Supplemental appendix to Leight, "The impact of positive agricultural income shocks on rural Chinese households" (not for publication)

February 7, 2018

S1 Data appendix

Again, the primary analysis seeks to estimate the effects of increased quota income on investment in and income derived from agriculture, investment in and income derived from non-agricultural household businesses, outside employment, migration, borrowing, and consumption. I will provide more details here about the construction of agricultural income and consumption.

Agricultural income is calculated valuing all agricultural production at the market price observed in each village-year cell; the market price of each crop or product is calculated as a sales-weighted average of unit prices reported by households. The agricultural products reported include wheat, rice, corn, soybeans, cotton, rapeseed, sugar, fiber, tobacco, fruit, silk, tea, herbs, vegetables, pork, beef and lamb, poultry, eggs, milk, fishery products, lumber, bamboo and forestry products.

This income measure is then deflated using a weighted Laspeyres price index constructed from the same prices, employing 1993 as the base year. Algebraically, the Laspeyres index can be written as follows, where i indices agricultural products of interest.

$$Lasp_t = \frac{\sum_{i=1}^{N} Q_{i,1993} P_{it}}{\sum_{i=1}^{N} Q_{i,1993} P_{i,1993}} \tag{1}$$

$Q_{i,1993}$ is mean output of the good in 1993. P_{it} denotes the mean price observed for the good in year t. Note the Laspeyres index does not vary across provinces.

In the robustness checks, I also demonstrate that the results are consistent when a Paasche index is employed to deflate agricultural income, constructed using output weights based on the final year (2002). The Paasche index can be constructed as follows.

$$Paasche_t = \frac{\sum_{i=1}^{N} Q_{i,2002} P_{it}}{\sum_{i=1}^{N} Q_{i,2002} P_{i,2002}} \tag{2}$$

Consumption is reported as the value of non-staple consumption, including non-staple foods and all other consumption, and staple (grain) consumption in yuan. Both consumption variables are calculated as the sum of directly reported cash consumption and consumption of own-farm output (of both grain and non-grain items).

In order to value own-consumption of farm output, I use data on the reported quantities of consumption of grain and non-grain food. Quantity consumed (though not prices or expenditure) is reported for grain, vegetables, vegetable and animal oil, pork, beef and lamb, milk, poultry, eggs, fish and shrimp, fruit and sugar. For grain, the quantity purchased in the market is also reported, and thus I can calculate what proportion of total consumption corresponds to own-output. Unfortunately, since this fraction is not reported separately for other consumption goods, I impute this fraction for all other goods reported in order to estimate the quantity of own-farm output consumed. This quantity is then valued employing the market price for this good in the village-year cell, calculated as the sales-weighted average of crop sales; data is not available on the local prices of purchased food items.

Thus "grain consumption" is the sum of expenditure on grain and the imputed value of own-grain consumption; "non-staple consumption" is the sum of expenditure on all consumption items excluding staple grains (both food and non-food), and the imputed value of consumption of own-farm non-grain products. Consumption is reported in yuan and deflated employing a province- and year-specific consumer price index generated by Brandt and Holz (2006).

S2 Specification checks on the first stage

In this section, I present additional specification checks on the first stage. Note that the first stage results are presented in Section 3.2 of the paper in conjunction with specification checks that demonstrate that quota quantity is systematically correlated with price in heterogeneous cultivation areas, but not in homogeneous cultivation areas. Accordingly, the sample for the primary analysis, including the robustness checks presented here, is limited to homogeneous cultivation areas.

First, an additional channel through which the income effect of quota production could become a price effect is if households are constrained in quota production. In other words, quota-constrained households sell all their grain as quota sales. Only around 1% of household-years in the relevant sample report grain production equal to quota sales. Column (1) of Table S1 shows the results of the following regression, where C_{ivpt} is a dummy for households that are constrained in quota production.

$$C_{ivpt} = \beta Clim_{vp} + \nu_{pt} + \epsilon_{ivpt} \tag{3}$$

The results show no evidence that there is a correlation between the probability that a household is constrained in quota sales and the climatic index.[1]

Columns (2) through (4) of the same table show the results of three regressions that test the decomposition of quota income. The objective is to check whether residual variation in quantity over time and variation in quota price can be treated as exogenous conditional on province-year fixed effects: i.e., to test whether there is a first stage in ΔQ

[1]The primary two-stage least squares results are also robust to dropping these households entirely.

or $\tilde{P}$. To do so, the following equations are estimated to test for a correlation between the climatic index and two quantity residuals (Q^{res}_{ivpt} and Q^{rice}_{ivpt}), as well as quota price ($\tilde{P}_{vt}$). Q^{res}_{ivpt} is defined as the residual from regressing the quota quantity Q_{ivpt} on village fixed effects, and Q^{rice}_{ivpt} is the residual from regressing the quota quantity on the area of rice cultivated.

$$
\begin{aligned}
Q^{res}_{ivpt} &= \beta Clim_{vp} + \nu_{pt} + \epsilon_{ivpt} && (4)\\
Q^{rice}_{ivpt} &= \beta Clim_{vp} + \nu_{pt} + \epsilon_{ivpt} && (5)\\
\tilde{P}_{vpt} &= \beta Clim_{vp} + \nu_{pt} + \epsilon_{vpt} && (6)
\end{aligned}
$$

The results show coefficients that are small in magnitude relative to the standard deviation of the dependent variable and insignificant, confirming the hypothesis that the only robust correlation is between mean quota quantity and the climate index.[2] The specification checks reported in Columns (2) through (4) are also consistent if they are re-estimated employing the FAO index as the independent variable.

In Column (5), I generate a dummy variable equal to one if there is evidence of quota phase-out in a particular community. There is very little evidence of quota phase-out in general: only 8% of all village-year cells observed show any evidence of absent grain quotas, and in some cases the number of households sampled is low. When the phase-out dummy is regressed on the climatic index of interest, there is no evidence of any relationship between the two. Finally, in Columns (6) and (7) the quota quantity is regressed on variables capturing annual precipitation and temperature conditional on village fixed effects, in order to test whether quota policy responds to annual climatic fluctuations. The coefficients of interest are again insignificant.

S3 Ordinary least squares

In this section, I present the ordinary least squares results. This specification has a clear source of bias: namely, the endogenous determination of quota quantity by county leaders. As already noted, Wang et al. (2003) find in regressing quota quantity on a range of explanatory variables at the village level that quota quantity is generally positively correlated with both income and the relative salience of agriculture. Evidence on this point can also be drawn from this dataset by regressing the economic outcomes of interest X_{ivpt} on quota quantity in 1993, Q^{1993}_{ivp}, including the same fixed effects employed in the primary specification

$$
\begin{aligned}
Y_{ivpt} &= \beta Q^{1993}_{ivp} + \lambda_{vp} + \nu_{pt} + Clim_{vp} \times P^{sum}_{ivpt} + \eta^{clim}_{vp} \times P^{g}_{ivp,t-2} + \eta^{clim}_{vp} \times \gamma_t \\
&+ \eta^{ind}_{vp} \times \gamma_t + \epsilon_{ivpt} && (7)
\end{aligned}
$$

This regression captures whether households with greater quota quantities at the start of the period in 1993 show differential trends in primary economic outcomes in subsequent

[2]This result may initially seem counterintuitive given the evidence in the literature cited above that the mean quota price is also generally lower for rice. In fact, this correlation is evident across provinces, but not within provinces. Residual price variation within a province-year is idiosyncratic.

years, conditional on village and province-year fixed effects.[3]

The results are reported in Panel A of Table S2; note the dependent variables are all standardized to have mean zero and standard deviation one, other than the dummy variables. The estimated coefficients are all positive, and all are significant with the exception of non-agricultural investment. This suggests that the OLS estimates can be expected to show a strong upward bias relative to the two-stage least squares results.[4]

Panel B of Table S2 reports the OLS estimates, where quota income is measured in hundreds of yuan. All the coefficients are positive and significant, with the exception of the coefficients on non-agricultural household investment and borrowing. The magnitudes imply an increase in quota income of 100 yuan leads to an increase in agricultural investment of .2 standard deviations, an increase in agricultural production of around .08 standard deviations, and increases in non-agricultural investment and income of between .01 and .05 standard deviations. Consistent with the previous evidence, in general the OLS estimates are upward biased relative to the two-stage least squares estimates for agricultural investment and production.

S4 Two-stage least squares: Additional variables

In order to test the robustness of the observed decline in agricultural investment, I re-estimate the two-stage least squares specification (reproduced here for convenience) for a number of additional variables.

$$\begin{aligned} Y_{ivpt} &= \beta I_{ivp,t-1} + \lambda_{vp} + \nu_{pt} + Clim_{vp} \times P_{vpt}^{sum} + \eta_{vp}^{clim} \times P_{ivp,t-2}^{g} + \eta_{vp}^{clim} \times \gamma_t \\ &+ \eta_{vp}^{ind} \times \gamma_t + \epsilon_{ivpt} \end{aligned}$$

This includes the nominal value of expenditure on inputs (seeds, fertilizer, animals and tools); the nominal value of agricultural output; and the value of agricultural output adjusted employing a weighted Paasche index in which output in the final year (2002) is employed to construct the weights. The results reported in Panel A of Table S3 are all consistent.

By contrast, there is no robust data on human capital investment or attainment in this dataset, and thus it is not possible to examine in great detail whether human capital investments are responsive to the observed income shock. Data is available on expenditure on medical care, tuition and cultural services, and the educational attainment of the primary laborer. As reported in Panel B of Table S3, there is no evidence of a significant impact of income shocks on any of these outcomes.

S5 Other channels

Given the evidence from the two-stage least squares results presented in Section 4.2 of the main paper that positive income shocks lead to substitution into non-agricultural

[3]If households do not report quota quantity or do not appear in the panel in 1993, the quota quantity from the first year in which they appear prior to 1998 is employed as the independent variable. Households that did not enter the panel prior to 1998 are omitted from this specification.

[4]The same results are found if the specification is re-estimated employing quota quantity in 1995 as the measure of initial quota.

production, it is also useful to briefly explore two other potential channels that would be consistent with the observed pattern. There is a rich literature that analyzes risk-based poverty traps: households required to maintain a minimum subsistence level of consumption may fail to enter high-risk, high-return productive sectors due to the higher risk associated with these productive activities, if access to consumption-smoothing mechanisms is limited.

In this sample, evidence about the mean and variance of returns to labor and capital in different sectors can be generated by estimating production functions for investment in grain cultivation, cash crop cultivation, and each of the specified non-agricultural sectors, and then evaluating the standard deviation of these returns across villages. For both labor and capital, the variance of returns is lowest in grain cultivation, followed by cash crop cultivation and non-agricultural production; the same is generally true for the mean return.[5] In this sample, however, there is no evidence of substitution from staple to cash crop cultivation. In fact, if the primary two-stage least squares specification is re-estimated employing cash crop income as a percentage of total agricultural income as a dependent variable, the estimated coefficient is negative, though insignificant, as reported in Column (7) of Table S3. The absence of any substitution from staple to cash crop cultivation is suggestive evidence that the alleviation of a risk-based poverty trap is not of first-order importance.

An additional potential channel could be a correlation between quota price shocks and shifts in the returns to investment in agricultural and non-agricultural production. Further evidence will be presented in the robustness checks that quota quantity and price are generally uncorrelated with economic outcomes previously observed in the household or village. However, if an increase in quota prices is associated with an (unobserved) increase in the average local relative return to investment in non-agricultural production vis-a-vis agricultural production, then households may exit agricultural production.

In this case, if there is any household-level heterogeneity in relative productivity in the two sectors, exit would be concentrated among households expected to be relatively more productive in non-agricultural production. This hypothesis can be tested by examining heterogeneity with respect to the educational level of the primary worker in the household, presumed to be correlated with relatively higher returns in non-agricultural production. The reduced form can be re-estimated including an interaction term with this educational variable, $Educ_{ivpt}$, and additional controls for household educational attainment, denoted X_{ivpt}.[6] This yields the following specification.

$$\begin{aligned} Y_{ivpt} = {} & \beta_1 Clim_{vp} \times \tilde{P}_{vp,t-1} + \beta_2 Clim_{vp} \times \tilde{P}_{vp,t-1} \times Educ_{ivpt} + X_{ivpt} \\ & + \lambda_{vp} + \nu_{pt} + Clim_{vp} \times P^{sum}_{vpt} + \eta^{clim}_{vp} \times P^{g}_{ivp,t-2} + \eta^{clim}_{vp} \times \gamma_t + \eta^{ind}_{vp} \times \gamma_t + \epsilon_{ivpt} \end{aligned} \tag{8}$$

The results are reported in Table S6, and show no evidence of any heterogeneity in the observed results with respect to education. (Some households do not report educational attainment, leading to a slightly smaller sample.) The absence of any variation in

[5] Tabulations are not reported for concision, but are available upon request.

[6] The control variables include a linear control for education, a dummy for education above primary school, both variables interacted with the climate-agricultural price interaction term, and an additional control variable for the household demographic structure (multi-generational household), closely correlated with education. The educational variable is de-meaned for ease of interpretation. While there is relatively little variation in education over time, this variable is reported in each year and can vary if the identity of the primary laborer worker over time.

substitution into non-agricultural production with respect to education suggests that the quota price shock is not simply proxying for unobserved shifts in the relative returns to investment in different sectors.

S6 Robustness checks

S6.1 Correlated shocks

The existence of other policy or price shocks correlated with changes in the quota price that also exhibit systematic cross-sectional variation would also be problematic for the identification strategy. In order to test whether there is evidence of this phenomenon, I evaluate whether there is any correlation between the quota price shocks, indices of local agricultural and non-agricultural prices, and variables capturing local policy variation: the number of local officials recorded in the sample, the proportion of agricultural inputs that are state-subsidized, and taxes and collective fees.

The method of calculating prices for agricultural output has been described in Section 3.2 of the main paper; the price index employed as a dependent variable is P_{vpt}^{sum}, also utilized as a control variable in the main specification. Unfortunately, households do not report information about the prices of the goods or services that non-agricultural household businesses sell. Limited information is available, however, about the price of non-agricultural consumption goods (more specifically, durable goods) that households purchase. More specifically, households report the number of durable goods they own and the amount of consumption expenditure on durable goods in each year, allowing for an estimation of the price per good purchased for those household-year observations in which a durable good was acquired. (This durable goods expenditure is a subset of the non-staple expenditure analyzed in the main results.) I then calculate the mean at the village-year level of the durable goods prices; 31 village-year cells report no durable goods purchases, and thus the durable good price index is missing.

Each variable of interest is standardized to have mean zero and standard deviation one, and employed as the dependent variable in the primary two-stage least squares specification, equation (8). The results are reported in Panel A of Table S7, and show coefficients that are uniformly insignificant. Importantly, there is no evidence that quota price shocks have a significant effect on the price indices for agricultural output, or the summary price index for durable goods consumed. This suggests that general equilibrium effects on local prices are not a significant source of bias.

S6.2 Endogenous determination of quota quantity and prices

Another potential source of bias in these results could be strategic behavior by households around the quota quantity. If the determination of the quota quantity is responsive to household behavior, then households facing variation in the quota price may manipulate their consumption or investment decisions in an attempt to lower or increase their quota. If their incentives to do so vary across areas with different climatic conditions, then the observed patterns could simply reflect households' efforts to manipulate the quota target.

In order to test this hypothesis, I regress lagged economic outcomes, employing the same summary measures previously employed, on quota quantity and the interaction of

quantity with the climatic index, including household and province-year fixed effects.

$$Y_{ivp,t-1} = \beta_1 Q_{ivpt} + \beta_2 Q_{ivpt} \times Clim_{vp} + \phi_{ivp} + \nu_{pt} + \epsilon_{ivpt} \tag{9}$$

The objective is to test whether there is a pattern of reverse causality in which households' economic decisions determine the quota quantity they face in a subsequent year, and whether this relationship varies systematically across areas with different climatic conditions. The results are shown in Panels B and C of Table S7; the independent variables are standardized to have mean zero and standard deviation one. The estimated coefficients are uniformly insignificant.

In addition, it is important to evaluate whether the quota price observed is responsive to local variation in economic conditions. The measure of quota price that I employ varies only at the village-year level. Accordingly, I collapse the data to the village-year level and estimate an equation analogous to equation (10), regressing lagged economic outcomes on the price and the interaction of the price and the climatic index. This specification includes 340 village-year cells. The equation of interest can be written as follows, including village and province-year fixed effects.

$$Y_{vp,t-1} = \beta_1 \tilde{P}^q_{vpt} + \tilde{P}^q_{vpt} \times Clim_{vp} + \lambda_{vp} + \nu_{pt} + \epsilon_{vpt} \tag{10}$$

The results of estimating equation (10) are reported in Panel D and E of Table S7, again employing the same summary measures of economic outcomes and standardizing the explanatory variables to have mean zero and standard deviation one. There is little evidence of systematic correlations between past economic outcomes and the quota price.

S6.3 Attrition

Given that the sample of interest is not a fully balanced panel, there is also the risk of bias introduced by differential attrition. The core sample includes eight years, and the average household in the sample is observed in six years. In order to evaluate differences in terms of households' duration in the panel, I estimate the following specification in which the dependent variable is the number of observations for household i, and the independent variable is the climatic index of interest at the village level. Standard errors are clustered at the provincial level.

$$NumObs_{ivp} = \beta Clim_{vp} \tag{11}$$

The results reported in Columns (1) and (2) of Table S8 demonstrate that there is no systematic difference in the average duration of a household in the panel comparing across areas with different propensity to cultivate rice.

In addition, I evaluate the hypothesis that the quota price itself predicts exit from the sample. (This could be a concern if a high quota price generates exit from agriculture, and non-agricultural households are more likely to exit from the panel.) Using the full panel, I regress a dummy variable equal to one if the observation corresponds to the final year in which a particular household is observed on the first, second and third lags of the quota price, conditional on the same fixed effects employed in the primary specification.

The results reported in Columns (3) and (4) of the same table confirm that there is no evidence that the first, second or third lags of quota income predict attrition from the sample. This suggests that attrition is not systematically correlated with the variation in quota income that is of interest here, and thus is unlikely to be a source of bias.

S6.4 Quota enforcement

In addition, I also evaluate whether quota enforcement differs systematically across areas with different climatic conditions. Unfortunately, enforcement cannot be measured contemporaneously in the primary dataset, as households do not separately report the quota quantity assigned and the quota quantity sold. Evidence from earlier surveys in the same sample suggests that 95% of quota quantity contracted is delivered. Households that fail to produce the quota quantity (including households that have exited agriculture) may face the obligation either to purchase grain at the market price and resell it to the government, or pay the equivalent in cash.[7]

In addition, some data is available that can shed some light on variable quota enforcement. First, households report whether any member is a government employee, a village cadre, or a party member. I can test whether quota income is significantly correlated with these measures of political influence, and if the correlation varies across villages with different climatic conditions, estimating the following specification.

$$\begin{aligned} Q_{ivpt} &= \beta_1 X_{ivpt} + \beta_2 X_{ivpt} \times Clim_{vp} + +\lambda_{vp} + \nu_{pt} + Clim_{vp} \times P^{sum}_{vpt} P^{g}_{ivp,t-2} + \eta^{clim}_{vp} \times \gamma_t \\ &+ +\eta^{clim}_{vp} \times +\eta^{ind}_{vp} \times \gamma_t + \epsilon_{ivpt} \end{aligned} \tag{12}$$

As reported in Columns (1) through (3) of Table S9, there is some evidence of lower quota income for government employees, but the relationship does not significantly co-vary with climatic conditions.[8]

Second, a separate survey of village leaders reports the total number of party members, economic officials, and village officials in the village, a variable I interpret as a rough measure of enforcement capacity. The survey also reports the quantity of quota grain delivered relative to the amount contracted in the years 1990 and 1991. I regress these variables on the climatic index conditional on province-year fixed effects, and find no evidence that enforcement capacity or quota delivery is significantly correlated with climatic conditions. These results, reported in Columns (4) through (8) of Table S9, suggest that variation in enforcement may be limited.

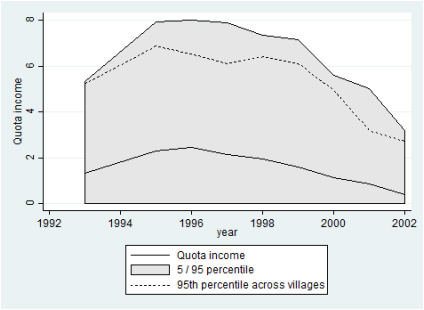
[7] In this data, village leaders report in surveys in 1990, 1991 and 1993 what fraction of overall quota sales in their village were re-sales of purchase grain or cash payments by households that did not produce the grain themselves; these sales accounted for only 1.5% and 6% of total quota sales, respectively. Households also report in surveys between 1986 and 1991 what fraction of their quota sales corresponded to re-sales and cash payments, and the reported proportions are 1.4% and 1.7% of the total. It should be noted that quota fulfillment in cash may be higher in years in which the quota constitutes a higher proportion of total grain production, in which case these numbers may be underestimates.

[8] These lower quotas may also reflect the fact that some government employees in rural areas are not allocated land, and thus are not expected to produce grain.

S7 Figures and Tables

Figure S1: Descriptive statistics: Grain quota

(a) Quota income



(b) Quota tax

Notes: Figure S1a shows mean household-level quota income by year in hundreds of yuan, as well as the 95th percentile of the distribution of village-level means of quota income by year. Figure S1b shows the mean implicit tax posed by the quota system by year, calculated as the difference between the market and the quota price multiplied by the quota quantity, as a percentage of total income; again, the 95th percentile of the distribution of village-level means by year is also included.

Source: Data from the RCRE household panel analyzed by the author.

Table S1: Robustness checks on the first stage

	Infra. dummy	Quantity res.	Quan. rice res.	Quota price	Quota dummy	Quota quan.	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Clim. index	-.002	-13.653	27.816	-.015	-.0001		
	(.009)	(10.960)	(55.511)	(.019)	(.100)		
Annual precip.						9.749	
						(14.741)	
Annual temp.							114.188
							(124.304)
Fixed effects	Prov.-year	Prov.-year	Prov.-year	Prov.-year	Prov.-year	Village	
Clustering	Province	Province	Province	Province	Province	Two-way clustering	
Obs.	16203	16174	16034	16194	16203	15522	13081
F	.047	1.416	.229	.608	1.73e-06	.381	.699

Notes: The dependent variable in Column (1) is a dummy variable equal to one if household grain production is equal to quota sales. In Columns (2) and (3) the dependent variables are the residual of quota quantity regressed on village fixed effects and rice area, respectively; in Column (4), the dependent variable is quota price, and in Column (5) it is a dummy variable equal to one if a village reports quota phase-out. For Columns (1) through (5), the independent variable is the climatic index constructed using weather data and annual measures of precipitation and temperature, all normalized to have mean zero and standard deviation one. In Columns (6) and (7), the dependent variable is quota quantity, and the independent variables are annualized measurements of precipitation and temperature. Fixed effects and clustering are as reported in the table. Asterisks indicate significance at the ten, five, and one percent level, respectively.

Source: Data from the RCRE household panel analyzed by the author.

Table S2: Differential trends and OLS

	(1) Agri. input	(2) Agri inc.	(3) Non-agri. inv.	(4) Non-agri. inc.	(5) Tot. inc.	(6) Outside labor	(7) Migration
Panel A: Quota quantity and differential trends							
Quota index 1993	.312 (.068)***	.132 (.029)***	.012 (.021)	.030 (.014)**	.068 (.021)***	.031 (.013)**	.022 (.012)*
Obs.	15873	15873	15873	15873	15873	15873	15873
Panel B: Ordinary least squares							
Quota income (lagged)	.167 (.026)***	.075 (.012)***	.002 (.004)	.011 (.002)***	.043 (.006)***	.015 (.003)***	.010 (.003)***
Obs.	16203	16203	16203	16203	16203	16203	16203

Notes: All specifications include village and province-year fixed effects, the interaction of the climatic index and a summary measure of market prices, climatic index quantile fixed effects interacted with the two year lagged market price, climatic quantile index fixed effects interacted with year fixed effects, and industrial quantile fixed effects interacted with year fixed effects. Standard errors are estimated employing two-way clustering at the province and year level. The independent variable in Panel A is quota quantity in 1993 or the first year in which a village is observed in the panel; the independent variable in Panel B is quota income, lagged, in hundreds of yuan. Asterisks indicate significance at the ten, five, and one percent level, respectively.

The dependent variable in Column (1) is a summary variable of agricultural investment, calculating using principal component analysis on six variables (area sown, agricultural labor, value of fertilizer employed, value of seeds employed, investment in animals, and investment in tools). The dependent variable in Column (2) is agricultural income. The dependent variable in Column (3) is a summary variable of non-agricultural investment, calculated using principal component analysis on four variables (a dummy variable for any new cash investment in non-agricultural machinery, a dummy variable for any labor invested in a non-agricultural business, and the amount of labor and cash investment reported in non-agricultural businesses). The dependent variable in Column (4) is income from non-agricultural household businesses and wage labor, and the dependent variable in Column (5) is total income. The dependent variable in Column (6) is a dummy variable for any outside labor; the dependent variable in Column (7) is a dummy variable for any labor worked as a migrant.

Source: Data from the RCRE household panel analyzed by the author.

Table S3: Robustness checks: Agriculture and human capital investment

Panel A: Alternate agricultural variables

	Raw input values				Standardized variables		
	Fertilizer value	Seeds value	Animal inv.	Tools inv.	Output nominal	Output - Paasche-adjusted	Cash crops: frac. total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Quota income (lagged)	-25.346 (48.910)	-22.052 (4.691)***	31.501 (94.616)	-15.202 (13.446)	-.120 (.050)**	-.117 (.069)*	-.077 (.052)
Obs.	16076	16203	15511	15941	16203	16203	16133

Panel B: Human capital

	Medical exp.	Cultural services	Tuition	Educ. attainment
	(1)	(2)	(3)	(4)
Quota income (lagged)	.572 (.779)	48.979 (88.795)	-8.966 (85.478)	.090 (.070)
Obs.	16202	16203	16202	16176

Notes: All specifications include village and province-year fixed effects, the interaction of the climatic index and a summary measure of market prices, climatic index quantile fixed effects interacted with the two year lagged market price, climatic quantile index fixed effects interacted with year fixed effects, and industrial quantile fixed effects interacted with year fixed effects. Standard errors are estimated employing two-way clustering at the province and year level. The independent variable is quota income, instrumented by the lagged interactions of two climatic indices of the propensity to cultivate rice (derived from weather data and FAO data respectively), and the quota price. Asterisks indicate significance at the ten, five, and one percent level, respectively.

The dependent variables in Panel A include value of fertilizer and seeds reported used, in yuan; and new investment in tools and animals, reported in yuan. These variables are not deflated to account for inflation. The dependent variable in Column (5) is agricultural income that is not deflated; in Column (6), it is agricultural income deflated using a Paasche index; and in Column (7), it is the fraction of total agricultural income accounted for by cash crops. In Panel B, the dependent variables include reported household expenditure on medical services, cultural services and tuition; and the educational attainment of the primary laborer.

Source: Data from the RCRE household panel analyzed by the author.

Table S4: Alternate specifications

	Agri. input (1)	Agri inc. (2)	Non-agri. inv. (3)	Non-agri. inc. (4)	Tot. inc. (5)	Outside labor (6)	Migration (7)
Panel A: Climatic index within 50-kilometer radius							
Quota income (lagged)	-.190 (.082)**	-.122 (.072)*	.213 (.115)*	.056 (.056)	-.053 (.043)	.050 (.054)	.173 (.088)**
Obs.	16203	16203	16203	16203	16203	16203	16203
Panel B: Migration and lagged village characteristics							
Quota income (lagged)	-.113 (.057)**	-.139 (.133)	.213 (.144)	-.0005 (.048)	-.098 (.047)**	-.048 (.039)	.046 (.039)
Obs.	16145	16145	16145	16145	16145	16145	16145
Panel C: Alternate quota price measures							
Quota income (lagged)	-.338 (.136)**	-.181 (.064)***	.216 (.188)	.078 (.047)*	-.133 (.036)***	.096 (.042)**	.212 (.086)**
Obs.	16203	16203	16203	16203	16203	16203	16203

Notes: All specifications include village and province-year fixed effects, the interaction of the climatic index and a summary measure of market prices, climatic index quantile fixed effects interacted with the two year lagged market price, climatic quantile index fixed effects interacted with year fixed effects, and industrial quantile fixed effects interacted with year fixed effects. Standard errors are estimated employing two-way clustering at the province and year level. The independent variable is quota income, instrumented by the lagged interactions of two climatic indices of the propensity to cultivate rice (derived from weather data and FAO data respectively), and the quota price. The dependent variables are defined in the notes to Table S2. Asterisks indicate significance at the ten, five, and one percent level, respectively.

In Panel A, the climatic index constructed from precipitation and temperature uses a radius of 50 kilometers around the county centroid. In Panel B, a range of additional lagged village-level controls (migration levels as a percentage of population, the number of village enterprises, the size of the village labor force, value of productive assets, the quantity of arable land, area sown in grain and cash crops, and total production of grain and cotton) are included. In Panel C, the linear difference between the quota and market prices is employed as a measure of the quota price shock and interacted with the climatic indices to construct the instruments.

Source: Data from the RCRE household panel analyzed by the author.

Table S5: Alternate specifications, cont.

	Agri. input (1)	Agri inc. (2)	Non-agri. inv. (3)	Non-agri. inc. (4)	Tot. inc. (5)	Outside labor (6)	Migration (7)
Panel A: Sample excluding low grain production households							
Quota income (lagged)	-.188 (.058)***	-.134 (.077)*	.201 (.115)*	.076 (.059)	-.064 (.046)	.050 (.058)	.177 (.090)**
Obs.	16031	16031	16031	16031	16031	16031	16031
Panel B: Sample excluding cases of quota phase-out							
Quota income (lagged)	-.260 (.087)***	-.219 (.105)**	.325 (.203)	.140 (.091)	-.057 (.071)	-.004 (.054)	.187 (.112)*
Obs.	14910	14910	14910	14910	14910	14910	14910
Panel C: Sample including additional controls for leading grain market price							
Quota income (lagged)	-.174 (.095)*	-.206 (.041)***	.172 (.097)*	.054 (.041)	-.101 (.034)***	.037 (.053)	.156 (.077)**
Obs.	16203	16203	16203	16203	16203	16203	16203
Panel D: Sample including fixed effects constructed using FAO index							
Quota income (lagged)	-.191 (.079)**	-.027 (.099)	.204 (.073)***	.052 (.051)	-.016 (.049)	.080 (.043)*	.162 (.068)**
Obs.	16203	16203	16203	16203	16203	16203	16203
Panel E: Sample of heterogeneous cultivation villages							
Quota income (lagged)	-.085 (.102)	.019 (.040)	.003 (.067)	-.021 (.036)	-.00004 (.053)	.014 (.039)	.033 (.021)
Obs.	11576	11576	11576	11576	11576	11576	11576

Notes: All specifications include village and province-year fixed effects, the interaction of the climatic index and a summary measure of market prices, climatic index quantile fixed effects interacted with the two year lagged market price, climatic quantile index fixed effects interacted with year fixed effects, and industrial quantile fixed effects interacted with year fixed effects. Standard errors are estimated employing two-way clustering at the province and year level. The independent variable is quota income, instrumented by the lagged interactions of two climatic indices of the propensity to cultivate rice (derived from weather data and FAO data respectively), and the quota price. The dependent variables are defined in the notes to Table S2. Asterisks indicate significance at the ten, five, and one percent level, respectively.

In Panel A, the sample is restricted to exclude households where quota sales are equal to total reported production of grain. In Panel B, the sample is restricted to exclude village-years where there is evidence of quota phase-out (no quota sales reported in that year or any subsequent year). In Panel C, interactions between climatic index quantile effect and leads of the grain market price are included. In Panel D, fixed effects defined using the FAO index are added (quantile-year interactions and quantile-price interactions). In Panel E, the main specification is re-estimated using the sample of heterogeneous cultivation villages.

Source: Data from the RCRE household panel analyzed by the author.

Table S6: Additional evidence on channels

	Agri. input (1)	Agri inc. (2)	Non-agri. inv. (3)	Non-agri. inc. (4)	Tot. inc. (5)	Outside labor (6)	Migration (7)
Clim. index x price (lagged)	-.004 (.002)**	-.003 (.004)	.003 (.001)**	.002 (.001)*	-.001 (.002)	.001 (.001)	.003 (.001)***
Education int.	.0009 (.000)	-.001 (.001)	.0009 (.0007)	-.0002 (.0007)	-.0003 (.0006)	-.0003 (.0004)	.0005 (.0004)
Obs.	16176	16176	16176	16176	16176	16176	16176

Notes: All specifications include village and province-year fixed effects, the interaction of the climatic index and a summary measure of market prices, climatic index quantile fixed effects interacted with the two year lagged market price, climatic quantile index fixed effects interacted with year fixed effects, and industrial quantile fixed effects interacted with year fixed effects. Standard errors are estimated employing two-way clustering at the province and year level. Standard errors are estimated employing two-way clustering at the province and year level. The dependent variables are defined in the notes to Table S2. Asterisks indicate significance at the ten, five, and one percent level, respectively.

The independent variables include the climatic index-price interaction (employing the weather-derived climatic index), and the triple interaction including a linear variable corresponding to the educational level of the primary laborer in the household.

Source: Data from the RCRE household panel analyzed by the author.

Table S7: Robustness checks

Panel A: Correlated shocks

	Ag. price	Non ag. price	Cadre	Party	State inputs	Taxes	Coll. levies	Fees	Fines
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Quota income (lagged)	-.009	.084	.028	-.034	.062	-.028	.262	.509	-.069
	(.051)	(.259)	(.046)	(.051)	(.057)	(.212)	(.207)	(.435)	(.312)
Obs.	16203	11978	16176	16195	16203	15832	16065	15992	15979

Panel B: Endogenous determination of quota quantity

	Lagged Agri. input	Lagged Agri inc.	Lagged Non-agri. inv.	Lagged Non-agri. inc.	Lagged Tot. inc.	Lagged Outside labor	Lagged Migration
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Quota quantity	.112	.053	.086	.004	-.0007	-.010	.007
	(.153)	(.084)	(.102)	(.031)	(.083)	(.049)	(.038)
Quota quantity int.	-.046	-.042	-.084	-.011	.017	.002	-.020
	(.146)	(.066)	(.086)	(.022)	(.067)	(.043)	(.040)
Obs.	16203	16203	16203	16203	16203	16203	16203

Panel C: Endogenous determination of quota quantity (GAEZ index)

Quota quantity	-.075	-.030	.079	.005	-.023	-.039	.004
	(.069)	(.033)	(.068)	(.029)	(.030)	(.021)*	(.013)
Quota quantity int	.195	.051	-.124	-.019	.060	.044	-.028
	(.097)**	(.068)	(.093)	(.062)	(.037)	(.032)	(.015)*
Obs.	16203	16203	16203	16203	16203	16203	16203

Panel D: Endogenous determination of quota price

Quota price	-.098	-.137	.006	.068	-.039	.053	-.006
	(.143)	(.139)	(.087)	(.036)*	(.082)	(.054)	(.033)
Quota price int.	-.010	.102	.043	-.058	.030	-.073	-.010
	(.101)	(.133)	(.093)	(.032)*	(.076)	(.057)	(.037)
Obs.	340	284	340	340	284	340	340

Panel E: Endogenous determination of quota price (GAEZ index)

Quota price	-.110	-.036	.052	.019	-.006	-.007	-.010
	(.066)*	(.044)	(.046)	(.014)	(.022)	(.012)	(.016)
Quota price int.	.003	-.003	-.010	-.004	-.005	-.007	-.006
	(.017)	(.045)	(.031)	(.014)	(.021)	(.021)	(.024)
Obs.	340	284	340	340	284	340	340

Notes: In Panel A, the dependent variables are summary measures of prices for agricultural output and non-agricultural (durable) consumption goods, and policy measures measured in the local village and year; the independent variable is lagged quota income, instrumented by the two climatic indices of interest. All specifications include village and province-year fixed effects, the interaction of the climatic index and a summary measure of market prices, climatic index quantile fixed effects interacted with the two year lagged market price, climatic quantile index fixed effects interacted with year fixed effects, and industrial quantile fixed effects interacted with year fixed effects. Standard errors are estimated employing two-way clustering at the province and year level.

In Panels B through E, the dependent variables are lagged values of the primary outcomes of interest in the main analysis, defined in the notes to Table S2. The independent variables in Panels B and C are quota quantity and the interaction of quota quantity with the climatic index, both standardized to have mean zero and standard deviation one; household and province-year fixed effects are included. The independent variables in Panel D and E are quota price and the interaction of quota price with the climatic index, both standardized to have mean zero and standard deviation one; data at the village-year level is employed, and village and province-year fixed effects are included. Standard errors are estimated employing two-way clustering at the province and year level. Asterisks indicate significance at the ten, five, and one percent level, respectively.

Source: Data from the RCRE household panel analyzed by the author.

Table S8: Attrition

	Number observations		Final year	
	(1)	(2)	(3)	(4)
Climatic index	.420			
	(.390)			
FAO index		.150		
		(.431)		
Quota income lagged			.003	-.062
			(.004)	(.075)
Quota income lagged year 2			-.00004	
			(.00003)	
Quota income lagged year 3			-9.18e-06	
			(.00006)	
Obs.	3798	3798	14772	16203

Notes: In Columns (1) and (2), the dependent variable is the number of years a household is observed in the panel. The independent variables are the two climatic indices of propensity to cultivate rice employed in the main analysis, standardized to have mean zero and standard deviation one; standard errors are clustered at the province level. In Columns (3) and (4), the dependent variable is a dummy variable equal to one if it is the last year in which a household appears in the panel. The independent variables are quota income lagged and quota income lagged by two and three years; both specifications include village and province-year fixed effects, the interaction of the climatic index and a summary measure of market prices, climatic index quantile fixed effects interacted with the two year lagged market price, climatic quantile index fixed effects interacted with year fixed effects, and industrial quantile fixed effects interacted with year fixed effects. Standard errors are estimated employing two-way clustering at the province and year level. In Column (4), quota income is instrumented with the instruments constructed using climatic indices and price. Asterisks indicate significance at the ten, five, and one percent level, respectively.

Source: Data from the RCRE household panel analyzed by the author.

Table S9: Quota enforcement

	Quota quantity			Party	Economic	Cadres	Quota fulfilled	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Government employee	-41.230							
	(11.932)***							
Employee int.	.151							
	(15.377)							
Cadre		7.092						
		(10.022)						
Cadre int.		-8.576						
		(9.687)						
Party member			-3.031					
			(7.531)					
Party member int.			-13.778					
			(5.523)**					
Climatic index				.202	-.117	1.138	-1.752	.003
				(.158)	(.201)	(1.831)	(1.416)	(.015)
Obs.	16128	16147	16155	397	397	396	814	136

Notes: The dependent variable in Columns (1) to (3) is quota quantity; the independent variables are dummy variables for a household including a government employee, a party cadre, or a party member, and these variables interacted with the climatic index for propensity to cultivate rice. The dependent variables in Columns (4) through (8) are the number of party members, administrative committee members, economic committee members, and cadres reported in the village, and the percentage of the assigned quota reported fulfilled. The quota reported fulfilled is only reported prior to 1993. The specifications in Columns (1) through (3) include village and province-year fixed effects, the interaction of the climatic index and a summary measure of market prices, climatic index quantile fixed effects interacted with the two year lagged market price, climatic quantile index fixed effects interacted with year fixed effects, and industrial quantile fixed effects interacted with year fixed effects. Standard errors are estimated employing two-way clustering at the province and year level. The specifications in Columns (4) through (8) include province-year fixed effects, and standard errors clustered at the village level. Asterisks indicate significance at the ten, five, and one percent level, respectively.

Source: Data from the RCRE household panel analyzed by the author.

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