A Proofs

Proof of Proposition 1. (i) Without the future term, the objective in (2) changes at the rate $b+q>0$ per centner for $X_D < T_D$ and at the rate $b-q_O<0$ for $X_D > T_D$, so it is maximised at $X_D = T_D$. The future term is non-increasing in every x_i, so it cannot make a total above T_D optimal, and by the condition on q it cannot make a total below T_D optimal. Hence $X_D = T_D$.

(ii) and (iii). Impose $X_D = T_D$ with multiplier λ_D and write the Lagrangian $\mathscr{L} = bT_D - \delta_O \sum_i [v(\bar{a}_i) - v(a'_i)] + \lambda_D (T_D - \mu_D A_V - \zeta_D A_F)$. Let χ_i equal one if farm i is short of seed and zero otherwise; then $\partial a'_i / \partial x_i = -(\varphi/\varsigma)\chi_i$. Write $\bar{\mathbb{E}}_V[z] = \sum_{i \in V_D} z_i n_i \bar{a}_i / A_V$ and $\bar{\mathbb{E}}_F[z]$ likewise, the averages per statutory centner. Then

$$\frac{\partial \mathscr{L}}{\partial \mu_D} = -A_V \left[\delta_O (\varphi/\varsigma) \bar{\mathbb{E}}_V[v'(a'_i)\chi_i] + \lambda_D \right], \qquad \frac{\partial \mathscr{L}}{\partial \zeta_D} = -A_F \left[\delta_O (\varphi/\varsigma) \bar{\mathbb{E}}_F[v'(a'_i)\chi_i] + \lambda_D \right].$$

At an interior μ_D the first derivative is zero, so $\lambda_D = -\delta_O (\varphi/\varsigma) \bar{\mathbb{E}}_V[v'\chi]$. Substituting into the second,

$$\frac{\partial \mathscr{L}}{\partial \zeta_D} = -A_F \, \delta_O (\varphi/\varsigma) \left(\bar{\mathbb{E}}_F[v'(a'_i)\chi_i] - \bar{\mathbb{E}}_V[v'(a'_i)\chi_i] \right).$$

On the failed farms $\chi_i = 1$ and a'_i is below the area of every short farm in V_D; since v is concave, $v'(a'_i)$ on a failed farm exceeds v' on every short farm in V_D, and $\chi_i \le 1$ lowers the second average further. The bracket is therefore positive and $\partial \mathscr{L}/\partial \zeta_D$ is negative for every $\delta_O > 0$, so ζ_D falls to its lower bound of one. The sign of $\partial \mathscr{L}/\partial \zeta_D$ does not depend on δ_O, which is (iii). With $\zeta_D = 1$ and $X_D = T_D$, $\mu_D = (T_D - A_F)/A_V$. □

Proof of Proposition 2. (i) Let v_1 and v_2 be bounded. For any shortfall the two maximisations in (8) run over the same interval, and their objectives differ by at most $\delta \sup |v_1 - v_2|$; hence the operator on the right of (8) is a contraction of modulus δ in the supremum norm, and by Banach's theorem it has a unique bounded fixed point. If v is non-decreasing, then w in (9) is non-increasing in σ; since $x(y,a)$ is non-decreasing in a and the shortfall $\sigma(y,a)$ is non-increasing in a (the residual rises with a because $x_a \le y$), the operator maps non-decreasing functions into non-decreasing functions, and the fixed point is non-decreasing.

(ii) In (9) the maximand $\delta v(a') - (1+\lambda)\varsigma a'$ is single-peaked at a^*. Its maximiser over $[\bar{a} - \sigma/\varsigma, \, \bar{a}]$ is $\max\{a^*, \, \bar{a} - \sigma/\varsigma\}$. Substituting into $r = \sigma - \varsigma(\bar{a} - a')$ gives $r^* = \max\{0, \, \sigma - \varsigma(\bar{a} - a^*)\}$, which is (10).

(iii) The tolerance is zero if and only if $a^* = \bar{a}$, that is, if and only if the maximand is non-decreasing at $\bar{a}$, which under single-peakedness is $\delta v'(\bar{a}) \ge (1+\lambda)\varsigma$. Under full filling the farm returns to $\bar{a}$ every spring, so $v(a) = \mathbb{E}[x(y,a)] - (1+\lambda)\,\mathbb{E}[\sigma(y,a)] + \delta v(\bar{a})$. The shortfall is continuous in the residual at both boundaries of the seed-constrained regime, so v may be differ-

entiated under the expectation. Inside the regime the shortfall falls with the residual at the rate φ, and the residual rises with the area at the rate $y - x_a$; outside it the shortfall is zero. Hence $v'(\bar{a}) = \mathbb{E}[x_a] + (1+\lambda)\varphi\,\mathbb{E}[(y-x_a)\chi]$. □

B The Reporting Game

Assumption 1 of Section 5 states that the obligatory delivery was computed from the registered sown area and that neither the farm's report of its harvest nor an assessment of it entered the claim. This appendix derives that property from the form of the claim and sets out the evidence in the accounts that is consistent with it. The quantity of grain the state required a farm to deliver, its claim on the farm, had to be computed from something the state could observe. Soviet procurement used two quantities for this purpose: the farm's harvest and the area the farm had sown. Above the farm the harvest was not measured directly: it was either reported by the farm from its own barn or estimated by a commission from the standing crop. A claim computed from the harvest could therefore be influenced from both sides: the farm could understate its harvest, and the official who assessed it could overstate it. I call this interaction the reporting game. The sown area, by contrast, was recorded before the harvest and could be checked by inspection, so a claim computed from it could not be influenced through the harvest by either side. Section B.1 formalises this distinction in a model in which the claim is a weighted combination of the assessed harvest and the sown area; when the weight on the harvest is zero, neither the farm nor the assessor gains from misreporting (Proposition B.1). Section B.2 describes the three claims that stood on a collective farm in 1933, one computed from sown area and two from the harvest, and Table B.1 summarises the evidence on each. Within a district, the grain delivery did not vary with the farm's own harvest (Section B.3). The fee paid to the machine-tractor station varied with the farm's harvest approximately in proportion, and the harvest from which it was computed exceeded the harvest recorded in the farm's barn (Section B.4). Under the flax contract, which remained a claim on output, the crop recorded in 1933 was a small fraction of the crop recorded the following year (Section B.5). The two claims on grain were set independently of each other (Section B.6); this independence is Assumption 2 of Section 5.

B.1 The Model

Consider one farm in one year. The farm harvests H centners of grain. The harvest is known to the farm but not to the state. Before the harvest, the farm sows $\bar{a}$ hectares; the area is entered in a land register, which officials can check. The state requires the farm to deliver T centners of grain. The claim T can be computed in two ways. Under a crop share, the farm delivers a fraction τ of its

harvest. Under a land tax, the farm delivers a fixed quantity n per hectare sown; I call n the norm. To treat both forms in one framework, let the claim be a weighted combination of the two, with weight θ on the crop share:

$$T = \theta\tau\hat{H} + (1-\theta)\,n\bar{a}, \qquad 0 \le \theta \le 1. \tag{B.1}$$

The harvest that enters equation (B.1) is $\hat{H}$, the harvest as assessed for the purpose of the claim, rather than the true harvest H. The two differ when the farm conceals part of its harvest, so that the harvest it reports falls short of the true harvest by $h \ge 0$ centners, and when the official who assesses the farm's harvest, whom I call the assessor, adds $o \ge 0$ centners to the assessment in order to raise the claim. Hence

$$\hat{H} = H - h + o. \tag{B.2}$$

Both actions are costly. Concealing grain requires labour and hiding places and exposes the farm to prosecution; the law of 7 August 1932 made the theft of collective property a capital offence (Davies and Wheatcroft, 2004). Let $c_F(h)$ denote the farm's cost of concealing h centners. Overstating the harvest exposes the assessor to sanction; the law of 19 January 1933 prohibited any delivery obligation above the norm (art. 17; Sovnarkom SSSR and TsK VKP(b), 1933d), and the order of 20 June 1933 made the imposition of a supplementary plan a criminal offence (art. 5; Sovnarkom SSSR and TsK VKP(b), 1933a). Let $\kappa_O c_O(o)$ denote the assessor's cost of overstating the harvest by o centners, where $\kappa_O > 0$ measures the severity of the sanction. Both cost functions are zero at zero, increasing and strictly convex, and their marginal costs rise from zero without bound.

The farm's payoff is the harvest it retains net of the cost of concealment, $H - T - c_F(h)$. The assessor is judged by the quantity collected. Let $B' > 0$ denote the value to the assessor of one additional centner delivered; the assessor's payoff is $B'T - \kappa_O c_O(o)$. The farm chooses h and the assessor chooses o. The marginal payoffs are

$$\frac{\partial}{\partial h}\left[H - T - c_F(h)\right] = \theta\tau - c_F'(h), \qquad \frac{\partial}{\partial o}\left[B'T - \kappa_O c_O(o)\right] = B'\theta\tau - \kappa_O c_O'(o). \tag{B.3}$$

The marginal benefit of concealment to the farm is $\theta\tau$: removing one centner from the assessed harvest lowers the claim by $\theta\tau$ centners. The marginal benefit of overstatement to the assessor is $B'\theta\tau$: adding one centner to the assessed harvest raises the claim by $\theta\tau$ centners, each worth B' to the assessor. Both marginal benefits are proportional to $\theta\tau$. Neither depends on the norm, on the sown area, on the true harvest, or on the other agent's action.

In a numerical example, suppose that a farm sows 100 hectares and harvests 500 centners. Under a land tax with a norm of 2 centners per hectare ($\theta = 0$), the farm owes 200 centners,

whether it reports 500 centners or 400 and whether the assessor records 500 or 600. Under a crop share of one fifth ($\theta = 1$, $\tau = 0.2$), the farm owes 100 centners if it reports its harvest truthfully and 80 if it reports 400, so concealing 100 centners saves it 20. If the assessor records 600 centners, the farm owes 120, so the 100 centners added bring in 20. Under the land tax, neither side gains anything by misreporting the harvest. Proposition B.1 states the general result.

Proposition B.1. *Let $\tau > 0$, and let c_F and c_O satisfy the assumptions above. (i) If $\theta = 0$, the unique equilibrium is $h^* = o^* = 0$. (ii) If $\theta > 0$, the unique equilibrium is $h^* = (c_F')^{-1}(\theta\tau) > 0$ and $o^* = (c_O')^{-1}(B'\theta\tau/\kappa_O) > 0$; both are strictly increasing in $\theta\tau$.*

Proof. If $\theta = 0$, the farm's payoff is $H - n\bar{a} - c_F(h)$, which is strictly decreasing in h, and the assessor's payoff is $B'n\bar{a} - \kappa_O c_O(o)$, which is strictly decreasing in o. Each is maximised at zero, whatever the other agent does. If $\theta > 0$, each payoff is strictly concave in the agent's own action and has a positive derivative at zero, $\theta\tau$ for the farm and $B'\theta\tau$ for the assessor. Each first-order condition in (B.3) therefore has a unique root, and the root increases with $\theta\tau$ because marginal cost is increasing. In both cases the optimal action of each agent does not depend on the action of the other, so the equilibrium is in dominant strategies. □

When the claim is computed entirely from sown area, neither the farm nor the assessor gains from misreporting the harvest, whatever the share rate and whatever the penalties. The farm's report does not affect what it owes, and the assessment is not a decision. When any part of the claim is computed from the harvest, both misreport, and the quantity collected is the joint result of concealment by the farm and overstatement by the assessor. The higher the share rate, the larger both distortions.

The proposition concerns the harvest, not the land. A claim computed from sown area gives the farm an incentive to understate its area and an official an incentive to overstate it. The Soviet state inspected the register: the yield commissions verified the sown area (Section 2), and the sowing plan for the following year was based on the area last recorded. Across the 31 agricultural districts of Sverdlovsk oblast, the logarithm of a district's 1934 collective sowing plan rose with the logarithm of its recorded 1932 sown area with a coefficient of 0.86 (R^2 0.90). In the paper the registered area is treated as verified. The model covers a single year, whereas in the Soviet case an intertemporal consideration made a claim on the harvest still less attractive to the farm. Under the contract system in force until 1932, the quantity a farm had to deliver was apportioned to it on the basis of its expected harvest and could be raised during the year where the crop looked good (Section 2). A farm that revealed a good harvest could therefore expect a higher claim in the same year and in the next. Under the norm introduced in 1933, the following year's obligation was again computed from sown area, so a harvest revealed in one year did not raise the claim in the next.

The laws and decrees of 1933 fixed a value of θ for each claim on a collective farm. The law of 19 January 1933 computed the grain delivery from the hectares of planned spring sowing and actual winter sowing at a norm per hectare (arts. 1 and 2; Sovnarkom SSSR and TsK VKP(b), 1933d): $\theta = 0$. The decree of 5 February 1933 computed the fee to the machine-tractor station as a percentage of the farm's gross harvest, with the gross harvest fixed for each farm by a district commission (decree no. 346, arts. 9 to 12; Sovnarkom SSSR, 1933): $\theta = 1$, with $\hat{H}$ the commission's figure and τ the percentage due for the operations performed, about 9 per cent of the gross harvest on the farms in the panel (Section 3). The decree of 11 August 1933 kept flax under contract: the farm owed the procurement agency Zagotlen a quantity of fibre and seed fixed in a contract enforceable in court, and kept whatever remained after delivery (decree no. 370, arts. 1 to 3; Sovnarkom SSSR and TsK VKP(b), 1933c). Flax was not brought under obligatory delivery and no norm per hectare was set for it, so the claim on flax was computed from the crop: $\theta = 1$. Proposition B.1 therefore predicts that neither the farm nor the assessor misreported under the grain delivery, and that both did under the station's fee and under the flax contract, more under the flax contract, which took a far larger share of the crop, than under the fee (Section B.5). Since all three claims were levied on the same farms in the same year, the prediction can be compared with the accounts within a farm-year, holding the harvest, the weather, the district and the officials constant. Table B.1 summarises the evidence.

The form of the 1933 law corresponds to the optimal contract in models of costly state verification (Townsend, 1979; Border and Sobel, 1987), in which the principal sets a fixed payment and verifies the agent's circumstances only when the agent reports that it cannot pay. In 1933 the fixed payment was the norm, and verification took the form of the yield commissions' certification of a failed harvest (Section 2); the treatment of the farms so certified is examined in Sections 5.4 and 6.2.

B.2 Three Claims on One Farm

In 1933 a collective farm of Sverdlovsk oblast stood under three claims of two forms (Section 2). The obligatory delivery was computed from the registered sown area at the district norm, $\theta = 0$, at 1.8 centners per hectare at the median farm. The station's fee was computed from the harvest a district commission assessed for the farm, at the statutory percentages for the operations performed, $\theta = 1$ with a rate of about 9 per cent of the harvest on the panel's payers. The flax contract was a claim on the crop at a quantity and quality fixed in the contract, $\theta = 1$; the accounts put the state's take at 0.69 of the farm's flax seed harvest at the median farm and at the whole harvest on three farms in ten. Table B.1 sets the three claims side by side: the base and who fixed it, the elasticity of the claim to the farm's own harvest within a district-year, and the relation between the base and

the harvest in the barn.

Table B.1: Three claims on one farm, 1933: the evidence on each.

	obligatory delivery	station fee	flax contract
base	registered sown area	assessed harvest	contracted output
weight on the harvest, θ	0	1	1
rate	1.8 centners per hectare at the median farm	0.086 of the harvest at the median payer	state tax 0.69 of the farm's own flax seed harvest at the median; 1.00 on 29 per cent of farms
who fixed the base	the register, checked by the commissions	the district commission, on the inter-district commission's yield	the contract with Zagotlen
elasticity of the claim to the farm's own harvest within district-year, 1933	-0.006 (0.047), 180 farms	1.64 (0.74), 53 farms; statutory 1.0	not estimated
1934	-0.056 (0.040), 224 farms	0.98 (0.39), 106 farms; statutory about 1.4	not estimated
the base against the barn harvest	the barn does not enter	assessed over barn: median 1.23, mean 1.59, 45 farms; standard deviation of the log 0.44, against 0.21 on the 25 farms whose bill the station measured itself	recorded seed yield 0.26 centners per hectare in 1933 against 1.41 in 1934; 34 farms with a sown area and no flax entry
in 1934		barn yield band below the assessed band on 84 per cent of 74 served farms	flax area 12,941 to 6,311 hectares; 55 per cent of the flax seed sown bought, against 3 per cent of grain seed

Notes. Delivery: Table 3, panel B. Fee: log fee per hectare of station work on log yield within districts, farms with a spring yield of at least three centners per hectare, standard errors clustered by district; the statutory elasticity is one under a share of the harvest and about 1.4 under the 1934 schedule of quantities by yield band; the assessed harvest is recovered from the fee under the statutory percentages of decree no. 346 on the farms whose fee was mostly for field work, after excluding nine farms whose fee entries failed the audit of the accounts; the 25 farms whose fee was mostly for threshing and combining, work the station measured on its own machines, are the comparison. Flax: the state tax on flax seed over the farm's own seed harvest on the 170 farms with a harvest in 1933; the yields of 1933 and 1934 are medians over all farms with a harvest, and on the 152 farms that harvested and sowed flax in both years they were 0.23 and 1.45; the areas are for the whole panel; the seed sources are from the seed accounts of 1934.

B.3 The Delivery

Within a district-year the multiple of the statute did not vary with the farm's own barn yield: the elasticity is -0.006, with a standard error of 0.047, on the 180 farms of 1933 with a yield of at least four centners per hectare, and -0.056 (0.040) on the 224 of 1934 (Table 3, panel B). A served and an unserved farm in the same district-year delivered the same multiple of their respective statutes,

the difference being 0.013 log points with a standard error of 0.021. The characteristics the office could observe from the district seat explain six per cent of the variation within districts, and the population within ten kilometres of the farm is the only one with a measurable effect. Under Proposition B.1 a claim with $\theta = 0$ gives neither side a reason to misreport the harvest, and no report of the harvest enters it; the flatness of the delivery within districts is what that predicts. The delivery is consistent with less misreporting than under the two claims that stayed on the harvest, and the accounts do not show that misreporting was absent: a claim on land can be reduced by understating the sown area, and the register was the state's check on that.

B.4 The Station Fee

The fee rose with the farm's own barn harvest within districts, with an elasticity of 1.64 (standard error 0.74) on the 53 payers of 1933 with a spring yield of at least three centners per hectare and 0.98 (0.39) on the 106 of 1934, against a statutory elasticity of one under the 1933 share and about 1.4 under the 1934 schedule by yield band. The harvest the fee was computed from can be recovered on the farms whose fee was mostly for field work, by dividing the fee by the statutory percentages for the operations recorded. On the 45 such farms of 1933 the assessed harvest exceeded the barn harvest by 23 per cent at the median and 59 per cent at the mean, with a standard deviation of the log ratio of 0.44; on the 25 farms whose fee was mostly for threshing and combining, work the station measured on its own machines, the standard deviation is 0.21. A field loss between the standing crop and the barn that varied between 5 and 35 per cent across farms would give a standard deviation of about 0.11, and a quarter of the 45 farms were assessed at more than twice their barn harvest. In 1934, when the fee was a quantity per hectare by the yield band the district commission assigned, the band implied by the fee lay above the band of the barn yield on 84 per cent of 74 served farms. The assessor's overstatement and the farm's understatement cannot be separated within the difference (Section 6.5); what the accounts show is a base that stood above the barn on most farms and was dispersed across farms far more than a loss factor would be.

B.5 Flax

The terms of the 1933 flax contract are not among the sources available to me; decree no. 370 fixes only that the obligation was a quantity of fibre and seed set in the contract and fulfilled at contract quality. In the accounts the state took 0.69 of the farm's flax seed harvest at the median farm in 1933 and the whole of it on 29 per cent of the 170 farms with a harvest, leaving 0.05 centners of seed per hectare of flax against about one centner needed to resow. The recorded flax seed yield was 0.26 centners per hectare in 1933 and 1.41 in 1934; on the 152 farms that harvested and sowed flax in both years it rose from 0.23 to 1.45, a change of 1.82 log points against 0.26 for

the same farms' grain. Thirty-four farms of 1933 sowed flax and entered nothing on any flax line of the account. The flax area fell from 12,941 to 6,311 hectares, and 55 per cent of the flax seed sown in 1934 was purchased, against 3 per cent of grain seed. These are aggregates. The recorded 1933 flax yield is almost entirely transitory and the take is censored at one, so an elasticity of the recorded crop to the claim is not estimated at the farm. The aggregates are consistent with the direction Proposition B.1 gives for a claim on the crop at a high rate, concealment of the crop and the withdrawal of effort from it, and they do not separate the two.

B.6 Independence of the Two Obligations on Grain

The delivery and the fee were set by different bodies on different bases, and the accounts show no interaction between them at the farm. In the same district-year a served farm delivered the same multiple of its own statute as an unserved farm, the difference being 0.013 log points with a standard error of 0.021 on 441 farm-years (Table 3, panel E), so the office did not collect more or less from the farms that also paid the fee. On the 45 farms of 1933 whose assessed harvest is recoverable, the farm's multiple of the statute is uncorrelated with the ratio of its assessed to its barn harvest: the correlation of the logs is 0.09 (p 0.55), and within districts the slope is -0.03 with a standard error of 0.09. The office's multiple and the commission's assessment did not move together at the farm. This is Assumption 2 of Section 5.

C Construction of the Counterfactuals

Every schedule of Section 7 replaces the observed delivery of each farm-year by another quantity of grain, holds everything else in the account at its recorded value, and converts the difference into food and into members a year later through equations (14) to (16). This appendix gives the sample, the district multiples, the rule that constructs each schedule and the conversion, in the order in which the computation runs.

The sample. The farm-years are those of the delivery sample of Section 3 with a recorded number of members and a computable food measure: 452 farm-years in 72 district-years with at least three farms. The district multiple is computed on the farms of the district-year whose barn yield was at least four centners per hectare; the two district-years of 1933 in which every farm fell below that yield have no multiple and are dropped, which leaves the 440 farm-years, 213 of 1933 and 227 of 1934, in 70 district-years, holding 124,864 members. The statutory obligation of a farm-year is the sum over crops of its sown area times the rate of STO decree no. 78 for its status, served or not served by a machine-tractor station, the status being the farm's own recorded station work; the

statutory total so computed is 0.7 per cent apart from the total under the rule that treats as served every farm that paid a fee, which Table 3 uses.

The district multiples. For each district-year the multiple μ_D is the ratio of the deliveries of its farms with a barn yield of at least four centners to their statutory obligations, and the failed level ζ_D is the same ratio over its farms below that yield where it has any, and the pooled ratio over all such farms, 0.974, where it has none.

The schedules. Writing D_i for the observed delivery, H_i for the barn harvest, $A_i = n_i \bar{a}_i$ for the statutory obligation and $T_D^a = \sum_{i \in D} A_i$ and $T_D^b = \sum_{i \in D} x_i^b$ for the statutory total and the office's total of a district-year, the schedules are

$$
\begin{aligned}
&x_i^a = A_i, \\
&x_i^b = \mu_D A_i \text{ if the barn yield is at least four centners per hectare, and } \zeta_D A_i \text{ otherwise,} \\
&x_i^c = \max\{x_i^b - r_i,\ 0\}, \text{ with } r_i \text{ the seed lent for the 1934 sowing, on the farm-years of 1933,} \\
&x_i^d = T_D^b H_i \big/ \textstyle\sum_{j \in D} H_j, \qquad x_i^g = T_D^a H_i \big/ \textstyle\sum_{j \in D} H_j.
\end{aligned}
$$

The subsistence-first schedules hold every farm the total allows at the line. For each farm-year the largest delivery that leaves its members at 2,100 kilocalories per member per day is the cap

$$\bar{x}_i = \max\Big\{ D_i + \frac{K_i - 2{,}100 \times 365 \times N_i}{3{,}400 \times 100 \times \pi},\ 0 \Big\},$$

where K_i is the food distributed, N_i the members and π the pass-through of Section 5.2. Schedule (e) sets $x_i^e = \min\{\bar{x}_i,\ s_D H_i\}$ with the scalar s_D chosen in each district-year so that $\sum_{i \in D} x_i^e = T_D^b$; a farm's delivery rises with its harvest up to the point at which its members would fall below the line, and the remainder of the total is carried by the farms with more grain. Where the caps of a district-year sum to less than its total, 21 district-years of the 70 under the office's total and 14 under the statutory total, every farm delivers its cap and the shortfall of the total is spread over the farms in proportion to the harvest; two farm-years cannot reach the line even at a zero delivery. Schedule (f) is the same construction at the statutory total. The concentrated schedules (e′) and (f′) differ only where the caps fall short of the total: the shortfall is then assigned to the farms with the most grain beyond their cap, each up to its whole harvest, so that the number of farms pushed below the line is the smallest the total allows.

The conversion. Under a schedule x the food of a farm-year is $K_i + 3{,}400 \times 100 \times \pi \times (D_i - x_i)$, bounded below at zero, and food per member per day follows from equation (13) with a floor of 300

kilocalories before the response is applied. Members a year later are $N_i(k_i^x/k_i)^{\varepsilon}$ with $\varepsilon = 0.135$, and the people lost between two schedules are the difference of these sums, equation (16); deaths and departures are 37 and 63 per cent of every figure. The intervals of Tables 14 and 15 recompute each difference at $\varepsilon \pm 1.645 \times 0.032$. The counts of farm-years below the line treat a farm held exactly at the line as above it. A component is the difference between two schedules named in Table 14; the grain attributed to a reallocation is half the sum over farm-years of the absolute change in the delivery.

The seed loan and the fee. The seed loan of schedule (c) is the grain seed booked as lent by the state for the 1934 sowing, 13,546 centners on 93 farm-years of 1933; its charge is a tenth of it. The part of the loan that schedule (e) would have made unnecessary is, on each relieved farm, the smaller of its loan and φ times the grain that (e) leaves it above (b), with $\varphi = 0.57$. The comparison for the station's fee replaces, on the 37 farms of 1933 in this sample whose assessed harvest is recoverable, the recorded fee by the statutory percentages applied to the barn harvest, and converts the difference to food and to members in the same way.

D Data Appendix

The flags. Each farm-year of the panel carries the result of the checks described in Section 3.2 as a set of flags, and every sample of the paper is defined by them. Thirty-one farm-years on 16 farms are unusable as a whole and enter nothing. Thirty-four farm-years have an unusable station sheet and are excluded wherever the station's work or fee enters; nine further farm-years of 1933 whose fee entries failed the audit of the accounts, seven with a recorded fee out of proportion to the recorded work and two with a fee that disagrees between two sheets of the form by more than a quarter, are excluded from the recovery of the assessed harvest in Appendix B. Ten farm-years have an unusable delivery entry and are excluded from every use of the delivery. Ninety-five farm-years have a ploughing figure derived from the other entries rather than reported; they are kept, and the results that use the station's ploughing are unchanged when they are dropped. Three farm-years have an unusable distance and six a doubtful farm total; neither enters any result reported.

The statutory obligation. The obligation of a farm-year is the sum over crops of the sown area times the rate of STO decree no. 78 of 27 January 1933 for Ural oblast: per hectare, 1.9 centners of wheat, 2.3 of rye, 1.6 of oats and 0.8 of legumes for a farm not served by a machine-tractor station, and 1.5, 1.8, 1.3 and 0.6 for a served farm; barley, millet, buckwheat and the other grains are charged at the oats rate. The rates of 1934 are not among the sources available to me, and the 1933 rates are applied to both years; the difference between the years is read as the change in the

statute and in the plan together (Table 11). Winter rye is taken from the winter sowing where the crop entry is blank. A farm is served when its own account records station work in the year; in the district tests of Table 3 a farm is served when it paid a fee, and the two rules differ on 25 of the 452 farm-years of the counterfactual sample and move the statutory total by 0.7 per cent.

Food per member. The food a farm distributed to its members from a harvest is the sum of the grain and legumes paid by labour-days, by crop, together with the grain set aside for the tractor drivers' pay and for the families of servicemen and the food lent by the state, the potatoes and vegetables distributed from the collective fields, and the milk of the household's own cow, at 3,400 kilocalories per kilogram of grain, 770 per kilogram of potatoes, 250 per kilogram of vegetables and 640 per litre of milk, the cow's yield being taken at 1,000 kilograms of which 85 per cent stays with the household. The total is divided by the members on 1 January following the harvest and by 365. The measure excludes what a household bought, gathered or received from outside the farm, and it is an annual average.

The seed accounts. The seed requirement of a farm is 1.52 centners per hectare of its registered 1933 grain area; the shortfall is the excess of the requirement over the seed fund the farm held after the 1933 harvest; the loan is the grain seed booked in the account as lent by the state for the 1934 sowing, and the food and fodder lent under the same heading are counted separately. The 227 farms with a reconciled seed account are those whose seed account of 1934 passed the checks of Section 3.2. The land released from flax is the reduction in a farm's flax area between 1933 and 1934 where the area fell, and zero otherwise.

Members and households. The members of a farm are recorded on 1 January 1934 and on 1 January 1935, and the households that joined and that left during 1934, the latter voluntarily, by expulsion and for other reasons, are recorded on the 1934 form. Households are converted to members at the farm's own members per household on 1 January 1934. The population response of Table 5 uses the 252 farms with members at both dates and food from the 1933 harvest.

Districts and coordinates. Each farm is placed in its district on the administrative frame of 1928 and at the coordinates of its settlement. District-years are formed on that frame. The district's mean yield is the mean over its farms in the sample; the district's harvest over its obligation, in Table 8 and Figure 7, is the sum of the barn harvests of its farms with a yield of at least four centners per hectare divided by the sum of their statutory obligations.

The assessed harvest. On a served farm of 1933 the harvest the fee was computed from is recovered by dividing the fee by the sum of the statutory percentages of decree no. 346 for the operations the station recorded on the farm, the operations being taken from the station sheet of the account, with the ploughing of fallow capped at the winter area, a second ploughing capped at the first, and the fee prorated to grain where the station also worked other crops. The recovery is used only on the farms whose fee was mostly for field work; on the farms whose fee was mostly for threshing and combining the harvest the station measured on its own machines is the base, and these farms serve as the comparison in Appendix B.