a vector of covariates. To account for scale differences, we control for the area of the parish. To capture geographical differences, we control for terrain elevation and a vector (n=11) of soil type fixed effects $s$, which capture further differences in the agricultural potential of a parish (see Allen (1982) on the importance of soil type as a measure of soil productivity differences. Data come from the Food and Agricultural Organization (FAO)).

**Spatial correlation**. We are concerned about spatial correlation in outcomes and our instrument as well as spatially correlated unobservables. We pursue several strategies to assuage this issue. First, as noted above, we 'shift' the introduction of the instrument to London, which reduces the impact of geographical common shocks. Second, we directly control for location by including latitude and longitude, latitude interacted with longitude, and region fixed effects (n=4), as covariates.[29] Third, we report point estimates successively removing nearby parishes in the construction of our instrument. In this 'donut' estimation we instrument enclosure in parish using information further away from that parish. If enclosure and outcomes spatially cluster, this may violate the exclusion restriction and by removing nearby parishes we purge the construction of the instrument of this problem. Finally, to account for spatial correlation in unobservables, we report Conley (1999) standard errors correcting for arbitrary two-dimensional spatial correlation. We consider parishes within 70 kilometers of one another to be potentially spatially correlated. We choose 70 kilometers because, when we vary this cutoff, 70 km yields the most conservative standard errors. As a comparison we report heteroskedasticity robust standard errors. Because enclosure was predominantly a rural phenomenon, we restrict our sample to rural England, defined as being outside a historical city or borough. In practice, this excludes about 600 cities and towns.

We use the first stage in equation 4 together with the following second stage:

$$Y_p = \beta_0 + \beta_1 E_p + X_p \beta_2^{'} + s + v_p \tag{5}$$

This model relates an outcome $Y$ in parish $p$ to Parliamentary enclosure through an indicator $E_p$, which equals one if parish $p$ is enclosed through Parliament at any point between 1750 and 1830. Since our outcome variables are measured close to 1830, we measure the effect of being enclosed during 1750-1830 at the end of this period. Our coefficient of interest is $\hat{\beta}_1$. In Appendix Figure 6, we present scatter plots of the basic correlations between enclosure and our outcomes of interest, and in the next section we present estimates in table format.

We estimate the system of equations 4 and 5 using Two Stage Least Squares. Studying such models, Imbens and Angrist (1994) showed that with a binary instrument and a binary endogenous variable, instrumental variable analysis identifies a Local Average Treatment Effect (LATE). Subsequent contributions showed that the LATE logic extends to models with covariates and continuous instruments (see e.g. Angrist and Imbens (1995) and Angrist et al. (2000)). In our study, the LATE is the treatment effect for the subset of parishes for whom the instrument influences the decision to petition. These parishes are referred to as the 'compliers'. In the introduction we used the term to 'consider' enclosure, which we

[29] Our regions are defined as follows. We define the 'North' as being composed of the Cheshire, Cumberland, Durham, Lancashire, Northumberland, Westmorland, and Yorkshire. We define the 'South-West' as Cornwall, Devon, Dorset, Gloucestershire, Somerset, and Wiltshire. We define the 'East' as Bedfordshire, Berkshire, Buckinghamshire, Cambridgeshire, Essex, Hertfordshire, Hampshire with the Isle of Wight, Huntingdonshire, Kent, Oxfordshire, Norfolk, Suffolk, Surrey, and Sussex. We define the 'Midlands' as Derbyshire, Herefordshire, Leicestershire, Lincolnshire, Northamptonshire, Nottinghamshire, Rutland, Shropshire, Staffordshire, Warwickshire, and Worcestershire.

can now make precise. Because the decision to petition for enclosure should consider the likelihood of a petition passing in Parliament a parish is a complier and considers enclosure if either they petition or they would have petitioned had they faced a different value of the instrument. Parishes that stood to gain so little that they would have never petitioned regardless of the value of the instrument, or 'never takers', are downweighted by the 2SLS estimator.[30] The group of parishes that consider Parliamentary enclosure is the 'policy relevant' group because the Parliamentary route to enclosure was instituted exactly for these parishes.

**Marginal treatment effects**. The above discussion suggests that it is important to relate the LATE to the ATE, to quantify the degree to which selection into Parliamentary enclosure affects our results, and to compare our results to previous estimates in the economic history literature. We do this in the Appendix relying on recent advances in the literature on 'marginal' treatment effects (Björklund and Moffitt (1987); Heckman (1997); Heckman and Vytlacil (1999); Heckman and Vytlacil (2005); Heckman and Vytlacil (2007)) which allows us quantify selection.

## 4.7 Balance

In this section we study the exclusion restriction underpinning our identification strategy. We have argued that parishes are small relative to constituencies, and by leaving out individual parishes we purge the instrument of a direct connection with the parish whose (absence of) enclosure is being instrumented. For our identification strategy to be valid, we require the instrument to be excludable. Although this requirement is not formally testable, we study balance on observables to build a case for its plausibility.

Table 2 reports results from several estimates of a linear model of the following form:

$$Y_p = \beta_0 + \beta_1 Z_p + X_p \beta_2^{'} + s + \varepsilon_p \tag{6}$$

In this equation, $Z_p$ and $X_p$ are defined as above. We use several pre-determined variables as outcome variables $Y_p$. We first study whether differences in economic development before the start of our study period correlate with our instrument. If so, the exclusion restriction is likely violated. We consider tax revenues in 1525 from the Tudor Lay Subsidies (Sheail, 1968), both per capita and in levels. The Lay Subsidies are reported at the parish level and reflect income differences before the start of our study period. Column (3) studies potential productivity measured by the agricultural suitability for growing wheat, as computed by the Food and Agricultural Organization, and column (4) uses total population in 1525, measured from the Lay Subsidies. Next, we study differences in social structure, starting with MPs or members of the nobility living in a parish in 1700, before the start of our study period. We code this variable from Adams (1700). Finally, we follow Allen (1992) who argues that the presence of well-to-do farmers, or yeomen, was important for agricultural development. We measure the presence of yeomen from a dataset of probate records made available by the Cambridge Center for Population history. These are records of wills, which include social status identifiers. We measure the fraction of individuals leaving a will

[30] In a model with covariates, Angrist and Imbens (1995) show that with covariates estimating the LATE involves saturating $X_p$. Angrist and Pischke (2008) note that saturation is undesirable in practice and instrumental variable estimation including both the instrument and covariates linearly is often a good approximation. However, this may not hold generally (Blandhol et al., 2022).

that were identified as yeomen.[31] We report standardized coefficients. On all measures, we find balance in the sense that estimated coefficients are small and insignificant.

While it is never possible to check balance on all (un)observables, these results provide credence to our assertion that our instrument is excludable: Characteristics of an individual parish that may correlate with the potential return to enclosure are uncorrelated with our instrument.

# 5 Two Stage Least Squares Results

In this section we use our main identification strategy to estimate the LATE of Parliamentary enclosure and we find that it is associated with increases in wheat yields and land inequality.

In Table 3 we report our 2SLS implementation of equations 5 and 4. We begin with the natural log of wheat yield in bushels per acre as our outcome variable, and we vary the inclusion of covariates.

Panel I reports estimates of Equation 5, panel II provides estimates of Equation 4, and panel III reports reduced form estimates. In panel II, we find a positive and significant first stage. Increasing the leave-one-out pass rate of nearby enclosure Bills from zero to one results in a 58% to 77% increase in the probability of being enclosed through Parliament. Using Conley standard errors with a spatial cutoff of 70km we find first stage F-statistics of 13 to 25. These F-statistics are our most conservative measure of the strength of the first stage. Using either heteroskedasticity robust standard errors or different distance cutoffs leads to larger F-statistics. We report results with different distance cutoffs in the Appendix. These estimates support the informativeness assumption of our instrument and provide evidence that our instrument is strong enough for our second stage estimates to be credible.

Panel I reports the second stage 2SLS estimates corresponding to these first stages. In columns (1) and (2) we study wheat yield. Column (1) presents results controlling for fixed effects only and column (2) presents our main result for wheat yield, including our full set of covariates. We find a positive and significant effect of enclosure on the natural log of wheat yield. The combined results in panels I and II, column (2), are corroborated by our result in Panel III, column (2), which shows a positive and significant correlation between our instrument and ln(Wheat Yield). The estimated effect of Parliamentary enclosure on wheat yield in column (2), 0.45 (Conley s.e. 0.19) is interpretable as a percentage change. Therefore, enclosing through Parliament is associated with 45% higher yields. We choose our Conley standard errors - like for the computation of the F-statistic - to be as conservative as possible. When we use either heteroskedasticity robust standard errors (reported in Table 3) or vary the cutoff (reported in the Appendix) we estimate more precise effects.

In columns (3) and (4) we study land inequality. In column (3) we only control for fixed effects, and in column (4) we present our main result. We find that the effect of enclosure on land inequality is equal to 0.22, relative to a mean of 0.74. This result is significant at the 5% and 1% level using respectively stringent Conley standard errors or heteroskedasticity robust standard errors. As before, the reduced form results in Panel III are in line with this finding. Taken together, the estimates in this section show a significant

[31] A probate record is a record of possessions at death. These data have been analyzed in Keibek (2017b). In Keibek (2017a), the author estimates that around 1700, 14-17% of adult males were probated. We use probates between 1688 and 1715. We have 93,852 probate records, evenly distributed over this period, and we compute the fraction of individuals that were identified as yeomen in this dataset. We have data for 7,336 parishes.

effect of Parliamentary enclosure on wheat yield and land inequality. Subject to the exclusion restriction, these results are interpretable as causal.[32]

**Donut estimation**. For wheat yield, it may be the case that both yields and enclosures cluster spatially so that more parishes close to a petitioning parishes are enclosed themselves and - perhaps - higher rates of enclosure pass in areas where yields also spatially cluster. To mitigate this concern we rerun our main IV regression successively removing the nearest $n$ parishes from consideration when constructing our instrument. We vary $n$ between 0 and 300 (out of $k = 350$) and we plot the resulting point estimates in Figure 5. We find that we can remove about the nearest 100 parishes without substantially altering the main result. After removing 100 the coefficient declines to zero. We indicate with a vertical line the coefficient for removing 10 parishes which corresponds (on average) to two rings of parishes removed. In the Appendix we report tabular results removing 10 parishes from the construction of our instrument for both outcomes. Results are very similar.

**Robustness**. In the Appendix, we implement several exercises to assess robustness of the measurement of our main variables, our specification, and inference. We first vary the bandwidth $k$ in the construction of our instrument, as well as the cutoff used in the computation of our spatial standard errors. We then use the share of the land area of parish as the measure of Parliamentary enclosure, rather than an indicator, to show robustness to measuring Parliamentary enclosure this way. We then vary measurement of our main outcome variables. We first show that we can use yields for barley or oats to obtain similar, albeit noisier, results. When then vary the measurement of inequality. We use inequality of land size rather than value, and we control for the number of landowners, obtaining very similar results. Following our discussion on challenges to identification, we also control for the presence of drainage and turnpikes. This does not affect our results.

**Discussion of the estimated treatment effects**. Our 2SLS findings speak to the long-standing debate on the effect of enclosures on English agricultural development and also the broader question of the impact of the privatization of property rights on the rural sector. As we noted in section 2, the preponderance of research in economic history has found much smaller effects of enclosures on crop yields. This contrasts with contemporary before and after calculations, which suggested large effects, and the more recent development and growth literature that finds large productivity effects of changes in property rights and rural innovation. Our IV estimates, at 45%, are more consistent with these latter studies. We conjecture that these estimates, as well as our own are in line with the true effect of Parliamentary enclosure because both try to account for selection.

In the Appendix we study this conjecture, by comparing the LATE and ATE of Parliamentary enclosure as 'marginal treatment effects'. The main advantage of this alternative approach for our purposes is that it allows the decomposition of a simple OLS result and the LATE estimated by our instrumental variables strategy above. We find that 75 percent of the difference between the OLS and the LATE is due to selection. Our substantive interpretation of this observation is that this is fundamentally due to partially enclosed parishes standing to gain little from Parliamentary enclosure. We provide full details of this exercise in the

[32] An important second requirement has recently been pointed out by Blandhol et al. (2022). The LATE interpretation of a Two Stage Least Squares estimate was originally established for a model without covariates (Imbens and Angrist, 1994). For models with covariates, the LATE interpretation carries over if all covariates are saturated. Blandhol et al. (2022) show that a linear approximation to the saturated specification can lead to divergence between the 2SLS estimate and the LATE. When we estimate our models without covariates we obtain similar estimates.

Appendix.

# 6 Results using a plot-panel

In this section, we revisit our plot level panel of rents/acre. As we discussed in section 2, rents have been used in various studies to measure the returns to Parliamentary enclosure. In particular, under a set of assumptions, the increase in rents associated with enclosure allows one to calculate an estimate of the implied increase in productivity.

Our data form an unbalanced panel at the level of the plot-year. Parliamentary enclosure years and rent/acre observations rarely overlap. We therefore aggregate to the plot-decade level. This results in an unbalanced plot-decade panel. In Appendix Figures 7 and 8, we plot the conditional distribution of observations over time, conditioning on whether an observation for rent/acre was available in the decade of Parliamentary Enclosure. From this 'regular' panel, we construct an additional stacked panel. The stacked panel is constructed by, for each plot that is enclosed in a decade, matching it to a suitable subset of control plots. Plots are included as control plots if they are never enclosed, and if they have rent/acre observation in the decade of enclosure of the enclosed plot. This procedure results in a smaller panel dataset with a single treated plot and several control plots. We refer to such a treatment-control dataset as a minipanel. We stack all minipanels to produce the 'stacked panel'. Such stacked panels are standard in the literature (see e.g. Cengiz et al. (2019)).[33]

In the regular panel, we estimate a standard panel event-study of the following form:

$$Y_{pt} = \gamma_p + \nu_t + \sum_{k=-4}^{4} \beta_k * \mathbb{1}(t = k) * E_p + X_{pt}\beta'_X + \varepsilon_{pt} \tag{7}$$

Where $Y_{pt}$ is the rent/acre of plot $p$ in decade $t$. $\gamma_p$ and $\nu_t$ are plot and decade fixed effects. $k$ indexes periods relative to the treated period for plot $p$ and $E_p$ is a time-invariant indicator for Parliamentary enclosure. $X_{pt}$ is a vector of county times decade indicator variables, capturing trends in rent/acre, which we allow to vary by county. Our coefficients of interest are the $\beta_k$. For periods before treatment, these coefficients capture (differential) pre-trends between plots that will be enclosed through Parliament and plots that will not. After treatment, they capture the potentially time-varying treatment effect of Parliamentary enclosure on rent/acre.[34] The identifying assumption of such models is the untestable parallel trends assumption, which we study through reporting pre-trends. The presence of parallel pre-trends lends credence to the presence of counterfactually parallel post-trends. We cluster standard errors at the plot level.

[33] Several other methods are available that address various forms of staggered treatment timing, as well as the potential presence of heterogeneous effects. For varying reasons, these estimators do not perform at all, or not well, in unbalanced panels. In Appendix Table A18 we review each commonly used estimator and detail how it deals with missing data. Generally, each estimator focuses on balanced subsamples of the full dataset which often reduces the effective number of observations substantially. We discuss the exact implementation of each estimator, it's method for dealing with unbalanced panel and why it is less applicable to our particular data structure than the models we present here.

[34] In the stacked panel, this equation takes the following form:

$$Y_{mpt} = \gamma_m p + \nu_m t + \sum_{k=-4}^{4} \beta_k * \mathbb{1}(t = k) * E_p + X_{mpt}\beta'_X + \varepsilon_{mpt} \tag{8}$$

The main difference is the fact that all fixed effects are interacted through with indicators for each individual minipanel $m$.

Results are in Table 4. In columns (1) and (2) we study the regular panel, and in columns (3)-(5) we study the stacked panel. Rows report coefficients, ordered to increase in time-relative-to-treatment. All effects are expressed relative to the last pre-treatment decade. All pre-treatment coefficients are statistically indistinguishable from the last pre-period and there is no discernible pattern in their size over time, in any column. The row labeled 'Enclosed x Decade 0' is average rent/acre in the decade of Parliamentary enclosure, conditional on fixed effects, and relative to the last pre-treatment period. Consider the most restrictive model, in column (5). The coefficient in this row is 0.247 (clustered s.e. 0.1). Indicating that rent/acre went up by 0.25, relative to a sample mean of about 1. In the next decade the effect is larger and more precise, reflecting the fact that Parliamentary enclosure takes time to implement. Treatment effects are significant until period 4. This makes sense as over time unenclosed plots in the control group get enclosed too. We find similar effects in the regular panel, in our most restrictive specification in column (2). Columns (1) and (3)-(4) gradually introduce fixed effects. As we add the relevant fixed effects, estimated effects do not change much quantitatively but get more precise.

In sum, in this section we used a different identification strategy, resting on a parallel trends assumption rather than an exclusion restriction, as well as a different outcome variable, rent rather than wheat yield, to find a similarly positive treatment effect of Parliamentary enclosure. We now study mechanisms and then we conclude by studying downstream consequences of Parliamentary enclosure.

# 7 Mechanisms

In this section we study mechanisms that may connect Parliamentary enclosure to our outcomes. We mentioned some of the most prominent potential mechanisms in the introduction. They all relate to inefficiencies and transactions costs caused by the collective governance of the open fields and commons prior to enclosure and also the sub-optimal nature of piecemeal enclosure. For changes in agricultural yield, the reorganization of property rights plausibly impacted incentives to innovate. Coordination was now less central to the adoption of new technologies or experimentation with new techniques. Strip farming, for example, limited the scope to shift from arable to pasture due to shared investment in ploughs, and the larger contiguous fields necessary for pasture. Other mechanisms may also be at play. A Parliamentary enclosure act usually allowed for the construction of new roads or the improvement and extension of existing roads. Such infrastructure investments may separately have been conducive to trade and development. Unfortunately, our data does not allow us to investigate some of the other mechanisms associated with the inefficiencies of piecemeal enclosure - for example the irrationality of landholdings created by piecemeal enclosure and inability to reap scale effects. For inequality, the most plausible mechanisms suggested in the literature is the prohibitive costs of the implementation of Parliamentary enclosure which forced people with smaller plots to 'sell out'. We investigate this mechanism in our section on migration below.

In this section we present OLS evidence on some of the potential channels behind our results on agiricultural yield. We start by studying innovation, measured by agricultural patents. If Parliamentary enclosures led to enhanced incentives for innovation and improvement, we may see more agricultural patents being filed by residents of enclosed parishes. We use data from Dowey (2013), who collected a database of agricultural patents. These returns allowed us to geographically locate the patents, as they record the place of residence of the patent holders. We use the count of patents in a particular place, not the count of

patentees (there can be multiple patentees on one patent). The variable we construct is the total number of patents that were registered to people living in a parish between 1750 and 1850.

A related strand of proposed mechanisms concerns the adoption of more effective agricultural practices, which may have been more attractive after Parliamentary enclosure because there was no longer a need to coordinate (Young, 1771). To capture this potential mechanism, we consider the planting of turnips and four-course crop rotation as two basic agricultural improvements. Planting turnips or 'nitrogen fixing' crops like clover in between other crops like wheat, or between harvests, replenishes the soil while still yielding a crop and allowing for continuous harvesting. These crops were usually planted as part of a four-course crop rotation (wheat, barley, clover, and turnips), which replaced three-course rotation or two-course rotation, which often included unproductive fallow (Allen, 2008). We record the adoption of these practices from survey data compiled by Kain and Prince (1985). Their surveys record the acreage of parish planted with turnips (at the time of the survey) and an indicator for whether a parish practiced four-course crop rotation. We expect that Parliamentary enclosure improves agricultural practices because these improvements can now be chosen individually rather than necessitating coordination.

Next we examine the externalities associated with the re-organization of property rights by looking at the quality of roads. This mechanism has been less emphasized in the literature (but has been studied in other contexts, see Bogart (2005)). We code an indicator equal to one if the quality of roads in a parish was assessed to be poor in the tithe surveys (Kain and Prince, 1985).

Table 5 presents results. For comparability, we present standardized coefficients. The corresponding instrumental variable results are in the Appendix, Table A13. We find that Parliamentary enclosure is associated with more agricultural patents, a greater area of turnips grown and an increase in the practice for four-course crop rotation. This all suggests that Parliamentary enclosure stimulated higher crop yields by incentivizing innovation and investment. Finally, we find that enclosed parishes are less likely to have poor roads, providing evidence for the positive externalities of re-organizing property rights.

While it is never possible to fully explore all mechanisms, we have sketched in this section a number of potential mechanisms linking Parliamentary enclosure to economic change. We find support for increased innovation and the adoption of better, but known, agricultural practices. This likely reflects the fact that individual farmers no longer needed to coordinate or were able to take advantage of larger more consolidated farms and scale effects. We also provide tentative evidence in support of Parliamentary enclosure being associated with infrastructure improvement.

# 8 Downstream consequences: Structural transformation

In the introduction we highlighted the potential link between property rights rationalization and structural transformation working through increases in agricultural productivity. In this section we directly study structural transformation as one possible downstream consequence of Parliamentary enclosure.

We measure structural transformation in two ways. First, from the 1831 English census we code the share of males over 20 employed in manufacturing (Gatley, 2005). Second, from a report by Parliament we record an indicator variable equal to one if a parish had a textile mill in 1838 (Parliament, 1839). See Heldring et al. (2021) for more detail on this source.

Table 6 present results. We present OLS results here, and provide the corresponding IV results in the

Appendix Table A14. In columns (1) and (2) we use manufacturing employment. Point estimates are in row 1. Manufacturing employment in 1831 is about 1 percentage point higher in parishes that were enclosed through Parliament, relative to a mean of 3 percent. This result holds with fixed effects only (column (1)) and with our full set of covariates (column (2)). In columns (3) and (4) we instead focus on whether a parish was home to a textile mill. We find that parishes are about 0.7 percentage points more likely to be home to a textile mill if they experience Parliamentary enclosure, relative to a mean of 2.6. Across these two outcomes, the association between Parliamentary enclosure and structural transformation is very similar: Being enclosed through Parliament increases either measure of industrialization by about one-third.

# 9 Downstream consequences: Migration

In this section, we examine one of the most interesting conjectures about the spillovers generated by Parliamentary enclosure - that it contributed to structural change and manufacturing by "setting free" an agricultural population that then became an industrial proletariat. As we discussed in section 2, existing research is inconclusive. Here we explore a novel strategy for examining this hypothesis in a much more comprehensive way than has previously been attempted.

To do so, we start with the 1851 full count UK census (Schurer and Higgs, 2023). We measure migration from a parish by comparing - for each person in the country - their place of residence to their parish of birth. We then count the number of migrants - individuals for which residence is different from place of birth - by parish of origin. In addition, we measure migrants that go to the industrial heart of England - Lancashire, Cheshire and the West Riding of Yorkshire.

We start by analyzing migration to this sample of three counties in the industrial north. In Figure 6 we plot the number of migrants to these counties, by county of origin, normalized by the 1801 population of a parish in the left panel.[35] We see that migration to the industrial north is heavily skewed towards counties that are directly adjacent, like the other parts of Yorkshire and Lincolnshire. In the right panel of this Figure we order counties as in the left panel, but now plot migration shares to London. We see an inverted pattern. These observations suggest that migration was targeted to *local* centers of economic activity.

As a starting point of our analysis, we analyze this non-linear pattern by computing the share of migrants that migrate to the industrial north, and binning this variable into one bin for parishes that do not send any migrants to the north (about 40% of the sample); and quintile indicator variables for parishes that send at least one migrant to the industrial north. The results are in Appendix Table A15. This Table shows that parishes enclosed through Parliament are 12 percentage point likely to have zero migrants (or thirty percent of its mean), and are significantly more likely to be in the top quintile of sending parishes (4 percentage points more likely, relative to a mean of 5 percent). Enclosed parishes are not more likely to be in the intermediate quintiles. We then compute the share of parishes that enclose through Parliament by region of the country in Table A16. We find that Parliamentary enclosure was relatively concentrated in the north and the midlands, regions close to the industrial north. These initial explorations suggest that migration is very local, and Parliamentary enclosure happened to be more common close to where

[35] Data on the population for parishes in 1801 is available from https://www.visionofbritain.org.uk/.

the industrial revolution took place. Parishes enclosed through Parliament are therefore more likely to be in the top quintile of the (conditional) distribution of sending migrants to the industrial north. We now present OLS results using different measures of migration as dependent variables. The corresponding IV results are in the Appendix, Table A17.

Results are in Table 7. Following our initial exploration, each outcome variable in this table is an indicator equal to one if a parish in in the top quintile of the distribution of a measure of migration. We use the conditional distribution, conditioning on having at least one emigrant, and refer to these parishes as 'emigrant parishes'. In column (1) we use the share of migrants that migrate to the industrial north to compute this indicator. We find that places enclosed through Parliament are 3 percentage points more likely to be an emigrant parish, relative to a mean of 5%.[36] In column (2) we study the probability of being a emigrant parish to the industrial north, not relative to total migration, but relative to migration to London. We find that parishes enclosed through Parliament are 3 percentage point more likely to be an emigrant parish to the industrial north rather than London, relative to a sample mean of 5%. This finding is in line with the narrative in the previous paragraph, and also with the analysis we cited in the background section in Allen (1992). Parishes enclosing through Parliament are relatively concentrated in the north, and migration is local. We therefore find that Parliamentary enclosure, as Marx conjectured, is associated with migration to the north. When we re-estimate the same relationship in the Appendix instrumenting Parliamentary enclosure we find similar results, albeit with larger coefficients, as before.

The second part of Marx' argument is that those that migrated to the north were more likely to end up in the new factories. We study this prediction by using the information on occupations that is recorded within the 1851 census. We use the census classification of historical occupations (HISCO) to classify individuals into either manufacturing occupations, agriculture occupations, or 'other'.[37] We then compute the fraction of migrants that end up in manufacturing, as well as the fraction of migrants to the north that end up in manufacturing. As before, we report results using indicator variables for the top (conditional) quintile of the distribution of these variables. Results are in columns (3) and (4). We do not find robust results to support this part of Marx' thesis; both point estimates are small and not significant at conventional levels. In the Appendix we find similarly inconclusive results using our instrumental variable strategy.

# 10 Conclusion

The English Parliamentary enclosures were highly controversial at the time yet they are also associated with dramatic transformations in the English countryside. In this paper we have provided the first comprehensive and causal evidence of their economic effects. Our first contribution is the most comprehensive dataset to date of Parliamentary enclosures and agricultural outcomes. Our second contribution is to propose two empirical strategies for estimating the causal effect of enclosure. In our main estimates we compare parishes that were enclosed by Parliament to those that were not. We exploit the institutional process of enclosure to construct an instrumental variable for *Parliamentary* enclosure as the leave-one-out

[36] The mean of the dependent variable is not equal to twenty percent for two reasons. First, we condition on having at least one migrant before computing quintiles. 41% of parishes do not send any migrants to the north. Second, these are quintiles of values of the ratio of migrants to the north to total migrants, and the number parishes that have values of this ratio above the eightieth percentile of this variable can be smaller than $59/5 \approx 12$ if there are repeated values in lower quintiles.

[37] We use HISCO top level classes 7, 8 and 9 for manufacturing and 6 for agriculture.

mean of the success of Parliamentary enclosure acts in an area around the parish. We find that enclosure led to substantial increases in both wheat yields and land inequality. These results confirm two famous sets of hypotheses about the impact of Parliamentary enclosures which have claimed that they had large positive effects on incentives and productivity, see Young (1808), but at the same time led to severe increases in inequality, for example Marx (1990). The results on yields speak to an important literature in economics about the extent to which different systems of property rights are consistent with efficient outcomes (for example Coase (1960), Demsetz (1967), Hardin (1968) and Ostrom (1990)). We confirm the significant positive effects of enclosures using a completely different dataset and identification strategy using a panel of plot level information on rents. We also provide evidence for the mechanisms via which enclosure raised crop yields, showing in particular that it raised patenting (innovation), facilitated the adoption of better farming techniques and created positive externalities on local infrastructure. Our final contribution is to link enclosures to recent work emphasizing the role of productivity changes in agriculture and industrialization and structural transformation more broadly. Our findings are consistent with the notion that the privatization of rural land in England not only spurred agricultural productivity but also facilitated broader economic changes. Most interestingly, we provide the first systematic evidence consistent with Marx's hypothesis that enclosure created an industrial proletariat. We find that it did differentially push people off the land, but they only ended up in industry because enclosures were primarily in parts of England close to the industrializing north.

Our distributional results reveal a fascinating political economy of the reform of property rights. Prior to 1750, even though traditional governance mechanisms were unable to allocate common resources efficiently, they could not be reformed politically because people likely anticipated the large redistributional effects. These existed because upon Parliamentary enclosure some sorts of rights were much easier to confirm than others and because imperfections in capital markets meant that poor people were not able to benefit from any improvements in productivity. The innovation of the Parliamentary process allowed enclosure to move forward in one third of English parishes because it allowed large landowners to over-ride those who had previously blocked change. This came at a cost, however, in the form of increased land inequality.

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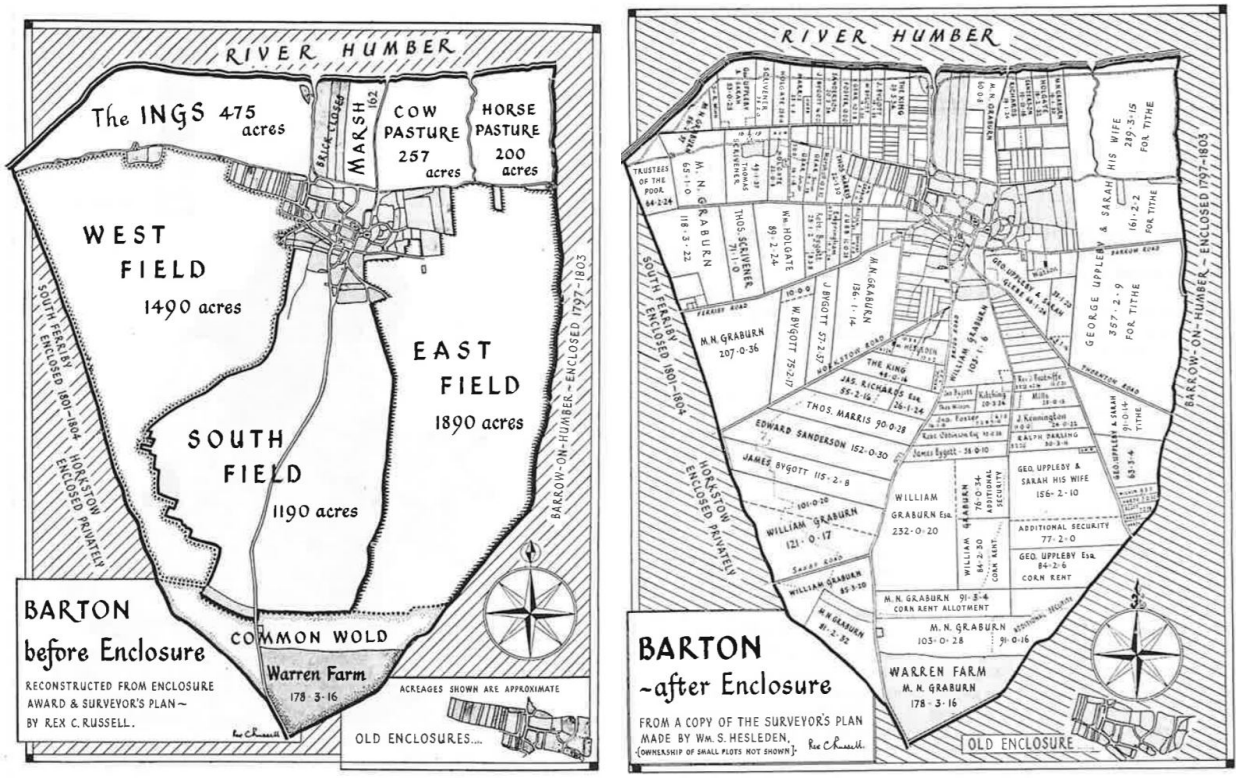
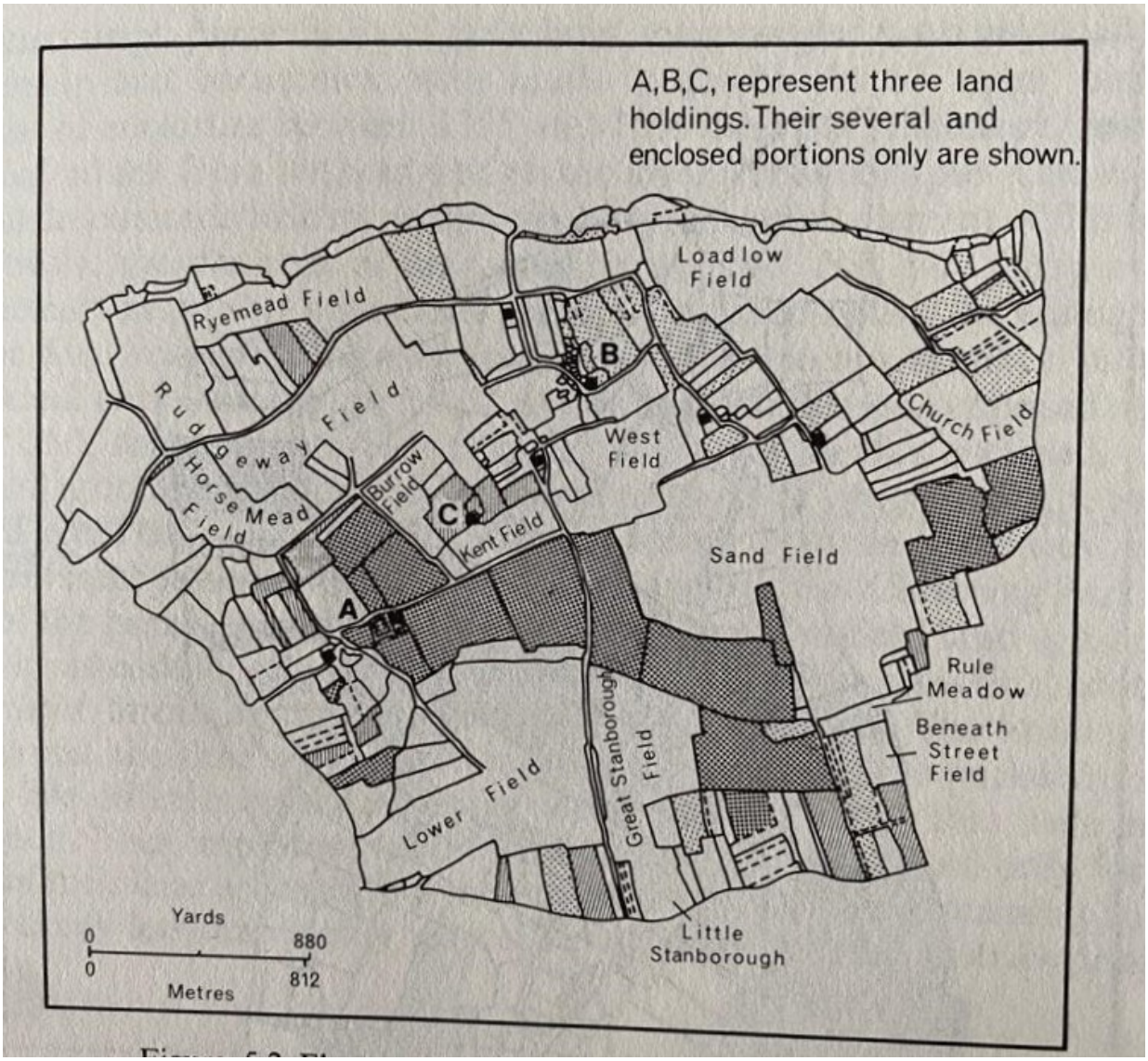
Figure 1: Organization of landownership in Barton before and after Enclosure



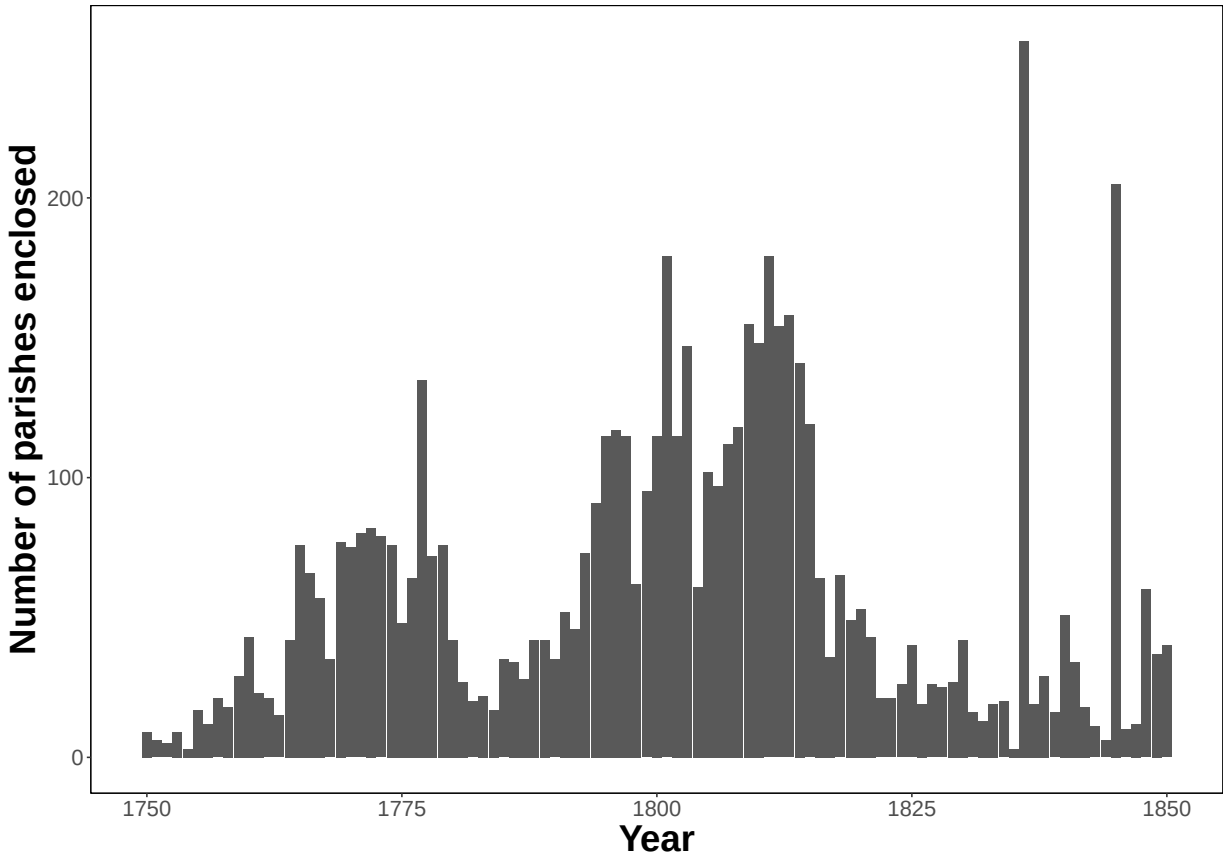

Notes: the map on the left shows the commonly held plots of land in Barton-upon-Humber, before enclosure. Barton was enclosed between 1797 and 1803. The right map reflects the results of Parliamentary enclosure. Source: Mingay (1997).

Figure 2: Organization of landownership in Elmstone Hardwick




Notes: This map shows the distribution of landownership in Elmstone Hardwick in 1838 before it was enclosed through Parliament. Source: Yelling (1977).

Figure 3: The number of parishes enclosed through Parliament, by year

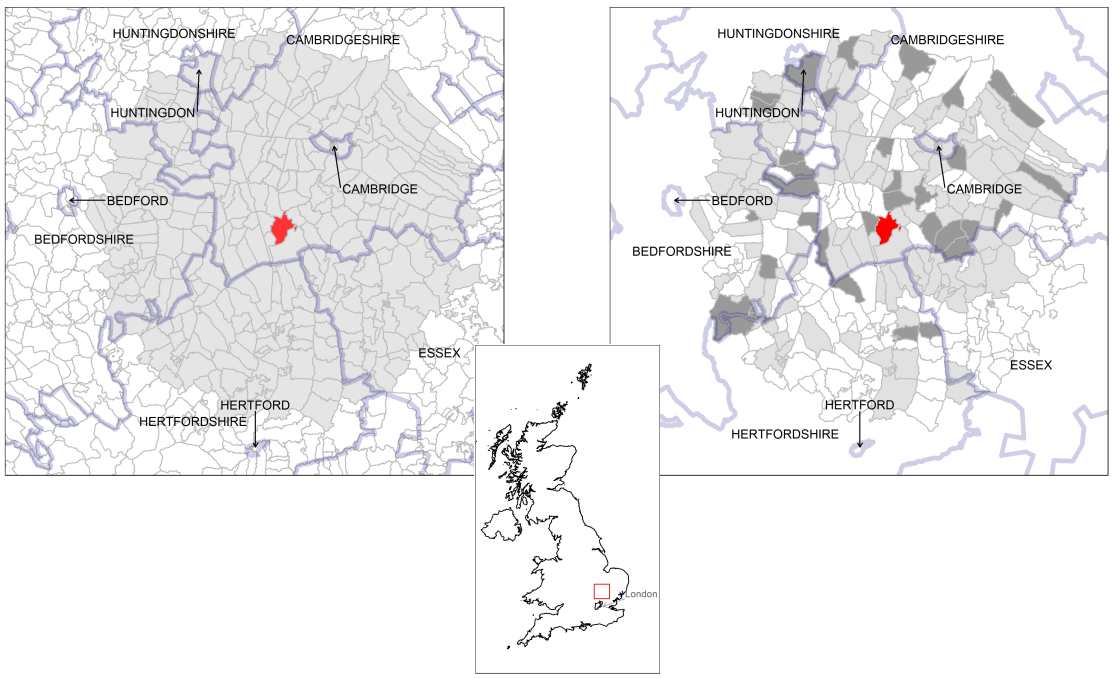



Notes: This graph shows the total number of enclosed parishes per year. Source: Tate and Turner (1978).

Figure 4: Instrument Construction

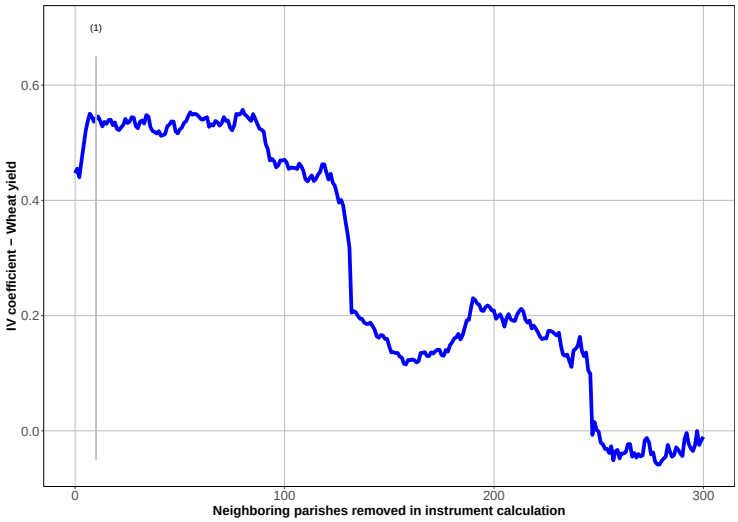
(a) Meldreth with k = 350 nearest neighbors

(b) Neighbors by Parliamentary enclosure attempt status



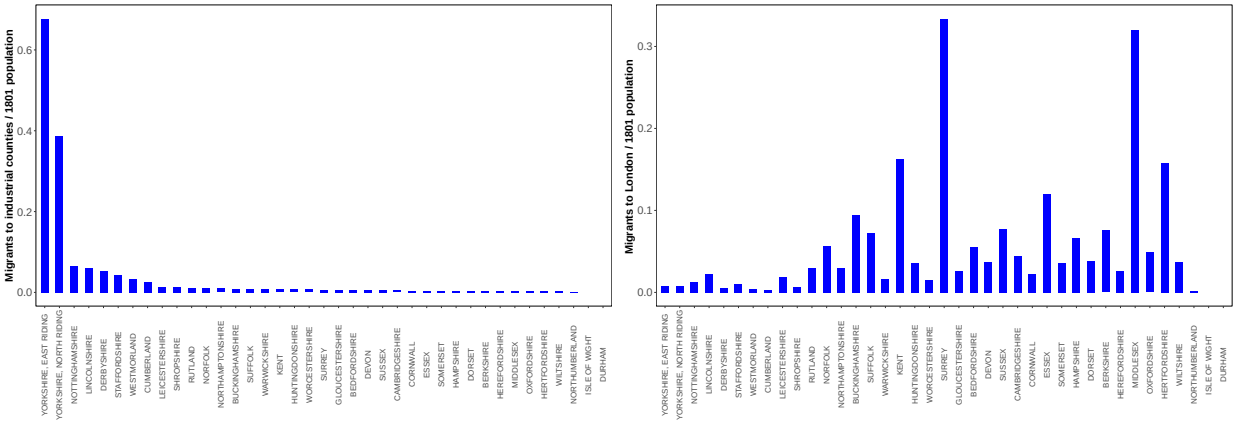

Notes: Subfigure (a) shows the parish used for this case study, Meldreth, is in red. Parishes in gray are those within k = 350 neighbors of Meldreth. Constituency boundaries are in purple, with associated text in black. Subfigure (b) shows the parish used for this case study, Meldreth, in red. Parishes outside of k = 350 neighbors are omitted. Parishes in white never attempted to enclose. Parishes in light grey successfully petitioned to enclosed. Parishes in dark grey failed their petition to enclose at least once. Constituency boundaries are in purple, with associated text in black. A figure depicting the location of our case study is superimposed between the two subfigures. The red bounding box is the extent of Subfigures (a) and (b).

Figure 5: Removing neighbors in instrument construction




Notes: This Figure plots coefficients from our main regression using wheat yield on the vertical axis. On the horizontal axis we plot the number of nearest neighbors of parishes we remove in the construction of the instrument. The point estimated removing zero parishes corresponds to Table 3, Panel I, column (1). We indicate by (1) the coefficient removing the 10 nearest parishes. This corresponds to about two 'rings' of adjacent parishes. We report this point estimate in the Appendix.

Figure 6: Migration to industrial counties and London, by county




Notes: The left panel of this Figure shows total migration to the industrial north (Lancashire, Cheshire, and Yorkshire: West Riding) normalized by population in the 1801 census, by county. The right panel orders counties as in the left panel, and graphs migration to London. Both panels omit the industrial north itself.

Table 1: Summary statistics for main outcome variables

| *Sample:* | | Parliamentary enclosure | | No Parliamentary enclosure | | | |
|---|---|---|---|---|---|---|---|
| | N | mean | sd | mean | sd | difference | t-stat |
| ln(Wheat Yield) in bushels per acre | 4003 | 3.08 | 0.19 | 3.04 | 0.23 | 0.04 | 5.81*** |
| Gini (land value) | 5015 | 0.78 | 0.19 | 0.71 | 0.21 | 0.07 | 12.02*** |

Notes: ln(Wheat Yield) in bushels per acre is the natural log of the number of bushels of wheat per acre. Gini (land value) is a Gini coefficient of the value of land owned by parishioners in the 1836 tithe returns.

Table 2: Balance tests

| *Dependent variable:* | Tax revenue per capita 1525 | Tax revenue 1525 | Suitability for wheat | Population 1525 | Number of MPs 1700 | Number of nobility 1700 | Fraction of yeomen 1700 |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Leave-one-out successful enclosure | 0.008 | -0.006 | -0.004 | 0.045 | 0.003 | 0.004 | 0.019 |
| | (0.015) | (0.018) | (0.035) | (0.032) | (0.012) | (0.013) | (0.033) |
| | [0.010] | [0.010] | [0.007] | [0.015] | [0.015] | [0.011] | [0.012] |
| Observations | 6791 | 7581 | 13919 | 7581 | 9339 | 9339 | 7414 |
| $R^2$ | 0.02 | 0.08 | 0.50 | 0.32 | 0.01 | 0.00 | 0.12 |
| *Scale*: Parish area | Y | Y | Y | Y | Y | Y | Y |
| *Geography*: Elevation | Y | Y | Y | Y | Y | Y | Y |
| *Location*: Latitude, longitude, latitude*longitude | Y | Y | Y | Y | Y | Y | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y | Y | Y | Y |

All regressions are estimated using OLS. The unit of observation is a parish. All regressions restrict to rural parishes. All point estimates are standardized. Tax revenue per capita 1525 is total tax revenue divided by total population in the 1525 Lay Subsidy returns. Income 1525 is total tax revenue in the 1525 Lay Subsidy returns. Suitability for Wheat is the suitability of the soil for growing wheat. Population 1525 is total population in the 1525 Lay Subsidy returns. Number of MPs living in parish in 1700 is the number of members of parliament in 1700 that have their residence in a parish. Number of nobility living in parish in 1700 is the number of members the nobility in 1700 that have their residence in a parish. Fraction of yeomen 1700is the fraction of people who submitted probates between 1688 and 1715 that were yeomen. The instrument is the leave-one-out fraction of the proposed enclosures that pass through Parliament and are enacted into law. We take the nearest k parish neighbors and compute total $\frac{\text{successful enclosures}}{\text{attempts to enclose}}$ in this range. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table 3: The effect of Parliamentary enclosure on wheat yield and inequality

| *Dependent variable:* | ln(Wheat Yield) in bushels per acre | | Gini (land value) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | | *Panel I: IV estimates* | | |
| Parliamentary enclosure (yes/no) | 0.48 | 0.45 | 0.16 | 0.22 |
| | (0.31) | (0.19) | (0.08) | (0.10) |
| | [0.09] | [0.08] | [0.04] | [0.05] |
| Mean dep. var. | 3.05 | 3.05 | 0.74 | 0.74 |
| SD dep. var. | 0.21 | 0.21 | 0.21 | 0.21 |
| Observations | 3641 | 3641 | 4446 | 4446 |
| | | *Panel II: first stage* | | |
| | | *Dep. var.: Enclosed (yes/no)* | | |
| Leave-one-out successful enclosure | 0.58 | 0.58 | 0.77 | 0.68 |
| | (0.16) | (0.14) | (0.15) | (0.14) |
| | [0.06] | [0.06] | [0.07] | [0.07] |
| Conley F-stat on Excluded Instrument | 13.41 | 16.68 | 25.16 | 24.51 |
| | | *Panel III: Reduced Form* | | |
| Leave-one-out successful enclosure | 0.28 | 0.26 | 0.12 | 0.15 |
| | (0.14) | (0.09) | (0.07) | (0.06) |
| | [0.04] | [0.04] | [0.03] | [0.03] |
| *Scale*: Parish area | N | Y | N | Y |
| *Geography*: Elevation | N | Y | N | Y |
| *Location*: Latitude, longitude, latitude*longitude | N | Y | N | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y |

Notes: All regressions in panel I are estimated using two-stage least squares. The unit of observation is a parish. All regressions restrict to rural parishes. ln(Wheat Yield) in bushels per acre is the natural log of the number of bushels of wheat per acre. Gini (land value) is a Gini coefficient of the value of land owned by parishioners in the 1836 tithe returns. Parliamentary enclosure (yes/no) is the predicted enclosure probability from the corresponding first stage reported in Panel II. The instrument is the leave-one-out fraction of the proposed enclosures that pass through Parliament and are enacted into law. We take the nearest k parish neighbors and compute total $\frac{\text{successful enclosures}}{\text{attempts to enclose}}$ in this range. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table 4: The effect of Parliamentary enclosure on land rents

| | Dep. var.: Rent/Acre | | | | |
|---|---|---|---|---|---|
| | Regular panel | | Stacked panel | | |
| | (1) | (2) | (3) | (4) | (5) |
| Enclosed x Decade -4 | -0.126 | -0.120 | -0.116 | -0.043 | 0.033 |
| | (0.139) | (0.147) | (0.143) | (0.159) | (0.184) |
| Enclosed × Decade -3 | 0.046 | 0.032 | 0.051 | 0.129 | 0.130 |
| | (0.108) | (0.113) | (0.112) | (0.132) | (0.145) |
| Enclosed × Decade -2 | 0.026 | 0.030 | 0.043 | 0.066 | 0.092 |
| | (0.107) | (0.109) | (0.110) | (0.124) | (0.135) |
| Enclosed × Decade 0 | 0.171* | 0.207** | 0.168* | 0.233** | 0.247** |
| | (0.091) | (0.095) | (0.092) | (0.096) | (0.100) |
| Enclosed × Decade 1 | 0.145 | 0.195** | 0.133 | 0.256** | 0.281*** |
| | (0.088) | (0.092) | (0.090) | (0.101) | (0.103) |
| Enclosed × Decade 2 | 0.140* | 0.199** | 0.128 | 0.167* | 0.187* |
| | (0.081) | (0.090) | (0.083) | (0.093) | (0.101) |
| Enclosed × Decade 3 | 0.163* | 0.244** | 0.143 | 0.130 | 0.182* |
| | (0.091) | (0.097) | (0.094) | (0.103) | (0.109) |
| Enclosed × Decade 4 | 0.050 | 0.105 | 0.023 | 0.089 | 0.094 |
| | (0.106) | (0.111) | (0.110) | (0.118) | (0.123) |
| Mean | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| Observations | 10804 | 10804 | 4817672 | 2703451 | 2703451 |
| Nr. of plots | 4347 | 4347 | 14405 | 2999 | 2999 |
| *Plot fixed effects* | Y | Y | Y | Y | Y |
| *Decade fixed effects* | Y | Y | Y | Y | Y |
| *Minipanel × period* | N | N | N | N | Y |
| *Minipanel × plot* | N | N | N | Y | Y |
| *County trends* | N | Y | N | N | Y |

Notes: All regressions are estimated using OLS. The unit of observation in columns (1) and (2) is an agricultural plot decade. Decades run between 1710 and 1920. We refer to this dataset as the 'regular panel'. In columns (3)-(5) the unit of observation is a minipanel-plot-period. This dataset is constructed by, for each plot that is enclosed in a decade, identifying a suitable subset of control plots. Plots are included if they are never enclosed, and if they have rent/acre observation in the decade of enclosure of the focal plot. We refer to such a treatment-control dataset as a minipanel. We stack all minipanels to produce the 'stacked panel'. All regressions restrict to rural parishes. Rent/acre is the rent of a plot in pounds divided by total acreage of a plot. Enclosed × Decade is an indicator equal to one if a plot was enclosed in the relevant decade. Decades are numbered relative to the decade of Parliamentary enclosure (decade 0). Plot fixed effects and period fixed are a vector of indicator variables for each plot and each decade. For columns (3)-(5) we interact plot and period fixed effects with fixed effects for each minipanel. County trends is a vector of indicator variables for each county interacted with decade indicator variables. Heteroskedasticity robust standard errors, clustered at the plot level, are in parentheses.

Table 5: Mechanisms: Innovation and Coordination

| *Dependent variable:* | Innovation | | Coordination | |
|---|---|---|---|---|
| | Nr. Agr. Patents | Road quality poor (yes/no) | Turnips grown (acres) | Four-crop rotation (yes/no) |
| | (1) | (2) | (3) | (4) |
| Parliamentary enclosure (yes/no) | 0.04 | -0.11 | 0.14 | 0.11 |
| | (0.02) | (0.03) | (0.05) | (0.05) |
| | [0.00] | [0.01] | [0.04] | [0.03] |
| Observations | 13920 | 5288 | 2290 | 5288 |
| $R^2$ | 0.01 | 0.04 | 0.24 | 0.14 |
| *Scale*: Parish area | Y | Y | Y | Y |
| *Geography*: Elevation | Y | Y | Y | Y |
| *Location*: Latitude, longitude, latitude*longitude | Y | Y | Y | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y |

Notes: All regressions are estimated using OLS. The unit of observation is a parish. All regressions restrict to rural parishes. Nr. Agr. Patents is the number of agricultural patents filed by residents of a parish between 1750 and 1830. Road quality poor (yes/no) is an indicator equal to one if the qualities of the road in a parish is assessed poor by the tithe surveyors. Turnips grown (acres) is the total number of acres of turnips grown in 1831. Four-crop rotation (yes/no) is an indicator equal to one if a parish practiced four course crop rotation, usually consisting of wheat, barley, clover, and turnips. Parliamentary enclosure (yes/no) is an indicator equal to one if a parish was enclosed through Parliament at any point between 1750 and 1830. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table 6: Structural transformation

| *Dependent variable:* | Manuf. emp. 1831 (%, *100) | | Textile mill (yes/no, *100) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Parliamentary enclosure (yes/no) | 0.97 | 1.44 | 0.74 | 0.79 |
| | (0.58) | (0.59) | (0.44) | (0.47) |
| | [0.21] | [0.21] | [0.31] | [0.32] |
| Mean dep. var. | 2.98 | 2.98 | 2.62 | 2.62 |
| SD dep. var. | 10.37 | 10.37 | 15.97 | 15.97 |
| Observations | 11300 | 11300 | 13920 | 13920 |
| $R^2$ | 0.09 | 0.12 | 0.02 | 0.03 |
| *Scale*: Parish area | N | Y | N | Y |
| *Geography*: Elevation | N | Y | N | Y |
| *Location*: Latitude, longitude, latitude*longitude | N | Y | N | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y |

Notes: All regressions are estimated using OLS. The unit of observation is a parish. All regressions restrict to rural parishes. Manuf. emp. 1831 is the share of males over 20 employed in manufacturing in the 1831 census. We multiply this variable by 100 for convenience. Textile mill (yes/no) is an indicator variable equal if a textile mill was present in a parish in 1838. We multiply this variable by 100 for convenience. Parliamentary enclosure (yes/no) is an indicator equal to one if a parish was enclosed through Parliament at any point between 1750 and 1830. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table 7: Migration to the industrial north

| *Dependent variable: Indicator for being in the top conditional quintile of:* | Migrants to ind. counties /total migrants | Migrants to ind. counties /migrants to London | Migrants in manufacturing /total migrants | Migrants to ind. counties in manufacturing /total migrants to ind. counties |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Parliamentary enclosure (yes/no) | 0.03 | 0.03 | 0.02 | 0.01 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| | [0.01] | [0.01] | [0.02] | [0.01] |
| Mean dep. var. | 0.05 | 0.05 | 0.12 | 0.09 |
| SD dep. var. | 0.22 | 0.23 | 0.32 | 0.29 |
| Observations | 12097 | 12097 | 12097 | 12097 |
| $R^2$ | 0.38 | 0.25 | 0.04 | 0.02 |
| *Scale*: Parish area | Y | Y | Y | Y |
| *Geography*: Elevation | Y | Y | Y | Y |
| *Location*: Latitude, longitude, latitude*longitude | Y | Y | Y | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y |
| *Excluding birth in industrial counties*: | Y | Y | Y | Y |

Notes: All regressions are estimated using OLS. The unit of observation is a parish. All regressions restrict to rural parishes. Migrants to ind. counties /total migrants is an indicator equal to one if a parish is in the top quintile of the distribution of the ratio of the number of migrants that migrate to industrial counties (Lancashire, Cheshire, and Yorkshire: West Riding) to total migrants. When computing quintiles we condition on having at least one migrant to the north. Migration is measured in the 1851 census by comparing parish of residence to parish of birth. Migrants to ind. counties /migrants to London is an indicator equal to one if a parish is in the top quintile of the distribution of the ratio of the number of migrants that migrate to industrial counties to the number of migrants to London. Migrants in manufacturing/total migrants is an indicator equal to one if a parish is in the top quintile of the distribution of the ratio of the number of migrants employed in manufacturing to total migrants. Migrants to ind. counties in manufacturing /total migrants to ind. counties is an indicator equal to one if a parish is in the top quintile of the distribution of the ratio of the number of migrants to industrial counties employed in manufacturing to the number of migrants that migrated to industrial counties. For both employment-based variables, we restrict the sample in which we compute these ratios to individuals for whom employment information is available. Parliamentary enclosure (yes/no) is an indicator equal to one if a parish was enclosed through Parliament at any point between 1750 and 1830. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

# Appendix for: The economic effects of the English Parliamentary enclosures

Leander Heldring James A. Robinson Sebastian Vollmer

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This appendix contains further background to our empirical strategy, the process of Parliamentary enclosure, selection into Parliamentary enclosure, additional figures, and additional results for 'The economic effects of the English Parliamentary enclosures'.

## Contents

# 1 The Parliamentary procedure for Enclosures

In this section we provide further background to the legal procedure for Parliamentary enclosure. We first report the procedural steps taken in Parliament when assessing and eventually enacting a Bill. Then, we describe the standing orders. The standing orders are the legal requirements a Bill needs to meet in order to be enacted.

## 1.1 Private Bills

Enclosure bills were local bills, in the sense that they affected a small part of the population and covered at most a handful of parishes, but typically a single parish. The procedure for Private Bills has not meaningfully changed between the eighteenth century and today. Here we reproduce verbatim the current procedure:[1]

> "Although it goes through similar stages as a public bill, a private bill has different stages and rules. For example, anyone "specially and directly" affected by private bill can (during particular periods) petition against the bill in both the Commons and the Lords. There are preliminary steps that must be taken before a Private Bill can be presented to Parliament. Private Bills are deposited in Parliament on the 27 November and are scrutinised by the Examiners of Petitions for Private Bills before being formally presented before Parliament in January. Some bills will start in the Lords and others will start in the Commons.
>
> Once presented the bill will go through the following stages in each House in turn:
>
> First reading (formal introduction of the Bill, which is held without debate) Petitioning period (Starting on or about 22 January and ending about 8 or 10 days later in the Commons and a about fortnight in the Lords, When the bill goes to the second House the petitioning period in either Houses is 10 days and begins on the day of first reading.)
>
> Second reading (This is often approved formally unless a Member wishes to have a debate on the Bill. In the Commons the motion may be repeatedly blocked, which can delay progress indefinitely. The principles of the bill are debated on third reading.)
>
> Committee stage (Bills which have outstanding petitions against are considered by an Opposed Bill Committee, whereas bills not petitioned against go to an Unopposed Bill Committee. Both committees are specially appointed. In the Lords it is possible for a bill to be considered by an Opposed Bill Committee and an Unopposed Bill Committee.)

[1] We take the procedure from https://www.parliament.uk/about/how/laws/bills/private/private-stages/, current as of 12/01/2020.

Report stage (Only available in the Commons and is the last chance for MPs to amend the bill. In the Lords, private bills do not have a report stage after they have left committee.)

Third reading (The principles of the bill are debated on third reading. It is the opportunity for the House to reject the bill. It is also the last chance for MPs and Lords to debate or block a Private Bill. In Lords the bill can be amended on third reading.)

When a Bill has passed through both Houses it may return to the first House (where it started) when amendments made by the second House are considered.

Royal Assent (granted by the Monarch) means that the Bill becomes an Act of Parliament"

The practical implementation of these steps required skilled lawyers, some of whom wrote guides on navigating Parliament. One particularly useful guide was written by Charles Ellis, who systematically lists the necessary steps for Private Bills and enclosure bills in particular. He describes the committee proceedings as follows Ellis (1802, p. 88):

"the allegations contained in the preamble of the bill, the signatures to the consent bill, a statement of each person's property concerned in the inclosure or drainage, &c. (I mean) as to quantity and value, are required to be proved in the manner beforementioned, at the committee on the bill. Some of the printed bills for the use of the members, should have the blanks filled up in them, and such alterations inserted as are intended to be proposed at the committee. At the committee, the solicitor will first be called upon to prove that the notices (unless they have been already proved before a committee on the petition) were affixed on the church-door, and the person who affixed them should attend with a, copy of the notice. Next, the state of property must be proved : Almost every old proprietor in the parish can prove it, and' any one will be sufficient. Then the signatures to the consent bill, and the answer of every proprietor who has not signed the bill; and lastly, the preamble of the bill must be proved. The solicitor leaves the consent bill, state of property, and a print with all the blanks filled up and the amendments made in it, with the committee clerk, to enable him to make out the report, &c.: But the consent bill and state of property must be procured again from the committee clerk, as they will be wanted at the committee in the House of Lords"

Every proposed enclosure went through these steps, and we use this procedure as part of our identification strategy, described in more detail in the paper.

## 2 Further detail on our empirical strategy

**Setup**. Our empirical strategy starts from a simple Roy (1951) model of selection into treatment. Let $Y_{p1}$ be a potential outcome for parish $p$ if enclosed through Parliament and $Y_{p0}$ be the potential outcome for parish $p$ if it is not enclosed through Parliament. Such parishes may be piecemeal or partially enclosed to various extents. Following Roy (1951) we start with:

$$Y_{p1} = \mu_1 + V_{p1} \tag{1}$$

$$Y_{p0} = \mu_0 + V_{p0} \tag{2}$$

Here $\mu_j$ is a term common to all parishes with status $j$, and $V_{ij}$ is a parish specific idiosyncratic term. We assume $E(V_{ij}) = 0$.

Parishes are either enclosed through Parliament, or not, $E \in \{0, 1\}$. We don't observe potential outcomes, instead we observe realized outcomes $Y_p$. Realized and potential outcomes are related as follows:

$$Y_p = E_p Y_{p1} + (1 - E_p) Y_{p0} \tag{3}$$

We define the *individual treatment effect* as:

$$\Delta_p = Y_{p1} - Y_{p0} = \mu_1 - \mu_0 + V_{p1} - V_{p0} = E(\Delta_p) + V_{p1} - V_{p0} \tag{4}$$

The individual treatment effect has an observed component $\mu_1 - \mu_0$ and and unobserved component $V_{p1} - V_{p0}$. $E(\Delta_p)$ is the Average Treatment Effect (ATE).

**Linear regression**. Suppose we wanted to estimate the ATE using the following regression:

$$Y_p = \mu_0 + \Delta_p E_p + V_{p0} \tag{5}$$

We cannot identify the $\Delta_p$ individually. Substituting in 4:

$$Y_p = \mu_0 + E(\Delta_p) E_p + V_{p0} + E_p(V_{p1} - V_{p0}) \tag{6}$$

This is just a simple linear model:

$$Y_p = \mu_0 + E(\Delta_p) E_p + \varepsilon_p \tag{7}$$

Below we add covariates and fixed effects and estimate this equation:

$$Y_p = \beta_0 + \beta_1 E_p + X_p \beta_2^{'} + s + \varepsilon_p \tag{8}$$

It is immediate that if there is selection into treatment, $E(V_1|E = 1)$ will not equal $E(V_0|E = 0)$, then our linear regression does not identify the ATE (see also Angrist and Pischke (2008, Chapter 2.3)).

**Modelling the decision to enclose**. Heckman and Vytlacil (2005) and Brinch et al. (2017) propose a generalization of instrumental variable methods to understand the effect of selection on our estimate of the treatment effect of enclosure. Suppose parishes decide to petition Parliament based on the perceived expected return to enclosing:

$$E^* = \alpha + \beta Z_p - U_p \tag{9}$$

Here we assume the existence of an instrument $Z$. $U$ is a mean zero disturbance term. In the literature,

$-U$ is often named the 'resistance' to treatment. We observe Parliamentary enclosure $E_p = 1$ if $E^* > 0$ or $\alpha + \beta Z_p > U_p$. Note that because $U_p$ is unobservable, so is $E^*$.[2]

**Instrumental variables estimation**. We use Equation 9 as a first stage equation in a standard instrumental variables model. We require $V_1, V_0, U \perp\!\!\!\perp Z|X$ where $X$ is a vector of covariates. This is a standard exclusion restriction. In addition, we require an informativeness assumption, and a monotonicity assumption. These are standard for the estimation of both the LATE and the MTEs (Vytlacil, 2002).

If these assumptions are met, we can estimate a version of Equation 9 as a first stage. In our paper, we add covariates and fixed effects $s$ and estimate the following first stage, Equation (4) in the main body of the paper:

$$E_p = \gamma_0 + \gamma_1 Z_p + \gamma_2^{'} X_p + s + \varepsilon_p \tag{10}$$

We include the same covariates $X_p$ and fixed effects $s$. We use this first stage together with the following second stage, Equation (5) in the main body of the paper:

$$Y_p = \beta_0 + \beta_1 E_p + \beta_2^{'} X_p + s + v_p \tag{11}$$

We saw that in our linear model, under no selection, we estimate the ATE:

$$ATE = E(Y_1 - Y_0) \tag{12}$$

Or, conditional on covariates, $ATE(X) = E(Y_1 - Y_0|X)$. Our instrumental variables model instead estimates a Local Average Treatment Effect (LATE) (Imbens and Angrist, 1994) for a subgroup of parishes that are induced by the instrument to change their treatment status. In the case of a binary instrument, let $E_1$ be the treatment that was chosen if $Z = 1$ and $E_0$ be the treatment that was chosen when $Z = 0$. The set of parishes for which $E_1 > E_0$ are know as the 'compliers'. The LATE is then defined as:

$$LATE = E(Y_1 - Y_0|E_1 > E_0) \tag{13}$$

This extends in a straightforward way including covariates and to continuous instruments (Angrist and Imbens, 1995; Angrist et al., 2000) and we can simply write $LATE = E(Y_1 - Y_0|\textit{complier})$ like we do in the paper.[3] The only case in which the ATE equals the LATE is when everyone is a complier. We argue in the paper that this is unrealistic since there were very heterogeneous returns to enclosing through parliament. Therefore, we cannot know whether any differences in estimated coefficients between our linear and instrumental models are due to the fact that the ATE and LATE are different *estimands* or due to, for example, measurement error, or violations of the exclusion restriction. We now study Marginal Treatment Effects (MTEs) to estimate the ATE and LATE within one model.

**Marginal Treatment Effects**. Marginal Treatment Effects (MTEs) are a generalization of standard

[2] In the paper we consider a more general $f(Z)$. Here, we use $\alpha + \beta Z_p$.

[3] An important additional requirement when estimating instrumental variable models with covariates is, formally, it is required to saturate all covariates (Blandhol et al., 2022). Angrist and Pischke (2008) note that saturation is undesirable in practice. However, this may not hold generally, especially in regression specifications with a large number of fixed effects (Blandhol et al., 2022).

instrumental variables techniques. The idea is to estimate the treatment effect by levels of 'resistance' or for those parishes that are marginal at that level of resistance. In order to define MTEs, we first normalize Equation 9. Let $F_U$ be the distribution function of $U$. We normalize by applying this function. We expect parish $p$ to be enclosed through Parliament if $F_U(\alpha + \beta Z_p) > F_U(U_p)$. Because $F_v$ is a distribution function, $F_U(\alpha + \beta Z_p)$ lies between zero and one and $F_U(U_p)$ is uniformly distributed between zero and one. Following Brinch et al. (2017) we then define the 'propensity score' of observing a Parliamentary enclosure:

$$r(z) = P(E = 1|Z = z) = F_U(\alpha + \beta Z_p) \tag{14}$$

Redefine $U = F_U(U)$ and we observe that $E = 1$ if $r(z) > U$.

Marginal Treatment Effects are treatment effects for parishes at a particular quantile of $U$. Formally:

$$MTE(u) = E(Y_1 - Y_0|U = u) \tag{15}$$

With covariates, we get $MTE(u, X) = E(Y_1 - Y_0|X, U = u)$. The main advantage of this approach is that MTEs relate to the ATE and LATE in a very straightforward way.

$$\text{ATE} = E(Y_1 - Y_0) = \int_0^1 MTE(u)du \tag{16}$$

$$\text{LATE} = E(Y_1 - Y_0|E_1 > E_0) = \int_0^1 MTE(u) * weights_{LATE}(u)du \tag{17}$$

The $weights_{LATE}(u)$ rescale the MTEs to their contribution to the LATE. These weights are formally defined in Heckman and Vytlacil (2007).

For our purposes, estimating MTEs gives us estimates of the LATE and the ATE. Below we compare these to our estimated treatment effects in our instrumental variables models to study selection into Parliamentary enclosure. We then compare the ATEs to the treatment effects that we estimate using OLS in this appendix. This allows us to understand what fraction of the difference between the estimated effects is due to the fact that the OLS estimates the ATE - under no selection, in practice the OLS estimates will not exactly be equal to the ATE - and a 2SLS procedure estimates the LATE.

**Marginal Treatment Effects estimation**. We follow the 'separate approach' for estimation of the MTEs Brinch et al. (2017). Ignoring covariates for now, our objective is to estimate:

$$MTE(U) = E(Y_1 - Y_0|U) \tag{18}$$

The separate approach separates estimation for $E(Y_1|U)$ and $E(Y_0|U)$. We have

$$E(Y_1|U) = E(Y_1|U, E = 1) = E(\mu_1 + V_1|r > U) = \mu_1 + E(V_1|r > U) \tag{19}$$

$$E(Y_0|U) = E(Y_0|U, E = 0) = E(\mu_0 + V_0|r < U) = \mu_0 + E(V_0|r < U) \tag{20}$$

The terms $E(V_1|r > U)$ and $E(V_0|r < U)$ capture selection, analogously to the terms $E(V_1|E = 1)$ and

$E(V_0|E=0)$ in the introductory section above.

In practice, we proceed in three steps. We first assume a functional form $E(Y_1|U)$ and $E(Y_0|U)$. Following Brinch et al. (2017) we assume a quadratic functional form in $U$:

$$E[Y(e)|X, U=u] = \gamma_0 + \gamma_1 X + \gamma_2 u + \gamma_3 u^2, \quad e = 0, 1 \tag{21}$$

Here $U$ is uniformly distributed, and we observe $X$. We do not know the gammas. We proceed as follows. In Equation 19 we noted that $E[Y_0|X, U] = E[Y_0|X, U, r < U]$. We know that in order for a parish to not be enclosed $r < U$ has to hold. We can use this fact to integrate $U$ out and get an expression that relates $E(Y_0|X)$ and $r$:

$$\begin{aligned} E(Y_0|X, r<U) &= \frac{1}{r}\int_0^r E(Y_0|U, X)du = \frac{1}{r}\int_0^r \gamma_0 + \gamma_1 X + \gamma_2 u + \gamma_3 u^2 du \\ &= \gamma_0 + \gamma_1 X + \gamma_2 \frac{r}{2} + \gamma_3 \frac{r^2}{3} \end{aligned}$$

An analogous operation gives $E(Y_1|X)$ as a function $r$. This means that we can now estimate the gammas using information on $r$. We estimate the propensity scores $r$ using a first stage probit regression of $E_p$ on all covariates and our instrument $Z_p$. We then use the predicted values from this regression to 'control' for selection:

$$E[Y_e|X, r, E=e] = \beta_0 + \beta_1 X + \beta_2 r + \beta_3 r^2, \quad e = 0, 1 \tag{22}$$

From this regression, we recover the estimated beta coefficients, and construct the gamma coefficients. We now know the estimated gammas and we know that $U$ varies uniformly between zero and one. Therefore we present our MTE results graphically varying $U$. In our paper, we graph the two functions for $E(Y_1|U)$ and $E(Y_0|U)$ separately as well as the MTE(U) function as $MTE(U) = E(Y_1 - Y_0|U)$.

# 3 Heterogeneous Treatment Effects

We now discuss our MTE results in more detail. We first report results for ln(Wheat Yield) in Figure 1. In Subfigure (a) we plot several quantities of interest as a function of the resistance to treatment $U$. The most important one is the MTE curve, which traces out treatment effects of Parliamentary enclosure as a function of $U$. Since this curve is downward sloping, treatment effects are higher for parishes that are less likely to 'resist' enclosure, as we would expect. At high levels of resistance to the treatment we suspect parishes are partially or piecemeal enclosed. Even if, as we noted, Parliamentary enclosure might still bring benefits for such a parish, nevertheless they likely stood to gain less from enclosing via Parliamentary act. We can see that these parishes would have had a low treatment effect had they enclosed through Parliament. We interpret this result as consistent with our hypothesis that this is because they have already captured some of the gains of enclosure. As $U$ decreases the number of piecemeal enclosed parishes falls. Accordingly, the treatment effect rises because the counterfactual comparison becomes Parliamentary enclosure and

informal governance, rather than Parliamentary enclosure and enclosure through other means.[4]

Subfigure (b) contains the main results of this exercise. It plots the ATE computed within the MTE framework (from equation 16), our 2SLS estimate from our main Table in the paper, and the corresponding LATE from the MTE framework (equation 17). In addition, we report results from an OLS regression, reported in Table A3 below. This regression is the corresponding linear regression for our IV regressions of yield on our Parliamentary Enclosure indicator from the paper. The main conclusion from subfigure (b) is that, comparing lines vertically, the ATE is lower than the LATE. Within the MTE framework, it is easy to see why. The LATE downweights parishes with higher resistance and estimates the treatment effect for compliers only. We plot the LATE weights in Subfigure (a). Comparing lines vertically in Subfigure (b), we see that 75 percent of the difference between the OLS and the LATE estimates is explained by the distance between the ATE and LATE.[5]

In other words, the fact that the ATE and LATE estimate the treatment effect of Parliamentary enclosure for different groups of parishes explains most of the observed difference in estimated effects between them. Our substantive interpretation of this observation has been that this is fundamentally due to partially enclosed parishes standing to gain little from Parliamentary enclosure, but at the same time being in the control group for cross-sectional analyses that do not account for selection. We can further substantiate this point by studying potential outcomes separately. We do so in Subfigure (c) by plotting potential outcome Equation 21. We find that the potential outcome of enclosure, $Y_1$, is essentially constant across values of $U$. In contrast, the potential outcome for not enclosing, $Y_0$, is sharply upward sloping, indicating that the heterogeneity in the treatment effect, $Y_1 - Y_0$, is driven by heterogeneity in $Y_0$. We interpret this finding as follows: Had parishes not enclosed, productivity depends on the degree to which partial enclosure is successful. $U$ captures this because partially or piecemeal enclosed parishes resist Parliamentary enclosure. For parishes with high $U$, we therefore see a treatment effect under counterfactual Parliamentary enclosure that is close to the treatment effect under partial or piecemeal enclosure. For parishes with less piecemeal enclosure (low $U$) not enclosing leads to substantially lower productivity than a counterfactual Parliamentary enclosure would bring. This results in a large difference between $Y_0$ and $Y_1$ and a large MTE. This means that parishes that had undergone little piecemeal enclosure stood to gain most from Parliamentary enclosure whereas parishes that had already more substantially enclosed stood to gain less.

In Figure 2 we repeat this exercise for land inequality. 78 percent of the difference between the 2SLS and the OLS estimates of the effect of Parliamentary enclosure on inequality is explained by the difference in the ATE and the LATE. Subfigure (c) shows that for land inequality too, the untreated potential outcome is driving the result, with parishes likely to resist Parliamentary enclosure already having realized increases in inequality. These are likely the parishes that managed to enclose unanimously precisely because they were highly unequal to begin with which concentrated decision making power.

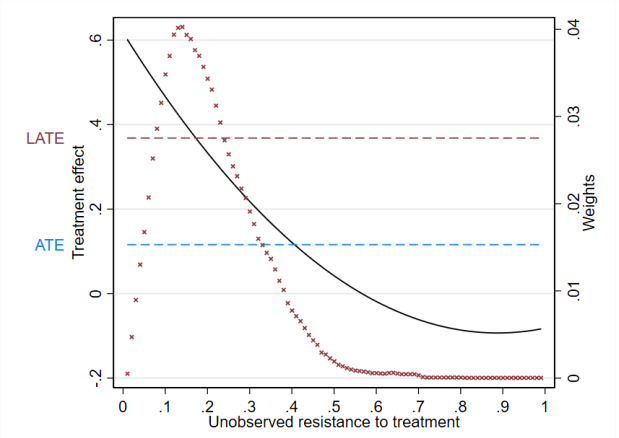
[4]We estimate the MTE curve when there is support of the propensity scores on the entire interval [0, 1] for both enclosed and unenclosed samples. If there is no intersecting support, then we have to extrapolate MTEs. We show in the Appendix that we have good support on the interval [0, 0.7] and that beyond 0.7 our results are partially extrapolated using the assumed quadratic functional form of Equation 21.

[5]In addition, note that the OLS is not equal to the ATE. This is due to selection into Parliamentary enclosure along other dimensions than the potential gain from Parliamentary enclosure. Also note that the LATE is not exactly equal to our 2SLS estimate. This is essentially an approximation error and not substantively important. We discuss this approximation in the next subsection.

In this section we provided evidence that the ATE is lower than the LATE for Parliamentary enclosure. We argue, and substantiate, that this is due to selection into Parliamentary enclosure. Failing to account for this type of selection may explain the low estimates of the effect of Parliamentary enclosure in previous contributions. Note that because what parishes stand to gain is ultimately unobservable, modern techniques for estimating counterfactual outcomes are necessary to estimate a more realistic treatment effect of Parliamentary enclosure. We now discuss two more technical aspects of MTE estimation, before providing supporting case study evidence on how selection into Parliamentary enclosure worked.

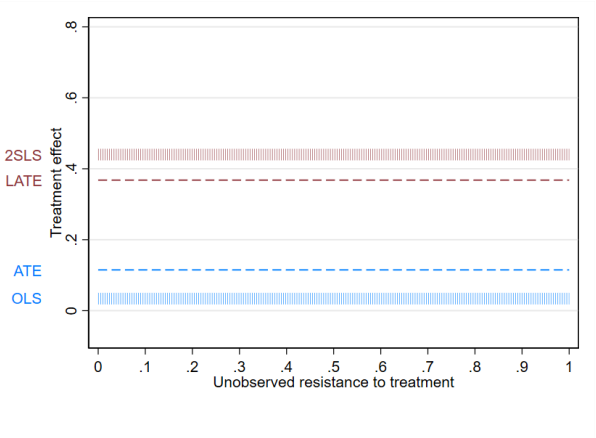
Figure 1: Marginal Treatment Effects for ln(Wheat Yield)

(a) MTE Curve



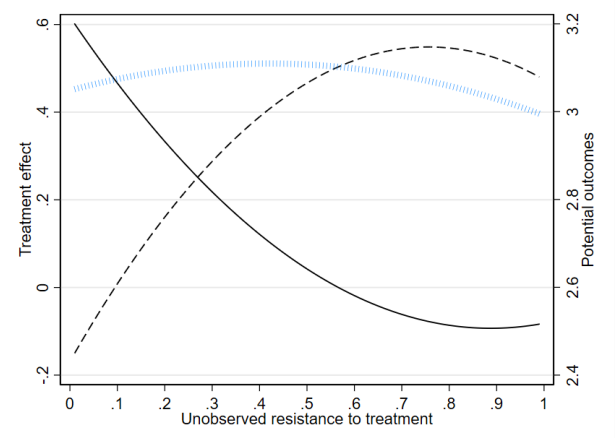

Notes: The Marginal Treatment Effect (MTE) curve traces out the treatment effect as a function of unobserved resistance to enclosure in solid black. We derive both the LATE and ATE, plotted in dashed red and dashed blue respectively, from the MTEs. The ATE is a arithmetic average of the MTE, while the LATE is a weighted average of the MTE for compliers, with the weights plotted as red crosses.

(b) 2SLS vs OLS




Notes: In the MTE framework, we derive both the LATE and the ATE. These are the horizontally dashed lines in red and blue respectively, same as above. The 2SLS estimate is plotted as the vertically dashed red line, while the OLS estimate is plotted as the vertically dashed blue line. Estimates for OLS taken from Table A3, column (2). Estimate for 2SLS taken from Table **??**, column (2), panel I.

(c) Potential Outcomes




Notes: We plot the MTE curve in this figure, together with the curves for $Y_1$ and $Y_0$. The MTE curve is the vertical difference between these two curves.

# 4 Additional discussion of MTE Figures

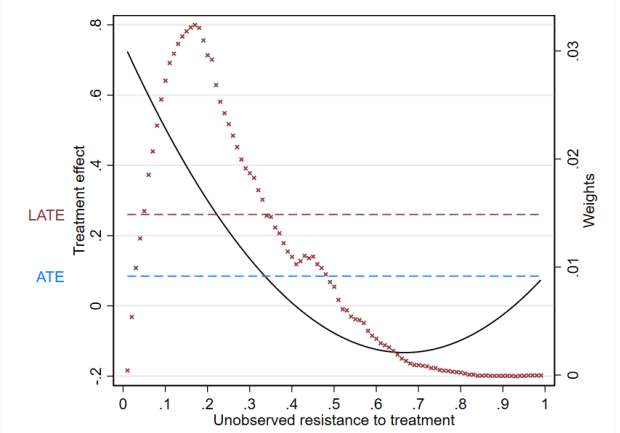
In this section, we continue our discussion of figures 1 and 2.

## 4.1 Why is the LATE different from 2SLS

Sub-figure(b) of figures 1 and 2 plot the OLS, 2SLS, ATE and LATE. The OLS estimates are always smaller than the ATE, which reflects selection and motivates our instrumental variables strategy. We would expect 2SLS estimates to be near exactly equal to the LATE. The fact that these in practice diverge slightly

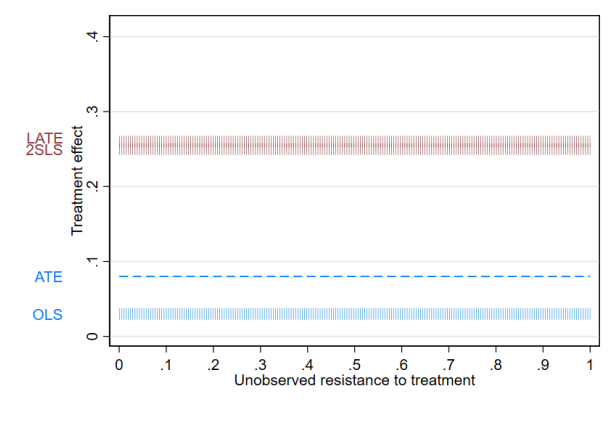
Figure 2: Marginal Treatment Effects for Gini (land value)

(a) MTE Curve



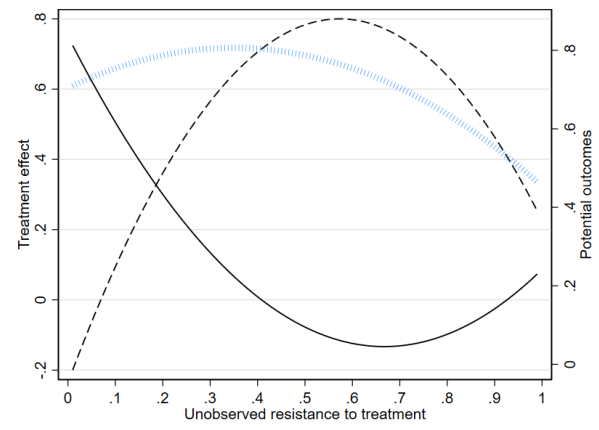

Notes: The Marginal Treatment Effect (MTE) curve traces out the treatment effect as a function of unobserved resistance to enclosure in solid black. We derive both the LATE and ATE, plotted in dashed red and dashed blue respectively, from the MTEs. The ATE is a arithmetic average of the MTE, while the LATE is a weighted average of the MTE for compliers, with the weights plotted as red crosses.

(b) 2SLS vs OLS




Notes: In the MTE framework, we derive both the LATE and the ATE. These are the horizontally dashed lines in red and blue respectively, same as above. The 2SLS estimate is plotted as the vertically dashed red line, while the OLS estimate is plotted as the vertically dashed blue line. Estimates for OLS taken from Table A3, column (4). Estimate for 2SLS taken from Table **??**, column (4), panel I.

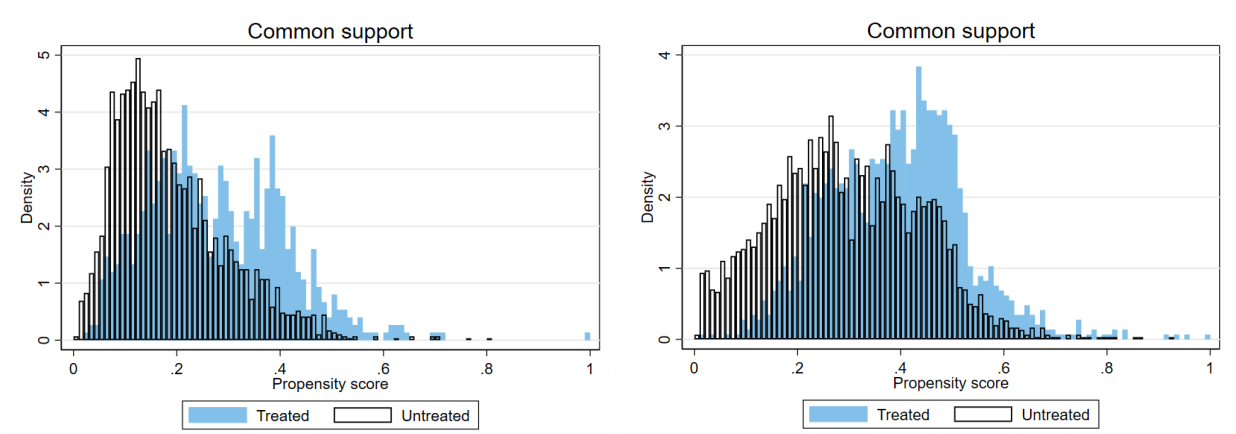
(c) Potential Outcomes




Notes: We plot the MTE curve in this figure, together with the curves for $Y_1$ and $Y_0$. The MTE curve is the vertical difference between these two curves.

Figure 3: Common Support

(a) Log(Wheat Yield) (b) Gini




Notes: The MTE is identified where there is common support. Outside of the areas of common support, extrapolation must be used. We use the full support because we wish to explore the relationship between the 2SLS and OLS results, which are estimated using the full dataset.

is due to two different forms of approximation error. First, the 2SLS estimator with covariates only exactly identifies the LATE when it is saturated in the instruments and covariates. Without this saturation, the 2SLS estimator with linear covariates approximates the LATE and we observe an approximation error (Angrist and Pischke, 2008, Chapter 4.5.2). Second, there may be approximation error in the MTE curve both because of the quadratic parametric assumption on the relationship between the potential outcomes and the propensity score, equation 22 or small violations in the common support assumption (see below). In practice, the 2SLS and LATE derived from the MTE are quantitatively close, indicating the approximation error is small.

### 4.2 Common Support

MTE estimation requires there to be common support along the area of the propensity score for valid estimation (Brinch et al., 2017), i.e. the intersection of of the propensity scores for the subsamples of treated and untreated units most be non-empty. Appendix Figure 3 plots the common support of the MTE estimation from figures 1 and 2 respectively. While there is good common support in the interval $[0, 0.7]$, for higher values of $U$ we need to extrapolate treatment effects. This is not uncommon in applied settings, and the implementation of extrapolation is straightforward. Nevertheless, our estimated treatment effects for values of $U$ over 0.7 are extrapolated and should be interpreted with some caution.

## 5 Case Study Evidence

### 5.1 Agricultural Yields and Efficiency

The large quantitative effects of enclosure we find are consistent with the case study and historical literatures when we bear in mind the great deal of heterogeneity that was created by the extent and nature

of piecemeal enclosures. With respect to yields a great deal of evidence suggests that unenclosed and piecemeal enclosed land was often inefficiently organized and used. Parliamentary enclosure might have advantages for parishes that had undergone even sizeable piecemeal enclosures because it allowed for a global rationalization of holdings, it created a definitive map and legal rights in ways that more informal enclosures did not. But whether this was so depended on how such enclosures had taken place. When land inequality was high or the parish enclosed by one or a very few landowners, for example, such benefits might be few because global rationalizations were possible without a Parliamentary act.

In the introduction to the paper we noted that the preponderance of contemporary analysis did support quite large positive effects. The general optimism about increased productivity is reflected in the language of enclosure acts. The Bill submitted to Parliament in 1782 for the enclosure of Kingston Deverill in Wiltshire began:

> The lands ... lie intermixed and dispersed, in small parcels and most of them are inconveniently situated in respect to the Houses and inclosed lands of the Owners and Proprietors thereof; and in their present Situation are incapable of any considerable Improvement; and it would be very advantageous to the several Persons interested therein ... if the same were divided, and specific Shares thereof allotted to them in Severalty, in proportion to their respective Rights and Interests therein; but the same cannot be effected without the Aid and Authority of Parliament (Mingay, 1997, p. 33).

This clearly suggests that those proposing "inclosure" thought it would promote "improvement".[6] Several mechanisms, some of which we investigate in the paper, were often discussed which could explain this. One is the consolidation of the strips in the open fields and the rationalization of haphazard piecemeal enclosures. Contemporary commentators consistently viewed this as a huge benefit either because people could farm and invest without the costs of coordinating with others, or because there were scale economies. In 1794 Thomas Stone remarked

> The first great benefit resulting from an enclosure is contiguity, and the more square the allotments are made, and the more central the buildings are placed, the more advantages are derived to the proprietors in every respect (Stone, 1808, 143).

William Marshall, author of a series of studies of the rural economies of different counties emphasized the sheer rationalization of holdings, stating "In Rural Economy, straight lines and right angles are first principles which can seldom be deviated from with propriety" (Marshall, 1788, p. 125). Yet on his extensive travels he found that reality was different noting in the piecemeal enclosed Vale of Pickering that "each man's property is still perhaps scattered over the township" (Marshall, 1788, p. 8) while in East Norfolk he noted the "abundance of petty enclosures" which he found "disgraceful" (Marshall, 1787, p. 125). Summing up a large literature Yelling opines "the effects of piecemeal enclosure ... were .. deplored by those concerned with the proper layout of farms. For the structure of piecemeal-enclosed holding rarely approached the ideal: normally the process of enclosure and consolidation had drifted apart ... so that enclosures preserved

[6]The eighteenth century commentator Henry Homer observed that "The necessity of universal agreement among proprietors especially where they are numerous is an almost insurmountable obstruction to any improvements being made in lands during their open field state" (Homer, 1766, p. 7-8).

many of the defects of the old open-field arrangements" (Yelling, 1977, 125-126). Chapman and Seelinger (1995, 36) also notes how piecemeal enclosure "tended to perpetuate holding fragmentation". Parliamentary enclosure allowed for greater consolidation and rationalization of landownership.

Second, the partially documented nature of such arrangements led to disputes. Yelling notes that a benefit of a Parliamentary enclosure was that it "had the advantage that it set aside all doubt about the validity of enclosure" (Yelling, 1977, 9). Gray (1915, 305) also notes that a consequence was "to establish authoritative titles to ownership" . Hence by confirming "the entire existing arrangement" (Yelling, 1977, 13) Parliamentary enclosures helped to definitively settle property rights and "provided a degree of security which was lacking in informal piecemeal enclosures" Chapman and Seelinger (1995, 36). In the view of (McCloskey, 1972, 24), a Parliamentary act "was necessary in order to prevent one man from imposing on his fellow villagers a revival of the open fields whenever it suited his immediate convenience, by reasserting his ancient rights of common after the enclosure". Important to definitively settling property rights was the Parliamentary enclosure produced an official map. Yelling notes that "Unlike general enclosures, piecemeal activity gave little incentive to the production of special maps or surveys" (Yelling, 1977, 71) .

Third, the efficient use of the open fields required mass cooperation within the village and stopped individuals experimenting with new techniques. Additionally, land was wasted in the many "balks", which were lands reserved for divisions or access ways between strips. The fact that herds mingled together on the open field also made it very difficult to engage in selective breeding of animals, an important investment. Young argued in his *General Report on Enclosures* submitted to the Board of Agriculture in 1808 that

> there can be no doubt of the superior profit to the farmer by cultivating enclosures, rather than open-field arable. In one case he is in chains - he can make no variation according to soil, to circumstances, or times. He is bound down to the production of corn only ... a mere horse in a team, he must jog on with the rest. Quoted in Daunton (1995, p. 113).

Another piece of relevant evidence supporting the quantitative effects we find is that, as we documented in the paper, enclosure was extremely costly. The expected increase in yields must have been sufficiently high to make paying these costs upfront worthwhile.

Nevertheless, as we noted, how important any of these mechanisms were depended on how extensive piecemeal enclosure was and how it had taken place. In practice there was a great deal of heterogeneity in the extent to which benefits could be expected to flow from Parliamentary enclosure.

## 5.2 The Impact on Inequality and labor Migration

With respect to land inequality case study evidence supports the idea that enclosure was associated with large increases and provides several mechanisms via which it increased.[7] The proximate reason seems to be that large farms expanded at the expense of small farms. This was both because small landowners lost land at enclosure and because other smallholders sold out. We provide direct evidence in Section 9 that Parliamentary enclosure was associated with greater out-migration, consistent with the contraction of smallholdings. Farms may have got smaller because individuals had less well defined rights to the commons rights, or because of the land they lost through compensation for the tithe holder. Smallholders may have

[7] Allen (1992) concluded this from his data on rental rates.

sold out because their farm was too small to be viable, or they did not have the wealth to cover the costs of Parliamentary enclosure upfront. The case study evidence supports all these channels.

Detailed studies of the compensation of rights suggest that this was a source of increased inequality at enclosure. Often, as in Croston, Lancashire, studied by Rogers (1993), common land, in this case Croston Finney, was "owned" by large landowners; "whereas the proprietary claims of the Hesketh and de Trafford families as Lords of the Manor were acknowledged, their possession was also conditioned by an insistence on user-rights which attached to copyholders and other freeholders" (Rogers, 1993, p. 146). However, "Such rights did not belong to every villager but were attached to open-field holdings or certain cottages, and only their owners or occupiers were certainly entitled to make use of them" (Neeson, 1993, p. 56). When Parliamentary enclosure came, the legal rights of the Hesketh and de Traffords trumped the informal use rights of other residents. They received almost 600 of the 800 acres of the Finney (Rogers, 1993, p. 146). The main problem was that "Mere customary users of the common land had no legal right to compensation in the event of an enclosure, and did not generally receive it" (Armstrong, 1989, p. 722). Alternatively, "only narrowly defined legal right was acknowledged at enclosure; more widely enjoyed customary right was sometimes ignored ... while rights attached to land were relatively safe ... rights and customs enjoyed by inhabitants were more vulnerable" (Neeson, 1993, pp. 63, 78). In Barton-upon-Humber between 12% and 15% of claims that were made on the commons were rejected by the enclosure commissioners (Russell, 1968, p. 27-28). Thus the rights to collect furze and turbary were extinguished, typically without any compensation. Other rights, particularly those associated with cottages, which might involve the right to put a cow on the commons, were better defined legally and were compensated, but possibly insufficiently since their implications for land were not clear (e.g. how much land should one be compensated with now that there is no commons on which to tether your cow?).

Neeson showed how in Burton Latimer the commissioners "compensated the house-dwellers and cottage commoners for their eight hundred acres of wold with about seventy three acres situated in the same place" (Neeson, 1993, p. 217). Young himself observed that few enclosure allotments for non-legal rights were above one acre in size and he quoted an enclosure commissioner as saying "which being insufficient for the man's cow, both cow and land are sold to the opulent farmer" (Mingay, 1975, pp. 101, 137).

When it took place, the commutation of the tithe seems to have complemented the impact of the inequitous recognition of rights. In Neeson's research on Northamptonshire, in the parish of West Haddon, the Lord of the Manor Thomas Whitfield owned 262 acres and the right to collect the tithe prior to enclosure and 600 acres (about a quarter of the parish) afterwards (Neeson, 1993, p. 205). In Hibaldstow, Lincolnshire, the lord of the manor, William Dalison received 1241 acres of land in the "general allotment" and in addition 110 acres in lieu of tithes and a further 58 acres for giving up "manorial rights". His total allotment left him owning a third of the parish (Russell, 1968, p. 16-17). The impact of tithe commutation was systematically quantitatively large. Martin (1979, p. 333) calculated that "17.4 per cent [of lands] re-allotted under Warwickshire awards were transferred to compensate for loss of tithe dues." In Buckinghamshire it was 20% (Turner, 1984, p. 65). Turner comments "Tithe commutation was calculated at about one fifth or one sixth of the open field land and one eighth or ninth of the commons ... This ... was almost certainly in excess of the value of the original tithe" (Turner, 1984, p. 65-66). In Barton the tithe owners, the Upplebys, were compensated with 1161 acres of land (Russell, 1968, p. 32) close to

Turner's 20%. In addition the tithe owner did not have to cover the costs associated with this extra land, for example fencing, which fell on the other landowners, see Turner (1984, p. 54) in general and Russell (1968, p. 25) for the details of this in the Barton case.

This inequitous treatment of rights and the potential impact of tithe commutation often led the smallholders to oppose the Parliamentary enclosure to start with and after it happened they "sold out to settle their tithe payments, or to avoid the cost of fencing and draining, or because the land was useless without the commons" (Neeson, 1993, p. 217). The case study evidence is overwhelming that smallholders did sell out and this land was accumulated by the larger and wealthier landowners. In Croston, though others apart from the Hesketh and de Traffords did receive allocations, many sold out with the number of farmers owning less than 5 acres going from 68 before enclosure to 40 afterwards (Rogers, 1993, p. 146). In West Haddon, while the Whitfield family accumulated land, as we saw above, "After enclosure the number of landowners ... fell by 18 per cent" (Neeson, 1993, p. 204). Neeson's broader evidence from Northamptonshire shows both a contraction of small farms, an expansion of large farms and a rapid turnover in ownership, and using the Land Tax returns she shows that movement out of these returns after enclosure "was most common amongst those with least land" (Neeson, 1993, p. 230). These findings are echoed in Martin's research on Warwickshire and he documents that as a consequence of enclosure "the overall share of the smaller proprietors was reduced as well as their numbers" (Martin, 1979, p. 337). In Buckinghamshire "It is quite clear from the evidence in the land tax that the total number of landowners decreased over the forty-year period from the 1780's to the 1820's" (Turner, 1975, p. 566).

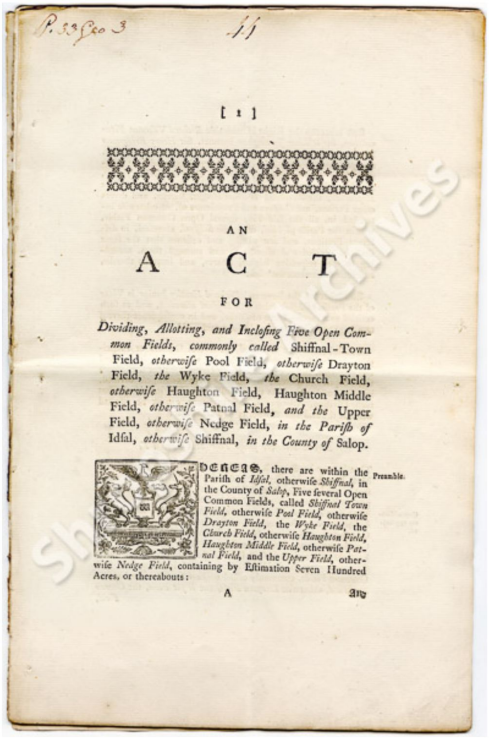
Though the Land Tax records to not directly speak to this, other evidence suggests it is likely that small proprietors sold out to larger landowners. Martin's conclusion is that "enclosure held out a good opportunity, in a generally thin market, of enlarging upon an existing possession" (Martin, 1979, p. 339).[8] Turner, studying the parish of Little Brickhill in Buckinghamshire, noted a large decrease in the number of landowners in the year prior to the enclosure act. "In this case there was a massive accumulation by a George Henry Rose of Westminster, including the prestigious purchase of the manor ... These declines measure a sudden selling out by the owners in an effort to avoid enclosure costs" (Turner, 1975, p. 568). Martin noticed that Parliamentary enclosure awards sometimes actually record incidences of land sales during the process of enclosure, which could take years. "In fact, land purchases are recorded in at least 55 of 133 awards which deal with common-field land, while some 34 (25 per cent) record the engrossment of purchased land by the principal estate owner" (Martin, 1979, p. 338). By engrossment Martin means the expansion of their properties by large landowners.

Overall then, while the quantitative effects we find are large, they are consistent with the case study and historical literatures, bearing in mind the great deal of heterogeneity that there clearly was.

[8]For similar evidence from Leicestershire see Hunt (1959).

# 6 Additional figures

Figure 4: An enclosure act



[ 1 ]

AN

A C T

FOR

*Dividing, Allotting, and Inclosing Five Open Common Fields, commonly called* Shiffnal-Town Field, *otherwise* Pool Field, *otherwise* Drayton Field, *the* Wyke Field, *the* Church Field, *otherwise* Haughton Field, Haughton Middle Field, *otherwise* Patnal Field, *and the* Upper Field, *otherwise* Nedge Field, *in the Parish of* Idfal, *otherwise* Shiffnal, *in the County of* Salop.

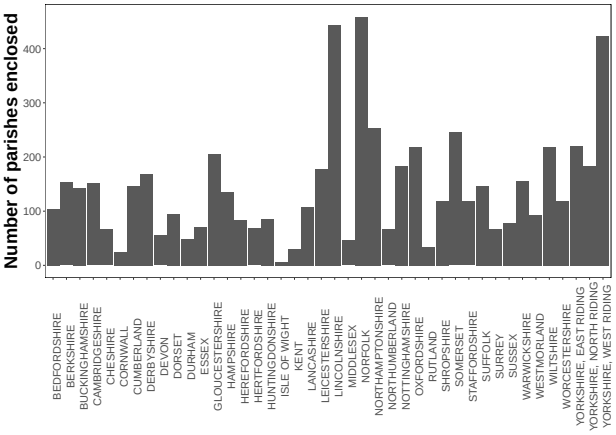
Preamble.

Whereas, there are within the Parish of *Idfal*, otherwife *Shiffnal*, in the County of *Salop*, Five feveral Open Common Fields, called *Shiffnal Town Field*, otherwife *Pool Field*, otherwife *Drayton Field*, the *Wyke Field*, the *Church Field*, otherwife *Haughton Field*, *Haughton Middle Field*, otherwife *Patnal Field*, and the *Upper Field*, otherwife *Nedge Field*, containing by Eftimation Seven Hundred Acres, or thereabouts:

A

Notes: Example of an enclosure act.

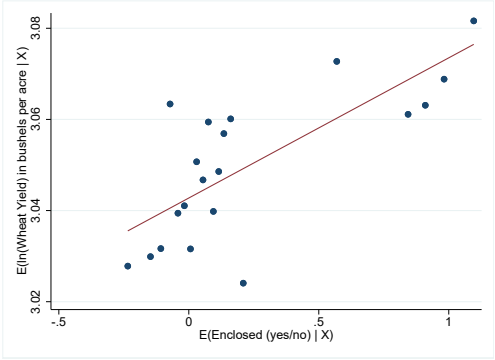
Figure 5: The number of parishes enclosed through Parliament, by county



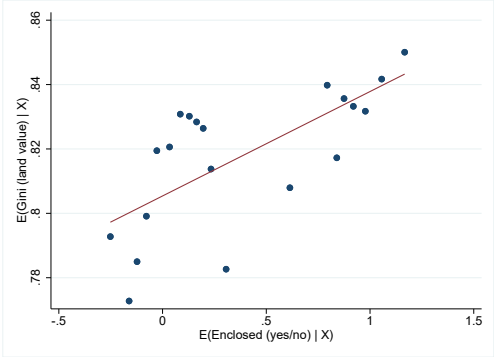

Notes: This graph shows the total number of parishes that enclosed through Parliament, by county. Source: Tate and Turner (1978).

Figure 6: Scatterplots for main outcomes

(a) Log(Wheat Yield)

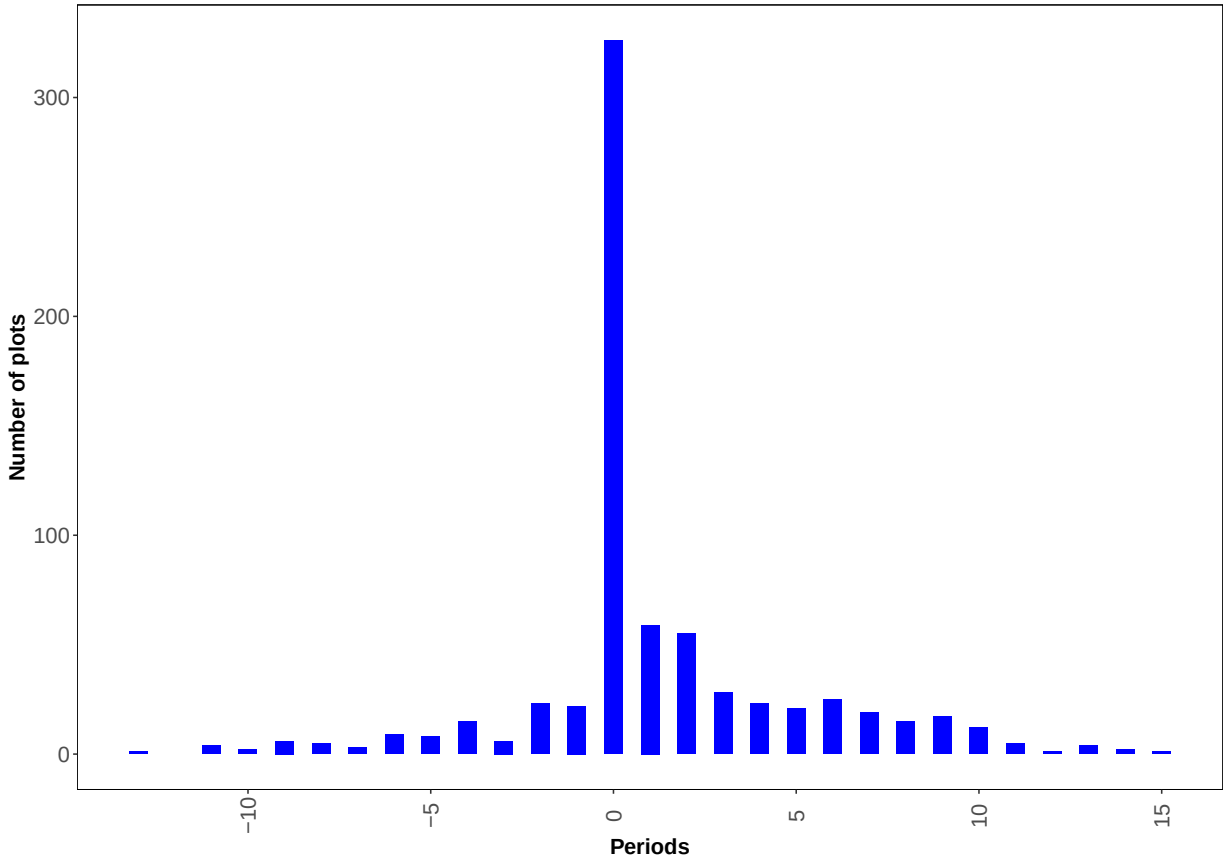



(b) Gini



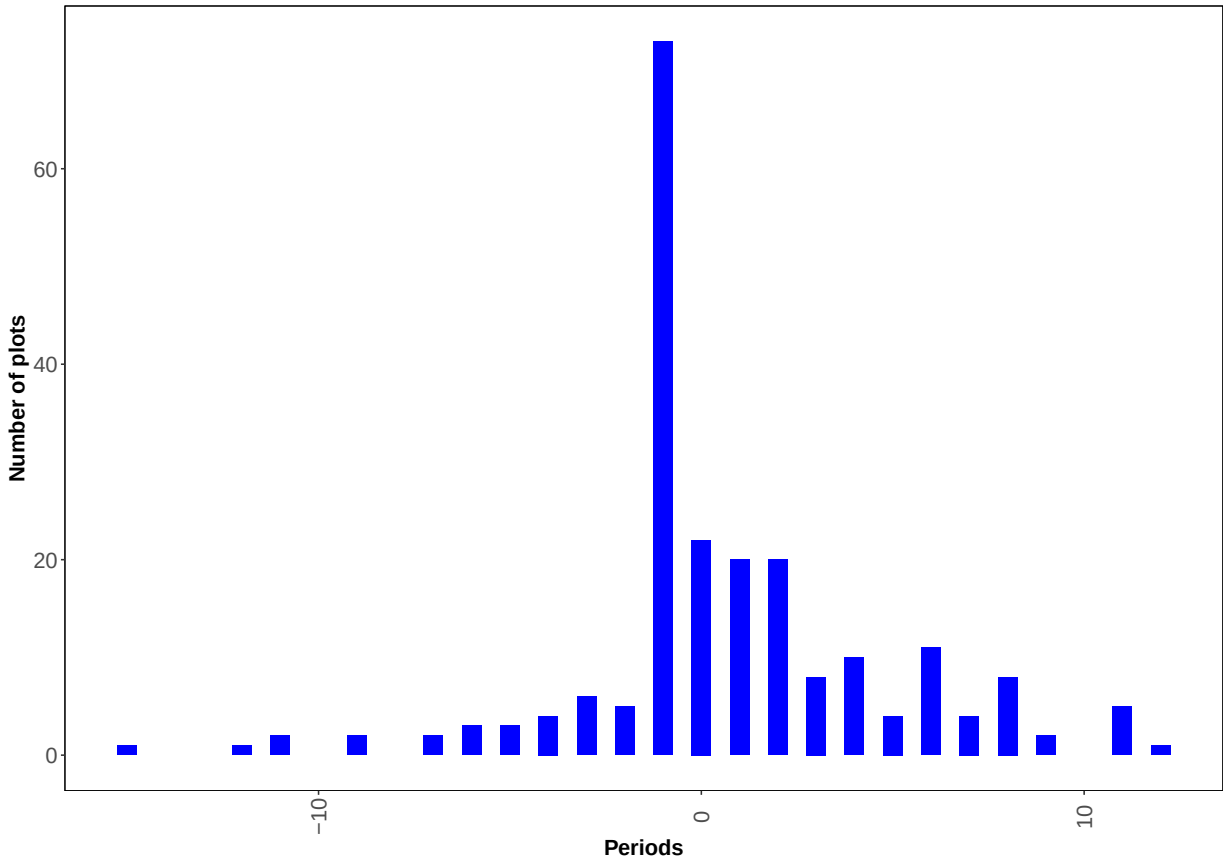

Notes: These figures are residualized and binned scatter plots (using 40 bins) visualizing estimates of equation 1 in the main paper. We partial out covariates and fixed effects and plot a linear fit of each outcome against predicted enclosure. The bins reflect the raw underlying data. We bin the x-axis into 40 bins, and each dot represents the average the relevant outcome variable within that bin. Table 2 presents the same results in table format.

Figure 7: Periods available for plots wih observation in period 0



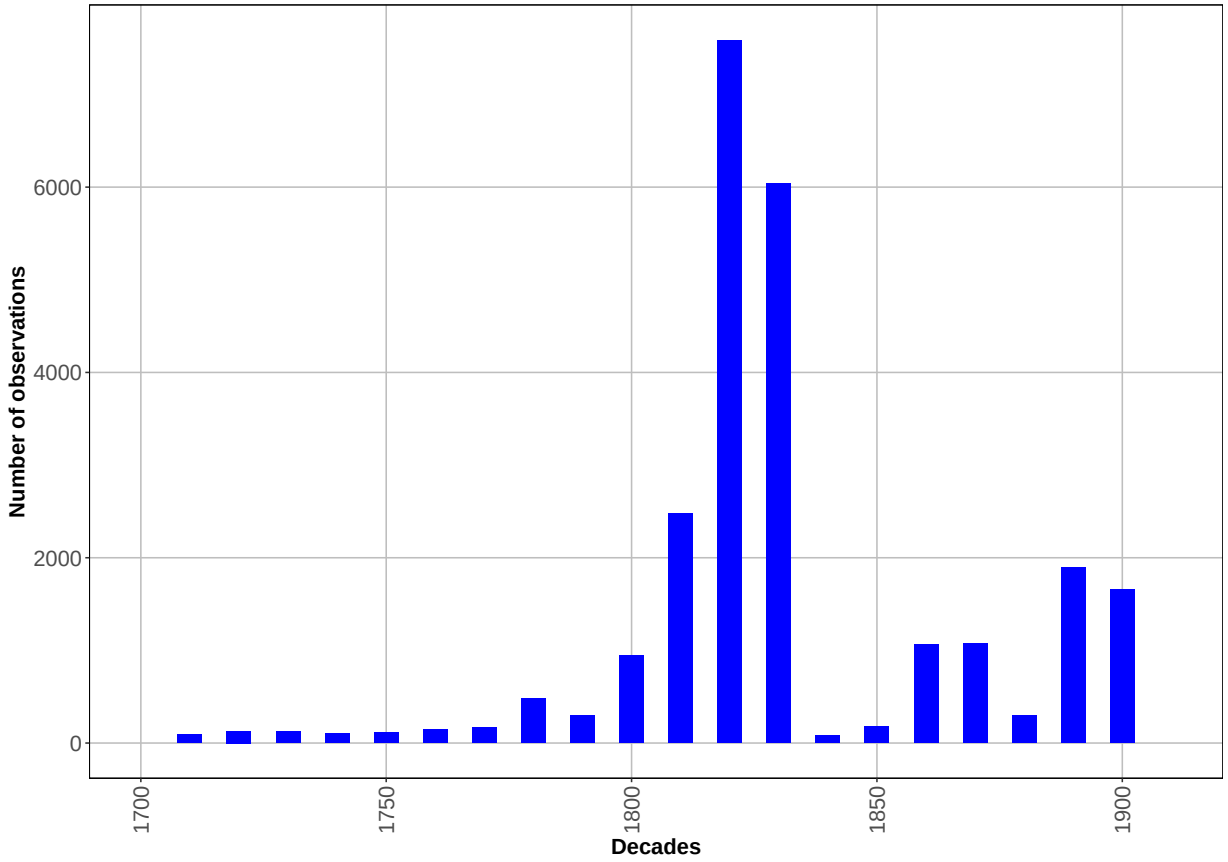

Notes: For our panel dataset of plot-decades, this Figure shows the distribution of availability of rent/acre observations conditional on observing rent/acre in the decade in which a plot was enclosed.

Figure 8: Periods available for plots with observation in period -1




Notes: For our panel dataset of plot-decades, this Figure shows the distribution of availability of rent/acre observations conditional on observing rent/acre in the decade prior to the decade in which a plot was enclosed.

Figure 9: Number of observations per period




Notes: For our panel dataset of plot-decades, this Figure shows the distribution of availability of rent/acre observations by decade.

# 7 Additional results

In this section, we implement several additional analyses. We first show robustness to two aspects of our instrumental variable analysis: The range of the bandwidth of the Conley standard errors, and the number of nearest neighbors in the construction of the instrument. We then estimate our main relationship of interest using OLS. This corresponds to equation 8 above. We compare the estimated effect to the average treatment effects (ATEs) estimated in our main paper. We then perform several robustness exercises, using our instrumental variable strategy from the main paper. We first show that using the share of a parish that in enclosed does not affect our main results. We then repeat our results for wheat yield using data on yields for two other crops, barley and oats. Then, we show that our main result is robust to measuring inequality in different ways, and to controlling for drainage and turnpikes. Finally, we study the acreage of various crops under cultivation. We find that acreages for wheat, barley, and arable land generally do not change. We find an increase in the acreage of grassland, consistent with the conversion of the commons.

## 7.1 Construction of our instrument

In Table A1 we vary the bandwidth within which we include parishes in the computation of the Conley standard errors. We vary the bandwidth from 20 to 100 kilometers. We see that all results are significant at all bandwidths. For the paper, we have chosen the most conservative bandwidth, at 70 kilometers. In Table A2 we vary the number of nearest neighbors included in the construction of our synthetic committee. We vary the number of neighbors from 250 to 500 in steps of 50. All results are significant using any of the number of included neighbors.

## 7.2 OLS results

In this section we estimate a linear relationship between Parliamentary enclosure and our outcomes of interest. We find that Parliamentary enclosure is associated with higher agricultural yields and higher land inequality. We start by estimating a simple model, using OLS:

$$Y_p = \beta_0 + \beta_1 E_p + X_p \beta_2^{'} + s + \varepsilon_p \tag{23}$$

Like in our main paper $Y_p$ is an outcome of interest for parish $p$, $E_p$ is an indicator equal to one of a parish was enclosed through Parliament between 1750 and 1830, and zero otherwise. $X_p$ is a vector of covariates, and $s$ is a vector of fixed effects.

Table A3 reports estimates of equation 8. The structure of the table is the same as the structure of our table of IV results in our main paper. Columns (1) and (2) use the natural log of wheat yield in bushels per acre measured in 1836 as the dependent variable. In column (1) we only include soil type and region fixed effects. In column (2) we include all covariates. We report estimates of $\hat{\beta}_1$ in row 1. We find that Parliamentary enclosure is associated an increase in the natural log of yield of 0.04 to 0.03, which corresponds to a 3 percent increase in yield. This estimated effect is stable across columns (1) and (2) and statistically significantly different from zero. In columns (3) and (4) we then study land value inequality. In columns (3) and (4) we find that, conditional on only fixed effects in column (3) or all covariates in column (4), enclosure is associated with a 0.03 to 0.04 increase in the Gini coefficient.

**Interpretation of the estimated effect size**. The control group in these OLS regressions is composed of those parishes that were unenclosed, parishes that were enclosed unanimously, but more important quantitatively, parishes which were piecemeal enclosed to some extent. A parish that was piecemeal enclosed before the start of Parliamentary enclosure, may already have more unequal landholdings, relative to a parish about to enclose through Parliament, and may have already realized the potential productivity increases of enclosure. Such parishes self-select out of Parliamentary enclosure and are part of our control group. Therefore, our OLS results are likely to underestimate the true effect of *Parliamentary* enclosure. We address this issue in detail in our paper.

### 7.3 Removing nearest neighbors

In Table A4 we remove the ten nearest parishes to a parish in the construction of our instrument. In the paper we present a Figure that varies the number of nearest neighbors removed. Results are very similar.

### 7.4 Measurement of enclosure

In Table A5 we replace our enclosure dummy with the share of land in a parish enclosed. Results are qualitatively the same as when using our enclosure indicator.

### 7.5 Barley and oats yield

In Table A6 we repeat columns (1) and (2) of Table 2 from our paper twice. Rather than focusing on wheat yield as the outcome of interest, we study barley yield, and oats yield. We find similar estimated effects. However, the sample sizes we have for these outcomes are about half the size of the sample size we have for wheat, and estimated effects are therefore more noisy.

### 7.6 Inequality measurement

In Table A7 we repeat columns (3) and (4) of Table 2 from our paper. In columns (1) and (2) we use a Gini coefficient over land size, rather than land value as the dependent variable. In columns (3) and (4) we go back to land value, but in addition we control for the number of landowners in a parish. This covariate aims to capture a mechanically high or low Gini if there are very few inhabitants in a parish. Throughout we find very similar effects to Table 2, with the one exception being that using our stringent standard errors the point estimate in column (1) is no long statistically significant. When we account more precisely for location in column (2), the point estimate is significant using both types of standard errors.

### 7.7 Controlling for drainage and turnpikes

In Table A8 we repeat Table 2 from our paper, including two additional covariates. We first code an indicator equal to one if drainage was recorded in the tithe surveys (Kain and Prince, 1985). Second, we code an indicator equal to one if a turnpike passed through a parish, using data made available to us by Dan Bogart. Both drainage and turnpikes were set up through local acts, which passed through Parliament in

a similar way as enclosure Bills did. When we include these covariates our sample size (in columns (2)-(4) falls considerably, as we are now restricted to the data available in the tithe surveys. In each column, the estimated effect of enclosure remains strong and significant.

## 7.8 Crop acreages

In Table A9 we study the acreages planted for various crops. We take this data from the tithe surveys (Kain and Prince, 1985). A concern that may arise in interpreting our results is that enclosure freed up the most productive land for use for certain crops and that productivity improvements are simply driven by the most productive land being re-allocated, rather than changed incentives for innovation and coordination.

The way we address this issue is to show that acreages planted for main crops do not meaningfully change with enclosure but that acreage used for grassland increases. This finding is consistent with the commons being privatized but primarily used for grazing. Naturally, this test does not address any compositional changes within the open fields that may have reallocated plots to different uses.

We report results in Table A9. Acreage of arable land goes up, but not significantly. Acreages of wheat and barley also go up, but insignificantly. Acreage of Oats goes down, significantly. These results are consistent with part of the commons being brought under cultivation, but not being particularly concentrated in one crop. In column (5) we study acreage under grassland, and this goes significantly. This is consistent with the commons, which used to be at least in part meadow, being privatized.

## 7.9 Measurement of yield within the parish

In the data section in the paper we highlighted a subtle measurement issue. Often, at Parliamentary enclosure, tithes were commuted. This may mean that the data source we use to measure yields, which is based on the tithe commissioners' records, actually reports yields for parts of the parish that were not enclosed by Parliament. In the paper, we discuss this issue. Here we provide robustness checks. We measure whether tithes were commuted in two ways. First, we remove the midlands. The midlands are reported by Kain and Prince (2000) to have been less surveyed by the tithe commissioners.[9] Second, we use a report by Parliament from 1836 that records whether - as part of Parliamentary enclosure - tithes were commuted or not. We code an indicator equal to one if tithes were commuted.[10] Using this indicator, we restrict our sample as follows: We remove parishes that had their tithes commuted as part of Parliamentary enclosure. This leaves only parishes as 'treated' that were enclosed by Parliament, but left their tithes intact. Results are in Table A10, which repeats column (2) and (4) from our main table, removing midlands counties (columns (1) and (3)) and parishes where the tithes were commuted (columns (2) and (4)). We find that doing this does not meaningfully change our results. This means that the fact that sometimes Parliamentary enclosure commuted the tithes, and that our main data sources come from tithe-related records, does not invalidate our results.

[9] We define the midlands as follows: Bedfordshire, Buckinghamshire, Huntingdonshire, Leicestershire, Lincolnshire, Northamptonshire, Rutland, Warwickshire, and Yorkshire: East Riding.

[10] The full title of the report is: "A return, from the inclosure and other private acts in which provisions are included for the commutation of tithes, of the proportion in land, yearly money payment, or corn rent, allotted in lieu of tithe; distinguishing old inclosures, the open field land, and the commons, and the proportions of tithe allotted in the case of each of such description of lands.". The report is dated March 15th, 1836 and is part of the Parliamentary Papers. It can be viewed using 'Parliamentary papers online': https://archives.parliament.uk/online-resources/parliamentary-papers/.

## 7.10 Yield observations in enclosed parishes

In the exercise of the previous paragraph, the number of observations between our main regressions and the estimates in Table A10 does not fall very much. For example, if we compare column (2) of Table 3 and columne (2) of A10 the number of observations falls from 3641 to 3491. This is because among parishes for which we observe yield outcomes, we do not have many that commuted their tithes as part of Parliamentary enclosure. Because in total about 1/3 of parishes had their tithes commuted at enclosure, we now study whether it is the case that *enclosed* parishes - by Parliament - for which we observe yield are different than enclosed parishes for which we do not observe yield.

To study this, we code an indicator equal to one if a parish is enclosed by Parliament and we do not observe yields, and zero if a parish is enclosed through Parliament and we do not observe yield. With this indicator we implement two exercises. First we replicate our balance table, Table 2, from the paper, using this indicator as the right hand side variable of interest. Second, we include any variables on which we do not find balance as covariates.

Table A11 contains balance results. All estimated effects are expressed in standard deviations. All estimated coefficients are small. With the exception of the suitability for wheat all estimated effects suggest that a one standard deviation increase in the probability of tithe data missing is associated with less than 0.05 of one standard deviation change in the dependent variables. For the suitability for wheat, we see a 0.06 of a standard deviation reduction. While all estimated effects are small, some are significant. Tax revenue per capita in 1525 balances, but taxes in levels and population in levels do not. Same with the number of MPs in 1700 and wheat suitability. This suggest that we are less likely to observe tithe observations for enclosed parishes in larger, more populated, and less agriculturally productive parishes. It may be that the tithe commissioners' focused on the countryside rather than more urban places. For our analyses, we want to ensure that our results are not confounded by this type of selection.

We therefore re-estimate our main regression for wheat yield including the covariates that did not balance in the previous table. The result is in Table A12. In columns (1) and (2) include the same covariates as column (1) of Table 3, and column (3) and (4) replicate the covariates of column (2) in Table 3. However, in columns (2) and (3) we now include tax revenue and population in 1525, the suitability of the soil for growing wheat, and the number of MPS in 1700. Note that therefore, columns (1) and (3) replicate the main results from Table (3) and columns (2) and (4) include the new covariates. Comparing columns (1) and (2) we observe an increase in the point estimate from 0.5 to 0.6, but a decline in observations from 3641 to 1877. This reduction is due to the lack of overlap between the Parliamentary Enclosure, yield, and covariate data availability. This reduction in observations by about fifty percent increases standard errors, but the results remains significant using heteroskedasticity robust standard errors and is just marginally insignificant using the most stringent Conley standard errors. In columns (3) and (4) we observe a similar pattern. Point estimates go up, as do standard errors due to a drop in observations. All in all, inclusion of these variables does not meaningfully alter the conclusions of our main results.

## 7.11 IV results: Mechanisms

In the paper we present OLS results for several mechanisms linking Parliamentary enclosure to increases in agricultural yield. Here we present the corresponding IV results, in Table A13. Results are qualitatively

similar to the OLS, with higher coefficients, as expected. For patents, standard errors go up beyond conventional significance levels. For all other outcomes, we retain precision.

### 7.12 IV results: Downstream consequences

In the paper we present OLS results for downstream consequences of Parliamentary enclosure. Here we present the corresponding IV results, in Table A14. Results are qualitatively similar to the OLS, with higher coefficients, as expected.

### 7.13 Additional results for migrants

In the paper we present evidence that enclosure was associated with increased migration to industrializing counties the north of England. In this section, we present two additional tables that support these results. In Table A15 we revisit the distribution of migrants to industrial counties over space. In the paper we showed that most migrants to industrial counties come from nearby counties. This fact would suggest that the treatment effect of enclosure may be non-linear. We study this by binning the distribution of the number of migrants to industrial counties. In column (1) we use an indicator equal to one of a parish did not have any migrants going to the north. Columns (2)-(6) report results using quantiles of the conditional distribution of migrants to industrial counties, for parishes with at least one migrant. We observe that parishes that enclosed through Parliament are less likely to send zero migrants to the north, and more likely to be in fourth and fifth quintiles of the conditional distribution of migrants. This non-linear effect is driven by the fact that a) most migrants to industrial counties come from nearby counties and b) Parliamentary enclosure is concentrated in the midlands and the north. We show this latter point in Table A16.

In Table A17 we revisit the main migration results from the paper, and report the corresponding instrumental variable estimates to the OLS results reported there. We find qualitative similar effects, with larger coefficients. As before, these larger coefficient reflect selection into Parliamentary enclosure. For these migration outcomes, they now also reflect the non-linearity of the dependent variable.

Table A1: IV Robustness to Conley Bandwidth

| *Dependent variable:* | ln(Wheat Yield) in bushels per acre (1) | Gini (land value) (2) |
|---|---|---|
| Bandwidth | | |
| 20 | 0.447 | 0.218 |
| | (0.145) | (0.077) |
| 50 | 0.447 | 0.218 |
| | (0.184) | (0.094) |
| 70 | 0.447 | 0.218 |
| | (0.188) | (0.096) |
| 100 | 0.447 | 0.218 |
| | (0.171) | (0.098) |
| *Scale*: Parish area | Y | Y |
| *Geography*: Elevation | Y | Y |
| *Location*: Latitude, longitude, latitude*longitude | Y | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y |

Notes: All regressions are estimated using 2SLS. The unit of observation is a parish. ln(Wheat Yield) in bushels per acre is the natural log of the number of bushels of wheat per acre. Gini (land value) is a Gini coefficient of the value of land owned by parishioners in the 1836 tithe returns. All point estimates in this table are from Instrumental Variable regressions like in the main body fo the paper. The difference between rows is the bandwidth used when computing Conley standard errors. The instrument is the leave-one-out fraction of the proposed enclosures that pass through Parliament and are enacted into law. We take the nearest k parish neighbors and compute total $\frac{\text{successful enclosures}}{\text{attempts to enclose}}$ in this range. Conley standard errors are in parentheses. Bandwidth is listed under column 'distance cutoff'. Kernel is triangular throughout.

Table A2: IV Robustness to Number of Nearest Neighbors

| *Dependent variable:* | ln(Wheat Yield) in bushels per acre (1) | Gini (land value) (2) |
|---|---|---|
| Neighbors | | |
| 250 | 0.469 | 0.164 |
| | (0.208) | (0.086) |
| 300 | 0.463 | 0.192 |
| | (0.200) | (0.090) |
| 350 | 0.447 | 0.218 |
| | (0.188) | (0.096) |
| 400 | 0.425 | 0.240 |
| | (0.182) | (0.105) |
| 450 | 0.424 | 0.253 |
| | (0.182) | (0.111) |
| 500 | 0.444 | 0.259 |
| | (0.189) | (0.116) |
| *Scale*: Parish area | Y | Y |
| *Geography*: Elevation | Y | Y |
| *Location*: Latitude, longitude, latitude*longitude | Y | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y |

Notes: All regressions are estimated using 2SLS. The unit of observation is a parish. ln(Wheat Yield) in bushels per acre is the natural log of the number of bushels of wheat per acre. Gini (land value) is a Gini coefficient of the value of land owned by parishioners in the 1836 tithe returns. All point estimates in this table are from Instrumental Variable regressions like in the main body fo the paper. The difference between rows is the bandwidth used when computing Conley standard errors. The instrument is the leave-one-out fraction of the proposed enclosures that pass through Parliament and are enacted into law. We take the nearest k parish neighbors and compute total $\frac{\text{successful enclosures}}{\text{attempts to enclose}}$ in this range. The parish itself is not counted as a neighbor. k is listed under column 'Neighbors'. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km.

Table A3: Parliamentary enclosure, agriculture, and inequality

| *Dependent variable:* | ln(Wheat Yield) in bushels per acre | | Gini (land value) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Parliamentary enclosure (yes/no) | 0.04 | 0.03 | 0.03 | 0.04 |
| | (0.02) | (0.01) | (0.02) | (0.01) |
| | [0.007] | [0.007] | [0.007] | [0.007] |
| Mean dep. var. | 3.05 | 3.05 | 0.74 | 0.74 |
| SD dep. var. | 0.21 | 0.21 | 0.21 | 0.21 |
| Observations | 3728 | 3641 | 4527 | 4446 |
| $R^2$ | 0.01 | 0.32 | 0.05 | 0.08 |
| *Scale*: Parish area | N | Y | N | Y |
| *Geography*: Elevation | N | Y | N | Y |
| *Location*: Latitude, longitude, latitude*longitude | N | Y | N | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y |

Notes: All regressions are estimated using OLS. The unit of observation is a parish. All regressions restrict to rural parishes. ln(Wheat Yield) in bushels per acre is the natural log of the number of bushels of wheat per acre. Gini (land value) is a Gini coefficient of the value of land owned by parishioners in the 1836 tithe returns. Parliamentary enclosure (yes/no) is an indicator equal to one if a parish was enclosed through Parliament at any point between 1750 and 1830. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table A4: Instrument construction: Remove 10 nearest neighbors

| *Dependent variable:* | ln(Wheat Yield) in bushels per acre | | Gini (land value) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Enclosed (yes/no) | 0.60 | 0.54 | 0.24 | 0.34 |
| | (0.37) | (0.23) | (0.10) | (0.15) |
| | [0.10] | [0.09] | [0.06] | [0.08] |
| Mean dep. var. | 3.05 | 3.05 | 0.74 | 0.74 |
| SD dep. var. | 0.21 | 0.21 | 0.21 | 0.21 |
| Observations | 3641 | 3641 | 4446 | 4446 |
| *Scale*: Parish area | N | Y | N | Y |
| *Geography*: Elevation | N | Y | N | Y |
| *Location*: Latitude, longitude, latitude*longitude | N | Y | N | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y |

Notes: All regressions are estimated using 2SLS. The unit of observation is a parish. All regressions restrict to rural parishes. ln(Wheat Yield) in bushels per acre is the natural log of the number of bushels of wheat per acre. Gini (land value) is a Gini coefficient of the value of land owned by parishioners in the 1836 tithe returns. Parliamentary enclosure (yes/no) is an indicator equal to one if a parish was enclosed through Parliament at any point between 1750 and 1830. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table A5: Measurement: Using share of land enclosed

| *Dependent variable:* | ln(Wheat Yield) in bushels per acre | | Gini (land value) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Share of Land Enclosed | 1.68 | 1.68 | 0.67 | 1.15 |
| | (1.21) | (0.81) | (0.41) | (0.81) |
| | [0.358] | [0.367] | [0.208] | [0.378] |
| Mean dep. var. | 3.05 | 3.05 | 0.74 | 0.74 |
| SD dep. var. | 0.21 | 0.21 | 0.21 | 0.21 |
| Observations | 3641 | 3641 | 4446 | 4446 |
| *Scale*: Parish area | N | Y | N | Y |
| *Geography*: Elevation | N | Y | N | Y |
| *Location*: Latitude, longitude, latitude*longitude | N | Y | N | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y |

Notes: All regressions are estimated using 2SLS. The unit of observation is a parish. All regressions restrict to rural parishes. ln(Wheat Yield) in bushels per acre is the natural log of the number of bushels of wheat per acre. Gini (land value) is a Gini coefficient of the value of land owned by parishioners in the 1836 tithe returns. Enclosure (share of parish area) is the share of land of a parish that is enclosed between 1750 and 1830. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table A6: Alternative crop yields

| *Dependent variable:* | ln(Barley Yield) in bushels per acre | | ln(Oats Yield) in bushels per acre | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Parliamentary enclosure (yes/no) | 0.20 | 0.19 | 0.17 | 0.15 |
| | (0.26) | (0.20) | (0.24) | (0.22) |
| | [0.112] | [0.096] | [0.107] | [0.114] |
| Mean dep. var. | 3.45 | 3.45 | 3.41 | 3.41 |
| SD dep. var. | 0.24 | 0.24 | 0.18 | 0.18 |
| Observations | 2283 | 2283 | 2701 | 2701 |
| *Scale*: Parish area | N | Y | N | Y |
| *Geography*: Elevation | N | Y | N | Y |
| *Location*: Latitude, longitude, latitude*longitude | N | Y | N | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y |

Notes: All regressions are estimated using 2SLS. The unit of observation is a parish. All regressions restrict to rural parishes. ln(Barley Yield) in bushels per acre is the natural log of the number of bushels of barley per acre. ln(Oats Yield) in bushels per acre is the natural log of the number of bushels of oats per acre. Parliamentary enclosure (yes/no) is an indicator equal to one if a parish was enclosed through Parliament at any point between 1750 and 1830. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table A7: Inequality measurement

| *Dependent variable:* | Gini (land size) | | Gini (land value) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Parliamentary enclosure (yes/no) | 0.18 | 0.26 | 0.13 | 0.18 |
| | (0.09) | (0.12) | (0.09) | (0.12) |
| | [0.04] | [0.04] | [0.05] | [0.06] |
| Mean dep. var. | 0.74 | 0.74 | 0.74 | 0.74 |
| SD dep. var. | 0.21 | 0.21 | 0.21 | 0.21 |
| Observations | 4446 | 4446 | 4446 | 4446 |
| *Population*: Total number landowners | N | N | Y | Y |
| *Scale*: Parish area | N | Y | N | Y |
| *Geography*: Elevation | N | Y | N | Y |
| *Location*: Latitude, longitude, latitude*longitude | N | Y | N | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y |

Notes: All regressions are estimated using 2SLS. The unit of observation is a parish. All regressions restrict to rural parishes. Gini (land size) is a Gini coefficient of the size of land owned by parishioners in the 1836 tithe returns. Gini (land value) is a Gini coefficient of the value of land owned by parishioners in the 1836 tithe returns. Parliamentary enclosure (yes/no) is an indicator equal to one if a parish was enclosed through Parliament at any point between 1750 and 1830. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table A8: Controlling for drainage and turnpikes

| *Dependent variable:* | ln(Wheat Yield) in bushels per acre | | Gini (land value) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Parliamentary enclosure (yes/no) | 0.42 | 0.44 | 0.28 | 0.35 |
| | (0.29) | (0.18) | (0.09) | (0.13) |
| | [0.08] | [0.08] | [0.06] | [0.08] |
| Mean dep. var. | 3.05 | 3.05 | 0.74 | 0.74 |
| SD dep. var. | 0.21 | 0.21 | 0.21 | 0.21 |
| Observations | 3641 | 3641 | 2745 | 2745 |
| Drainage indicator | Y | Y | Y | Y |
| indicator | Y | Y | Y | Y |
| *Scale*: Parish area | N | Y | N | Y |
| *Geography*: Elevation | N | Y | N | Y |
| *Location*: Latitude, longitude, latitude*longitude | N | Y | N | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y |

Notes: All regressions are estimated using 2SLS. The unit of observation is a parish. All regressions restrict to rural parishes. ln(Wheat Yield) in bushels per acre is the natural log of the number of bushels of wheat per acre. Gini (land value) is a Gini coefficient of the value of land owned by parishioners in the 1836 tithe returns. Parliamentary enclosure (yes/no) is an indicator equal to one if a parish was enclosed through Parliament at any point between 1750 and 1830. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table A9: Acreages of various crops

| *Dependent variable: Acreage of* | Arable (1) | Wheat (2) | Barley (3) | Oats (4) | Grassland (5) |
|---|---|---|---|---|---|
| Parliamentary enclosure (yes/no) | 230 | 73 | 365 | -252 | 1015 |
| | (530) | (116) | (168) | (151) | (558) |
| | [196] | [46] | [79] | [80] | [256] |
| Mean dep. var. | 898 | 234 | 201 | 161 | 827 |
| SD dep. var. | 855 | 210 | 202 | 230 | 1125 |
| Observations | 4229 | 3633 | 2570 | 2125 | 4228 |
| *Scale*: Parish area | Y | Y | Y | Y | Y |
| *Geography*: Elevation | N | N | N | N | N |
| *Location*: Latitude, longitude, latitude*longitude | N | N | N | N | N |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y | Y |

Notes: All regressions are estimated using 2SLS. The unit of observation is a parish. All dependent variables are acreages of various crops in the 1836 tithe returns. Parliamentary enclosure (yes/no) is an indicator equal to one if a parish was enclosed through Parliament at any point between 1750 and 1830. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table A10: Removing parishes that were enclosed and had their tithe commuted

| *Dependent variable:* | ln(Wheat Yield) in bushels per acre (1) | (2) | Gini (land value) (3) | (4) |
|---|---|---|---|---|
| Parliamentary enclosure (yes/no) | 0.50 | 0.46 | 0.18 | 0.26 |
| | (0.32) | (0.19) | (0.07) | (0.10) |
| | [0.09] | [0.08] | [0.04] | [0.06] |
| Mean dep. var. | 3.05 | 3.05 | 0.75 | 0.75 |
| SD dep. var. | 0.22 | 0.22 | 0.20 | 0.20 |
| Observations | 3357 | 3491 | 3812 | 3928 |
| Removing counties (C), or parishes (P) | C | P | C | P |
| *Scale*: Parish area | Y | Y | Y | Y |
| *Geography*: Elevation | Y | Y | Y | Y |
| *Location*: Latitude, longitude, latitude*longitude | Y | Y | Y | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y |

Notes: All regressions are estimated using 2SLS. The unit of observation is a parish. All regressions restrict to rural parishes. ln(Wheat Yield) in bushels per acre is the natural log of the number of bushels of wheat per acre. Gini (land value) is a Gini coefficient of the value of land owned by parishioners in the 1836 tithe returns. Parliamentary enclosure (yes/no) is an indicator equal to one if a parish was enclosed through Parliament at any point between 1750 and 1830. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table A11: Balance tests for yield availability for enclosed parishes

| *Dependent variable:* | Tax revenue per capita 1525 | Tax revenue 1525 | Suitability for wheat | Population 1525 | Number of MPs 1700 | Number of nobility 1700 | Fraction of yeomen 1700 |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Tithe data missing (yes/no) | 0.021 | 0.028 | -0.067 | 0.045 | 0.019 | 0.025 | -0.031 |
| | (0.011) | (0.009) | (0.026) | (0.015) | (0.010) | (0.015) | (0.024) |
| | [0.014] | [0.010] | [0.012] | [0.014] | [0.010] | [0.017] | [0.021] |
| Observations | 2438 | 2736 | 3952 | 2736 | 2946 | 2946 | 2160 |
| $R^2$ | 0.02 | 0.16 | 0.44 | 0.33 | 0.01 | 0.01 | 0.17 |
| *Scale*: Parish area | Y | Y | Y | Y | Y | Y | Y |
| *Geography*: Elevation | Y | Y | Y | Y | Y | Y | Y |
| *Location*: Latitude, longitude, latitude*longitude | Y | Y | Y | Y | Y | Y | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y | Y | Y | Y |

All regressions are estimated using OLS. The unit of observation is a parish. All regressions restrict to rural parishes. All point estimates are standardized. Tax revenue per capita 1525 is total tax revenue divided by total population in the 1525 Lay Subsidy returns. Income 1525 is total tax revenue in the 1525 Lay Subsidy returns. Suitability for Wheat is the suitability of the soil for growing wheat. Population 1525 is total population in the 1525 Lay Subsidy returns. Number of MPs living in parish in 1700 is the number of members of parliament in 1700 that have their residence in a parish. Number of nobility living in parish in 1700 is the number of members the nobility in 1700 that have their residence in a parish. Tithe data missing (yes/no) is an indicator equal to one if a parish is enclosed through Parliament and we do not observe yield data. This indicator is equal to zero if a parish is enclosed through Parliament and we do observe yield data. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table A12: Controlling for determinants of the availability of tithe data

| *Dependent variable:* | ln(Wheat Yield) in bushels per acre | | ln(Wheat Yield) in bushels per acre | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Parliamentary enclosure (yes/no) | 0.48 | 0.60 | 0.45 | 0.55 |
| | (0.31) | (0.38) | (0.19) | (0.42) |
| | [0.09] | [0.19] | [0.08] | [0.24] |
| Mean dep. var. | 3.05 | 3.05 | 3.05 | 3.05 |
| SD dep. var. | 0.21 | 0.21 | 0.21 | 0.21 |
| Observations | 3641 | 1877 | 3641 | 1877 |
| *Scale*: Parish area | N | N | Y | Y |
| *Geography*: Elevation | N | N | Y | Y |
| *Location*: Latitude, longitude, latitude*longitude | N | N | Y | Y |
| Tax revenue 1525 | N | Y | N | Y |
| Population 1525 | N | Y | N | Y |
| Suitability for Wheat | N | Y | N | Y |
| Number of MPs 1700 | N | Y | N | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y |

Notes: All regressions in panel I are estimated using two-stage least squares. The unit of observation is a parish. All regressions restrict to rural parishes. ln(Wheat Yield) in bushels per acre is the natural log of the number of bushels of wheat per acre. Parliamentary enclosure (yes/no) is an indicator equal to one if a parish was enclosed through Parliament at any point between 1750 and 1830. Income 1525 is total tax revenue in the 1525 Lay Subsidy returns. Population 1525 is total population in the 1525 Lay Subsidy returns. Suitability for Wheat is the suitability of the soil for growing wheat. Number of MPs living in parish in 1700 is the number of members of parliament in 1700 that have their residence in a parish. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table A13: IV results: Mechanisms

| *Dependent variable:* | Innovation | | Coordination | |
|---|---|---|---|---|
| | Nr. Agr. Patents | Road quality poor (yes/no) | Turnips grown (acres) | Four-crop rotation (yes/no) |
| | (1) | (2) | (3) | (4) |
| Parliamentary enclosure (yes/no) | 0.12 | -2.38 | 1.16 | 1.78 |
| | (0.16) | (0.65) | (0.57) | (0.81) |
| | [0.19] | [0.41] | [0.37] | [0.32] |
| Observations | 13920 | 5288 | 2290 | 5288 |
| *Scale*: Parish area | Y | Y | Y | Y |
| *Geography*: Elevation | Y | Y | Y | Y |
| *Location*: Latitude, longitude, latitude*longitude | Y | Y | Y | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y |

Notes: All regressions are estimated using 2SLS. The unit of observation is a parish. All regressions restrict to rural parishes. Nr. Agr. Patents is the number of agricultural patents filed by residents of a parish between 1750 and 1830. Road quality poor (yes/no) is an indicator equal to one if the qualities of the road in a parish is assessed poor by the tithe surveyors. Turnips grown (acres) is the total number of acres of turnips grown in 1831. Four-crop rotation (yes/no) is an indicator equal to one if a parish practiced four course crop rotation, usually consisting of wheat, barley, clover, and turnips. Parliamentary enclosure (yes/no) is an indicator equal to one if a parish was enclosed through Parliament at any point between 1750 and 1830. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table A14: IV results: Downstream consequences

| *Dependent variable:* | Manuf. emp. 1831 (%) | | Textile mill (yes/no) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Parliamentary enclosure (yes/no) | 0.17 | 0.20 | 0.07 | 0.17 |
| | (0.10) | (0.10) | (0.08) | (0.10) |
| | [0.02] | [0.02] | [0.05] | [0.07] |
| Mean dep. var. | 0.03 | 0.03 | 0.03 | 0.03 |
| SD dep. var. | 0.10 | 0.10 | 0.16 | 0.16 |
| Observations | 11300 | 11300 | 4446 | 4446 |
| *Scale*: Parish area | N | Y | N | Y |
| *Geography*: Elevation | N | Y | N | Y |
| *Location*: Latitude, longitude, latitude*longitude | N | Y | N | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y |

Notes: All regressions are estimated using 2SLS. The unit of observation is a parish. All regressions restrict to rural parishes. Manuf. emp. 1831 is the share of males over 20 employed in manufacturing in the 1831 census. Textile mill (yes/no) is an indicator variable equal if a textile mill was present in a parish in 1838. Parliamentary enclosure (yes/no) is an indicator equal to one if a parish was enclosed through Parliament at any point between 1750 and 1830. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table A15: Regression on dummy for industrial migrants and quintiles of industrial migrant variable.

| *Dependent variable:* | No migrants (yes/no) variable | First Quintile | Second Quintile | Third Quintile | Fourth Quintile | Fifth Quintile |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Parliamentary enclosure (yes/no) | -0.12 | 0.01 | 0.00 | 0.03 | 0.04 | 0.04 |
| | (0.02) | (0.01) | (0.01) | (0.02) | (0.02) | (0.01) |
| | [0.01] | [0.01] | [0.01] | [0.01] | [0.01] | [0.00] |
| Mean dep. var. | 0.41 | 0.21 | 0.09 | 0.12 | 0.11 | 0.05 |
| SD dep. var. | 0.49 | 0.41 | 0.29 | 0.33 | 0.32 | 0.22 |
| Observations | 12097 | 12097 | 12097 | 12097 | 12097 | 12097 |
| $R^2$ | 0.10 | 0.06 | 0.02 | 0.05 | 0.09 | 0.23 |
| *Scale*: Parish area | Y | Y | Y | Y | Y | Y |
| *Geography*: Elevation | Y | Y | Y | Y | Y | Y |
| *Location*: Latitude, longitude, latitude*longitude | Y | Y | Y | Y | Y | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y | Y | Y |
| *Excluding birth in industrial counties*: | Y | Y | Y | Y | Y | Y |

Notes: All regressions are estimated using OLS. The unit of observation is a parish. In column (1), the dependent variable is an indicator equal to one if a parish does not send any migrants to industrializing counties (Lancashire, Cheshire, and Yorkshire: West Riding). In columns (2)-(5) the dependent variables are indicator variables for quantiles of the distribution of the number of migrants through industrial counties for parishes with at least one migrant. Parliamentary enclosure (yes/no) is an indicator equal to one if a parish was enclosed through Parliament at any point between 1750 and 1830. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table A16: Enclosed parishes by region

| | count | mean |
|---|---|---|
| London | 119 | 0.269 |
| North | 1172 | 0.481 |
| East | 4027 | 0.310 |
| Southwest | 2076 | 0.239 |
| Midlands | 2662 | 0.462 |

Notes: This table reports the number of parishes and the fraction of parishes that are enclosed by region. summary statistics by regions of the country. Their definitions are: Our regions are defined as follows. 'North' is composed of Cheshire, Cumberland, Durham, Lancashire, Northumberland, Westmorland, and Yorkshire. We define the 'Southwest' as Cornwall, Devon, Dorset, Gloucestershire, Somerset, and Wiltshire. We define the 'East' as Bedfordshire, Berkshire, Buckinghamshire, Cambridgeshire, Essex, Hertfordshire, Hampshire with the Isle of Wight, Huntingdonshire, Kent, Oxfordshire, Norfolk, Suffolk, Surrey, and Sussex. We define the 'Midlands' as Derbyshire, Herefordshire, Leicestershire, Lincolnshire, Northamptonshire, Nottinghamshire, Rutland, Shropshire, Staffordshire, Warwickshire, and Worcestershire.

Table A17: IV results: Migrants

| *Dependent variable:* | Migrants to ind. counties /total migrants (1) | Migrants to ind. counties /migrants to London (2) | Migrants in manufacturing /total migrants (3) | Migrants to ind. counties in manufacturing /total migrants (4) |
|---|---|---|---|---|
| Parliamentary enclosure (yes/no) | 0.59 | 0.54 | 0.01 | -0.03 |
| | (0.26) | (0.27) | (0.28) | (0.09) |
| | [0.06] | [0.06] | [0.07] | [0.06] |
| Mean dep. var. | 0.05 | 0.05 | 0.12 | 0.09 |
| SD dep. var. | 0.22 | 0.23 | 0.32 | 0.29 |
| Observations | 12097 | 12097 | 12097 | 12097 |
| *Scale*: Parish area | Y | Y | Y | Y |
| *Geography*: Elevation | Y | Y | Y | Y |
| *Location*: Latitude, longitude, latitude*longitude | Y | Y | Y | Y |
| *Regional differences*: Region fixed effects (n=4) | Y | Y | Y | Y |
| *Soil characteristics*: Soil type indicators (n=11) | Y | Y | Y | Y |
| *Excluding birth in industrial counties*: | Y | Y | Y | Y |

Notes: All regressions are estimated using 2SLS. The unit of observation is a parish. All regressions restrict to rural parishes. Migrants to ind. counties /total migrants is an indicator equal to one if a parish is in the top quintile of the distribution of the ratio of the number of migrants that migrate to industrial counties (Lancashire, Cheshire, and Yorkshire: West Riding) to total migrants. When computing quintiles we condition on having at least one migrant to the north. Migration is measured in the 1851 census by comparing parish of residence to parish of birth. Migrants to ind. counties /migrants to London is an indicator equal to one if a parish is in the top quintile of the distribution of the ratio of the number of migrants that migrate to industrial counties to the number of migrants to London. Migrants in manufacturing/total migrants is an indicator equal to one if a parish is in the top quintile of the distribution of the ratio of the number of migrants employed in manufacturing to total migrants. Migrants to ind. counties in manufacturing /total migrants to ind. counties is an indicator equal to one if a parish is in the top quintile of the distribution of the ratio of the number of migrants to industrial counties employed in manufacturing to the number of migrants that migrated to industrial counties. For both employment-based variables, we restrict the sample in which we compute these ratios to individuals for whom employment information is available. Parliamentary enclosure (yes/no) is an indicator equal to one if a parish was enclosed through Parliament at any point between 1750 and 1830. Conley standard errors correcting for spatial correlation are in parentheses. These use a triangular kernel with a boundary of 70km. Standard errors correcting for heteroskedasticity are in brackets.

Table A18: Performance of various heterogeneity robust Difference-in-Difference estimators in an unbalanced panel

| Estimator / Stata package /N | Comparisons done | Implied sample inclusion criteria |
|---|---|---|
| Borusyak et al. (2024) [BJS]<br>Stata package: *did_imputation*<br><br>N= 22 203 | The estimator computes each unit-period $ATT_{it}$ by substracting, for every treated observation, its imputed counterfactual outcome from that period t's observed outcome. Counterfactual outcomes are imputed by first estimating a regression with time- and unit-fixed effects using all untreated observations. The coefficients from the latter regression are then used to impute each treated observation's counterfactual outcome as the sum of that unit's unit-fixed effect and the corresponding period time-fixed effect. | For their untreated counterfactuals to be imputed, treated units require more than one observation from which at least one is an untreated observation. Thus, all treated units without pre-treatment observations are excluded from the analysis and only those with at least one pre and one post-treatment observation are used to calculate $ATT$s. (K=256, N=766)<br>Treated units for which there are only pre-treatment observations are included in the sample for the fixed-effects estimation which precedes the imputation. (K=106, N=120)<br>All observations of never-treated units are included in the sample (K=15 328, N=21 317) |
| De Chaisemartin and d'Haultfoeuille (2024) [dCdH]<br>Stata package: *did_multiplegt_dyn*<br><br>When computing the estimator for 5 post-treatment periods, the following sample of switchers is reported:<br>Effect 1: 22<br>Effect 2: 7<br>Effect 3: 8<br>Effect 4: 4<br>Effect 5: 4 | This estimator is computed exclusively among switchers, i.e. units for which there is at least one pre- and one post-treatment observation. The estimator computes each $ATT(g,l)$, the $ATT$ at time $g+l$ for the cohort of units first treated in period $g$. It does so by comparing the change in outcomes between period $g-1$ (the first pre-treatment period) to period $g+l$ among all switchers $g$, to the change in outcomes for all groups whose treatment has not changed yet at $g+l$ and who have in period $g$ (the period when treatment happens) the same treatment as cohort $g$. | Since comparisons are made between outcomes at $g-1$ and $g+l$ and between treated units and those with the same period $g$ treatment level, the estimator considers, for every $ATT(g,l)$, exclusively switchers with at least one observation in $g-1$, one observation in period g and one observation in $g+l$. |
| Callaway and Sant'Anna (2021) [CS]<br>Stata package: *csdid*<br><br>N= 8 063 (default option) | The estimator departs from a structure of cohorts, in which each cohort is a group of units that were treated for the first time in the same period $g$. The estimator computes, for each cohort $g$ and period $g+l$, an $ATT$ comparing the outcome change between $g-1$ and $g+l$ among cohort $g$, to the outcome change in the same period of all the never-treated (default option) or all never-treated plus all those not yet treated at period $g+l$ (not-yet option). | Because comparisons are made for outcomes between $g-1$ and $g+l$, treated units are included in the estimation of $ATT$s only when they contain an observation in period $g-1$ and at least one post-treatment observation. (K=54, N=169)<br>In the default option, only never-treated units are included as controls. However, pre-treatment observations of treated units for which there only pre-treatment observations are included in the sample of controls as if they were never-treated if they are pariwise balanced for their pre-treatment periods. (K=20, N=43)<br>Among never-treated units, observations are included in the sample when they are available in pairs that match the period-paris $(g-1, g+l)$, for all cohorts $g$ and all $l$. (K=3 228, N=7 851) |

TABLE A18 (CONTINUED)

| Estimator / Stata package /N | Comparisons done | Implied sample inclusion criteria |
|---|---|---|
| Sun and Abraham (2021) [SA]<br>Stata package: eventstudyinteract<br><br>N=12 391 | This estimator is computed using an event-study design regression with relative-time dummies interacted with the binary variable identifying treated periods. In the canonical event-study specification, a single dummy-variable interaction is specified for every relative-time period, where the relative-time dummy takes the value of 1 in the respective period observation for all units. In that case, the dummy variables $D_k$ are defined for every relative period before ($k < 0$) and after ($k \geq 0$) treatment. In contrast, the interaction terms in the event-study regresssion of the SA estimator is specified with a set of dummies $D_{kg}$ for every relative-time period k and every cohort first treated in period g. The control group are by default the never treated units, if available, or the last-treated cohort otherwise, in which case the treated observations should be dropped.<br>With this specification using $D_{kg}$ as relative-time dummies in the interactions, the coefficients of each interaction term are the $ATT_{g+l}$ of every cohort $g$ at relative period $g + l$. When omitting the interaction dummy variables for relative-time period $-1$, these $ATT_{g+l}$ coefficients are equivalent to the change in outcomes of the respective cohort $g$ between period $g - 1$ and period $g + l$. | The *eventstudyinteract* package employs the command $reghdfe$ to estimate the regression specification with the interacted terms. When specifying unit fixed effects , $reghdfe$ includes in the estimation sample only the observations from units for which the unit FE can be estimated. That is, all units with more than one observation (N=12 391).<br>Implicitly, each $ATT_{g+l}$ can be only computed for those observations for which there is a change in the dummy, i.e. for units within cohort $g$ for which we can calculate a difference between the omitted period $g - 1$ and period $g + l$. In practice, this means that each coefficient in the OLS regression is capturing variation exclusively among this subsample of switchers.<br>Note that, conceptually, the $ATT_{g+l}$ computed with the estimator proposed by Sun and Abraham (2021) is equivalent to the CS estimator using the never-treated units as control. Thus, in practice, both estimation programs will yield the same $ATT_{g+l}$ when computed on a balanced panel. In an unbalanced panel, however, not all untreated observations fulfill the sample restrictions imposed by csdid and therefore, the underlying sample and the estimated $ATT_{g+l}$ are not equal with both packages. |

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