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Land acquisition for industrialization and compensation of displaced farmers☆

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ABSTRACT

This paper addresses the question of how farmers displaced by acquisition of agricultural land for the purpose of industrialization ought to be compensated. Prior to acquisition, the farmers are leasing in land from a private owner or local government with a legally mandated sharecropping contract. Compensation rules affect the decision of the landlord to sell the land ex post to an industrial developer, and ex ante incentives of tenants and landlord to make specific investments in agricultural productivity. Efficiency considerations are shown to require farmers be over-compensated in the event of conversion.

1. Introduction

A major issue in contemporary development policy concerns compensation paid to those whose traditional livelihoods are uprooted by modern industrial projects. This involves both equity and efficiency considerations. In the absence of a welfare state those who are rendered unemployed by industrialization are left at the mercy of market forces. Inadequate compensation of such groups results in a political and social fallout, which can undermine the political sustainability of such programs.

Political effects aside, compensation policies have important effects on economic efficiency as well. They affect decisions made by landowners to convert land from agricultural to industrial use. Frictions in the leasing market (e.g., resulting from moral hazard and low wealth of tenants) can result in farmers earning surpluses which would be foregone in the event of eviction. Landowners would have no private incentive to incorporate these losses in their decision to convert land. Inadequate compensation can thereby create incentives for excessively rapid industrialization. Moreover, the anticipation of such conversions in the future breeds insecurity of tenure among those currently engaged in agriculture, with implications for their incentives to undertake investments that enhance farm productivity.

These problems have surfaced quite prominently all over the world in the past two decades, and in particular, in rapidly industrializing countries such as China and India.[1] The transition to industrialization in these countries has been marked by conversion of agricultural land into land earmarked for industrial projects and urban real estate development. The process has been facilitated by local or regional governments anxious to raise the rate of growth in their jurisdictions, which generate large spillover effects and/or raise government revenues. At the same time, farmers cultivating these lands and workers employed by these farmers lose their livelihoods. The compensations paid to those displaced have been criticized as being inadequate. The process of determining and implementing these compensations has been described as arbitrary, ad hoc and lacking transparency. There have also been complaints of the lack of any rights or participation of those displaced in the process of transition.

These problems of compensation have created widespread social and political tensions. For instance, Cao et al. (2008) report that in the

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[1] See Chan (2003), Ding (2003, 2007), and Su (2005).

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first nine months of 2006, China reported a total of 17,900 cases of "massive rural incidents", in which a total of 385,000 farmers protested against the government. They go on to state that:

> "…there are currently over 40 million dispossessed farmers due to urban expansion and transportation networking and 70% of the complaints lodged from farmers in the past 5 years are related to rural land requisition in urbanization" (Cao et al., 2008, pp. 21–22).

Likewise in the eastern state of West Bengal in India, farmers were displaced by a motor car project started in 2007 for which land had been compulsorily acquired by the state government.[2] A significant proportion of these protested that the compensation paid to them was inadequate. These protests were orchestrated by the principal opposition party to the party controlling the state government. The resulting tension and confrontations eventually led to the industrial group in question moving its factory to a different state in India in 2008, and eventually contributed to the incumbent government being voted out of power in 2011. Despite agreement between most parties that the land ought to be converted to industrial use, the problem of inadequacy of compensation caused the process of conversion to be reversed.

These events raise important questions regarding economic principles that should guide the design and implementation of compensation for agents displaced by industrial development projects. According to most legal frameworks, property owners do not require the permission of their current tenants or workers in order to sell the property. Nor are they required to compensate them in the event that the tenant gets evicted or the workers lose their jobs. Ownership rights include both freedom to decide how the property is to be used as well as freedom over the sale of the property. Yet the preceding events in China and India raise the question whether tenants or workers employed by landowners should be legally entitled to some compensation if the owner were to sell the property. And if so, what principles should guide the design of such compensation.

The purpose of this paper is to initiate a theoretical analysis of compensation arrangements for incentives of owners to sell and concerned parties to invest in productivity-enhancing investments. We examine contexts with limited scope for transferability of utility, owing to limited liability and wealth of agents undertaking productive investments, which is relevant to poor farmers in developing countries. Like most of the existing literature, we focus on implications for efficiency, as evaluated by a utilitarian social welfare function which neglects the issue of distributive equity. We examine whether there is an efficiency argument for restricting the rights of owners over the sale of assets in the sense of mandating compensation of displaced tenants. If so, inclusion of considerations of distributive justice would further strengthen the argument, in contexts where landowners and industrial developers are substantially wealthier than displaced farmers.

We study a setting where a landlord (or local government which is the de facto owner) currently leases a large number of contiguous plots of agricultural land to different tenants.[3] The landlord and tenants make specific non-contractible investments in their respective plots. The law stipulates the share of the agricultural produce that must be given to tenants, as well as lump-sum compensations they are entitled to if they were to be evicted as a result of sale of the land.[4] Sharecropping arrangements are necessitated by limited liability and limited wealth of tenants, combined with uncertainty in agricultural production. These imply fixed rent contracts are unenforceable when adverse production shocks occur.[5] Moreover, compensations paid in the event of acquisition are lump-sum owing to the inability of the government to accurately evaluate the productivity enhancing investments already made in the plots being acquired.[6]

Opportunities for sale of the entire area of land to an external industrialist arise stochastically, and the landlord makes this decision after specific investments have been made in agricultural improvement. The indivisibility and large scale of the industrial project imply that the owner either sells all the plots of land to the industrialist, or none of them. As there are large numbers of tenants, the investment decisions of any particular tenant has a negligible effect on the owner's decision to sell. This implies that possible 'disciplinary' effects of the threat of uncompensated eviction do not arise.[7]

The question we analyze concerns the effects of varying the compensation paid to the tenant in the event of a sale. We consider three channels of potential impact: the owner's decision to convert, and resulting implications for ex ante investments of the two parties respectively.

In the absence of specific investments, the only allocative role of property rights concerns their implications for decisions for whether or not the property will be sold. Optimal resource allocation necessitates paying compensation to the tenant so that the landlord correctly internalizes the cost imposed on the latter as a result of the property sale. This will be traded off against the various benefits that will accrue to the landlord or the industrialist. If the rental market for property operates without distortion, the current rent captures the value to the tenant of leasing the asset. Since the landlord earns this rent which will be foregone upon selling the property, vesting the sole decision right over the sale to the landlord results in an efficient outcome. The argument is further strengthened if the landlord makes ex ante investments in the construction and upkeep of the property. Retaining full rights over sale will generate the correct (i.e., first-best) incentives to the landlord for making such investments.

However, in the presence of distortions in the rental market, the tenant may be earning a surplus (owing either to limited liability and moral hazard, or a legally stipulated minimum crop share).[8] In this case, vesting sole decision rights with the landlord concerning sale of the asset will generate socially excessive incentives to sell to third parties when the opportunity arises. This is because the landlord will neglect the effect of the sale on the loss of surplus by the tenants. To correct this problem, the landlord needs to pay a compensation to the tenant that equals the surplus lost by the latter in the event of conversion.

The effect of this distortion on the sale decision is compounded by effects on investment incentives. Sharecropping implies that both the landlord and the tenants under-invest in agricultural improvements. We show that increasing the compensation paid to tenants in the event of conversion raises investments by both landlords and tenants, owing to the induced effect on sale decisions by the landlord. By

[2] For a detailed account, see Ghatak et al. (2012).

[3] In the context of the Singur land acquisition by the West Bengal government, there were over 17,000 plots acquired, and at least 1600 households from whom agricultural land was acquired. See Ghatak et al. (2012, Tables 1a, 4).

[4] In West Bengal, for instance, tenancy is regulated by sharecropper protection laws that mandate a minimum share for tenants. See Banerjee et al. (2002) and Bardhan and Mookherjee (2011) for further details.

[5] This resembles the formulation of tenancy in Mookherjee (1997), and Banerjee et al. (2002). In the context of this paper, we additionally incorporate investments made by the landowner or local government, whereby a team moral hazard problem arises.

[6] See Ghatak et al. (2012) for a detailed analysis of the acquisition process in Singur, showing that the government was unable to identify many relevant characteristics of plots relevant to assessment of their market values. Hence the compensation for any given acquired plot ended up being largely independent of past investments made on that specific plot.

[7] If there was only a single plot and tenant in question, the owner would be more inclined to sell if the tenant invests less in agricultural productivity. In such a context, the threat of being evicted without suitable compensation would motivate the tenant to invest more. Increasing tenant's compensation in the event of sale could then reduce his incentive to invest. This 'disciplinary' effect does not arise in the context studied in this paper. In Ghatak and Mookherjee (2012) we study the context of a single tenant or agent, wherein results concerning optimal compensation turn out to be considerably different. In that paper we also allow the owner to design the tenancy contract, whereas in this paper the terms of the contract are set by law.

[8] For example, in tenancy models with moral hazard and limited liability (e.g., Banerjee et al., 2002; Mookherjee, 1997) it is not in the landlord's interest to extract all the rents from the tenant as this destroys the latters incentive to undertake costly investments that raise farm productivity. Fixed rent contracts are unenforceable in states of the world where adverse natural shocks depress tenants incomes so much that they are unable to pay the mandated rent. So the landlord offers a sharecropping contract which ends up generating rents for their tenants, particularly for those that are poor.

discouraging the incentive to sell, it raises the likelihood the land will be retained in agriculture, motivating both parties to invest more. Hence if tenants are not fully compensated, raising the level of compensation induces efficiency improvements on all three fronts simultaneously. It curbs the landlord's socially excessive inclination to sell the land, thereby lessening the over-conversion distortion. It raises the probability that the land will remain in agricultural use, which will in turn increase the investments made by landlord and the tenants. Hence efficiency considerations via investment incentives as well as conversion decisions dictate that tenants be over-compensated. We show that this result holds under fairly general conditions of technology and preferences, provided the landlord can appropriate all the social surplus resulting from conversion of the property to industrial use (e.g., using competitive bidding among potential industrial users). The result need not hold as generally if this condition is not met, but it will hold as long as landlord's own role in investing in land improvement is negligible compared to the tenant's role.

This paper adds to the existing theoretical literature on property rights by incorporating an important dimension of these rights that has not been analyzed, namely, the right of an owner to sell his property at will. Most of the existing literature has focused almost exclusively on *use rights* rather than *exchange rights*. This includes the literature in development economics on property rights (Besley (1995), and Besley and Ghatak (2009)) as well as the incentive effects of sharecropping tenancy and its regulation in a context of complete contracts subject to moral hazard and limited liability (see, for example, Banerjee et al. (2002), Mookherjee (1997), and Singh (1989)). This also includes the literature in organizational economics, on incomplete contracts and the nature of the firm following Edlin and Reichelstein (1996), Grossman and Hart (1986), and Hart and Moore (1990).[9]

We extend the models used in the tenancy literature mentioned above to investigate issues concerning regulation of exchange-rights: In particular, the key distortions arise from a problem of 'moral hazard in teams' generating under-investment in farm-specific assets by landlord and tenants (Eswaran and Kotwal (1985)). Empirical evidence for the importance of these incentives in the context of Indian agriculture has been provided by Banerjee et al. (2007), Bardhan and Mookherjee (2011), and Shaban (1987).[10]

This paper is also related to a large law and economics literature on eminent domain and compensation. This literature does not focus on tenancy-related issues, but it does address the issue of how compensation policy affects landowner investment incentives. In particular, to the extent landowners can invest in land value, Blume et al. (1984) show that compensation must be lump-sum to avoid moral hazard and that payment of full market value compensation can lead landowners to overinvest in their property. The key difference between their model and ours is that there are no distortions in capital markets or investment decisions in the former, like the sharecropping distortion in our model which generates under-investment. [11] Moreover, the subsequent law and economics literature has provided several counterarguments to the Blume–Rubinfeld–Shapiro argument for zero compensation, which bear some resemblance to issues incorporated in our model. For example, full market value compensation does not reflect the amount the landowner would have accepted in a consensual sale, and that this creates a risk of excessive application of eminent domain. See Miceli and Segerson (2007) for a review of this literature.

Section 2 introduces the model. Section 3 presents the main results, while Section 4 explores extensions of the basic model. Finally, Section 5 concludes.

2. Model

2.1. The environment

There is a landlord L who owns n identical plots and leases each of them to a tenant. The yield or quality of any given plot equals $Ap(x,y)$ where A is positive and p depends on non-negative investments x and y made by the landlord and the tenant. All tenants have identical preferences and costs; we shall focus on symmetric outcomes where they behave identically, and the landlord invests the same amount in every plot. The function p is assumed to be strictly increasing, strictly concave, twice-differentiable, and exhibiting complementarity between x and y: $p_{xy} \geq 0$. It is normalized so as to lie between 0 and 1, and can be interpreted as a probability of a successful harvest of value A. We shall assume an interior probability of a successful harvest, irrespective of investments: $0 < p(x,y) < 1$ for all non-negative x,y. In particular, there is some likelihood of a successful harvest even if there is no investment: $p(0,0) > 0$ and likewise, of a crop failure even if investments are chosen at the highest possible levels. This ensures that the level of the investments cannot be perfectly inferred by a third-party from any value of output, so that the agency problem has bite.

On any given plot the tenant incurs cost $c_T(y)$ while the landlord's cost equals $c_L(x)$, where c_T and c_L are both strictly increasing, strictly convex, and twice-differentiable functions. To avoid technical complications we assume marginal costs approach infinity as x and y approach finite capacity limits $\bar{x}$ and $\bar{y}$ respectively. We shall focus on interior equilibria; all equilibria will be interior if costs and marginal costs are zero at zero investment, since p_x, p_y are strictly positive.

After investments have been made, the landlord observes the value of p or equivalently the underlying investments x,y which are assumed to be observable but non-verifiable.[12] Then there is a random outside option available to the landlord to sell all the n plots together and earn v per plot, where $v \geq 0$ is drawn according to a density f and a corresponding distribution function F. The density function is positive and continuously differentiable everywhere on its support.

The landlord does not have the option to sell some of the plots and not the others: either all or none must be sold, because the competing use of the land entails an indivisibility (i.e., a factory is to be built which requires a minimum area). For most part we shall assume that the distribution of v is exogenously given. As we explain in Section 4, this requires the assumption that the landlord can capture all of the surplus from the alternative use of the land. We explain there how the results get modified if this assumption does not hold.

If the landlord does not sell, the farm yields are shared between landlord and tenant in fixed proportions $1-s$ and s stipulated by rental regulations. And if the landlord does sell, he is required by law to compensate each farmer by a lump-sum amount c. We suppose that there is a finite upper bound $\bar{c}$ to the extent of compensation. Our main focus will be on situations where the tenant is under-compensated, i.e., $c < spA < sA$, in which case $\bar{c}$ equals sA. Otherwise a natural upper bound to compensation would be A, the maximum value of the land in agriculture. [13] The compensation is not a function of the quality of the plot (because this is not verifiable by third parties).

[9] See Segal and Whinston (2013) for a review of this literature. Neither of these literatures focuses on exchange rights. Moreover, the organizational economics literature ignores the problem of borrowing constraints, which may cause additional agency problems by preventing individuals from owning an asset even when it is efficient for them to do so (e.g., under tenancy).

[10] The latter two papers study the effect of a sharecropping regulation program in West Bengal which would be expected to lower the landlord's incentive and raise the tenant's incentives to raise agricultural productivity. They both find a net increase in agricultural productivity as a result of the reform, indicating that the enhancement of tenant's incentives outweighed the reduction in the landlord's incentive.

[11] Our model also incorporates multiple plots of land and two-sided investments, but these differences are less essential.

[12] In the existing literature on tenancy, the usual assumption is output is verifiable but effort or investments are not observable. We make this assumption because in our model the landlord decides on whether to sell the land after investments have been made but before output is realized. In the alternative case where the landlord cannot observe p before deciding to sell, the same results will obtain. The arguments would be even simpler, since tenants will not have any incentive to manipulate the landlord's sale decision through their investment, and assumption (3) below on the number of tenants will no longer be needed.

[13] This helps avoid some technical complications.

A law which required the compensation to be some fraction of the price at which the land is sold would also have difficulty in getting enforced, as it would invite collusion between the landlord and the third party by understating the price, accompanied by hidden side payments. What is publicly verifiable instead is that ownership of the land has been transferred to a third party, whence the law mandates a lump-sum compensation to each displaced tenant.

Apart from c, the tenant's share s is also stipulated by the law (e.g., as is the case in West Bengal under Operation Barga), or in the form of property taxes that tenants are stipulated to pay to local governments in the Chinese context. This nevertheless leaves open the question whether the landlords would voluntarily offer the tenants a larger share than is mandated by the law. Given the lack of contractibility of the tenant's investment, this may help induce the tenant to invest more which raises the value of the land. Might this be in the interest of the landlord?

One context where the question is not pertinent is when the landlord cannot commit to honor promises to give tenants a large share than legally mandated: ex post the landlord would have an incentive to renege on this promise. Even if they could commit, we provide conditions in a later section under which the landlord would not want to offer more than the legally mandated share.[14]

The assumption of a sharecropping contract is a key one. Even in the absence of any legal regulations of tenancy contracts, standard models of tenancy subject to limited liability and wealth constraints argue that fixed rent contracts are unenforceable owing to uncertainties that afflict crop returns. There is no scope for a fixed rent, which is paid irrespective of the harvest from the land. One interpretation is that if retained in agriculture, the plots will either return A (a 'success') or nothing (a 'failure'), the tenants have no assets, are subject to limited liability, have zero outside options and no bargaining power vis-a-vis the landlord. Then it is not possible for transfers to tenants to be negative, and the landlord will have no incentive to pay positive transfers to any tenant in the event of a failure. The landlord-share $1-s$ can then be interpreted as the ratio of the transfer paid in the successful state to the value of the harvest realized.

Finally we impose an assumption concerning n, the number of tenants involved. To introduce this we need the following additional assumptions and notation. We assume the rate of change of the density f over the range $[(1-s)p(0,0)A, \bar{c}+(1-s)A]$ is bounded, i.e.,

$$M \equiv \sup_{v\in[(1-s)p(0,0)A,\bar{c}+(1-s)A]} \left\| \frac{f'(v)}{f(v)} \right\| < \infty \tag{1}$$

where $\bar{c}$ denotes the upper bound to the compensation to be paid to the tenant. We also impose a restriction on the degree of complementarity between the investments of the landlord and each tenant, as follows:

$$N \equiv \sup_{x,y} \frac{p_{xy}}{p_x p_y} < \infty. \tag{2}$$

We require n to be 'large' enough in the following sense:

$$n > \frac{1-s}{s}\left[1+\max\left\{sAM, \bar{c}\left(M+\frac{N}{1-s}\right)\right\}\right]. \tag{3}$$

A special case of this model is when p is linear:

$$p = \alpha x + \beta y + \gamma$$

with α, β, γ all positive; the investment costs are quadratic:

$$c_T(y) = \frac{y^2}{2}, c_L(x) = \frac{x^2}{2}.$$

The investments x,y are constrained to be less than one and we also assume $\alpha+\beta+\gamma<1$, so that the linear probability p is always less than 1.[15]

Moreover, the outside option v has a uniform distribution over the range $\left[0,\frac{1}{f}\right]$ with a constant density $f\in(0,1)$. In order to ensure interior solutions we impose the following additional restrictions: the upper bound to compensation $\bar{c} = A$, and in addition

$$A < \min\left\{1, \frac{1}{2f}\right\}$$

which restricts agricultural productivity to be less than one as well as the expected productivity of the land in industry. We will refer to this case as the linear-quadratic-uniform (LQU) case.

3. Analysis and results

We now return to the general model, and will occasionally refer to the LQU case.

3.1. The first best

As a benchmark we characterize the first-best. Here a hypothetical planner selects investments x,y and makes the conversion decision in order to maximize the sum of expected payoffs of landlord and tenants. In this setting the land will be converted, after the investments have been made by the tenants and the landlord, if and only if its value in industry exceeds its value in agriculture, i.e., if $v > pA$. Let $P^* \equiv \int_{pA}^{\infty} f(v)dv$ denote the probability of the land being converted under the first-best. In this case, expected social surplus per plot equals:

$$W(x,y) = pA\left[1-P^*\right] + \int_{pA}^{\infty} vf(v)dv - c_L(x) - c_T(y).$$

In general, there are two effects of increasing x or y: the effect on agricultural productivity conditional on land not being converted and the effect on the probability of land being converted, with higher investments lowering this probability.

The first-order conditions are

$$\frac{\partial W(x,y)}{\partial x} = p_x A\left[1-P^*\right] - c_L'(x) = 0 \tag{4}$$

$$\frac{\partial W(x,y)}{\partial y} = p_y A\left[1-P^*\right] - c_L'(y) = 0. \tag{5}$$

The marginal effects on the probability of conversion can be ignored owing to the Envelope Theorem: since the conversion decision is taken optimally, the owner is indifferent between converting and not converting at the margin.

These conditions are intuitive: they state that optimal level of investments is determined by equating marginal cost of investments to their expected marginal return, the latter equal to the probability of land staying in agriculture times the marginal increase in expected agricultural productivity.

3.2. Tenant incentives

We now turn to the second-best situation, where tenants and landlord behave to maximize their respective payoffs and select their investments independently, with the landlord subsequently deciding whether to sell the plots after observing the realization of

[14] The question of what values of s and c might voluntarily choose, and the welfare effects of regulating these, is studied in Ghatak and Mookherjee (2012).

[15] However, in this case marginal costs are linear and do not approach infinity as investments approach the capacity limit of one. Nevertheless investments will always turn out to lie in the interior of the unit interval.

v. At this stage, the landlord observes the quality $p_i = p(x_i, y_i)$ of each plot $i = 1, \ldots, n$, and will decide to sell if

$$v > c + (1-s)A\frac{1}{n}\sum_{i=1}^{n} p_i.$$

We shall be focusing on symmetric equilibria, where x_i and y_i are independent of i. Nevertheless to check whether it is an equilibrium, we need to check that unilateral deviations are unprofitable.

Let $\hat{P}(y_i; x, y)$ denote $1 - F\left(c + (1-s)A\left\{\frac{1}{n}p(x, y_i) + (1-\frac{1}{n})p(x, y)\right\}\right)$, the probability that the land will be converted when a tenant selects an investment y_i and expects all other tenants to select y and the landlord to select x. His expected payoff is then

$$U_T(y_i; x, y) = sAp(x, y_i)\left[1 - \hat{P}(y_i; x, y)\right] + c\hat{P}(y_i; x, y) - c_T(y_i). \tag{6}$$

The first-order condition for the tenant to optimally choose $y_i = y$ is then (with $P(x,y)$ denoting $\hat{P}(y; x, y)$):

$$\left[sA(1-P) + (spA - c)\frac{1}{n}Af(1-s)\right]p_y = c_T'(y) \tag{7}$$

where P and p are evaluated at x,y and f at $c + (1-s)pA$. The second-order condition is

$$c_T''(y) \geq \Delta_y \tag{8}$$

where $\Delta_y \equiv (1 + \frac{1}{n})s{p_y}^2 A^2(1-s)f + (spA - c)\frac{A^2(1-s)^2}{n}f' p_y^2 + [sA(1-P) + (spA - c)\frac{1}{n}(1-s)Af]p_{yy}$. We focus attention on the generic case where this second-order condition holds strictly, in order to carry out local comparative statics: in the LQU case this can be verified to always hold strictly.[16]

Differentiating the first-order condition (7) with respect to x, we obtain the slope of the tenant's reaction function:

$$y'(x) = \frac{\begin{array}{c}(1 + \frac{1}{n})sp_x p_y(1-s)A^2 f + (spA - c)\frac{A^2(1-s)^2}{n}f' p_x p_y \\ + \left\{sA(1-P) + (spA - c)\frac{1}{n}(1-s)Af\right\}p_{yx}\end{array}}{c_T'' - \Delta_y}. \tag{9}$$

Increasing investment by the landlord affects investment incentives in the following ways. The first and third terms in the numerator of the right-hand-side of (9) represent the effect of a rise in x on the marginal return from agriculture to the tenant's investment. Under the assumption of technical complementarity between the tenant's and landlord's investments, and that the tenant is under-compensated ($spA - c > 0$), both these terms are positive. A higher investment by the landlord reduces the likelihood of the land being converted, raising the tenant's incentive to invest. This strategic complementarity is augmented by the technical complementarity between their respective investments.

The middle term of the numerator of the right-hand-side of Eq. (9) represents the change in the tenant's incentive to manipulate the probability of conversion of the land, as a result of higher investment by the landlord. The sign of this depends on the slope of the density at the initial point, which can be either positive or negative. However, with n large enough (as represented by our assumption (3)) this term will be dominated by the sum of the first and the third terms. This applies even for cases where the tenants are over-compensated, owing to n being larger than the second expression inside the max operator on the right-hand-side of Eq. (3). Hence we obtain (using the term 'reaction function' to denote the symmetric equilibrium choice of investment by tenants, as a function of the (common) investment made by the landlord):

Lemma 1. *The reaction function of tenants is upward sloping.*

The proof of Lemma 1 is based on showing that the numerator of the right-hand-side of Eq. (9) is always positive. Consider first the case where the tenant is under-compensated or exactly compensated ($spA - c \geq 0$). Since $p_{xy} \geq 0$, the third term in the numerator of the right-hand-side of Eq. (9) is non-negative. So it suffices to show that the sum of the first two terms is positive. For this it is enough that $s + (spA - c)\frac{1-s}{n}\frac{f'}{f} > 0$. If $\frac{f'}{f}$ is non-negative this is obviously true, while if it is negative the assumption that the rate of change of f is bounded above by M and $n > \frac{1-s}{s}[1 + sAM]$ ensures this is the case. Now suppose that $spA - c < 0$. Now it suffices that

$$sp_x p_y(1-s)A^2 + \frac{spA - c}{n}\left[A^2(1-s)^2\frac{f'}{f}p_x p_y + (1-s)Ap_{xy}\right] > 0$$

which in turn holds if

$$s > -\frac{spA - c}{n}\left[(1-s)\frac{f'}{f} + \frac{p_{xy}}{Ap_x p_y}\right].$$

Since $spA - c \geq -\overline{c}$, this is ensured by the condition that $n > \frac{\overline{c}(M(1-s)+N)}{s}$, which in turn holds if Eq. (3) is true.

3.3. Landlord incentives

The landlord's expected payoff per plot is

$$U_L(x, y) = (1-s)pA[1-P] + \int_{c+(1-s)pA}^{\infty}(v - c)dF(v) - c_L(x) \tag{10}$$

when choosing an investment of x in each plot and expecting each tenant to invest y. The first order condition for an equilibrium is

$$(1-s)p_x A(1-P) = c_L'(x) \tag{11}$$

and the second-order condition is

$$c_L''(x) \geq \Delta_x \tag{12}$$

where $\Delta_x \equiv (1-s)Ap_{xx}(1-P) + p_x^2(1-s)Af$. We assume this to hold strictly, as it does in the LQU case.[17]

The slope of the landlord's reaction function is

$$x'(y) = \frac{(1-s)^2 p_x p_y A^2 f + (1-s)p_{xy}A(1-P)}{c_L'' - \Delta_x} \tag{13}$$

which is always seen to be positive. Since the landlord himself makes conversion decisions, there is no strategic investment motive akin to the tenant's which incorporates the indirect effect on the likelihood of sale. The other two motives are akin to the tenant's: apart from direct complementarity, higher investments by the tenants make it less attractive for the landlord to sell the land, which in turn motivates the landlord to invest more.

Lemma 2. *The landlord's reaction function is upward sloping.*

3.4. Equilibrium

Since both reaction functions are upward sloping, and investments are contained in a compact interval, the game played between the representative tenant and the landlord is supermodular (Vives, 2007). Standard arguments ensure the existence of at least one pure strategy symmetric Nash equilibrium. If there are multiple symmetric equilibria, they will be Pareto-ordered. However it is not easy to

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[16] It reduces to the condition $\frac{2}{n}s\beta^2 A^2(1-s)f < 1$, which holds since $2s(1-s) \leq \frac{1}{2}$, $Af < 1$, $A\beta^2 < A\beta < 1$.

[17] It reduces to the condition $(1-s)^2\alpha^2 A^2 f < 1$, which holds since $Af < 1$, $A\alpha^2 < A\alpha < 1$.

find general conditions for uniqueness of the symmetric Nash equilibrium.

In the LQU case, however, there is a unique symmetric Nash equilibrium with both investments x,y in the interior of the unit interval, for which the tatonnement dynamic is globally convergent. It is easy to check via direct computation that the parametric restrictions imposed for the LQU example suffice to ensure that for any investment made by the other party (x or y) which lies in the unit interval, the best response (respectively $y(x)$ or $x(y)$) also lies in the unit interval. Moreover, the slopes of the two reaction functions can be checked to be constant:

$$x'(y) = \frac{(1-s)^2\alpha\beta A^2 f}{1-\alpha^2A^2(1-s)^2 f} \tag{14}$$

which is smaller than 1 because $1>(1-s)^2A^2f\alpha(\beta+\alpha)$. Moreover,

$$y'(x) = \frac{(1+\frac{1}{n})s\alpha\beta(1-s)A^2 f}{1-(1+\frac{1}{n})s\beta^2A^2(1-s)f} \tag{15}$$

is smaller than one as $(1+\frac{1}{n})s(1-s)\beta Af(\alpha+\beta)\leq 2s(1-s)\beta Af(\alpha+\beta)<1$.

So there is a unique Nash equilibrium in the LQU case with interior investments. It can be explicitly solved[18]:

$$x = \frac{m_0+m_1n_0+(m_2+m_1n_2)c}{1-m_1n_1}, \quad y = \frac{n_0+n_1m_0+(n_2+n_1m_2)c}{1-m_1n_1} \tag{16}$$

where:

$$m_0 = \frac{(1-s)^2\alpha\gamma A^2 f}{1-(1-s)^2\alpha^2A^2 f}, \; m_1 = \frac{(1-s)^2\alpha\beta A^2 f}{1-(1-s)^2\alpha^2A^2 f}, \; m_2 = \frac{(1-s)\alpha A f}{1-(1-s)^2\alpha^2A^2 f}$$

and

$$n_0 = \left(1+\frac{1}{n}\right)s(1-s)\beta\gamma A^2 f - \left(1+\frac{1}{n}\right)s(1-s)\beta^2A^2 f,$$

$$n_1 = \frac{(1+\frac{1}{n})s(1-s)\alpha\beta A^2 f}{1-(1+\frac{1}{n})s(1-s)\beta^2A^2 f}, \quad n_2 = \frac{\beta Af\{s(1+\frac{1}{n})-\frac{1}{n}\}}{1-(1+\frac{1}{n})s(1-s)\beta^2A^2 f}.$$

In what follows for the general case, we shall focus on the properties of any Nash equilibrium which is locally stable in the sense that $y'(x)x'(y)<1$, where the slopes of the reaction functions are given by Eqs. (9) and (13). Standard arguments ensure generic existence and local uniqueness of at least one such equilibrium.[19] Global uniqueness of Nash equilibrium is therefore not needed for our analysis.

3.5. Effects of varying compensation c

Differentiating the landlord's first order condition (11) with respect to c:

$$x_c = \frac{(1-s)p_x Af}{c_L''-\Delta_x} + x'(y)y_c. \tag{17}$$

The first term on the right-hand-side is the direct effect of higher compensation on the landlord's incentive to invest, while the second term is the reaction to the tenant's change in investment. Using the second-order condition, the direct effect is positive. In other words, the landlord's reaction function shifts 'outwards'.

To examine the effect on the tenant incentives, differentiate the first order condition (7) to obtain:

$$y_c = \frac{\left\{s-\frac{1}{n}\left[(1-s)-(spA-c)(1-s)\frac{f'}{f}\right]\right\}Afp_y}{c_T''-\Delta_y} + y'(x)x_c. \tag{18}$$

Condition (3) ensures that n is large enough that the term in the numerator of the first term on the right-hand-side of Eq. (18) is positive. Intuitively, we can ignore the possibility of any single tenant's investment incentive being dominated by strategic manipulation of the probability of conversion. Hence the direct impact dominates, i.e., a rise in compensation lowers the probability of a sale, raising the tenant's incentive to invest. For a given investment by the landlord, then, the tenant's investment rises — the latter's reaction function also moves outwards.

The second term in the right-hand-side of Eq. (18) reflects the additional effect of the rise in c induced by the change in the landlord's investment. Using Eq. (17), we obtain the net effect:

$$y_c = [1-y'(x)x'(y)]^{-1} \times \left[y'(x)\frac{(1-s)p_xAf}{c_L''-\Delta_x} + \frac{s-\frac{1}{n}\left[(1-s)-(spA-c)(1-s)\frac{f'}{f}\right]Afp_y}{c_T''-\Delta_y}\right].$$

Local stability implies $y'(x)x'(y)<1$. By Lemma 1, $y'(x)>0$. Hence Eq. (3) implies $y_c>0$. Since $x'(y)>0$ by Lemma 2, it also follows that $x_c>0$. We thus arrive at the following result.

Proposition 1. *Starting with any locally stable Nash equilibrium, an increase in c induces both tenants' and landlord's investments to rise.*

3.6. Welfare implications

Consider the associated welfare implications of changing mandated compensation. To obtain some intuition here, it is helpful to distinguish between three effects we need to incorporate: on the tenant's investment, on the landlord's investment, and on the conversion decision. We have seen that the former two effects are positive. The resulting welfare effects will be positive, provided both tenant and landlord are under-investing to start with. This is indeed the case, as we now show.

Excluding investment costs, (gross) social welfare GW can be expressed as a function of p, the probability of conversion:

$$GW = ApF(c+(1-s)pA) + \int_{c+(1-s)pA}^{\infty} v\,dF(v) \tag{19}$$

whereupon it follows that

$$\frac{\partial GW}{\partial p} = A[F+(1-s)pAf]-f(1-s)A[c+(1-s)pA]. \tag{20}$$

The corresponding expression for the expected (gross) payoff of the tenant excluding investment costs is

$$GU_T = sApF(c+(1-s)pA) + c[1-F(c+(1-s)pA)] \tag{21}$$

implying

$$\frac{\partial GU_T}{\partial p} = sA[F+(1-s)pAf]-f(1-s)Ac \tag{22}$$

which is seen to be below Eq. (20). The corresponding expected (gross)

[18] The restriction that $c\leq A<1$ along with the other restrictions ensure these investments are less than one.

[19] For instance, if we introduce a parameter which affects marginal costs of investment monotonically, the existence and local uniqueness of locally stable equilibria can be ensured for a set of such parameter values of full Lebesgue measure, using standard transversality arguments (Mas-Colell et al., 1995, Proposition 17.D.3).

payoff of the landlord excluding investment costs

$$GU_L = (1-s)ApF(c + (1-s)pA) + \int_{c+(1-s)pA}^{\infty} v dF(v) \tag{23}$$

so that

$$\frac{\partial GU_L}{\partial p} = (1-s)A[F + (1-s)pAf] - f(1-s)A[c + (1-s)pA] \tag{24}$$

which is also below Eq. (20). Therefore:

Lemma 3. *Both landlord and tenants under-invest.*

This implies that if tenants and landlord invest more, utilitarian welfare will rise. What about the third effect, on the probability of conversion? Increasing c lowers the probability of conversion. If the tenants are under-compensated the landlord has a socially excessive incentive to convert, as he ignores the adverse consequence of conversion on the tenants' payoffs. Hence *all three distortions are ameliorated* upon raising the mandated compensation, if the tenants are under-compensated to start with. This is the main result of this paper:

Proposition 2. *Consider any locally stable Nash equilibrium in which tenants are under or fully-compensated ($spA - c \geq 0$). Then a small increase in the compensation will raise welfare, as well as the expected utility of each tenant. Hence at a welfare optimum tenants must be over-compensated.*

It may be helpful to verify the argument for this directly, instead of relying on the intuition provided above. Differentiating the tenant's payoff with respect to c, and using the first-order condition (7):

$$\frac{\partial U_T}{\partial c} = (spA - c)\left[1 + (1-s)A\left\{p_x x_c + \left(1 - \frac{1}{n}\right)p_y y_c\right\}\right] + sA(1-P)p_x x_c + P. \tag{25}$$

The first term is the effect of raising c, both directly and through induced effects on investments by others (the landlord and other tenants), on the under-compensation effect. The former lower the probability of a sale, if Proposition 1 applies, which raises each tenant's utility if they are being under-compensated in the event of a sale. The second effect is the direct effect of changes in investments of the landlord on the expected return to the tenant from agriculture. The third term is the direct effect on expected compensation, which is proportional to the probability of sale. The induced effect on own investments can be ignored owing to the Envelope Theorem.

The corresponding effect on the landlord's per plot payoff is

$$\frac{\partial U_L}{\partial c} = (1-s)p_y y_c A(1-P) - P \tag{26}$$

as the Envelope Theorem implies that effects operating through own investments and the sale decision can be ignored, leaving only the effect of changes in tenants investments on the landlord's expected crop share and the marginal financial cost of the compensation, equal to the probability of sale.

Combining Eqs. (25) and (26), the welfare (per plot) impact equals

$$\frac{\partial(U_L + U_T)}{\partial c} = (spA - c)\left[1 + (1-s)A\left\{p_x x_c + \left(1 - \frac{1}{n}\right)p_y y_c\right\}\right] + \left[sp_x x_c + (1-s)p_y y_c\right]A(1-P) \tag{27}$$

i.e., the sum of the effect on expected under-compensation of the tenant, and the external effect of investments of each party on the other. Combining the effects of all of the previous results, Proposition 2 now obtains.

A key factor driving all of the above results is the fact that the tenant is getting a surplus that the landlord cannot extract. In similar models of tenancy, limited liability constraints combined with low wealth of tenants enable them to earn rents. Here the contract is set by law and this itself could generate rents for the tenant. Still, even if a legal share is stipulated at s, to the extent the landlord can charge a fixed fee that reduces the tenant's payoff down to the reservation level, say, $\overline{u}$, the rents will disappear. Such fixed charges are not feasible for poor tenants who lack the wealth to pay them in states of the world where agricultural output turns out to be unexpectedly low owing to random external shocks. If such fixed charges could be collected, and the landlord could commit ex ante to a compensation payable to the tenant in the event of conversion, the over-conversion result would no longer hold. To see this, suppose the landlord can charge a fee t ex ante from the tenant although the incentive problems are as above. In that case, the landlord can set

$$t = U_T - \overline{u}$$

where U_T is the gross expected payoff of the tenant as defined above. Given this, the landlord's net expected payoff is

$$U_L + t = U_L + U_T - \overline{u}$$

where U_L is the gross expected payoff of the landlord as defined above. Since $U_L + U_T$ is expected social surplus, despite the incentive problems or the fact that s is legally stipulated, the landlord's decisions will be the same as the second-best surplus maximizing one.

Note that whether or not the tenants are under-compensated is not a condition on the primitives of the model. It entails a comparison between the compensation and loss experienced by tenants in the event of a sale, and the latter depends on the expected yield from the land, which depends in turn on investments. What is the connection between the compensation level c fixed by policy, and the extent of undercompensation $spA - c$? Does raising compensation necessarily lower the extent of undercompensation? This may not be the case if raising compensations raise the investment levels by a lot, so that the expected loss of tenants increases by more than the compensation amount.

We have been able to answer this question in the LQU case.

Proposition 3. *Consider the LQU case. Then there exists a level of compensation $c^* > 0$ such that the tenant is under, exactly and over-compensated whenever c is respectively smaller than, equal to, or bigger than c^*. Increasing c lowers the extent of under-compensation in this case.*

The proof of this involves detailed but straightforward calculations of the Nash equilibrium in the LQU case, which we omit.

We have not been able to obtain any definite result concerning the effect of c on the landlord's utility. This bears on the question whether the landlord would voluntarily offer some compensation to the tenant, and the need for regulating compensation. The landlord gains owing to increased investment of the tenant, but loses on account of the higher compensation in the event of a sale. From Eq. (26) the landlord is worse off as long as

$$(1-s)p_y y_c A < \frac{P}{1-P}. \tag{28}$$

In the LQU case, this condition is satisfied if f is sufficiently close to 0, as P tends to 1 while the left-hand-side of (28) tends to 0 (as y_c tends to 0). This is to be expected: the land will then be sold with probability approaching one, so the benefits of enhanced agricultural productivity are negligible while the financial cost of compensation is sizeable. We need to examine whether the opposite is true when f is large. Given the parameter restrictions in the LQU case where $A < \frac{1}{2f}$, we have an upper bound $\frac{1}{2A}$ to the value of f. What happens as f approaches this bound? The land will be sold with a probability of at least one half, implying a lower bound of 1 to the right-hand-side of Eq. (28). If the left-hand-side (which is a constant in the LQU case) is less than one, the landlord will always be worse off as c rises.

4. Extensions

Now we check the robustness of the main result to departures from various assumptions made so far.

4.1. Landlord's choice of s

So far we took s as exogenous, determined by a legal mandate. Might the landlord prefer to offer a higher share to the tenants, in the interest of motivating them to invest more? One presumes that if the legal floor on s is high enough the landlord would not want to offer the tenants a higher share, owing to the fact that it lowers the share accruing to the landlord the effect of which would outweigh any benefit resulting from higher investments made by tenants. Moreover, in this setting with endogenous conversion of land, there is a reason why increasing the share of the tenants may reduce their investment incentive. For a higher share accruing to tenants would make the landlord more inclined to sell the land, which would reduce the security of the tenants. If the tenant's investment incentive actually declined as a result, the landlord would never benefit from offering a higher share.

We verify this latter reason alone will make the landlord unwilling to offer a higher share to tenants beyond some legally mandated value of s. It can be checked that a sufficient condition for the tenant's investment to decline with higher s as a result of the effect on the landlord's conversion incentive is that[20]

$$\frac{F}{f} < pA\left[s - \frac{1}{n}(1-s) + (spA-c)(1-s)\frac{1}{n}\frac{f'}{f}\right] + (spA-c)\frac{1}{n}. \quad (29)$$

Specializing to the case of a uniform distribution where the density f is a constant and the support of the distribution is $\left[0, \frac{1}{f}\right]$, condition (29) reduces to

$$s > \frac{1}{2}\left[1 + \frac{c}{pA}\right] \quad (30)$$

implying that the tenant invests less when s rises as long as

$$s > \frac{1}{2}\left[1 + \frac{c}{p(0,0)A}\right]. \quad (31)$$

Hence if the legally mandated floor to s lies above the right-hand-side of Eq. (31), the landlord will not want to offer the tenants a higher share than mandated. This bound depends on c. If $c = 0$, note that this bound equals $\frac{1}{2}$. If the legally mandated compensation c is set at some constant fraction β of the loss spA suffered by the tenant, another bound on s is

$$s > \frac{1}{2-\beta}. \quad (32)$$

[20] This condition ensures that the tenants' reaction function shifts 'inwards'. Since the rise in s causes the landlord's reaction function to also shift inwards, the result follows from the complementarity between their investments.

4.2. Where landlord shares the surplus from conversion with the industrialist

Now consider what happens when the landlord shares the surplus resulting from conversion with the industrialist, as a result of Nash bargaining. Then the condition for conversion to take place is unaffected, as the joint benefit to the landlord and the industrialist has to exceed the compensation c that has to be paid to the tenants, and the former is still $v-(1-s)pA$. This implies that the expressions for the tenants' payoff and incentives are unaffected. However, the landlord's benefit from conversion is now $\frac{v-c-(1-s)pA}{2}$, and his actual payoff conditional on conversion is $\frac{v-c(1-s)pA}{2}$ instead of v. The main difference is that the landlord's payoff from conversion is itself a function of the compensation c as well as the landlord's payoff $(1-s)pA$ from the land in agriculture which matters as it forms the status quo for the bargaining with the industrialist. A higher value of the land in its agricultural use therefore provides a strategic advantage to the landlord by affecting his outside option in bargaining with prospective buyers. As we shall see below, this will increase the landlord's investment incentive considerably, which may induce over-investment by the landlord. This may in turn cause the welfare effects of increasing compensation to be reversed.

The landlord's expected payoff is now (where we normalize by setting $A = 1$):

$$U_L = (1-s)pF(c+(1-s)p) + \int_{c+(1-s)p}^{\infty} \frac{v-c+(1-s)p}{2} df(v) - c_L(x) \quad (33)$$

implying that

$$\frac{\partial GU_L}{\partial p} = (1-s)[F + (1-s)fp] + \frac{(1-F)(1-s)}{2} \quad (34)$$

where $GU_L \equiv U_L + c_L(nx)$ denotes the landlord's payoff gross of investment costs. Hence the landlord over-invests if Eq. (34) exceeds expression (20) for $\frac{\partial W}{\partial p}$, i.e.,

$$s[F + (1-s)fp] < f(1-s)[c+(1-s)p] + \frac{(1-F))(1-s)}{2}. \quad (35)$$

We now argue that there exist distributions F for which the results of the preceding section will get reversed. For instance, consider a situation where the value of the industrial project is so much larger than the value of the land used in agriculture that the land is very unlikely ex ante to be retained in agriculture. The maximum value of the land in agriculture is 1, since we have set $A = 1$. Consider compensation values $c \le A$, and suppose F and f evaluated at any $v \le 1$ are close to zero. Then condition (35) will hold, implying that the landlord will over-invest. With the land almost sure to be converted to industrial use, investment in the land for agricultural purposes has almost no social value. Yet the landlord continues to invest in order to boost his bargaining power vis-a-vis the industrialist.

With such a distribution over the industrial value v, the tenant's investment incentive will nearly vanish, as is evident from inspecting the first-order condition (7) for the tenant's investment. Since the welfare optimal level of investment is also close to zero, the tenant's under-investment tends to vanish. So from a welfare standpoint the dominant consideration is the over-investment of the landlord.

From Eq. (34) it is evident that an increase in c increases the landlord's investment incentive if

$$\frac{1}{2} > (1-s)\frac{-f'}{f} \quad (36)$$

which is satisfied in the case of a uniform distribution, or more generally if the density function f does not fall too fast. In such cases, increasing the tenant's compensation will encourage greater investment by the landlord, which will lower welfare if the landlord over-invests. Hence our previous result concerning socially desired levels of compensation is reversed.[21]

Proposition 4. *Suppose the landlord and the industrialist share the surplus from conversion of land via Nash bargaining, and we set maximum agricultural production A equal to 1. Consider any sequence of distributions F_m, $m = 1,2,..$ such that $F_m(1) \to 0$ as $m \to 0$, which satisfies condition (36) for all m. Then if the distribution over industrial value v is given by F_m where m is sufficiently large, increasing the mandated compensation c over the range [0,1] lowers welfare, and it is socially optimal to set the required compensation at 0.*

One case, however, where our earlier result continues to apply is when the technology is such that the landlord has no role to play in investing in agricultural improvement, whence only the tenant's investment incentives matter. If we consider a technology where p is independent of x, our earlier result continues to apply.

Proposition 5. *Suppose the landlord and the industrialist share the surplus from conversion of land via Nash bargaining, and there is no scope for the landlord to make any investments (p is independent of x, but strictly increasing and concave in y). Then if the tenant is under-compensated, welfare and the tenant's investment rise in c; hence at a welfare optimum the tenant must be over-compensated.*

5. Concluding comments

In this paper we have provided an analysis of compensation policy for farmers displaced by the process of industrialization. The need for such a policy arises from contracting frictions which take the form of a two-sided moral hazard problem with limited liability for tenants. There are distortions associated with specific investments made by tenants and landlords that are made to improve agricultural productivity, with a general tendency towards under-investment. Moreover, the limited liability of tenants implies that they earn a surplus that is not extracted by the landlord in the form of a fixed rent. This in turn implies that the landlord has a socially excessive tendency to convert the land to industrial purposes, as his private profit calculus ignores the loss of rents suffered by tenants in the process. Mandating compensation to the tenant in the event of conversion affects three distortions: the landlord's incentive to convert the land, and the specific investments of the landlord and tenant. We provided conditions under which economic efficiency dictates the tenants be over-compensated, in the sense that the tenants would be better off in the event of conversion. Otherwise if the tenants were under-compensated, a small increase in the compensation policy would reduce the size of each of the three distortions: it would reduce the incentive of the landlord to convert, thus raising the probability of retaining the land for agricultural use, which would boost investment incentives of both landlords and tenants. To these arguments would be added considerations of equity and political stability, in cases where tenants are substantially poorer than landowners or industrialists.

Our analysis was based on a model which abstracted from a number of significant real-world issues. One is the possibility that industrialists are privately informed about the value of the land in industrial use.[22] However, the landlord would have an incentive to extract this information through competitive bidding. If full extraction is not possible, the landlord would have to share the surplus with the industrialists that purchase the land. In that case we expect the analysis of the previous section would continue to apply, and our main result would continue to be valid provided the landlord's own investment role is negligible. If this is not the case, the landlord may have a socially excessive incentive to invest in agricultural quality of the land in order to raise his reservation utility in bargaining with investors. Raising the compensation level would then improve the distortions associated with the decision to convert, and raise the tenant's investment incentive, at the cost of aggravating the distortion involved in the over-investment of the landlord. These distortions would have to be traded off against each other.

A major assumption is that the supply of land is fixed ex ante. In the context of agricultural land this assumption may be quite reasonable. It is less reasonable in the context of real estate or industrial property. In the latter contexts mandating compensation to tenants will be likely to reduce the ex ante profitability for landlords to invest in real estate or property in the first place, generating an additional distortion of the sort emphasized in the traditional literature on effects of rent control or minimum wage laws. In the context of land, however, this distortion is unlikely to be important.

Another issue we abstracted from is heterogeneity across farmers and plots. It is unlikely that judicial authorities will be able to measure the quality of each individual plot leased and calibrate compensations based on such valuations. It is more likely that some kind of average valuation of land in the area will be used to set a standard rate of compensation, whereupon some tenants will end up being under-compensated. We conjecture that our results will continue to extend with regard to the average rate of compensation, i.e., on average, displaced farmers ought to be over-compensated. Nevertheless, the exact details of such an extension need to be worked out. The model also abstracted from considerations of risk-aversion. We conjecture, however, that risk aversion of tenants will further strengthen the case for fully compensating them.

We assumed for most part that the share of the tenants and the compensations paid in the event of conversion were determined by policy mandates. This can be rationalized if landlords cannot commit to paying tenants ex post more than the legal mandate. However, reputational considerations may allow landlords to offer more than is legally mandated. We provided a condition (on the mandated share) which guarantees that the landlord would not wish to offer a larger share ex ante even if he could commit to it. Nevertheless a fuller analysis of this issue is needed; this issue is analyzed in detail in a companion paper (Ghatak and Mookherjee, 2012).

This latter paper also shows that welfare arguments for over-compensation may not apply when the number of tenants is small. In the case of a single tenant, for instance, the threat of selling the land and not compensating the tenant can serve as a powerful incentive device to motivate the tenant to supply high levels of investment. This incentive effect is analogous to the disciplinary role of takeovers emphasized in the literature on corporate governance.

[21] In the following result we introduce a hypothetical sequence of distributions over v which converge to a limiting distribution in which the land is retained in agriculture with zero probability, in order to make precise the sense in which the industrial value can be sufficiently large relative to agricultural use, while still allowing the land to be retained in agriculture with positive (but negligible) probability. The latter is needed in order to ensure that the interior first-order-conditions still characterize equilibrium investments.

[22] See Ghatak and Ghosh (2011) for one approach to this problem.

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