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ABSTRACT

We use a dataset of the entire population of English Parliamentary enclosure acts between 1750 and 1830 to provide the first causal evidence of their impact. Exploiting a feature of the Parliamentary process that produced such legislation as a source of exogenous variation, we show that Parliamentary enclosures were associated with significantly higher crop yields, but also higher land inequality. Our results are in line with a literature going back to Arthur Young and Karl Marx on the effects of Parliamentary enclosure on productivity and inequality. They do not support the argument that informal systems of governance or "private orderings", even in small, cohesive, and stable communities, were able to efficiently allocate commonly used and governed resources.

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1 Introduction

In 1808 the English agriculturalist and arch "improver"[1] Arthur Young stumbled on a natural experiment. He noticed that the adjacent Cambridgeshire parishes[2] of Childersley and Hardwicke, even though "divided only by a hedgerow" (Young, 1808, p. 217), had startlingly different economic outcomes. In Hardwicke wheat yields were 16 bushels per acre while in Childersley, on the other side of the hedgerow, they were 24, 50% higher. What could explain the difference? Not the economic fundamentals since Childersley consisted of "perfectly similar soil" (Young, 1808, p. 217). Rather, Young attributed the difference to the fact that Hardwicke "remains in common field" while the land in Childersley had been enclosed.

Enclosure involved two distinct changes to rural property rights. It privatized the commons - land under common ownership to which villagers had several different usage rights - and consolidated scattered plots of land farmed by an individual household on the 'open fields' into one large plot, obviating the need to coordinate agricultural practices and investment. Such changes may in theory lead to large productivity improvements as land usage would no longer be subject to the 'tragedy of the commons' (Hardin, 1968) and investment returns would now accrue privately rather than publicly (Samuelson, 1954). However, theory and other types of evidence create room for doubt. We know that local institutions often emerge to govern the commons efficiently (Ostrom, 1990), especially if property rights are well-defined (Coase, 1960) and could be expected to change endogenously in an efficient way (Demsetz, 1967).[3]

Just as uncertain as enclosure's impact on productivity were its distributional consequences. Parliamentary enclosure, in particular, 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. Indeed, Neeson, using a similar natural experiment methodology to that wielded by Young, showed that the number of small landowners fell by 21% in Northamptonshire parishes after they were enclosed, while there was no change in unenclosed ones (Neeson, 1993, p. 249).

In this paper, we combine data on the universe of Parliamentary enclosure acts with data on agricultural yields and land inequality covering all of England to estimate their economic effects. Key to our study is

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[1] On "improvement" see Slack (2015).

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

[3] 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).

the fact that enclosure without the involvement of Parliament had gone on throughout the Middle Ages and Early Modern period by voluntary *unanimous* agreement. The crucial change Parliament enacted around 1700 was to provide an institutional way to manage the process of enclosure through a Parliamentary procedure which could be initiated by the owners of three quarters of the land (by value).[4] Henceforth, the owners of a majority of the land could petition Parliament to enact a proposal for enclosure of *all* common property. By about 1900, virtually all of England was under private consolidated ownership.[5]

In a new dataset covering 15,000 parishes in England, we compare parishes that were enclosed in the Parliamentary period (1750-1830), to parishes that were not enclosed by this method by the end of the period. We study the consequences of Parliamentary enclosure for productivity and distribution around 1830 by measuring agricultural yields and land inequality. We first estimate the effect of Parliamentary enclosure in a linear model, using Ordinary Least Squares (OLS). We find that in 1830, parishes that were enclosed by Parliament experienced 3% higher agricultural yields and a 4 percentage point increase in a land value Gini coefficient. The small magnitude of these estimated effects, although in line with more recent estimates cited in the next section, is inconsistent with the claims of Young (1808) and Marx (1990).

To interpret these OLS results, however, one must recognize that where enclosure had already taken place by unanimous agreement, parishes may have already realized the productivity improvements of enclosure and would *choose* to not pursue Parliamentary enclosure as they stood to gain little. They are, however, part of the control group, together with unenclosed parishes, biasing our OLS estimates of crop yields downwards. Similarly, the historical literature which we discuss in the next section suggests that it was far easier to get unanimous agreement when most of the parish was owned by a single person or perhaps a very small number of landowners. These parishes would tend to have high levels of land inequality, and would also choose to not pursue Parliamentary enclosure. They would therefore be in the control group biasing down the OLS estimates of the impact of Parliamentary enclosure on inequality. The presence of the choice between Parliamentary enclosure and unanimous enclosure creates a selection problem. The potential impact of this type of selection on estimates of the treatment effect of Parliamentary enclosure has not been emphasized in previous studies of its effects.

To account for this type of selection and to establish a causal interpretation of the effects of *Parliamentary* enclosure we use a feature of the Parliamentary process for approving a proposed enclosure as a source of variation. In particular, we construct in 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

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[4]This figure was never officially stated and in some accounts it was $\frac{4}{5}$. One interpretation is that while $\frac{4}{5}$ was desirable enclosure could still take place with the owners of $\frac{3}{4}$ of the land in favor.

[5]In fact the first Parliamentary enclosure was in 1604, at Radipole, Dorset, but it did not become established as a regular process until the eighteenth century.

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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. The main advantage of this source of variation is that it is defined for both parishes that petition and parishes that never petition, but is unlikely to generate variation in the likelihood of enclosure for unanimously enclosed parishes which would 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.[6] 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 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 for those 'complier' parishes that self-select into considering or taking the Parliamentary route to enclosure. Parishes that had already unanimously enclosed self-select out of the Parliamentary procedure, 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 agricultural yield of 45%. This estimated effect is in line with Young's study of Childersley and Hardwicke and the 'before-

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[6]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, electoral incentives were largely absent.

after' comparisons of single parishes made in contemporary agricultural reports (Stone, 1808; Rudge, 1807). This estimated effect is, as we discuss in the next section, also more 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). This last estimated effect is far more consistent with the case study evidence on enclosure, the inequitous recognition of rights, the high costs of its implementation, and the ensuing fall in the number of small landowners.

There may be several other reasons why our OLS estimates are smaller other than selection into Parliamentary enclosure. We therefore interpret our IV estimates through the lens of a recent literature on Marginal Treatment Effects (Heckman and Vytlacil, 2005; Brinch et al., 2017). We find that 75 to 78 percent of the difference between our OLS and IV estimates is captured by the fact that our IV models estimate a LATE whereas our OLS models estimate an Average Treatment Effect (ATE, under additional assumptions which we discuss). We interpret this finding as consistent with our conjecture that our IV estimates downweight unanimously enclosed parishes as well as with our conjecture that previous studies found a small treatment effect of Parliamentary enclosure because a subset of parishes in the control group already experienced unanimous enclosure and may have stood to gain nothing from Parliamentary enclosure. Since potential gains from choosing Parliamentary enclosure for unanimously 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.

Our results are in line with the 'tragedy of the commons' and other theoretical arguments pointing to the potential inefficiencies in shared governance and ownership of land. Even in communities as small, cohesive, and stable as a parish, informal governance mechanisms coordinating behavior and investment were less efficient than private ownership. Why? To understand this we then study mechanisms. For productivity, we focus on two types of mechanisms: Innovation and coordination. Contemporary advocates of Parliamentary enclosure suggested that it promoted "improvement", by which they meant investment, innovation, and experimentation in new techniques. We capture innovation with data on the count of agricultural patents filed in a parish and the quality of local infrastructure. Infrastructure is a novel channel, not emphasized in the literature so far, but often Parliamentary enclosure acts specified road building, both as part of general improvement and because privatization revoked rights of passage. To capture coordination, we measure the acreage in a parish that was either sown with turnips or subject to appropriate fallowing practices. Both tasks, sowing turnips and optimal fallowing, 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

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find evidence that Parliamentary enclosure is associated with both innovation and improved agricultural practices.

Our distributional results suggest however that enclosure was unlikely to have been Pareto improving. Anticipating that enclosure would skew the distribution of the commons towards those with legally better defined rights seems to have been a potent source of lack of unanimity. Even had property rights been equally respected at Parliamentary enclosure, the costliness of the process along with imperfections in the capital market deterred enclosure for smallholders. On the open fields, farmers who did not have sufficient liquidity could not afford the costs of Parliamentary enclosure. This led them to oppose enclosure and if it took place, sell out, thus contributing to increases in land inequality. We can use our data to directly study this 'selling out' mechanism. We find that Parliamentary enclosure is associated with significant falls in the share of individuals with little or no land, known as "cottagers".

Finally, we use our dataset to compare our results to those of Allen (1982), the most influential existing empirical study of Parliamentary enclosures. Using data for a sample of farms from the English Midlands, he concludes that there is no effect of Parliamentary enclosure on crop yields, only on inequality. When we focus on the subset of our dataset which coincides with his sample, we replicate his findings for agricultural yield. His conclusion that Parliamentary enclosure had no effect on yields was therefore correct within his sample, but for England as a whole we find that enclosure is associated with an increase in yields.

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 by showing that Parliamentary enclosure had a positive effect on agricultural yields, but also on substantially increased inequality. We also contribute to the broader debates on the role of property rights in development. In this seminal case, our findings do not support the notion that communities can innovate systems of governance to efficiently allocate collectively managed resources, the same conclusion reached by Bogart and Richardson (2009, 2011) for our context and period. In this sense, our work coincides with research on the efficiency benefits of individualized private property rights (Besley and Ghatak, 2009; Field, 2007; Galiani and Schargrodsky, 2010; Fergusson, 2013; Besley, 1995).

This paper proceeds as follows. The next section discusses the relevant historical and institutional background to this paper, 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. Section 3 introduces our dataset. Section 4 presents our main OLS results. Section 5 introduces our identification strategy and our estimation framework. Section 6 presents the Two Stage Least Squares estimate of the effect of Parliamentary enclosure. Section 7 discusses heterogeneous treatment effects. Section 8 discusses mechanisms. Section 9 focuses on the Midlands. Section 10 concludes.

2 Setting and context

In this section we provide the necessary background to pre-Parliamentary as well as Parliamentary enclosure. We first establish that Parliamentary enclosure entailed the division of the commons and the reorganization of scattered strips on the open fields into consolidated holdings. We then discuss that the process of enclosure was a bottom-up process instigated by the parish landowners and subject to transactions cost which meant that unanimous agreement was far more likely to take place when there were few landowners. In contrast, Parliamentary enclosure could take place if the owners of three quarters of the amount of land by value were in favor. We then provide an overview of the historical literature on the consequences of enclosure.

Although the existing literature is inconclusive on the ultimate economic effects of Parliamentary enclosure, it emphasizes several aspects of enclosure that are relevant for our study, in particular the likely impact on land inequality. First, enclosure meant a re-organization of rights, some of which were better defined legally than others. In the process of Parliamentary enclosure rights that were easier to establish legally typically trumped the others. Second, Parliamentary enclosure interacted with other simultaneous processes, particularly the commutation of the tithe in ways that increased land inequality. Third, Parliamentary enclosure was expensive and because capital markets were highly imperfect, small landowners found it difficult to raise the necessary resources to pay the costs of Parliamentary enclosure upfront.

2.1 What was Parliamentary enclosure?

What happened when a parish was enclosed?[7] 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.

In large 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 enclosure. The defining feature of open fields is that farmers owned a fixed amount of land, but this land lay scattered in strips in the three large fields. Barton also had various types of "common land"

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[7]For this and the next subsection we rely on several standard works, particularly Tate (1967), Yelling (1977), Turner (1980) and Mingay (1997)

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 on the cutting of bracken and furze, 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.

2.2 The Process of Enclosure

Enclosing a parish was a bottom-up process. Both before 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 there had to be unanimity amongst the landowners. The main point of this section is to show that the case study literature suggests that the main determinant of pre-Parliamentary enclosure was how concentrated landownership was. Parishes with one or very few landowners could reach a unanimous agreement more easily.

Enclosures were taking place by the fifteenth century but are much less well documented before the eighteenth century. Early enclosures seem to have been dominated by lords enclosing their *demesne* land, which was manorial land that was farmed by what would have originally been villeins (serfs). Kerridge (1969, p. 96-97) notes that

> the clearance of landed estates in the North-east lowlands ... was facilitated by the circumstance
> that the tenants were mostly without genuine estates in land; they were mere tenants at will
> ... usually the landowner or the farmer of the demesnes, strove to enclose the whole township
> for himself.

In his study of Kesteven, Lincolnshire, Mills (1959) found that early enclosure was initiated by resident lords and monastic foundations and the greater the presence of freeholders, the more enclosure was delayed. Martin (1979) also found that in Warwickshire early enclosures were promoted by the squirearchy attempting to consolidate estates. Thirsk (1967a, p. 254) sums up the evidence from Lincolnshire as indicating that "Something like 70% of the reported enclosures in the period 1485-1550 were carried out by the nobility and squirearchy alone". Slater (1907, p. 155) sums up his discussion of pre-Parliamentary enclosure by stating

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> It is clear that the Parliamentary enclosure of a given parish indicates that the lord of the manor, or principal landlord, had not secured such a complete ... influence over the parish as to enable him to effect an enclosure without an act of Parliament.

Enclosure in the sixteenth century was not encouraged by the fact that the government, rather than facilitating it, as was subsequently the case during the period of Parliamentary enclosures, actively discouraged it since it was thought to be driven by lords and led to increased land inequality, village depopulation, social discontent, and political instability. Starting in 1489 and for the next hundred years, Parliament actually passed acts to discourage enclosure (Thirsk (1967a) provides a detailed overview of this legislation).

By the middle of the sixteenth century, however, "enclosure is no longer primarily the work of the manorial lord who possesses all or virtually the whole of the lordship" (Yelling, 1977, p. 22). Now groups of landowners had to voluntarily agree to enclosure. This was a much more complex process as Chambers (1932, p. 142) pointed out

> though townships might be similarly situated in regard to the quality of soil they held ... a township that was divided amongst numerous owners ... would have many conflicting interests to overcome before enclosure could take place; while one that was in the hands of a single owner, and occupied mainly by tenants at will, or short leaseholders and so on, would be free from obstacles of this kind.

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).[8]

Since these pre-Parliamentary enclosures form the background to our study it is good to reflect on what is known about their incidence. Above we have emphasized that, given the difficulty of negotiating agreement amongst multiple parties, for example on the rights over the commons, the extent of land concentration was an important source of variation. This explains Yelling's comment that in terms of the early enclosures "the distribution could plausibly be explained by the ease with which unity of control could be obtained" (Yelling, 1977, p. 26). In consequence the acceleration of enclosures in the eighteenth century was a consequence of "the opportunity provided by the Parliamentary procedures to overrule opposition from small landowners" (Yelling, 1977, p. 113). In sum, parishes that enclosed before the Parliamentary period are likely to have been parishes with highly unequal landownership, since this concentrated decision making power.

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[8]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 (1967b) and Thirsk (1964, p. 23) for other related examples.

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 implement enclosure because it provided rules which over-ruled opposition to the enclosure. To start the process, the parishioners had to petition Parliament with a draft enclosure Bill. 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 Bill had to be fixed to the church door for three summer Sundays prior to the next Parliamentary 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 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 against 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 and Oliver (2011) for a

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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.

2.4   The immediate consequences of Parliamentary enclosure

In places like Barton, Parliamentary enclosure eliminated the big open fields, allocated these lands in consolidated holdings, and divided up the common land between anyone who could establish their rights to use it. 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 typically 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 compensated with extra land.

There are a few other important things to understand about this process. The first is the complicated nature of rights in the commons. 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 userights 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?).

The consensus amongst scholars is that there was little corruption in this process. 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, "the process as a whole did offer some limited safeguards, and certainly a considerable degree of openness" (Mingay, 1997, p. 57-58) and "the work of the commissioners was usually carried out with scrupulous fairness and attention to detail" (Armstrong, 1989, p. 721). An earlier synthesis by Gonner (1966, p. 76-77) reached a similar conclusion, stating even more confidently that "there seems to be no ground for alleging a general partiality on behalf of any particular class." Nevertheless, the situation is well summed up by Armstrong (1989, p. 722) when he notes "enclosure could be entirely legal in regard to respecting property rights and yet be inequitable". The pattern in Croston recurs frequently in the case study literature.

Second, 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 renegotiation of the tithe at Parliamentary enclosure seems to have been a systematic source of increased land inequality. 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

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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.

Third, 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 petition to Parliament which was the basis for an enclosure act. 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 forced parishioners to build new roads and fence their lands. These costs 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. In Barton, the costs of reorganizing the entire parish added up to about 13,000 pounds (Stone, 1808, p. 103). This was a very large sum relative to the total resale value of all land pre-enclosure of 2,000 pounds. 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 (Turner, 1981).

2.5   The Literature

Parliamentary enclosures and their consequences received a great deal of comment at the time from politicians and intellectuals. Many did not agree with Young on the productivity benefits. For example, William Cobbett in his *Rural Rides* continuously blames them for ruining the countryside. On October 31, 1822, travelling from Oakingham to London, he concludes "These enclosures and buildings are a waste, they are means misapplied, they are proof of national decline not prosperity" (Cobbett, 2001, p. 41) and he gives a firm "No" to the question as to whether or not Parliamentary enclosures represent "improvements".

Interestingly, however, the preponderance of more systematic contemporary analysis did support Young. Around the same time as he wrote a whole series of "General Views" of the agriculture in various counties were commissioned by the Board of Agriculture and several of these make the type of yield comparisons he did. Even better, some present evidence on yields before and after enclosure. For example, Bedfordshire in the parishes of Eaton and Milton Bryan wheat yields increased by 66% and 29% respectively (Batchelor, 1813, pp. 227, 238). Young himself, coincidentally, authored the report on Lincolnshire and reports data before and after for Barton which suggests that wheat yield increased by 150% after enclosure (Young,

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1808, p. 104). On average across all the reports for which there are before and after numbers, wheat yields increased by 66%.

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". Several mechanisms were often discussed which could explain this. One is the consolidation of the strips in the open fields. 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. 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). 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).[9]

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

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[9]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).

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).

Though most of the mechanisms advanced suggest that unenclosed parishes would be less efficient, there is little agreement on this in the academic literature. On the one hand, as we saw, Young himself and other contemporaries made many calculations suggesting that Parliamentary enclosure improved productivity. Such estimates would justify the enormous up front investment necessary to completely transform the layout of a parish, build roads and bridges, and fence off the new plots. Some modern assessments follow Young, 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. He concludes:

the major upsurge in agricultural output and productivity came after the mid-eighteenth century: this coincides with the major burst of Parliamentary enclosure (Overton, 1996, p. 167).

Another authoritative source, Clay (1984) recognizes that "open field communities could and did make alternations to their field course, and even to the physical lay-out of their fields ... as was necessary for the incorporation of the new crops into their farming system" (p. 133-134), but he nevertheless concludes "there is no doubt that where open field prevailed the need for communal agreements did retard the pace of change" (p. 134).

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. Indeed, the most sophisticated empirical work on the productivity effects of enclosure, due to Allen (1982), finds very little effect. He finds that the average treatment effect of Parliamentary enclosure on yield is rather low, with an increase of yield between 2.5% and 8.4%, depending on the dataset. McCloskey (1989) estimates higher increases, between 10 and 13%. Some modern scholars, like Daunton (1995, p. 114-117), accept this evidence as establishing that there were indeed few productivity effects.

In Table 7 we collect available estimates of the increase in wheat yields along with our own findings. Clearly, our own results are closer to those of Young and contemporaries rather than more modern economic historians. We believe that this is likely because nobody has yet proposed a methodology for solving the

inferential problem that Parliamentary enclosures were endogenous. Our approach gets closer to the true causal effect. Here the before and after comparisons are the most compelling and though we do not have the data to implement such a strategy on a large scale, it is interesting that our IV results come close to these findings.

Just as contemporaries debated the productivity impacts of enclosure, they also discussed the likely impacts on distribution. We saw already that during the Tudor period the government actively discouraged enclosure because they thought it led to land concentration and displacement of people, threatening social disorder. 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 Parlia-
> mentary form of the robbery is that of 'Bills for Inclosure of Commons', in other words decrees
> by which the landowners grant themselves the people's land as private property, decrees of ex-
> propriation of the people ... 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 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. This process was lodged within a larger dynamic of "primitive accumulation". 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.

Recent research does not support the notion that enclosure was illegal, because it the process leading to Parliamentary enclosure appears to have been uncorrupt and legalistic. It does nevertheless lead one to believe that it might also have been associated with increased land inequality. Allen (1992) concluded this from his data on rental rates and smallholders or "cottagers" do seem to have sold out and migrated after Parliamentary enclosure. This may have been because after they lost land through compensation for the tithe holder and the loss of commons rights, their farm was too small to be viable, or they did not have the wealth to cover the costs of Parliamentary enclosure. In Croston, though others apart from the Heskeths and de Traffords did receive allocations, many sold out with the number of farmers owning less

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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). In Burton Latimer the picture was similar. Neeson showed how 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). This inequitous allocation had 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). 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).

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).[10] 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.

Ultimately then, the existing literature is inconclusive. One can make theoretical arguments about the

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

efficiency of the open fields system (McCloskey, 1972; 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 even though it was legalistic. But by how much? All the mechanisms emphasized make conceptual sense, but what is their quantitative significance? Our study is motivated by the salience of the question and the unsettled state of the evidence.

3   Data

In this section we introduce the unit of observation used in the empirical analyses in this paper. We also introduce the main variables and discuss measurement. Table 1 presents summary statistics.

3.1   Unit of observation

The 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.[11] Each enclosure act explicitly enclosed either a single parish or a field common to several parishes. The parish is therefore the natural unit of observation for studying enclosure. 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.[12] We remove London and other cities and towns from our sample throughout.

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 2 shows the number of parishes enclosed over time. Our Appendix provides 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.

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[11]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.

[12]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 wheat yield, our sample is further constrained by the fact that parishes would have to grow wheat for yields to be measurable.

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 enclosure 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.

3.3 Outcome variables

We measure agricultural yield using data from Kain and Prince (2006), who study the records of the survey collected prior to the 1836 Tithe Commutation Act. In this process the commissioners measured agricultural yields for a large number of parishes, both enclosed and unenclosed. We record wheat yield in bushels per acre in 1836 from these returns. We focus on wheat, which has the most observations and was the most important staple crop around this time. From the Tithe commissioners' records (Kain and Prince, 2006), which were a part of the Tithe Commutation Acts, we record 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 as well as measures of the presence of cottagers, holders of small plots, which we will introduce below.

3.4 Other variables

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

3.5 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 Results: Enclosure, Yields and Land Inequality

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. These results are consistent with arguments advanced in section 2, but do not have a causal interpretation. We discuss our identification strategy in the next section.

4.1 Estimating equations

We start by estimating a simple model, using OLS:

$$Y_p = \beta_0 + \beta_1 E_p + X_p \beta_2^{'} + s + \varepsilon_p \tag{1}$$

This model relates an outcome Y in parish p to Parliamentary enclosure through an indicator E_p, which again equals one if parish p is enclosed 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 $\hat{\beta}_1$.

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 productivity differences. Data come from the Food and Agricultural Organization (FAO)). We are concerned about spatial correlation in outcomes and regressors, as well as spatially correlated unobservables. We therefore include latitude and longitude, latitude interacted with longitude, and region fixed effects (n=4), as covariates.[13] Throughout our analyses, we report het-

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[13]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 'South-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.

eroskedasticity robust standard errors, as well as 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. 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. In our Appendix, we present regression estimates of equation 1 graphically, and in the next section we present estimates in table format.

4.2 Results

In this section we provide OLS results relating Parliamentary enclosure to agricultural yield and land inequality. Table 2 reports estimates of equation 1. In section 2 we discussed that the ability to coordinate practices and the fact that landowners were now the residual claimants to any returns from agricultural investment may have increased agricultural yields. Columns (1) and (2) use the natural log of wheat yield in bushels per acre measured in 1836 as the dependent variable to study this idea. 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 0.03, 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 the Appendix we repeat this analysis using barley yield and oats yield as dependent variables. We find similar estimated effects, but Kain and Prince (2006) collected fewer observations, so these effects are more noisy than our estimated effects for wheat. In columns (3) and (4) we then study land value inequality. In section 2 we discussed how the costs of enclosure, as well as the loss of common rights, may have led to many parishioners having to sell their land to cover the costs of enclosure and tithe commutation or because their plot was no longer viable without common rights to, for example, pasturage. Larger landowners may have bought up smaller plots, increasing concentration of ownership. 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 0.04 increase in the Gini coefficient. In the Appendix we show that we get similar results when we use a Gini coefficient of land size, rather than land value, as the dependent variable. To show robustness to extreme Gini values resulting from a very small number of landowners we control for the number of landowners in the parish in the Appendix as well, with identical results.

Interpretation of the estimated effect size. The control group in these OLS regressions is composed of those parishes that were unenclosed, and parishes that were enclosed unanimously. A parish with

a handful of landowners who enclosed their landholdings 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. This observation implies that we face an estimation challenge: We aim to recover the treatment effect of Parliamentary enclosure comparing to a control group that is highly heterogeneous in terms of how much they stand to gain from Parliamentary enclosure. Such 'potential' gain is unobservable, we don't know how much more or maybe less productive an unanimously enclosed parish would have been had it enclosed through Parliament. We introduce several ways of making progress on this issue below. Note that previous attempts to estimate the effect of Parliamentary enclosure did not explicitly address this issue, and we conjecture that this may be what is driving the small estimated effects in the literature we discussed in section 2.

5   Identification

For our results in the previous section to be interpretable as causal, we require $Cov(enclosed, \varepsilon | X, s) = 0$. This is unlikely to hold in our context for the obvious reason that there may be unobservables that influence both the decision to enclose via Parliament and productivity or land distribution. In this section we introduce our identification strategy, which aims to estimate the causal effect of enclosure for those parishes considering Parliamentary enclosure. Aside from the potential effect of omitted variables, the fundamental identification challenge we face is self-selection out of Parliamentary enclosure of parishes that stood to gain little from it. We start by previewing identification, estimation, and inference.

Identification. Our identification strategy exploits the fact that enclosure Bills were enacted through Parliament in London, even though they mostly pertained to an individual parish, and at most to a few parishes. The decision in Parliament to pass a proposed enclosure fundamentally revolved around whether a committee of Members of Parliament (MPs) believed that a proposed enclosure satisfied a large number of legal requirements, called 'standing orders' (Lambert, 1971). This feature allows 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. The main advantage of this approach is that we can compute this leave-one-out mean both for parishes that petitioned and for parishes that did not. A second advantage is that, because we condition on petitioning, local common shocks, detrimental to typical leave-one-out instruments (Angrist, 2014), are unlikely to be a problem for us because such shocks would affect the incentives to petition, but not the process of judging a petition in London. Because the role of a committee can be interpreted as

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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)). What is different from these designs is that in our study parishes are not randomly assigned to committees. We discuss this issue at length and provide narrative and econometric evidence that is consistent with our claim that parishes are as-good-as-randomly assigned to committees. We then provide a number of 'balance checks' that show that factors at the parish level that may correlate with economic outcomes are uncorrelated with our instrument. This is fundamentally due to the fact that, rather than taking the average number of parishes around a parish that got enclosed, we use the number of petitions proposed to Parliament that pass, 'shifting' the construction of our instrument to Parliament in London.

Construction of the instrument. For every parish, we compute the fraction of petitions that pass in an area around the parish that plausibly proxies for the composition of a committee judging its petition in Parliament. In this computation, we leave out any petitions parish itself made.

Estimation. Due to self-selection out of Parliamentary enclosure for those parishes that do not stand to gain from it, the Two Stage Least Squares estimate of the effect of enclosure recovers the 'Local Average Treatment Effect' of enclosure, a weighted average across the treatment effects of parishes with different potential 'gain' from enclosure (Imbens and Angrist, 1994; Heckman and Vytlacil, 2005). After estimating the LATE, we estimate the different treatment effects of enclosure, by how much parishes stood to gain from enclosure, 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)). In line with our interpretation, these show that parishes that stood to gain little from enclosure are downweighted in our instrumental variable estimates. We interpret this finding as consistent with our conjecture that the presence of unanimously enclosed parishes biases our OLS estimates down.

Inference. The main challenge to inference in our study is spatial correlation. Our outcomes are plausibly spatially correlated, and our instrumental variable is spatially correlated by construction. When both outcome and right hand side variables of interest are spatially correlated, standard errors are particularly likely to be understated (Kelly, 2020). We discuss and implement a careful evaluation of spatial correlation and find that spatial correlation is indeed important for inference but does not invalidate our conclusions.

In the rest of this section we provide the necessary background to our identification strategy.

5.1   Parishes and Parliament

Each parish in England was part of a constituency, and each constituency sent two 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. 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. The franchise was heavily restricted to wealthy male citizens, less than ten percent to the population. Political competition was limited: 85% of elections in our sample period were uncontested. 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 virtually no control over the outcome of elections, unless they happened to be home to a large landlord or the MP himself.

5.2   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'. 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. The most important part of the Private Bill procedure was the formation of a committee to judge a proposed Bill. Within these committees, MPs were tasked with judging a Bill 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. Private Bills had the important distinction that all stakeholders in the proposed Bill needed to be appropriately heard. 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. For example, the enclosure specific standing orders specified that Bills needed to be posted on the church door. These orders also 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 other stakeholders

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(such as the owners of the tithe) 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. Through the standing orders and the committees, Parliament offered a mechanism to resolve disputes that would potentially scuttle unanimous agreement. 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.

5.3   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:[14]

> "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).

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[14]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.

There was a committee for every enclosure. It stands to reason that there was variation across committees in what fraction of enclosures within their jurisdiction passed. In addition, MPs were often more concerned with private business or with more visible acts than an enclosure act for one of 15,000 parishes potentially hundreds of miles away from London. For Private Bills, it is clear that MPs that weren't on the committee often did not show up to vote, and that the committee had a large degree of discretion over the rigor with which the standing orders were applied (Lambert, 1971).

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 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.

5.4 Our identification strategy

We posit that there are differences across committees in the fraction of proposed Bills under their jurisdiction that pass or would have passed had a similar committee been convened for a parish that did not in fact petition. If true, this observation implies that we could use the leave-one-out fraction of Parliamentary enclosures proposed that passed under the jurisdiction of the committees adjudicating a new petition as an instrument for enclosure. In the remainder of this section, we will discuss measurement, operationalization, challenges to identification, and balance.

5.5 The construction of our instrument

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, the committees would have been similar in had a parish petitioned. For parishes that did petition, this area captures parishes with similar committee representation to the petitioning parish. We then compute the leave-one-out mean of the proposed enclosures that passed within

this area, and over our sample period, and 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.[15] 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 3 contains three maps that provide intuition for the construction of the instrument for the parish 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

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[15]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.

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. 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.

5.6 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. 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.[16] 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 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.

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[16]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.

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.[17] Of this 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.[18] 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 drainage was in operation in the Appendix, and find that this does not explain our results (we ignore canals here since there were sufficiently few of them).

5.7   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.

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[17]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.

[18]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).

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 3 reports results from several estimates of Equation 1, where we replace enclosure with our instrument as the right-hand side variable of interest. We use several pre-determined variables as outcome variables. We 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 whether MPs or members of the nobility lived in a parish in 1700, before the start of our study period. We code this variable from Adams (1700). 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.

5.8 Estimation Framework

In this section we outline a simple framework that introduces our instrumental variable analysis. We provide a full framework starting from a simple Roy (1951) model in the Appendix. This framework jointly introduces our linear model which we estimated before, as well as the rest of our analyses. In this section we present a simplified version. We model the economic effects of enclosure as follows:

$$Y = \beta_1 E + X_p \beta_2 + V \tag{2}$$

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. As in our OLS estimates, we are interested in the treatment effect of Parliamentary enclosure. In Equation 2 this effect is captured by β_1. We now also express Equation 2 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 2 as:

$$Y = Y_0 + (Y_1 - Y_0)E = \beta_1 E + X\beta_2 + V \tag{3}$$

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 2, β_1 still captures the treatment effect and V still represents the disturbance term. Under the assumption that $Y_0, Y_1 \perp\!\!\!\perp E|X$, our OLS estimate of β_1 identifies $E(Y_1 - Y_0|X)$, or the Average Treatment Effect (ATE) (Angrist and Pischke, 2008, Chapter 2.3).[19]

The fundamental problem we face is selection into treatment based on unobservables: Parishes that enclosed by unanimity 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:

$$E = 1\{f(Z) - U \geq 0\} \tag{4}$$

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, parishes with a single landlord stand to gain very little, and the unobserved index for such parishes takes a very 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.

5.8.1 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):

$$E_p = \gamma_0 + \gamma_1 Z_p + X_p \gamma_2' + s + \varepsilon_p \tag{5}$$

E equals one if parish p is enclosed by Parliament at any point between 1750 and 1830, and zero otherwise. We include the same covariates X_p and fixed effects s as before. Z_p is our instrument. We use this first stage together with the following second stage:

$$Y_p = \beta_0 + \beta_1 E_p + X_p \beta_2' + s + v_p \tag{6}$$

As before in equation 1, we relate an outcome Y in parish p to Parliamentary enclosure through the same

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[19]The difference between $Y_0, Y_1 \perp\!\!\!\perp E|X$ and $Cov(enclosed, \epsilon|X, s) = 0$ is mainly notational.

covariates X_p as before, fixed effects s, and an indicator E_p. Our coefficient of interest is $\hat{\beta}_1$, the measured effect of being enclosed. We estimate the system of equations 5 and 6 using Two Stage Least Squares. Similar to our OLS results, we report both heteroskedasticity robust standard errors and Conley (1999) standard errors correcting for arbitrary two-dimensional spatial correlation. 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 that consider petitioning for enclosure and for whom the instrument may influence that decision. These parishes are referred to as the 'compliers'. Other parishes, like the ones with one landlord, that stood to gain very little from enclosure, are more likely to be 'never takers' as they are unlikely to petition for enclosure no matter what value the instrument takes.[20]

5.8.2   Estimating the MTEs of Parliamentary enclosure

An extensive literature has taken a different approach than the literature focused on potential outcomes and LATEs. Heckman (1979) first used an instrument to explicitly control for selection on observables of the form captured in Equation 4. Subsequent contributions have focused on estimating treatment effects by different *levels* of U. The object of interest in such exercises is a function relating a treatment effect of interest, $Y_1 - Y_0$, and U. The treatment effects recovered from such a function for a specific level of $U = u$ are referred to as 'marginal treatment effects' (Björklund and Moffitt, 1987; Heckman, 1997; Heckman and Vytlacil, 1999, 2005, 2007; Brinch et al., 2017). The main advantage of this alternative approach for our purposes is that we can re-estimate the ATE, the *estimand* of our OLS exercises, and the LATE, the estimand of our IV exercises, as weighted averages of the MTEs. By using our instrument to 'control' for selection and recovering both the ATE and LATE we study whether selection into treatment is indeed responsible for the small estimated treatment effects that we found in our OLS estimates.

In sum, we have three different objects of interest: the Average Treatment Effect (ATE) $E(Y_1 - Y_0|)$, which our previous OLS estimates captured (conditional on identifying assumptions, we return to this below), the Local Average Treatment Effect (LATE) $E(Y_1 - Y_0|X, \text{complier})$, which our Two Stage Least Squares estimator estimates, and a function defining Marginal Treatment Effects (MTEs) $E(Y_1 - Y_0|X, U)$ which we further discuss in section 7.

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[20]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).

6 Two Stage Least Squares Results

In this section we use our identification strategy to estimate the LATE of Parliamentary enclosure and we find that it is associated with increases in agricultural productivity and land inequality. However, our OLS estimates are significantly smaller than the estimated effects in this section. If our instrumental variable estimates are closer to the true effect of Parliamentary enclosure, this would explain the large contemporary push towards enclosure as well as why enclosure was so widespread despite its large costs. Yet, with Two Stage Least Squares analyses there may be many reasons for such a difference in estimated effects. We estimate MTEs in section 7 to show that 75% to 78% of the difference between the estimated effects using OLS and IV is due to the fact that our 2SLS estimates capture the LATE for compliers, and downweight those parishes that do not stand to gain anything from Parliamentary enclosure.

In Table 4 we report our 2SLS implementation of equations 6 and 5. As with our OLS results, we begin with ln(Wheat Yield) as our outcome variable, and we vary the inclusion of covariates. Columns (1) and (2) in this table therefore mimic columns (1) and (2) of Table 2.

Panel I reports estimates of Equation 6, panel II provides estimates of Equation 5, 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 13.27 to 24.88. 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 when computing these F-statistics leads to significant increases. 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 agricultural yield. Column (1) present results controlling for fixed effects only and column (2) presents our main result for agricultural 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 agricultural yield in column (2), 0.45 (Conley s.e. 0.14) is interpretable as a percentage change. Therefore, enclosing through Parliament is associated with 45% higher yields. We can benchmark our estimated effect against the long-run change in yield. Between 1300 and 1750, the start of our study, yields increased on average by 9 bushels to about 20 per acre (Allen, 2005). The gain in yield

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associated with enclosure is therefore approximately half that of the accumulated gain over the preceding 450 years.

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 effect of Parliamentary on agricultural yield and land inequality. Subject to the exclusion restriction, these results are interpretable as causal.[21]

Discussion of the estimated treatment effects. Our 2SLS findings speak to the long-standing debate on the effect of enclosures on English development. We collect the most prominent estimated effects in Table 7. For example, Allen (1982, 1992) estimates an increase of yield between 2.5% and 8.4%, depending on the dataset. This estimate is in line with our OLS estimates, at 3.4%. McCloskey (1989) estimates higher increases, between 10 and 13%. Turner (1980) finds higher estimates still at 26.4%. These studies make mostly cross-sectional comparisons, which, like our OLS estimates, are likely biased downwards due to the presence of unanimously enclosed parishes in the control group. Some contemporary estimates make more careful comparisons. As we discussed in our introduction, Arthur Young made a side-by-side comparison of two parishes and found a yield differential of 50%. The General View of Agriculture reports, cited in section 2 as well, allow before-after comparisons, and suggest yield increases of 66% (but note that this estimate is based on a small number of observations). Our IV estimates, at 45%, are more consistent with these latter estimates than with the more modern literature finding small effects. Subject to a very important caveat, our IV estimates resolve the problem that OLS estimates systematically underestimate the effect that Parliamentary enclosure by ensuring that comparisons between enclosed and unenclosed parishes take into account the potential productivity gains that unanimous enclosure brings.

The most important caveat to this conclusion is that the OLS estimates may be lower than our IV estimates for several reasons, not just negative selection into the control group and, therefore, the nature of the *estimand* (our 2SLS results estimate a LATE for the subsample of compliers whereas our OLS results estimate the ATE for all parishes). The disparity between estimates could similarly be due to measurement error or (severe) violations of the exclusion restriction underlying the IV estimates. Similarly, OLS estimates the ATE only under the assumption of no selection. In the next section we use advances in the literature

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[21]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.

on marginal treatment effects to show that the differences between the OLS and 2SLS results are primarily due to the differences in *estimands*.

7 Heterogeneous Treatment Effects

In this section we estimate heterogeneous treatment effects by unobserved resistance to the treatment, or the marginal treatment effect (MTE). This approach will allow us to decompose the difference between our OLS and IV estimates to understand what drives it. We find that selection out of Parliamentary enclosure by parishes that stood to gain little from it is an important driver of the low estimated effects in our OLS exercise relative to our IV estimates.

7.1 Marginal Treatment Effects

The object of interest when estimating MTEs is $MTE(u) = E[Y_1 - Y_0|U = u]$ where U is defined as the unobserved 'resistance to treatment' in Equation 4. In this section we discuss the estimation of the MTEs, largely following Brinch et al. (2017).

Normalization. The starting point in the literature is to study the *quantiles* of U rather than the (latent) values of U. Brinch et al. (2017) suggest the following normalization of equation 4:

$$f(Z) - U \geq 0 \iff p(E = 1|Z) - \tilde{U} \geq 0 \tag{7}$$

where $\tilde{U} \sim \text{Uniform}[0, 1]$. We re-label $\tilde{U}$ as U from here on. This expression implies that a 'propensity score' of getting treated for a level of the instrument has to be higher than U to decide to enclose through Parliament. We denote the propensity score as $r = p(E = 1|Z)$. After this step, we redefine the marginal treatment effects as $MTE(u) = E[Y_1 - Y_0|U = u]$ with $U \sim \text{Uniform}[0, 1]$.

The separate approach The implementation approach we follow is called the 'separate approach' (Brinch et al., 2017). The separate approach starts by estimating the propensity scores r from a 'first stage' Probit model, regressing our indicator for enclosure on all covariates and our instrument. The predicted values from this regression are the propensity scores r. Following Brinch et al. (2017) we then assume a quadratic relationship between potential outcomes and u in two subsamples, composed of all enclosed parishes, and all unenclosed parishes. We also add covariates.

$$E[Y_e|X, U = u] = \gamma_0 + \gamma_1 X + \gamma_2 u + \gamma_3 u^2, \quad e = 0, 1 \tag{8}$$

Here both the γs and u are unobserved. Brinch et al. (2017) show that we can derive from Equation 8

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the following parametric relationships:[22]

$$E[Y_e|X,r] = \beta_0 + \beta_1 X + \beta_2 r + \beta_3 r^2, \quad e = 0, 1 \tag{9}$$

Since we can estimate propensity scores r, we use the *estimated* coefficients $\hat{\beta}$ to recover the unknown coefficients γ. Because we now know each coefficient $\hat{\gamma}$ we can vary U between zero and one and plot the corresponding treatment effects in $Y(e)$-U space. The MTE curve is the vertical difference of the Y_1 and Y_0 curves. Note that the propensity score in Equation 8 acts as a 'control function' for the effect of selection into treatment (Heckman, 1979).

ATE and LATE as weighted averages of MTEs. For our purposes, the main advantage of estimating the MTEs is that Heckman and Vytlacil (2005) show that many parameters of interest can be written as a (known) weighted average of the MTEs. In particular, it is possible for us to derive both the LATE and the ATE in this framework. The ATE is simply the average of the MTE, while the LATE is a weighted average:

$$\text{ATE} = \int_0^1 MTE(u)du \tag{10}$$

$$\text{LATE} = \int_0^1 MTE(u) * weights_{LATE}(u)du \tag{11}$$

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

Identifying assumptions. Importantly, Vytlacil (2002) shows that the identifying assumptions necessary to estimate the LATE using Two Stage Least Squares and as a weighted average of MTEs are identical. We can therefore compare the estimated LATE in the previous section to the LATE estimated within the MTE framework.

In the next section we use this setup. Comparing the ATE to our OLS estimates and the LATE to our IV estimates allows us to decompose the difference between our OLS and IV estimates into the part that is due to the fact that the LATE and ATE are different *estimands* and a part that is due to other factors.

7.2 MTE Results

We now present our MTE results, starting with ln(Wheat Yield) in Figure 4. In Subfigure (a) we plot several quantities of interest as a function of the resistance to treatment U. The most important one is

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[22]To recover Equation 9 from Equation 8 note that we can rewrite Equation 8 for enclosed parishes as $E[Y_1|X, U = u] = E[Y_1|X, U = u, r < U]$ using Equation 7. Integrating out U gives Equation 9. An analogous operation recovers Equation 9 for unenclosed parishes. The Appendix provides more detail.

the MTE curve, which traces out treatment effects of 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 unanimously enclosed, as these parishes have no interest in 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 much of the gains of enclosure. As U decreases the number of unanimously enclosed parishes falls. Accordingly, the treatment effect rises because the counterfactual comparison becomes Parliamentary enclosure and informal governance, rather than Parliamentary enclosure and unanimous enclosure.[23]

Subfigure (b) contains the main results of this exercise. It plots, on the same axes, our main OLS estimate from Table 2, the corresponding ATE computed within the MTE framework (equation 10), our 2SLS estimate from Table 4, and the corresponding LATE from the MTE framework (equation 11). There are three main points to note here. First, 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. Second, the LATE is not exactly equal to our 2SLS estimate. This is essentially an approximation error and not substantively important. We discuss it in the Appendix. Third, and most importantly, 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. In other words, the fact that the OLS and 2SLS estimate the treatment effect of Parliamentary for different groups of parishes explains most of the observed difference in estimated effects between them. The rest is either explained by measurement error, selection into enclosure status that biases the OLS estimates downward, or violations of the exclusion restriction. Although the exclusion restriction is untestable, our balance checks provide evidence against the latter, and we conclude that our IV exercise identifies the effect of interest of this paper.

Our argument has been that the difference between OLS and 2SLS estimates is fundamentally due to unanimously enclosed parishes standing to gain little from Parliamentary enclosure, but at the same time being in the control group in the OLS analyses. We can further substantiate this point by studying potential outcomes separately. We do so in Subfigure (c) by plotting potential outcome Equation 8. We

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[23] 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 8.

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 unanimous enclosure is successful. U captures this because unanimously enclosed parishes resist Parliamentary enclosure. For parishes with high U, we therefore see essentially the same treatment effect under counterfactual Parliamentary enclosure as see under unanimous enclosure. For parishes without unanimous 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 unenclosed parishes stood to gain most from Parliamentary enclosure whereas unanimously enclosed parishes stood to gain little. This is, in turn, consistent with our claim that small OLS estimates are primarily driven by unanimously enclosed parishes.

In Figure 5 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.

These MTEs estimates are consistent with our OLS estimates being underestimates of the treatment effect of Parliamentary enclosure because those parishes that stood to gain little from Parliamentary enclosure self-select out of this procedure. Since these parishes likely already realized the treatment effects of the rationalization of field allocation and the division of the commons, our OLS estimates are an underestimate of the true effect of Parliamentary enclosure.

8   Mechanisms

In this section we study mechanisms that may connect Parliamentary enclosure to our outcomes. We discussed the most prominent potential mechanisms in section 2. For changes in agricultural productivity, they can be grouped under innovation and coordination. When landowners are residual claimants on their investment, their incentives to innovate are greater. Similarly, not having to coordinate with others may increase agricultural output. 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 forced the construction of new

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roads or the improvement and extension of existing roads. Such infrastructure investments may separately have been conducive to trade and development. For inequality, the most plausible mechanisms suggested in the literature discuss the prohibitive costs of the implementation of Parliamentary enclosure which forced people with smaller plots to 'sell out'. In this section we present OLS evidence on these potential channels.

We start by studying innovation, measured by agricultural patents, and the quality of roads, measured in an agricultural survey. If Parliamentary enclosures lead 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. We next study roads, a novel mechanism which 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, 2006). Table 5 presents results. We find that Parliamentary enclosure is associated with more agricultural patents being filed as well as with a lower probability of a parish having poor roads.

A second strand of proposed mechanisms concern 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 the act of fallowing 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 (Allen, 2008). Fallowing instead allows the land to 'recover' and was common in open field villages. Fallow land, however, can be pulled into continuous cultivation, provided farmers find the appropriate crop mix. We record the adoption of these practices from survey data compiled by Kain and Prince (2006). Their surveys record the acreage of parish planted with turnips (at the time of the survey) and an indicator for whether a parish leaves lands fallow. We expect that Parliamentary enclosure improves agricultural practices because these improvements can now be chosen individually rather than necessitating coordination. This is what we find in Table 5.

We now turn to the disappearance of people with smaller claims on the commons as a mechanism driving our observed increases in land inequality. We measure this by the number of cottagers as a fraction of the total number of landowners. We identify cottagers by the description of their landholdings in the tithe records. Although cottagers were typically thought to have no land at all, in the tithe records they are recorded as having at least the land the cottage is on. We therefore normalize by the number of

landowners. In section 2, we discussed the case study evidence for Parliamentary enclosure which suggests that smallholders might have had to sell out due to the high costs of buying out the tithe holder and the implementation of the enclosure act, as well as loss of common rights. In Table 5, column (5), we find that Parliamentary enclosure is associated with a lower share of small landowners in a parish. This result is consistent with disappearance of small landowners and engrossing as at least partially driving our finding that Parliamentary enclosure leads to higher land inequality.

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. We also provide tentative evidence in support of Parliamentary enclosure being associated with infrastructure improvement. Finally, we show that Parliamentary enclosure is associated with a falling number of cottagers.

9 The Midlands

In an important contribution, Allen (1982) studies the English Midlands and concludes that Parliamentary enclosure did not lead to improvements in agriculture, but did lead to higher inequality. In this section, we use our dataset to compare the part of England he studies to the rest of England.[24]

Table 6 presents four OLS estimates of Equation 1 for ln(Wheat Yield) and our land value Gini. Odd columns use our full sample and even columns subset to the Allen (1982) sample. When we look at agricultural yield we find a positive effect for the entire country, but a very small and insignificant effect for the Allen (1982) sample. This observation may be behind the divergence in results between our studies. Our sample allows us to study the entire country, which do not support his findings, but when we subset to Allen's sample, we replicate his findings. In contrast, while we find a positive effect on inequality in our sample (column (3)) we find enclosure is associated with lower levels of inequality within Allen's sample (column (4)). This may be because we measure inequality by a land value Gini, whereas Allen measured the shares of income accruing to different people in a parish.

10 Conclusion

The English Parliamentary enclosure movement is one of the most controversial economic policies in history. In this paper we have provided the first causal evidence of its economic effects.

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[24]To construct the Allen (1982) sample, we restrict to the following counties: Bedfordshire, Berkshire, Buckinghamshire, Cambridgeshire, Huntingdonshire, Leicestershire, Northamptonshire, Rutland, and Warwickshire.

As a basis for our results, we constructed a dataset that allows us to link Parliamentary enclosures to agricultural yields and land inequality. Across about 15,000 parishes covering all of England, we compare parishes that were enclosed by Parliament to those that were not. The heart of our contribution is an identification strategy which instruments whether or not a parish is enclosed by a Parliamentary act, with a leave-one-out mean of the success of Parliamentary enclosure acts in an area around the parish. We find that enclosure led to substantial increases in agricultural yield and a large increase in land inequality.

Our 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) or Hardin (1968), but at the same time led to severe increases in inequality, for example Marx (1990). They 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, because compensating tithe holders involved large amounts of land 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 in the form of increased land inequality.

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Figure 1: Organization of landownership in Barton before and after Enclosure
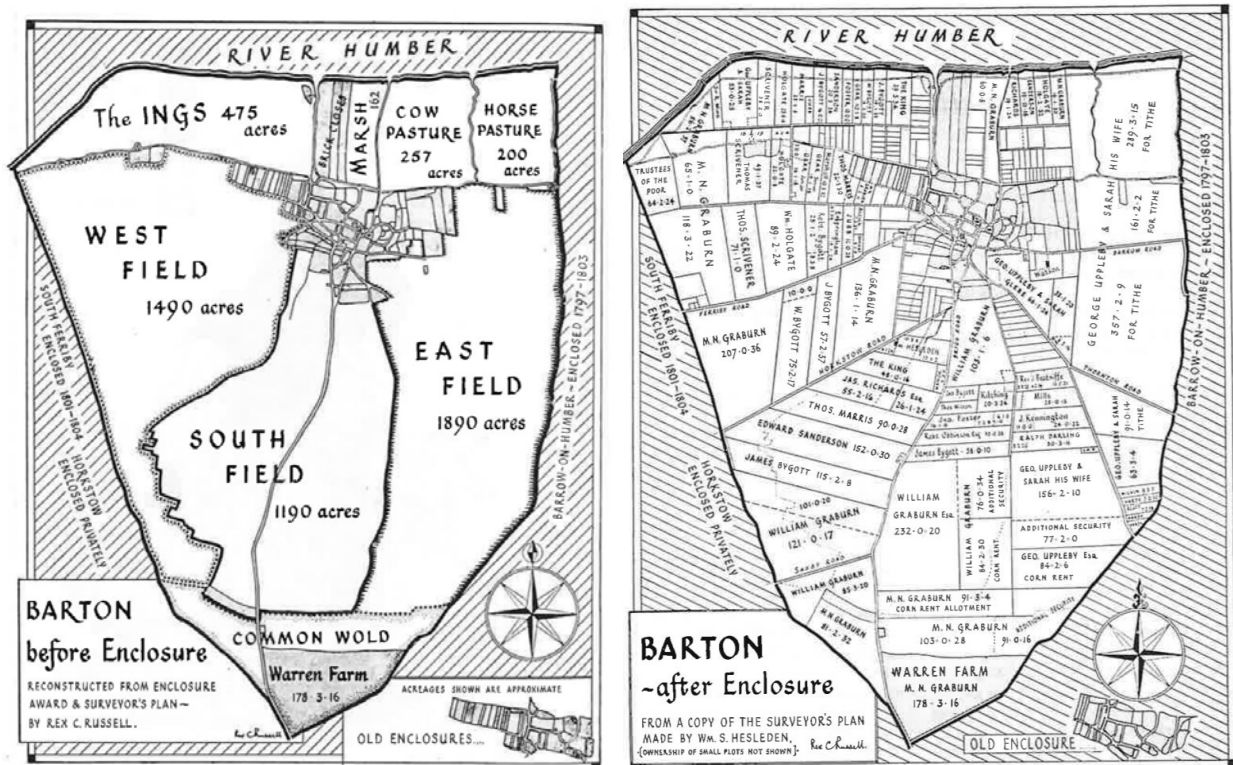
Notes: the map on the left shows the commonly held plots of land in Barton-upon-Humber, before enclosure. Barton was enclosed between 1797 and 1803. The right map reflects the results of Parliamentary enclosure. Source: Mingay (1997).

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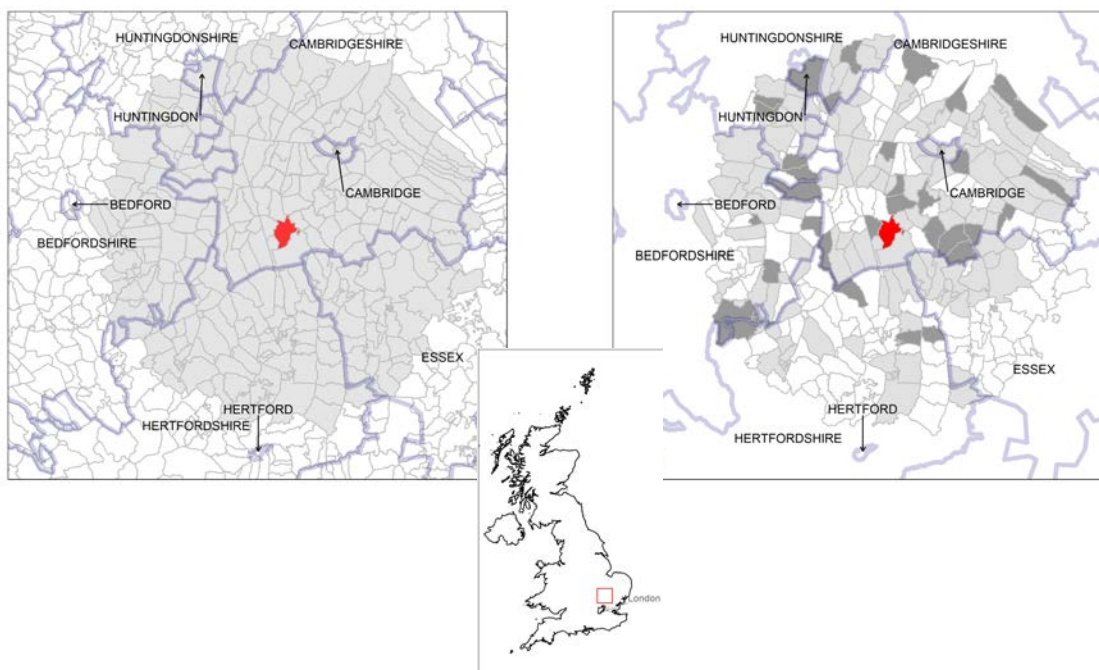Figure 2: THE NUMBER OF ENCLOSED PARISHES, BY YEAR
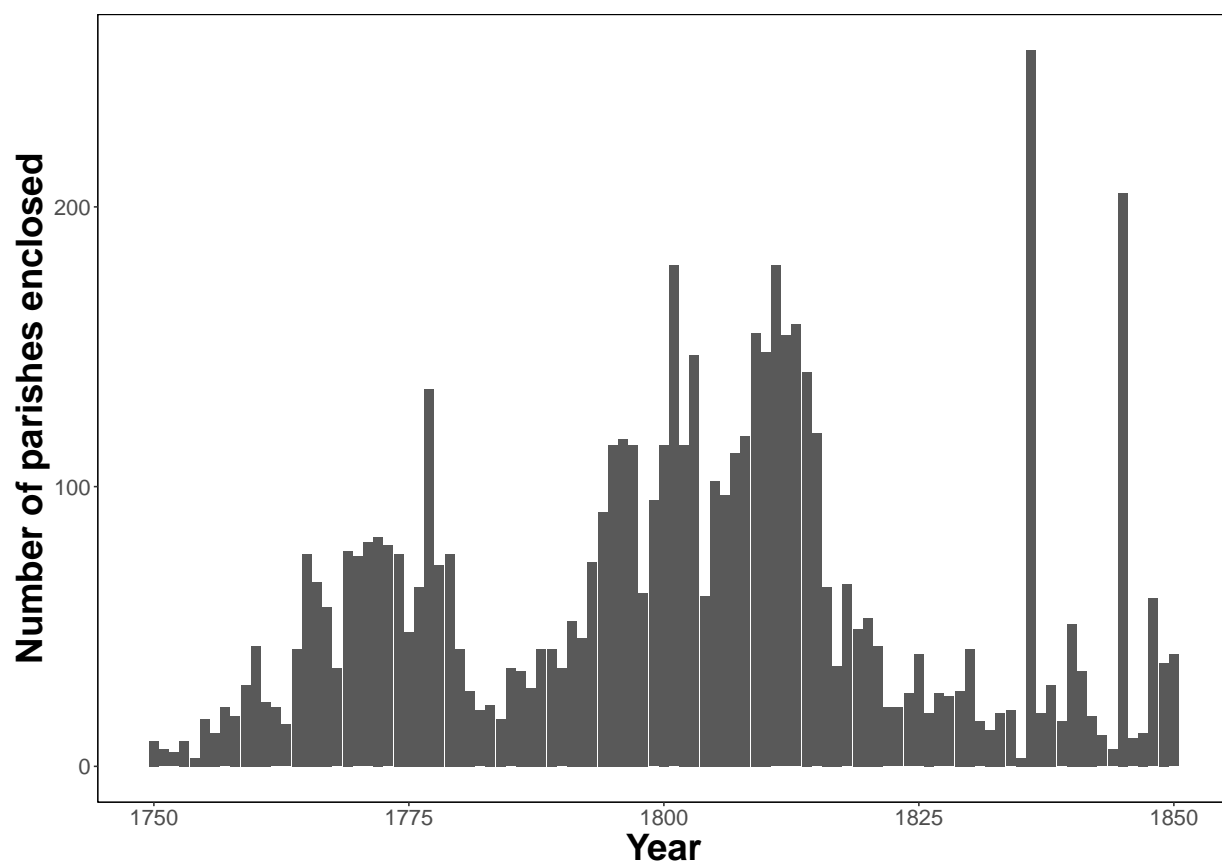
Notes: This graph shows the total number of enclosed parishes per year. Source: Tate and Turner (1978).

Figure 3: INSTRUMENT CONSTRUCTION

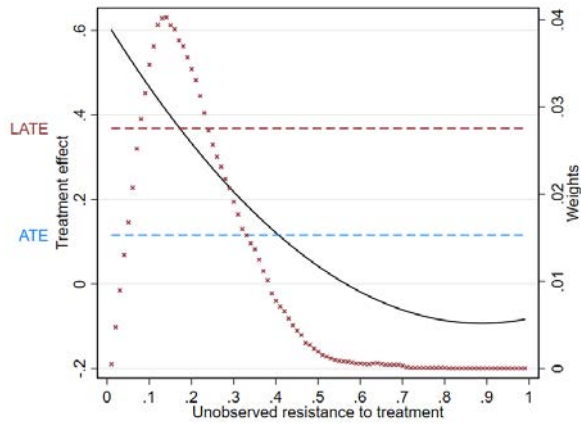(a) Meldreth with k = 350 nearest neighbors

(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).
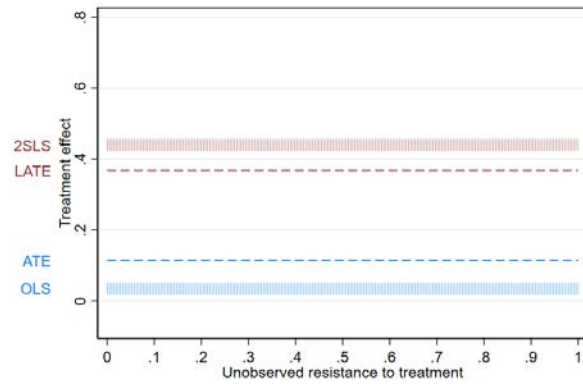
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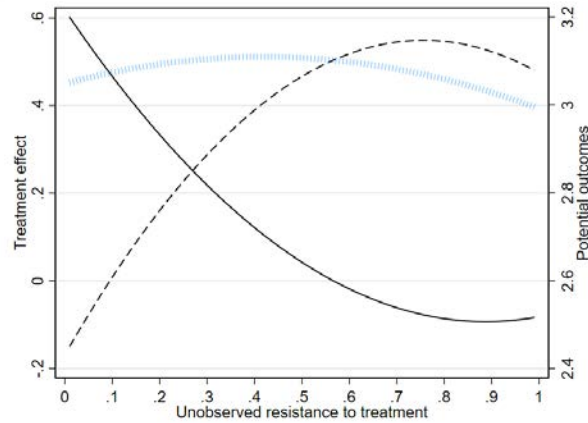Figure 4: MARGINAL TREATMENT EFFECT FOR LN(WHEAT YIELD)

(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 2, column (2). Estimate for 2SLS taken from Table 4, column (2), panel I.

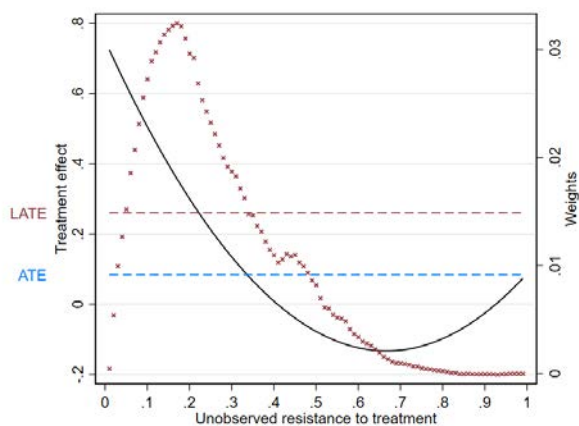(c) Potential Outcomes

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.
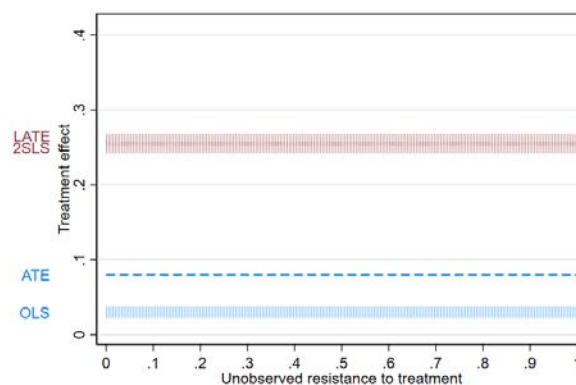
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Figure 5: Marginal Treatment Effect for Gini

(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 2, column (4). Estimate for 2SLS taken from Table 4, column (4), panel I.

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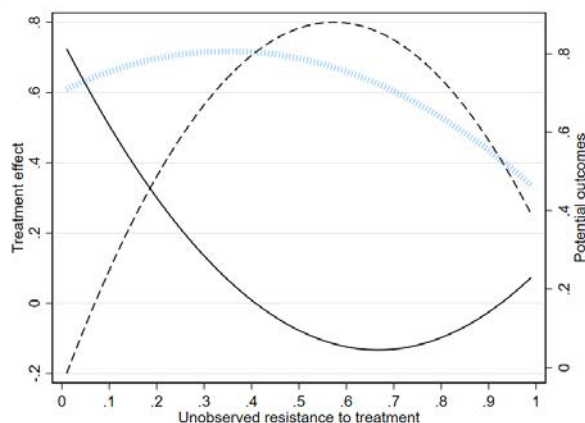
Notes: We plot the MTE curve in this figure, together with the curves for Y_1 and Y_0. The MTE curve is the vertical difference between these two curves.

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Table 1: Summary statistics for main outcome variables

Sample, parishes:		ENCLOSED		UNCENCLOSED			
	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: Parliamentary enclosure, agriculture, and inequality

Dependent variable:	LN(WHEAT YIELD) IN BUSHELS PER ACRE		GINI (LAND VALUE)	
	(1)	(2)	(3)	(4)
Enclosed (yes/no)	0.03	0.03	0.04	0.04
	(0.01)	(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	3641	3641	4446	4446
R^2	0.19	0.32	0.07	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 regression 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 (yes/no) is an indicator equal to one if a parish was enclosed 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 3: BALANCE TESTS

Dependent variable:	TAX REVENUE PER CAPITA 1525 (1)	TAX REVENUE 1525 (2)	SUITABILITY FOR WHEAT (3)	POPULATION 1525 (4)	NUMBER OF MPs 1700 (5)	NUMBER OF NOBILITY 1700 (6)
Leave-one-out pass rate nearby Enclosure Bills	0.005 (0.010) [0.007]	-0.004 (0.011) [0.006]	-0.004 (0.030) [0.007]	0.029 (0.020) [0.010]	0.001 (0.004) [0.004]	0.004 (0.012) [0.011]
Observations	6791	7581	13919	7581	9339	9339
R^2	0.02	0.08	0.50	0.32	0.01	0.00
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

All regressions are estimated using OLS. The unit of observation is a parish. All regression 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 is the suitability of the soil for growing wheat. Population 1680 is total population in the 1680 hearth tax returns. 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. 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 AGRICULTURAL YIELD AND INEQUALITY

Dependent variable:	LN(WHEAT YIELD) IN BUSHELS PER ACRE		GINI (LAND VALUE)	
	(1)	(2)	(3)	(4)
	Panel I: IV estimates			
Enclosed (yes/no)	0.48	0.45	0.16	0.22
	(0.31)	(0.14)	(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 pass rate nearby Enclosure Bills	0.58	0.58	0.77	0.68
	(0.16)	(0.14)	(0.15)	(0.15)
	[0.06]	[0.06]	[0.07]	[0.07]
Conley F-stat of Excluded Instrument	13.27	16.38	24.88	19.77
	Panel III: Reduced Form			
Leave-one-out pass rate nearby Enclosure Bills	0.28	0.26	0.12	0.15
	(0.14)	(0.06)	(0.07)	(0.07)
	[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 regression 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. Enclosed in this panel is the predicted enclosure probability from 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 5: Mechanisms: Innovation, Coordination, and Landownership

Dependent variable:	Innovation		Coordination		Ownership
	Nr. Agr. Patents	Road quality poor (yes/no)	Turnips grown (acres)	Lands fallow (yes/no)	Cottagers/ Landlord
	(1)	(2)	(3)	(4)	(5)
Enclosed (yes/no)	0.02	-0.11	0.13	-0.09	-0.17
	(0.01)	(0.04)	(0.04)	(0.04)	(0.04)
	[0.01]	[0.03]	[0.04]	[0.03]	[0.03]
Observations	13920	5288	2290	5288	3180
Scale: Parish area	Y	Y	Y	Y	Y
Geography: Elevation	Y	Y	Y	Y	Y
Location: Latitude, longitude, latitude*longitude	Y	Y	Y	Y	Y
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 OLS. The unit of observation is a parish. All regression 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. Lands fallow (yes/no) is an indicator equal to one if a parish was recorded as leaving lands fallow. Cottagers/Landlord is the number of cottagers divided by the number of landlords. Enclosure (yes/no) is an indicator equal to one if a parish was enclosed 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.

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Table 6: THE MIDLANDS

| Dependent variable: | LN(WHEAT YIELD) | | GINI | |
| | (1) | (2) | (3) | (4) |
	Country	Midlands	Country	Midlands
Enclosed (yes/no)	0.03	0.00	0.04	-0.04
	(0.01)	(0.02)	(0.01)	(0.02)
	[0.007]	[0.020]	[0.007]	[0.030]
Mean dep. var.	3.05	3.12	0.74	0.71
SD dep. var.	0.21	0.15	0.21	0.26
Observations	3641	275	4446	390
R^2	0.32	0.09	0.08	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 regression 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 (yes/no) is an indicator equal to one if a parish was enclosed 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: COMPARISON OF OUR ESTIMATES OF THE IMPACT OF PARLIAMENTARY ENCLOSURE TO THE LITERATURE

| Source: | LITERATURE | | | | | THIS PAPER | |
	(1) ALLEN (1982)	(2) ALLEN (1992)	(3) McCLOSKEY (1989)	(4) TURNER (1980)	(5) GENERAL VIEWS	(6) OLS	(7) 2SLS
Change in Wheat Yield	8.4 %	2.5%		26.4 %	66%	3.4%	45%
Implied Change in Productivity from Rents			10 to 13%				

Notes: This table reports estimates of the change in yield due to enclosure. The estimates in columns (1)-(4) are cross-sectional, comparing enclosed to unenclosed parishes. Column (5) is a before-after comparison in a sample of five parishes in the General Views of Agriculture from Bedfordshire, Cambridgeshire, Gloucestershire, Lincolnshire and one estimate for the county of Nottinghamshire, also from its General View of Agriculture. Column (1) is a sample taken from Arthur Young of several farms, as analyzed by Allen (1992). Column (2) is Allen (1992)'s own analysis which uses 1801 data and tries to control for soil type. Column (3) is from McCloskey (1989). Column (4) is from Turner (1980) reported in Allen (1992). Column (5) is computed as the average percentage change across six estimates from the General View of Agriculture, reported in Batchelor (1813, p. 227, 238), Gooch (1811, p. 126), Rudge (1807, p. 381), Stone (1808, p. 104), and Lowe (1798, p. 45). The estimates from Turner (1980); McCloskey (1989); Allen (1992) in percentage terms are reported in Boyer (1993).

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APPENDIX FOR:

THE ECONOMIC EFFECTS OF THE ENGLISH

PARLIAMENTARY ENCLOSURES

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This appendix contains further background to our empirical strategy, the process of Parliamentary enclosure, additional figures, additional results, and a table with data sources for 'The economic effects of the English Parliamentary enclosures'.

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1 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 unenclosed or enclosed by voluntary agreement. Following Roy (1951) we start with:

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

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

Here μ_j is a term common to all treated parishes, 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 can not identify the Δ_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:

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

In the main body of the paper we add covariates and fixed effects and estimate this equation as our first model (Equation (1)):

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

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^*. In the paper we describe a more general function $f(Z)$. Here $f(Z) = \alpha + \beta Z_p$.

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 (5) 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

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second stage, Equation (6) 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 $LATE = E(Y_1 - Y_0|complier)$ like we do in the paper.[1] 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 some parishes were already informally enclosed and would never petition Parliament. In this case, 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 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

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[1]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).

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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. In our paper, we compare these to our estimated treatment effects in our linear and instrumental variables models 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 $E(Y_1|X, U)$ and $E(Y_0|X, U)$. We have

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

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

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:

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

$$= \gamma_0 + \gamma_1 X + \gamma_2 \frac{r}{2} + \gamma_3 \frac{r^2}{3}$$

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 which we can estimate. 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. We graph the two functions for $E(Y_1|U)$ and $E(Y_0|U)$ separately as well as the MTE(U) function as $MTE(U) = E(Y_1 - Y_0|U)$.

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2 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.

2.1 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:[2]

"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

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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.)

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

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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.

3 Additional discussion of MTE Figures

In this section, we continue our discussion of figures 5 and 6 from the main body of the paper.

## 3.1 Why is the LATE different from 2SLS

Sub-figure(b) of figures 5 and 6 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 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.

3.2 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 4 plots the common support of the MTE estimation from figures 5, 6, 7 and 8 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.
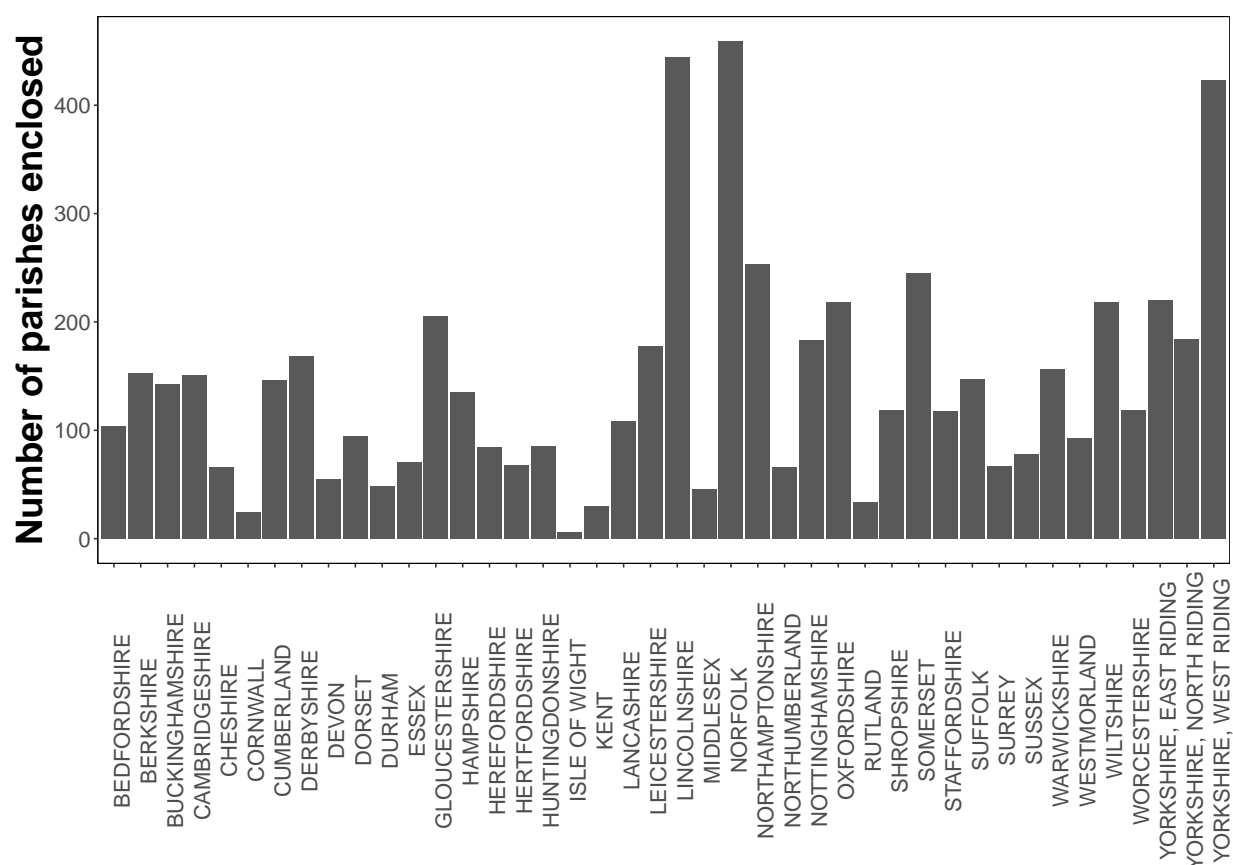
4 Additional figures
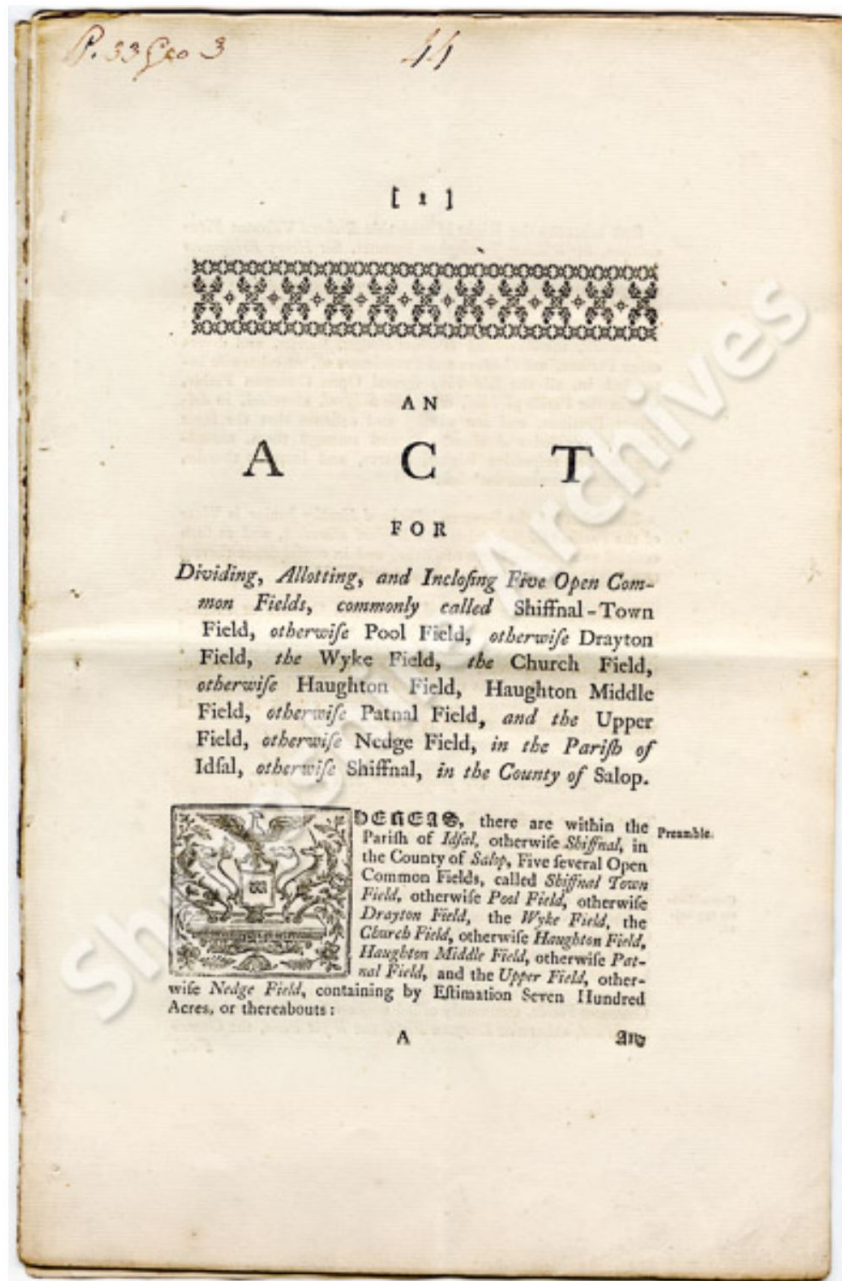
Notes: Example of an enclosure act.

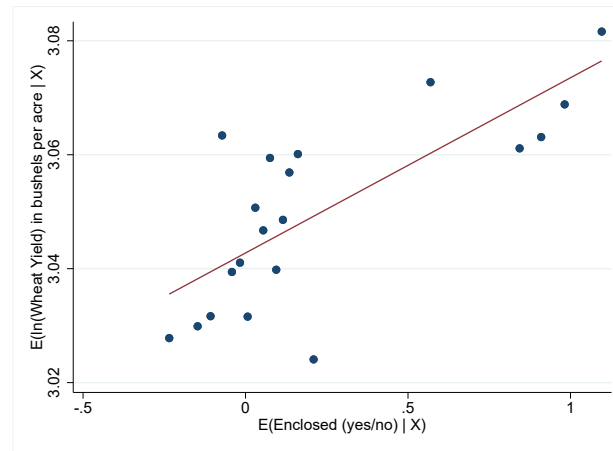Figure 2: The number of enclosed parishes, by county

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

Figure 3: SCATTERPLOTS FOR MAIN OUTCOMES

(a) Log(Wheat Yield)

(b) Gini
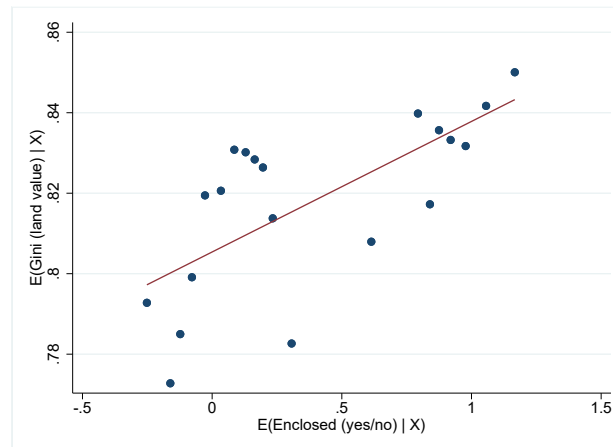
Notes: These figures are residualized and binned scatter plots (using 40 bins) visualizing estimates of equation 1 in the main paper. We partial out covariates and fixed effects and plot a linear fit of each outcome against predicted enclosure. The bins reflect the raw underlying data. We bin the x-axis 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.

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Figure 4: COMMON SUPPORT

(a) Log(Wheat Yield)

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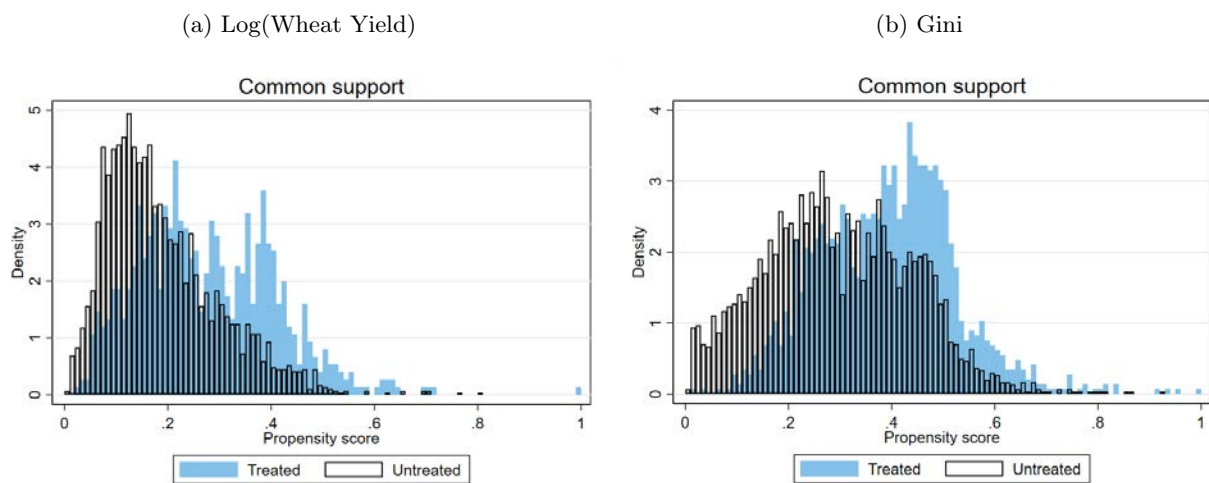
Notes: The MTE is identified where there is common support. Outside of the areas of common support, extrapolation must be used. We use the full support because we wish to explore the relationship between the 2SLS and OLS results, which are estimated using the full dataset.

5 Additional results

In this section, we 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. We also 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.

5.1 Inequality measurement

In Table A1 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.

5.2 Inequality measurement

In Table A2 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.

5.3 Controlling for drainage and turnpikes

In Table A3 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, 2006). 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.

5.4 Construction of our instrument

In Table A4 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 A5 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.

Table A1: ALTERNATIVE CROP YIELDS

Dependent variable:	LN(BARLEY YIELD) IN BUSHELS PER ACRE		LN(OATS YIELD) IN BUSHELS PER ACRE	
	(1)	(2)	(3)	(4)
Enclosed (yes/no)	0.01	0.02	0.01	0.01
	(0.01)	(0.01)	(0.02)	(0.01)
	[0.007]	[0.007]	[0.012]	[0.012]
Mean dep. var.	3.41	3.41	3.45	3.45
SD dep. var.	0.18	0.18	0.24	0.24
Observations	2701	2701	2283	2283
R^2	0.11	0.18	0.23	0.29
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 regression 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. Enclosure (yes/no) is an indicator equal to one if a parish was enclosed 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 A2: Inequality measurement

Dependent variable:	Gini (land size)		Gini (land value)	
	(1)	(2)	(3)	(4)
Enclosed (yes/no)	0.01	0.02	0.04	0.04
	(0.01)	(0.01)	(0.02)	(0.01)
	[0.006]	[0.006]	[0.007]	[0.007]
Mean dep. var.	0.75	0.75	0.74	0.74
SD dep. var.	0.18	0.18	0.21	0.21
Observations	4357	4357	4446	4446
R^2	0.04	0.05	0.07	0.08
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 OLS. The unit of observation is a parish. All regression 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. Enclosure (yes/no) is an indicator equal to one if a parish was enclosed 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.

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Table A3: Controlling for drainage and turnpikes

Dependent variable:	LN(WHEAT YIELD) IN BUSHELS PER ACRE		GINI (LAND VALUE)	
	(1)	(2)	(3)	(4)
Enclosed (yes/no)	0.02	0.03	0.06	0.06
	(0.01)	(0.01)	(0.01)	(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	3641	3641	2745	2745
R^2	0.20	0.32	0.15	0.16
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 OLS. The unit of observation is a parish. All regression 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 (yes/no) is an indicator equal to one if a parish was enclosed 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: 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***
	(0.116)	(0.073)
50	0.447***	0.218**
	(0.133)	(0.098)
70	0.447***	0.218**
	(0.137)	(0.105)
100	0.447***	0.218**
	(0.139)	(0.108)
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 estimates use 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. Share of pop. in agriculture is the number of males over 20 employed in agriculture divided by total population in the 1831 census. Share of pop. in industry is the share of the total population that is male and over 20 employed in manufacturing, retail, trade, and handicraft in the 1831 census. Gini (land value) is a Gini coefficient of the value of land owned by parishioners in the 1836 tithe returns. All point estimates in table are for treatment variable enclosure. 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 A5: 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*
	(0.147)	(0.091)
300	0.463***	0.192**
	(0.142)	(0.094)
350	0.447***	0.218**
	(0.137)	(0.105)
400	0.425***	0.240**
	(0.137)	(0.117)
450	0.424***	0.253**
	(0.140)	(0.125)
500	0.444***	0.259**
	(0.149)	(0.132)
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 estimates use 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. Share of pop. in agriculture is the number of males over 20 employed in agriculture divided by total population in the 1831 census. Share of pop. in industry is the share of the total population that is male and over 20 employed in manufacturing, retail, trade, and handicraft in the 1831 census. Gini (land value) is a Gini coefficient of the value of land owned by parishioners in the 1836 tithe returns. All point estimates in table are for treatment variable enclosure. 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.

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