Missing Women and the Price of Tea in China: The Effect of Relative Female Income on Sex Imbalance (Incomplete)

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Abstract

Severe sex imbalance exists in many developing countries. However, the observed association between sex ratios and economic conditions reflects omitted variables such as sex preference. This paper uses exogenous increases in agricultural income and relative female income caused by post-Mao reforms to estimate the effect of total household income and relative female income on sex ratios of surviving children. To correct for measurement error, I instrument for tea planting with geographical data. The results show that increasing income alone has no effect whereas increasing relative adult female income has an immediate and positive effect on survival rates for girls and education attainment for boys and girls. Conversely, increasing relative adult male income has an immediate and negative effect on the survival rate and education attainment for girls. (*JEL* I12, J13, J16, J24, O13, O15)

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1 Introduction

Many Asian populations are characterized by highly imbalanced sex ratios. For example, only 48.4% of the populations of India and China are female in comparison with 50.1% in western Europe. Amartya Sen (1990, 1992) termed this phenomenon "missing women". The existence of "missing women" has been discussed in studies of India and China by Burgess and Zhuang (2001), Clark (2000), Coale and Banister (1994), Gu and Roy (1995), Rosenzweig and Foster (2001), Das Gupta (1987) and Jensen (mimeo). The phenomenon of "missing women" is almost certainly due to behavioral factors that reflect a preference for male children.[1] These include selective abortion, infanticide and neglect (Foster and Rosenzweig, 2001). The result is that an estimated 30-70 million women are "missing" from India and China alone.

In the long run, skewed sex ratios can affect the marriage and labor markets (Angrist, 2002). A more immediate concern is that to select the sex of the child, parents without access to pre-natal gender revealing technologies must resort to infanticide or other forms of neglect which ultimately lead to the death of a child.

The purpose of this paper is to estimate the effect of economic conditions on sex ratios. Cross-country comparison shows that income and sex imbalance are negatively correlated. However, interpretation of this relationship is complicated by two facts: 1) sex imbalance also exists in rich countries (South Korea and Taiwan have the same sex ratios as China and India), and 2) sex imbalance in China is increasing, not decreasing, with economic growth. (Chart 1 shows that the fraction of males increased from approximately 50% for cohorts born before 1970 to almost 54% for cohorts born in the late 1980s). An alternative explanation posited by economists beginning with Becker argued that sex ratios respond to sex-specific economic conditions. For example, parents may wish to

[1] In a recent study of the impact of hepatitis B on sex ratios, Oster (2004) uses a back-of-the-envelope calculation to argue that 90% of the observed sex imbalance in China is explained by the effect of hepatitis infection of pregnant mothers on miscarriage of female fetuses. However, she ignores the fact that sex imbalance in China exists only for cohorts born after 1969 and the increase in sex imbalance was discrete (Chart 1). Since there is no evidence that hepatitis B infection rates increased discretely during this period, it is likely that her results overestimates the true effect of hepatitis.

avoid female children when marriage requires a large dowry. The main empirical challenge in establishing the link between sex ratios and economic conditions is that both sex ratios and economic variables may reflect omitted variables such as sex preferences.

The principle contribution of this paper is to develop and implement a strategy that captures the causal effect of economic conditions on sex ratios in China using exogenous variation in regional incomes over time. In particular, I exploit the variation in intensity of adult female and male labor input across crops and the exogenous variation in agricultural income caused by two post-Mao reforms (1978-1980). First, I use the increase in value of tea relative to grains and the fact that women pick tea to estimate the effect of an increase in relative female income on sex ratios. In other words, I compare the sex ratio for cohorts born before and after the reform, between counties which plant tea and counties which do not. Second, I use the increase in value of orchard fruits relative to grains and the fact that in the time and regions relevant to this study, men are the main producers of orchard fruits to repeat the experiment to estimate the effect of an increase in relative adult male income. Third, I use cash crops which experienced a similar value increase to tea but for which neither sex had a comparative advantage to estimate the effect of an increase in total household income without changing relative male and female incomes. I address the problem of measurement error in the data and the possibility that families which cared more about girls chose to plant tea after the increase in relative profitability of tea by instrumenting for tea planting with geographic data. Finally, I repeat the experiments to estimate the effects of relative adult female income, relative adult male income and total household income on education attainment.

Setting the study in China during the period of 1962-1990 has the advantages that migration was strictly controlled, almost no technological change occurred in tea production and sex-revealing technologies were unavailable to China's rural population for most cohorts in the study (Diao et. al., 2000; Zeng, 1993). In addition, the One Child Policy controlled the number of children each family was allowed to have.

The results show that economic conditions do affect the desirability of girls relative to boys. An increase in relative adult female income has an immediate and positive effect on the survival rate of girls. In the early 1980s, in rural China, increasing female adult income by US$7.7 (10% of average rural household income) increased the number of surviving girls by 1 percentage-point on average. Increasing relative female income also increased education attainment for girls. Conversely, increasing relative adult male income decreased both survival rate and education attainment for girls. Increasing total household income without changing the relative incomes of men and women had no effect on survival rates and education attainment of girls. These results are consistent with the observation that sex-imbalance exists in rich counties as well as poor countries and does not always decrease as countries become richer.

In addition to being of general scientific interest, the results of my study point to the possibility of non-coercive policies that can affect sex ratios. In particular, the results presented here suggest that factors that increase the economic value of women will also increase the probability that female infants are carried to term and female children live to adulthood.

Section 2 describes the background. Section 3 presents a simple model of the effect of adult income on sex imbalance. Section 4 describes the data. Section 5 discusses the empirical strategy and results. Section 6 offers conclusions.

2 Background

2.1 Previous Works

Becker (1981) argued that sex preference is not only affected by slow-moving endemic "cultural" features of society. Many studies since then have shown that it is often correlated with household income. However, the nature of this relationship is anything but settled. Edlund (1999) suggests that poorer states in India have more girls and rich states have more boys. For China, Gu and Roy (1995) show that the poorest regions, along with the richest regions have the least sex imbalance. Burgess and Zhuang (2001) use micro-level data from two provinces to show that boy-preference in allocation of health goods and tertiary education investment occur more in poor households. And surprisingly, Li (2002) found no correlation between sex ratios and factors such as household income, parents' education and the amount of monetary fine associated with the One Child Policy in a study using household level data from 8 provinces for children born during 1982-1987.

A second branch of the household literature, beginning with Ben Porath's study of Israeli female labor supply (1978, 1979), has also argued that relative female income and/or education also affect sex preference. For India, Rosenzweig and Shultz (1982) showed that female children receive a larger share of household resources relative to male children in communities where women's expected labor market employment is relatively high. In order to establish a causal relationship between parental outcome and child outcome, Foster and Rosenzweig (2001) uses the practice of patrilocal exogamy and productivity changes caused by technology adoption during the Green revolution to exploit the variation in returns to male and female children to identify how survival rates respond to economic incentives. Increased wages and/or education for adult women have also been shown to have a positive correlation with health and education outcomes for girls by Duflo (2002) in South Africa; Clark (2000), and Das Gupta (1987) in India; and Thomas et. al. (1991) in Brazil. For China, Burgess and Zhuang (2001) show that boy-preference is stronger in areas which have fewer non-farm employment opportunities. If men are more valuable for farm labor, the results suggest that increasing employment opportunities for women would decrease boy-preference. However, they do not establish this link directly.

2.2 Agricultural Reforms

Pre-1978 Chinese agriculture was mainly characterized by intense focus on grain production, allocative inefficiency, lack of incentives for farmers and low rural incomes (Sicular, 1988; Lin, 1988). Agricultural policies aimed at subsidizing urban industrial populations with cheap food mainly centered around production planning. After 1953 (*tong gou tong xiao*), planning was done at the central level, adjusted through discussion with the other levels of government, re-approved by the central government, and finally sent to production brigades and teams (Sicular, 1988a). Planning included mandatory targets for crop cultivation, areas sown, levels of input applications and planting techniques by crop. Amongst these targets, sown area was the most important, in part because these were easier to enforce. Mandatory targets required for grain cultivation often resulted in lower production of other crops that could have been more profitable in forest, grassland, or hilly areas.

Crops were divided into three categories. Category 1 included crops necessary for national welfare: grains, all oil crops and cotton. Procurement prices for grain during this period were generally 20%-30% lower than market prices (Perkins, 1966). Market trade of these products was strictly prohibited (Sicluar, 1988a). Category 2 included up to 39 products, including: livestock, eggs, fish, hemp, silkworm cocoons, sugar crops, medicinal herbs and tea (Sicular, 1988b).[2] Category 3 included all other agricultural items, mostly minor local items. These were not under quota or procurement price regulation.

Under the unified system, the central government set procurement quotas for crops of the categories 1 and 2 which filtered down to the farm or collective level. Quota production was purchased by the state at very low prices. These quotas were set so that farmers retained enough food to meet their own needs but in reality, farmers were left with little remaining surplus (Perkins, 1966). Non-grain producers produced grain and staples for their own consumption and sold all the cash crop output to the state at suppressed prices. Under this system, farmers had very little incentive to produce more than their quota.

After the Great Famine (1959-1961), the government re-emphasized grain production by increasing procurement prices for grain relative to other crops. Charts 2A and 2B show that procurement prices froze during the Cultural Revolution. The state resorted to commercial and production planning to carry out the objectives of grain production (*yi liang wei gang*) and self-sufficiency (*zi li geng sheng*). Increased production was promoted by enforcing mandatory sown area targets for crops and self-sufficiency by purchasing but not selling grain and oils in rural areas. Mandatory sown area targets often required cultivation on land unsuitable for grain. Grain production grew at substantial cost of other production. Production of crops which competed with grain for land suffered.

[2] The number of crops in each category changed over time. And the number of crops reported in for each category for a given year may vary across sources.

Living standards declined significantly in areas suitable for commercial crops (Lardy, 1983).

Post-Mao era reforms focused on increasing rural income, increasing deliveries of farm products to the state, and diversifying the composition of agricultural production by adjusting relative prices and profitability. This was mainly carried out by two sets of policies. The first set of policies gradually reduced planning targets and reverted to earlier policies of using procurement price as an instrument for controlling production (Sicular, 1988a). In 1978 and 1979, quota and above quota prices were increased by approximate 20%-30% for grain and certain cash crops. By 1980, prices had increased across all crops. Although category 1 crops benefited from the price increases, emphasis was placed on cash crops from category 2. The second set of policies, called the *Household Production Responsibility System* (HPRS) devolved responsibility from the collective, work brigade, or work team to households (Johnson, 1996; Lin, 1988). The HPRS was first enacted in 1980 and spread through rural China through the early 1980s. This devolved all production decisions and quota responsibilities from the work unit to individual households. Effectively, the HPRS allowed households to take full advantage of the increase in procurement prices by partially shifting production away from grain to cash crops when profitable.

The two reforms combined contributed to diversification of agricultural production, greater regional specialization, and less intensive grain cultivation (Sicluar, 1988a). There was an immediate and significant increase in the output of economic crops (Johnson, 1996; Sicular 1988a). However, although the value of all crops increased, continued emphasis on rural-urban subsidization of grain and other category 1 products caused the relative value of category 1 products to decrease.[3] I will compute the income from each crop directly in the next section. But the relatively larger increase in value of category 2 crops is also reflected in the disproportionate growth in output of category 2 crops in comparison with category 1 crops. Charts 2A and 2B show that although output for category 1 crops increased, there is little change in the rate of increase. Chart 2C shows the increase in the rate of increase for category 2 crops after the reform.

[3] The central government complained that the targets were under-fulfilled while production of economic crops greatly exceed plans (Sicular, 1988a).

In a second round of reforms, in order to reduce the fiscal burden of grain subsidies and because of excess supplies from previous years, the state increased urban grain retail prices and stopped guarantees of unlimited procurement of category one products at favorable prices. On average, contract procurement prices for grain were 35% lower than market prices (Sicular, 1988a). This combined with the de-regulation of other crops further decreased the relative-profitability of category 1 products. This reduction in relative returns for farmers was exacerbated by the uncertainty they faced from the newly opened and yet underdeveloped market channels.

Complete substitution away from producing grains was prevented by the state's continued enforcement of grain production quotas and suppression of intra-rural grain trade. As late as 1997, virtually every agricultural household planted staple crops (Eckaus, 1999). Using the 1997 Agricultural Census, Diao et. al. (2000) show that on average, 80% of sown area is devoted to grain and that self-sufficiency in grain was still an important part of Chinese agriculture.

One possible cause of the magnitude and speed of the response of the Chinese agricultural sector is the low labor productivity in the agricultural sector resulting from migration and other labor controls. Diao et. al. (2000) calculated that for a household with 0.7 hectares of land, only 29% of the household's laborers need to work full time on agriculture to produce the same output with the same technology. The remaining members could easily respond to take advantage of new economic opportunities. The existence of surplus labor is consistent with the fact that agricultural households very rarely hired labor from outside the family. In the 1997, household on average hired 0.013 permanent and 0.004 temporary workers (Diao et. al., 2000). Plentiful cheap adult labor would also reduce demand for child labor.

2.3 Tea and Orchard Production

This section discusses the male and female labor intensity in tea and orchard production and how the production of each reacted to post-Mao reforms. I will also directly estimate the income from each crop and show that: 1) income from category 2 cash crops (including tea and orchards) was larger than income from category 1 staple crops; and 2) income from tea did not exceed income from other category 2 cash crops. The latter fact is important in interpreting the effect of tea as a relative female income effect and not a total household income effect in the case where the income effect on sex ratio is non-linear. An increase in income from tea translates into an increase in income in total household income as well as an increase in relative female income. If the income effect on sex ratio is linear, I can show that there is no total household income effect by showing that cash crops in general do not have an effect on sex ratios. However, if income effects on sex ratio is non-linear, that is, if there exists some threshold income which must be met before income will affect sex ratio, then the logic above is only true if income from tea does not exceed income from other cash crops.

According to agriculture specialists and anecdotal evidence, tea is mainly picked by women and orchard fruits, in southern China, are mainly produced by men. Labor input data by sex by crop is not available to help determine the cause of such sex specialization across crops. One possible explanation comes from the combination of physical comparative advantage in the production of each crop and the continued government restrictions which meant that every household had to plant grain (Diao et. al., 2000; Eckaus, 1996). In other words, women are better at picking tea than planting grain.[4] In households that wished to produce tea after the reform, men continued to produce grain while women switched to tea production. Consequently, an increase in the value of tea picking translates into an increase in the value of adult female labor. Conversely, men are better at producing orchard fruits than in producing grain.[5] In households that wished to produce orchard fruits after the reform, men switched to orchard

[4] Adult women have a comparative advantage to picking tea over adult men and children because tea picking favors small and agile fingers. Green tea leaves cannot be broken and small tender leaves are more valuable. In addition, tea bushes are on average 2.5 feet (0.76 meters) tall, which disadvantages adult males who are on average taller than adult women.

[5] Adult men have a comparative advantage in orchard production during both sowing and picking periods. Sowing orchard trees is strength intensive as it requires digging holes approximately 3 feet (0.91 meters) deep. The strength requirement is re-enforced by the fact that Chinese soil is composed of 85% rock. The height of orchard trees means that adult males also have an advantage in picking over adult females and children. For example, the height of apple trees and orange trees range between 16-40 feet (4.9- 12.2meters) and 20-30 feet (6.1-9.1 meters), respectively. Thus, an increase in the value of orchard fruits translates into an increase in the value of adult male labor.

production while women continued planting grains. Thus, an increase in the value of orchard fruits translates into an increase in the value of adult male labor.

Child labor cannot be ruled out in any agricultural production. However, adult labor surplus resulting from land shortage, labor market and product market controls leaves little demand for child labor. Later in this paper, I will establish that the identification strategy does not depend on the assumptions that only women pick tea or only men produce orchard fruits.

The main effect of post-Mao reforms for tea production was to increase picking, which translates to an increase in relative adult female income as well as an increase in total household income and potential earning for girls. Considered a priority crop, tea production was collectivized into 500 state tea farms in the 1950s. Procurement and retail were completely nationalized by 1958 (Etherington and Forster, 1992). During the Cultural Revolution, the government pursued an aggressive expansion of tea fields. However, since farmers had little incentive to produce and tea picking is more difficult to enforce than sowing, most of the sown fields were left wild and untended until the post-Mao era, when the HPRS disaggregated the 500 state tea farms into over 90,000 household level tea production units. Tea bushes were restored by extensive tending and pruning (Forster and Etherington, 1992). Procurement price for tea, which was largely unchanged between 1958-1978, doubled between 1979 and 1984. Chart 3A shows the increase in procurement price and yield for tea. Since there was no change in sown area during this period, the yield increase reflects an increase in picking, which, in turn, reflects an increase in the value of female labor.

Chart 3B shows the income from grain and income from tea calculated using procurement price data and data on the output per standard day of labor by year and by crop. After 1979, income from tea increased at a faster rate than income from grains. I will exploit this increase to estimate the effect of an increase in relative adult female income on sex ratios.

Chart 4A shows the increase in orchard fruit production and procurement price after the reform. Chart 4B shows that the calculated income from orchard production increased at a faster rate than income from grains. I will exploit this increase to estimate the effect of an increase in relative male income on sex ratios.

Amongst category 2 crops, the government maintained more control on tea than other crops. Unlike other category 2 crops, tea was viewed as a political symbol by the central government from the early 1950s. In 1984, tea was one of the 9 crops to remain under designated procurement price. The central government continued to maintain a retail monopoly on tea up to the early 1990s. Until the late 1980s, China exported tea at subsidized prices. Part of the subsidy was achieved by suppressing procurement prices of tea (Etherington and Forster, 1992). Consequently, although price for tea grew significantly after 1979, tea was not as profitable as other cash crops. Chart 5 shows that the income from tea experienced similar increases to other category 2 cash crops immediately after the reform. But by 1983, although the income from tea continued to increase, the rate of increase was less than income from other category 2 crops. I will exploit the income increase from all category 2 crops (including tea and orchards) to estimate the effect of an increase in total household income on sex ratios.

3 Model of Sex Imbalance

In this section, I present a simple model of the household to illustrate the different mechanisms by which changes in adult income can affect sex ratios in the observed population. The model shows that adult income affects the desirability of daughters relative to sons through two mechanisms: 1) by changing the consumption value of having a girl relative to having a boy; and 2) by changing the investment value of having a girl relative to having a boy. Moreover, it shows that if households are not unitary (e.g. parents do not have identical preferences), a change in adult income will also affect the relative desirability of girls by changing the bargaining power of each parent within the household. It is beyond the scope of this paper to discern whether households in rural China are unitary. However, the model generates empirically testable predictions for the case where households are unitary and parents view children only as consumption goods.

3.1 Decision Rule

For most cohorts in this study, family size was constrained by China's family planning policies. Thus, I make the simplifying assumption that all households have exactly one child. The only decision which faces parents is the sex of their child. Because parents do not have access to prenatal sex revealing technology, parents select the sex of their child by deciding to keep or kill a child once she/he is born. Parents for each household i compare the maximum utility that they can derive from a girl and the maximum utility they can derive from a boy, and will choose to have a girl if $V_g^H - V_b^H > \varepsilon_i$, where V_s^H is the indirect utility of household H if it has a child of sex s, $s \in \{g, b\}$. ε_i is an independent and identically distributed preference shock that is normally distributed in the population, $\varepsilon_i \backsim N(0,1)$.

The probability of having a girl can be written as:

$$\Pr(S = g) = \Pr\left(\varepsilon_i < V_g^H - V_b^H\right) = \Phi(V_g^H - V_b^H) \tag{1}$$

An increase in the probability of having a girl will be reflected in the population as an increase in the fraction of girls.

Let y_ρ, $\rho \in \{m, f\}$ denote parents' (mother's and father's) incomes. The effect of an increase in a parent's income on the probability of having a girl relative to having a boy is represented by the partial derivative of the decision rule with respect to the parent's income.

$$\frac{\partial \Phi}{\partial y_\rho} \equiv \ \Phi_{y_\rho}$$

Note that the sign of Φ_{y_ρ} is determined by the sign of the derivative of the difference between the household's indirect utility if it has a girl and if it has a boy with that parent's income.

$$\Phi_{y_\rho} > 0 \quad \text{if} \quad \frac{\partial (V_g^H - V_b^H)}{\partial y_\rho} > 0$$

Henceforth, denote $\Gamma_{y_p} = \frac{\partial (V_g^H - V_b^H)}{\partial y_\rho}$.

3.2 Household Utility

$u_s^H = u^H(c)$, where c is the parents' consumption bundle, is the utility function of household H when it has a child of sex s, $s \in \{g, b\}$. Parents maximize utility subject to the household budget constraint. Credit markets are assumed to be perfect such that parents may save or borrow against the child's adult income. Thus, I can model parents' consumption and investment decisions in a one period model.

Normalize the price of consumption to equal 1. Households maximize the weighted sum of the mother's and father's utilities, u_s^m, u_s^f. Let y be the total household income. The indirect utility function $V_s(y)$ is the maximand of the optimization above.

$$V_s^H = \max_c \mu u_s^m(c) + (1-\mu)u_s^f(c), \quad \text{s.t. } c = y$$

The weight, μ, which characterizes bargaining power, is a function of the mother's and father's income ratio. Hence, the mother's bargaining power is increasing in her income and decreasing in the father's income. Note that the unitary model is simply the special case of the bargaining model where μ is 0 or 1.

The household budget constraint is composed of the incomes of the father, y_f, mother, y_m, and a child of sex s, y_s. Assume that the productivity of a child is positively correlated with the productivity of parents such that income of a child is a function of his/her parents' incomes, $y_s = y_s(y_f, y_m)$. Furthermore, assume that the correlation is stronger between a child and a parent of the same sex.

$$\frac{\partial y_g}{\partial y_m} > \frac{\partial y_g}{\partial y_f}, \; \frac{\partial y_b}{\partial y_f} > \frac{\partial y_b}{\partial y_m}$$

The investment value of a child is characterized by the inclusion of his/her income in the budget constraint. Thus, the Lagrangian for the household utility maximization is

$$\mathcal{L}_s = \max_c \mu u_s^m(c) + (1-\mu)u^f(c) - \lambda_s \left[c - (y_f + y_m + y_s)\right],$$

The effect of a parent's income on the probability of having a girl is

$$\Gamma_{y_\rho} = \frac{\partial \mu}{\partial y_\rho}\left[\left(u_g^m - u_b^m\right) - \left(u_g^f - u_b^f\right)\right] + \left[\lambda_g\left(1 + \frac{\partial y_g}{\partial y_\rho}\right) - \lambda_b\left(1 + \frac{\partial y_b}{\partial y_\rho}\right)\right] \quad (2)$$

It follows from the first order conditions that λ_g and λ_b are the marginal utilities of income in the two states of the world (e.g. when a household has a girl or when a household has a boy), $\frac{\partial u_g}{\partial y}$, $\frac{\partial u_b}{\partial y}$. The latter bracketed terms imply that holding other variables constant, the effect of a parent's income on the probability of having a girl is increasing in the difference between the marginal utilities of income when a household has a girl and when a household has a boy, $\lambda_g > \lambda_b$. This means that if a daughter compliments income more than a son, an increase in income will increase the desirability of daughters relative to the desirability of sons. In other words, an increase in parents' income will increase the probability of having a girl if girls are luxury goods relative to boys. Henceforth, I call this the relative "consumption value" from having girls.

Parental income also affects the probability of having a girl by changing the relative "investment value" from having a daughter. Equation (2) shows that holding other variables constant, the relative desirability of a girl will increase if the parent's income is more correlated with a girl's income than with a boy's income, $\frac{\partial y_g}{\partial y_\rho} > \frac{\partial y_b}{\partial y_\rho}$.

The terms $u_g^m - u_b^m$ and $u_g^f - u_b^f$ are the mother's and father's utilities from having a girl relative to having a boy. Equation (2) shows that as long as parents do not have the same relative utilities from having a daughter, $u_g^m - u_b^m \neq u_g^f - u_b^f$, an increase in parental income will also affect the probability of having a girl by affecting each parent's bargaining power, $\frac{\partial \mu}{\partial y_\rho}$.

In short, equation (2) shows that an increase in a parent's income will affect the relative desirability of girls by affecting: 1) parents' bargaining power, $\frac{\partial \mu}{\partial y_\rho}$; 2) the relative consumption values of girls, $\lambda_g - \lambda_b$; and 3) the relative investment value of girls, $\frac{\partial y_g}{\partial y_\rho} - \frac{\partial y_b}{\partial y_\rho}$.

It is easy to see that for the special unitary case, where μ is or 1, equation (2) reduces to

$$\Gamma_{y_\rho} = \lambda_g \left(1 + \frac{\partial y_g}{\partial y_\rho}\right) - \lambda_b \left(1 + \frac{\partial y_b}{\partial y_\rho}\right)$$

Where the interpretation of each term is the same as before. The only difference here is that bargaining does not play a role.

The difference between the effects of the mother's income and the father's income for the general case can be written as

$$\begin{aligned}\Gamma_{y_m} - \Gamma_{y_f} &= \left(\frac{\partial \mu}{\partial y_m} - \frac{\partial \mu}{\partial y_f}\right)\left[\left(u_g^f - u_b^f\right) - \left(u_g^m - u_b^m\right)\right] \\ &\quad + \lambda_g \left(\frac{\partial y_g}{\partial y_m} - \frac{\partial y_g}{\partial y_f}\right) - \lambda_b \left(\frac{\partial y_b}{\partial y_m} - \frac{\partial y_b}{\partial y_f}\right) \\ &> 0, \text{ since } \frac{\partial \mu}{\partial y_m} > \frac{\partial \mu}{\partial y_f}, \frac{\partial y_g}{\partial y_m} > \frac{\partial y_g}{\partial y_f}, \frac{\partial y_b}{\partial y_m} < \frac{\partial y_b}{\partial y_f}\end{aligned} \tag{3}$$

Equation (3) shows that changes in the mother's income and the father's income will have different effects on the probability of having a girl because they affect each parent's bargaining power differently and because the correlation between each parent's income and a child's income is different for boys and girls.

So far, I have assumed that parents view children as a form of investment as well as a form of consumption. However, it is possible that parents view having children only as a form of consumption. In this case, the household budget constraint does not include the income of the child and the household maximization problem is

$$\mathcal{L}_s = \max_c \mu u_s^m(c) + (1-\mu)u^f(c) - \lambda_s \left[c - (y_f + y_m)\right]$$

The effect of parental income on the probability of a girl is then

$$\Gamma_{y_\rho} = \frac{\partial \mu}{\partial y_\rho}\left[\left(u_g^m - u_b^m\right) - \left(u_g^f - u_b^f\right)\right] + \lambda_g - \lambda_b \tag{4}$$

The interpretation of the individual terms is the same as for equation (2). The difference is that the effect of the change in parental income on the child's income, $\frac{\partial y_s}{\partial y_\rho}$, no longer plays a part in the relative desirability of the child.

In the special unitary case, where μ is 0 or 1, equation (4) reduces to

$$\Gamma_{y_\rho} = \lambda_g - \lambda_b$$

Note that the equation above implies $\Gamma_{y_m} = \Gamma_{y_f}$, which means that when households are unitary and parents view children only as form consumption, the effect of mother's income on the probability of having a girl should be equivalent to the effect of father's income. The intuition is that when households are maximizing their utility, the marginal effect of income on consumption is the same across all sources of income. Consequently, if the empirical results show that mother's and father's incomes have different effects on population sex ratios, the hypothesis that parents in unitary households view children only as a form of consumption can be rejected.

4 The Data

This paper matches the 1% Sample of the 1997 *Chinese Agricultural Census*, 0.1% samples the 1990 and 2000 *Chinese Population Censuses*, and GIS geography data from the Michigan China Data Center at the county level. The sample includes 1,621 counties in China's 15 southern provinces, south of the Yellow River (Huang He) where any tea is planted.[6] Map 1A show that these counties are dispersed throughout southern China. The 1990 census data contain 52 variables, amongst which are data on sex, year of birth, education attainment, sector and type of occupation, and relationship to the head of household. Because of the different family planning policies and market reforms experienced by urban areas and rural areas, I limit the analysis to rural households. The individual and household level data are aggregated to the county level to match the agricultural census data. The number of individuals in each county-birth year cell is retained so that the later analysis are all population weighted.

Reliable data for procurement prices and output are not available for this period at the county level. For the sake of scope, accuracy and consistency between areas, this study uses county level agricultural data on the sown area from the 1% sample of the 1997 *China Agricultural Census*. Agricultural land is allocated by the village to farmers based on the number of members per household and quality of land. Land is usually allocated for 15 year terms (Burgess, 2004). There is no market for buying or selling land. The measurement error bias that results from using 1997 agricultural data to predict for agricultural conditions in the early 1980s is resolved by the instrumental variables strategy discussed later in the paper.

To assess whether counties that do not plant tea are good control groups for

[6] Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hunan, Hubei, Guandong, Guangxi, Sichuan, Guizhou, and Shanxi.

counties that plant tea, I look for systematic differences between the treatment and control groups. The ideal control group would be identical to the treatment group in every characteristic other than tea planting and the outcomes of interest. Panel A in Table 1 show that demographic composition and education attainment in tea counties are very similar to counties with no tea. The difference in ethnic composition will be controlled for in the regression analysis. Panel B shows that tea and non-tea counties are almost identical in sector of employment. 94% of the population is involved in agriculture. Panel C shows that households in tea counties farm less total land on average, devote more land to rice, garden production, and less land to orchards and grass for grazing. Tea counties also produce slightly more fish.

It is important to note the scarcity of land in the Chinese country side. On average, agricultural households only have 4.06-4.85 mu (0.20-0.32 hectares) of land per household. On average, households in counties that plant tea have only 0.15 mu (0.02 hectares) of land for tea. For a visual representation of the similarity in agricultural production between tea producing counties and non-tea producing counties, refer the Map 1B-1E, which map agricultural production of different types of cash crops and agricultural density. The black colored counties are counties which produce some tea. The gray shaded counties are counties which produce some garden vegetables (Map1B), orchard fruits (Map 1C) and fish (Map 1D). Map 1E shows counties which produce some tea and counties where the average farmable land per household exceeds the median of 4 mu (0.27 hectares). The maps show that tea producing counties are not geographically distant from counties which produce other cash crops. In fact, most tea producing counties also engage in other cash crop production.

5 Empirical Strategy

5.1 Identification

The main problem in identifying the effect of increased relative female-to-male earnings on child outcomes is that sex selection or investment in children's education and relative earnings are likely to be jointly driven by omitted household and community characteristics such as sex-preferences. For example, in communities with no boy bias, adult women will earn more and parents will view female children as less undesirable. When compared with communities with strong boy-bias, where adult women earn less and parents have very strong boy-preferences, we will find a positive correlation between adult female income and girl survival rates. However since female earnings and girl survival rates are jointly determined by sex preference, the correlation cannot reveal whether the increase in girl survival rate is caused by higher female earnings or by underlying sex preference which drives both adult female earnings and girls' survival rates. This problem is addressed by exploiting the increase in relative value of tea caused by two post-Mao policies during 1978-1980. The exogenous variation in relative adult female earnings allows me to estimate the causal effect of an increase in relative adult female earnings on relative survival rates of girls.

First, I estimate the effect of the agricultural reforms on girl survival rates in tea planting regions. The identification strategy uses the fact that the rise in adult female income varied across region and time of birth. Substantial variation in amount of tea sown existed across regions. Therefore, the number of surviving female children should have increased in tea planting regions for cohorts born close to and/or after the reform, and the increase should have been larger for regions which planted more tea. I use a differences-in-differences estimator to control for systematic differences both across regions and across cohorts. Only the combination of these two variations is treated as exogenous. In other words, I compare relative survival rates between counties which plant tea and counties which do not plant tea, for cohorts born before and after the reform. Comparing sex ratios within counties for cohorts born before and after the reform differences out time-invariant community characteristics. Comparing tea planting communities to non-tea planting communities differences out changes that are not due to planting tea. Thus, the causal effect of planting tea can be identified as long as tea planting areas did not experience changes which were systematically different from non-tea planting areas.

The date of birth and whether an individual is born in a tea planting region jointly determine whether he/she was exposed to the relative adult female income shock. In other words, tea is a proxy for female earnings. The validity of the identification strategy does not rely on the assumption that only women pick tea. If men or children picked tea, the proxy for relative female income will exceed actual relative female income. Hence, the strategy will underestimate the true effect of relative female income on sex ratio. If there are any unobserved time-invariant cultural reasons that affect both women to pick tea and desirability of female children, the effect will be differenced out by comparing cohorts born before and after the reform. The identification strategy is only in question if there is some time varying difference which coincides with the reform. For example, if the attitudes which drive sex preference changes in tea planting counties at the time of the reform, the estimate of the effect of planting tea will capture both the relative female income effect and the effect of the attitude change. Or, if the reason for women to pick tea was changed by the HPRS, the pre-reform cohort will be an inadequate control group. While I can not resolve the former problem, I address the latter concern by instrumenting for tea planting with time invariant geographic data.

Second, I investigate whether the increase in tea value affects relative survival rates because of the increase in relative female income rather than an increase in total household income. I estimate the effect of the reform on girls' survival in regions which plant cash crops that experienced equal or more value increase but for which adult female labor have no comparative advantage. Third, I use the increase in value of orchard fruits relative to other crops to investigate the effect of an increase in relative male income on sex ratios. The identification strategy of using exogenous price changes in sex-specific agricultural products to identify effects of changes in female-to-male wage ratio is similar to Shultz's (1985) study on Swedish fertility rates in the late 19th century, where he used changing world grain prices to instrument for changes in the female-to-male wage ratio.

I can check the identification strategy by estimating the effect of category 1 and category 3 crops on sex ratios. Category 1 crops continued to be strictly regulated after 1979. Category 3 crops were never regulated. Hence, the reforms of 1978-1980 did not increase the *rate* of increase in the value of either group of crops. If the identification strategy is valid, and the changes of sex ratios is due to the increases in relative value of category 2 crops, then the effect of category 1 crops and category 3 crops on sex ratios should not change after the reform. Chart 6A shows that indeed the effect of category 1 and 3 crops were identical before and after the reform.

5.2 Timing

To see that the effect of tea and orchards on sex ratios is due to the post-Mao agricultural reforms and not due to other changes in these regions, I check that the effect of tea and orchard on sex ratios increased in magnitude at the time of the reform. First, I estimate the effect of tea planted for each birth cohort.

$$sex_{ic} = \alpha + \sum_{l=1963}^{1990} (tea_i \times d_l)\beta_l + han_i\phi + \gamma_i + \psi_c + \varepsilon_{ic} \tag{5}$$

The fraction of males in county i, cohort c is a function of: the interaction term between tea_i, the amount of tea planted for each county i and d_l, a variable which indicates if a cohort is born in year l; han_i, control for the fraction of Han in each county i; γ_i,county fixed effects; and ψ_c, cohort fixed effects. Including the fraction of Han controls for differences in family planning policies which Hans and ethnic minorities faced. The dummy variable for 1962 and all of its interactions are dropped. β_l is the effect of planting tea on the fraction of males for cohort l. If the effect of tea on sex ratios was due to the reform, β_l should be similar between cohorts until approximately the time of the reform, after which, it should decrease. The coefficients in the vector β_l are plotted in Chart 6B. The effect of tea on fraction of males is more negative for cohorts born after 1979. Table 2 column (1) shows that they are statistically significant after 1979.

In a similar regression, I estimate the effect of orchard planted in each county i on the fraction of males in county i, cohort c.

$$sex_{ic} = \alpha + \sum_{l=1963}^{1990} (orchard_i \times d_l)\gamma_l + han_i\phi + \gamma_i + \psi_c + \varepsilon_{ic} \tag{6}$$

The coefficients in vector γ_l are plotted in Chart 6C. The effect of planting orchards on the fraction of males become more positive after 1979. Table 2 column (2) show that the results are statistically insignificant. Chart 6D plots the coefficients from a similar regression estimating the effect of all category 2 cash crops on fraction of males. The plot shows clearly that the effect of cash crops on sex ratio experienced no change after the reform. Table 2 column (3) presents the estimates.

5.3 Difference-in-Differences

To compare sex ratios in counties that plant tea to counties that do not, I estimate the following equation where the fraction of males in county i birth cohort c is a function of the interaction term of a dummy variable for whether a county plants tea and a dummy variable for whether a cohort is born after the reform, controlling for the amount of orchards and all cash crops planted, fraction of Han, county fixed effects, and a dummy variable for being born after the reform.

$$\begin{aligned} sex_{ic} &= \alpha + (tea_i * post_c)\beta_1 + (orchard_i * post_c)\beta_2 \\ &\quad +(cashcrop_i * post_c)\beta_3 + X_{ic}\zeta + \psi_i + post_c\gamma + \varepsilon_{ic} \end{aligned} \tag{7}$$

All standard errors are clustered at the county level. Table 3 columns (3) and (4) show that for cohorts born after the reform, the fraction of males decreased by 0.7 percentage point more in tea planting counties, where as it increased by 0.9 percentage points more in orchard planting counties. Both estimates are statistically significant at the 5% level.

5.4 OLS by Birth Cohort

To see that the timing of the effect is unchanged by including controls for orchards and cash crops, I estimate the following equation.

$$\begin{aligned} sex_{ic} &= \sum_{l=1963}^{1990}(tea_i \times d_l)\beta_l + \sum_{l=1963}^{1990}(orchard_i \times d_l)\gamma_l + \\ &\quad \sum_{l=1963}^{1990}(cashcrop_i \times d_l)\rho_c + \zeta Han_{ic} + \alpha + \psi_i + \gamma_c + \varepsilon_{ic} \end{aligned} \tag{8}$$

Table 4 shows the coefficients in the vectors β_l, γ_l and ρ_l for each birth cohort c from 1963 to 1990. 1962 is the reference year. The timing of the change in the effects of tea and orchard is similar to the the less restricted estimates of equation (5) and (6). The coefficients are plotted in Chart 7. The plotted coefficients show clearly that after the reform, planting orchards increased the fraction of males in surviving population, planting tea decreased the fraction of males and all category 2 cash crops had no effect.

5.5 OLS Issues

5.5.1 Differing Trends Across Counties

The long time horizon of the study suggests that a simple fixed effects estimate may not adequately control for different trends across counties. I address this issue by including linear trends at the county level. Column (1) of Table 5 shows the differences-in-differences estimate from equation (7). Column (2) shows the estimate with the inclusion of a county-level linear trend. The point estimate is almost identical to the less restrictive estimate of column (1) and statistically significant at the 5% level. Thus, the OLS estimate is robust to changes across counties over time.

5.5.2 Migration

Strict migration controls suppressed long term migration from rural areas throughout the period of the study. However, if migration patterns differed significantly between tea and non-tea areas, and between orchard and non-orchard areas, the OLS estimate could be capturing the effects of migration rather than of income changes. Cohorts born after the reform are 11 years of age or younger in the 1990 Census. Hence, migration would bias the estimates if households with boys are more likely to migrate out of tea areas and households with girls are more likely to migrate out of orchard areas. Migration controls, however, made migration of entire households impossible. Another possible cause for bias is if amongst pre-reform cohorts, females were more likely to migrate out of tea areas and males were more likely to migrate out of orchard areas.

To address this problem, I use equation (7) and *inferred* populations to estimate the upper and lower bounds of the effect of planting tea and orchards on sex ratios. To calculate the *inferred* populations, I use the fraction of urban residents in each province that report they are not born in that city and the population of the province to calculate the maximum possible number of rural-urban migrants per province. I use population of each county to calculate the fraction of provincial population in each county. I then add the multiple of this fraction and the maximum number of migrants for that province back into each county. I assume that the new additions are all born prior to the reform. To estimate the lower bound of the effect of tea, I assume that all the new additions to the pre-reform cohorts in tea counties are female. To estimate the upper bound of the effect of tea, I assume that all the new additions are male. Similarly, for the lower bound of the effect of orchard, I assume that all the added inferred migrants in orchard counties are male. And to estimate the upper bound, I assume that all the inferred migrants are female. The estimated bounds are very similar to the OLS estimates on the reported population, consequently ruling out the possibility that the results are driven by migration.

5.6 Instrumental Variables

Two problems motivate the use of instrumental variables. First, using 1997 agricultural data to proxy for agricultural conditions in previous years will cause measurement error. Second, the OLS estimate will be biased upwards if families which innately preferred girls relative to boys switched to planting tea after the reform. In this case, the OLS estimate will capture the innate girl-preference of families that chose to plant tea as well as a change in the desirability of girls caused by an increase in female earnings. I address both problems by instrumenting for the tea planting decisions with the average slope of each county.

Tea grows only in very particular conditions: hilltops, shielded from wind and heavy rain, warm semi-humid places. The exclusion restriction requires that the average slope of a county does not have any direct effect on differential investment decisions and is also not correlated with any other covariates in equation (7). Map 2 shows the slope variation in China, where darker areas are steeper. Map 3 overlays the map of counties which plant tea onto the slope map. The predictive power of slope for tea planting can be seen by comparing the tea planting counties with the steep regions in Map 2. I use the GIS data from Map 2 to calculate the average slope for each county and estimate the following first stage equation, where both the amount of tea planted and slope is time-invariant.

$$\begin{aligned} tea_i * post_c &= (slope_i * post_c)\lambda + (orchard * post_c)\delta_1 + \\ &\quad (cashcrop * post_c)\delta_2 + X_{ic}\zeta + \alpha + \psi_i + post_c\gamma + \varepsilon_{ic} \end{aligned} \tag{9}$$

I use the predicted residuals to estimate the following second stage regression.

$$\begin{aligned} sex_{ic} &= (tea_i * post_c)\beta + (orchard * post_c)\delta_1 \\ &\quad +(cashcrop * post_c)\delta_2 + X_{ic}\zeta + \alpha + \psi_i + post_c\gamma + \varepsilon_{ic} \end{aligned} \tag{10}$$

Columns (3) of Table 5 shows the first stage estimate from equation (9). The estimate is statistically significant at the 5% level. Column (4) shows the two stage least square estimate from equation (10). The estimate is larger than the OLS estimate and statistically significant. Column (5) shows the two stage least squares estimate including county-level linear trends. The estimate is similar in magnitude to the OLS estimate but no longer statistically significant.

The two stage least square point estimate is greatly reduced by including county-level linear trends. This suggests that there are trends in hilly areas which are not adequately controlled for by the less restrictive 2SLS estimate. Consequently, the exclusion restriction of the instrumental variables can only be satisfied conditional on the trends. In other words, conditional on the county-level linear trends, the OLS estimates are not driven by the endogenous decision to plant tea or measurement error. The similarity in magnitude between the 2SLS and OLS estimates conditional on linear trends and between the OLS estimate conditional on the linear trends and the OLS estimate not controlling for the trend reinforces the robustness of the OLS estimate.

5.7 Education Attainment

The main results of the effect of relative adult earnings on sex ratios rejected the hypothesis that parents view children only as a form consumption. However, since increasing adult agricultural earnings also increase the earnings potential of children, the main results cannot distinguish between the unitary model where children are a form of investment and the bargaining model of the household.

While it is beyond the scope of this paper to separate the unitary and bargaining models of the household, I investigate the effect of adult income changes on education attainment to establish the conditions for which the unitary model can explain the empirical results.

This analysis uses county-birth-cohort level data from the 2000 *Population Census.* In order to isolate the sample to children who had completed their education, I restrict the sample to cohorts born between 1962 and 1982. Individuals in the sample should not be affected by the Cultural Revolution since disruptions to schools were generally isolated to urban areas. I use cohorts which had not yet reached compulsory schooling age at the beginning of the reforms (born before 1974) as the pre-reform control.

I repeat the same experiment as before. I estimate the effect of planting tea, orchard and all cash crops on education attainment for all individuals, girls and boys separately. I also estimate it for the difference in education between boys and girls.

$$\begin{aligned} eduyrs_{ic} &= (tea_i * post_c)\beta_1 + (orchard_i * post_c)\beta_2 + \\ &\quad (cashcrop_i * post_c)\beta_3 + X_{ic}\zeta + \alpha + \psi_i + post_c\gamma + \varepsilon_{ic} \end{aligned} \tag{11}$$

Tea_i and $orchard_i$ are dummy variables for whether county i plants any tea or orchards, respectively. Columns (1) of Table 6 show that the increase in tea value increased overall education attainment by 0.16 years, where the increase in orchard fruit value decreased overall education by 0.9 years. Columns (2) and (3) show that tea increased education more for girls than for boys, orchards decreased education attainment for girls and had no effect on boys. All estimates are statistically significant at the 1% or 5% levels, except for the estimate of the effect of orchard on boys' education. Column (4) shows that tea decreased the male-female difference in education attainment whereas orchards increased the education difference. The former estimate is not statistically significant. The latter is statistically significant at the 1% level. Table 6 also shows that all category 2 cash crops have no effect on education attainment.

To observe the timing of the effect, I estimate the effect of planting tea by birth year.

$$eduyrs_{ic} = \sum_{l=1962}^{1982}(tea_i \times d_l)\beta_l + \sum_{l=1962}^{1982}(orchard_i \times d_l)\gamma_l + \sum_{l=1962}^{1982}(cashcrop_i \times d_l)\rho_c + \zeta Han_{ic} + \alpha + \psi_i + \gamma_c + \varepsilon_{ic} \quad (12)$$

The coefficients for each cohort l in vectors β_l, δ_l and ρ_l are shown in Appendix Table A2. They are not statistically significant. I plot the 3 year moving averages of the estimates of tea and orchards in Charts 8A-8C. Chart 8A shows that female education attainment was similar between tea and orchard areas until 1976, when it increased in the former and decreased in the latter. Chart 8B shows that education attainment for boys increased in both tea and orchard areas. Chart 8C shows that the male-female gap in education attainment began decreasing in tea areas for cohorts born 1976 and after. In orchard areas, the male-female gap increased for those same cohorts.

The results that increasing adult female income caused girls to be relatively more educated and that increasing adult male income caused boys to be relatively more educated can be explained by the unitary model if parents interpret the increase in adult female (male) income as an increase in girls' (boys') returns to education. The finding that an increase in adult female income increased overall education attainment while an increase in adult male income decreased overall education attainment is more puzzling. This can only be explained by the unitary model if an increase in female agricultural income has a different effect on returns to education from an increase in male agricultural income. The lack of income data prevents a direct investigation of this hypothesis.

6 Conclusion

This paper resolves the problem of joint determination in estimating the effect of changes in adult income on survival rate of girls. I find that increasing total household income without changing the relative incomes of men and women had no effect on survival rates of girls or education attainment. Increasing the share of female income had a large and immediate positive effect on the survival rates of girls and increased education for all children. Conversely, increasing the share of male income immediately decreased survival rates and education attainment of girls. The results suggest that parents do not have identical preferences.

The empirical findings give a clear and affirmative answer to the question of whether sex preference responds to economic incentives in the short run. In addition, the results say that increasing total household income without changing the relative shares of female and male income will have no effect on survival rates. Policy makers who aim to decrease sex imbalance should create policies that increase proportional adult earnings of the deficit sex. In other words, an effective method of immediately decreasing excess female mortality is to increase the relative income of adult women.

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Chart 1

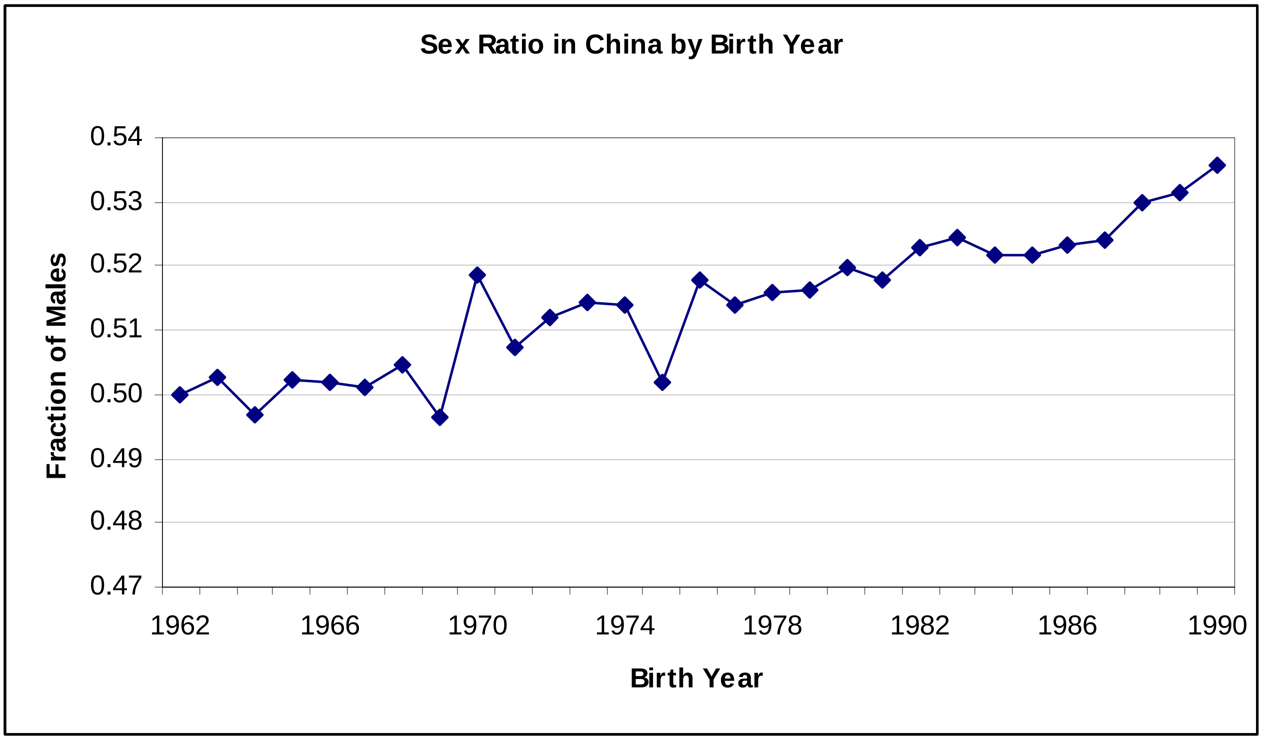


Chart 2A: Category 1 Crops

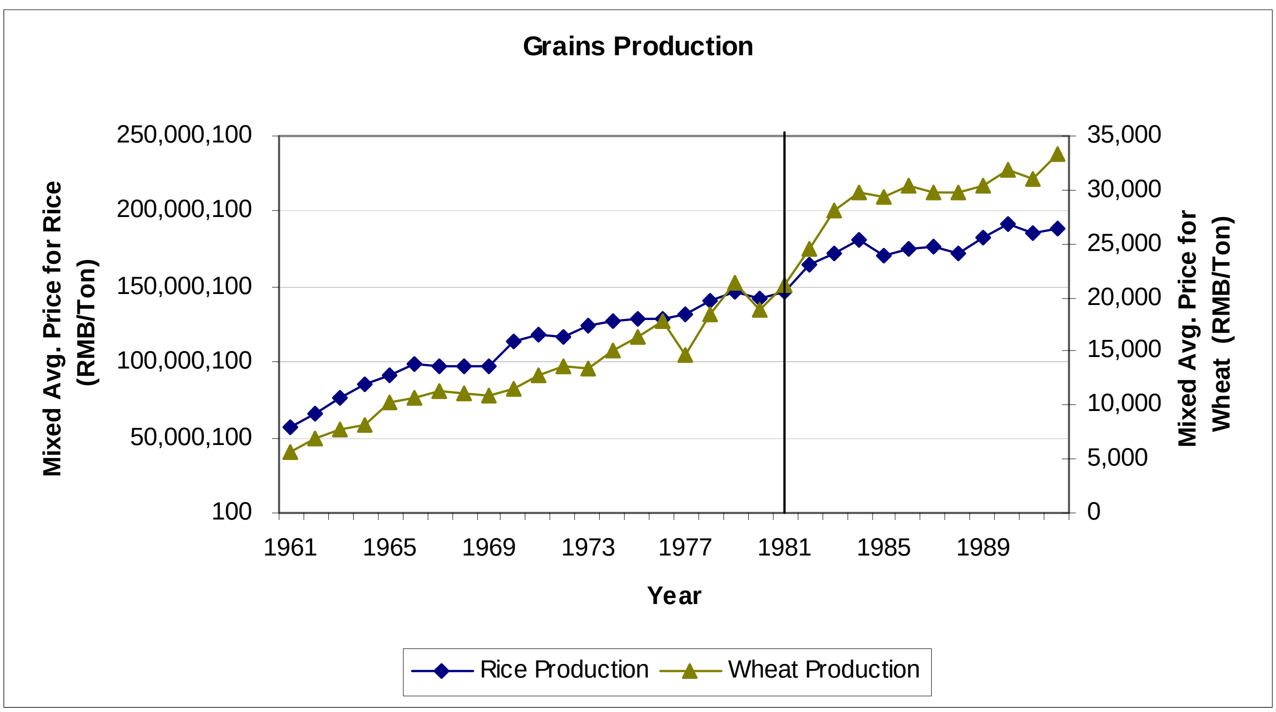


Chart 2B: Category 1 Crops

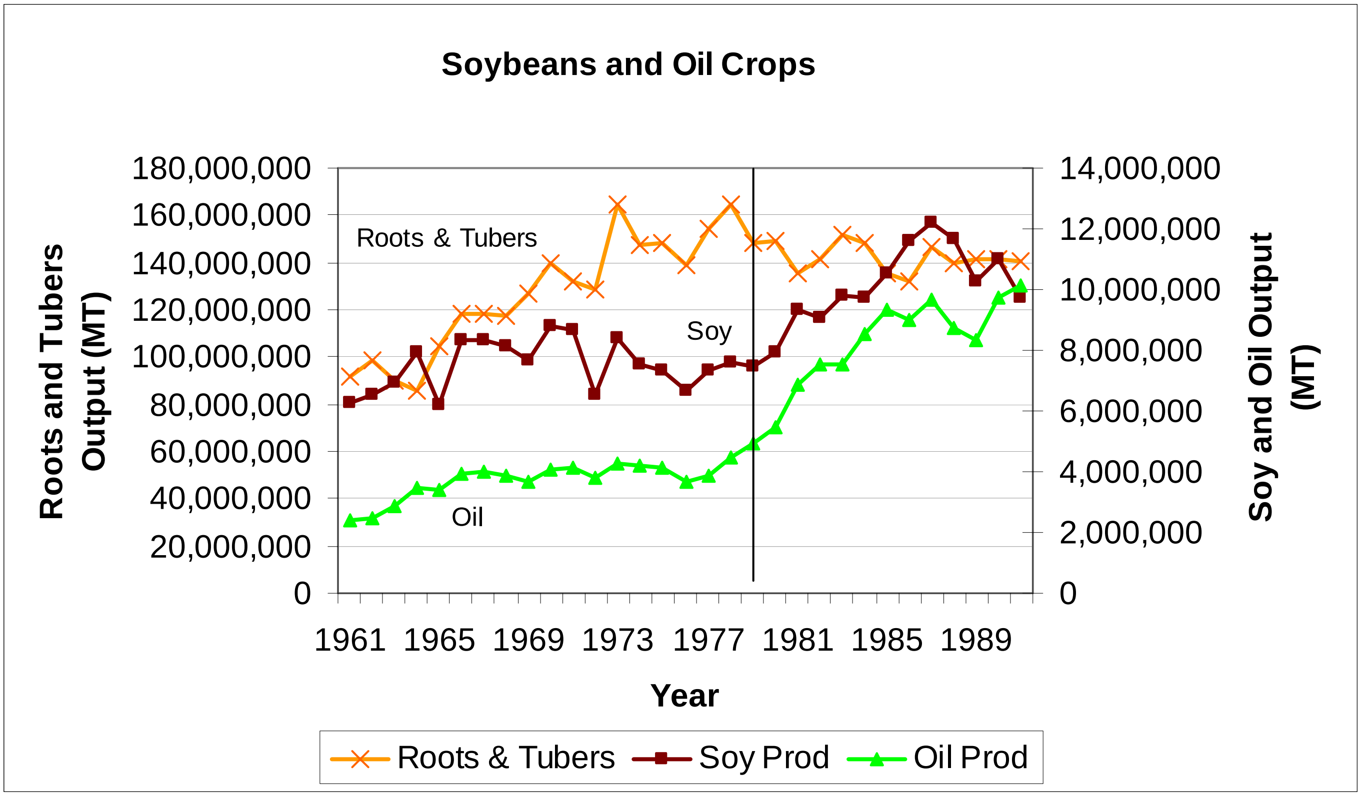


Chart 2C: Category 2 Cash Crops

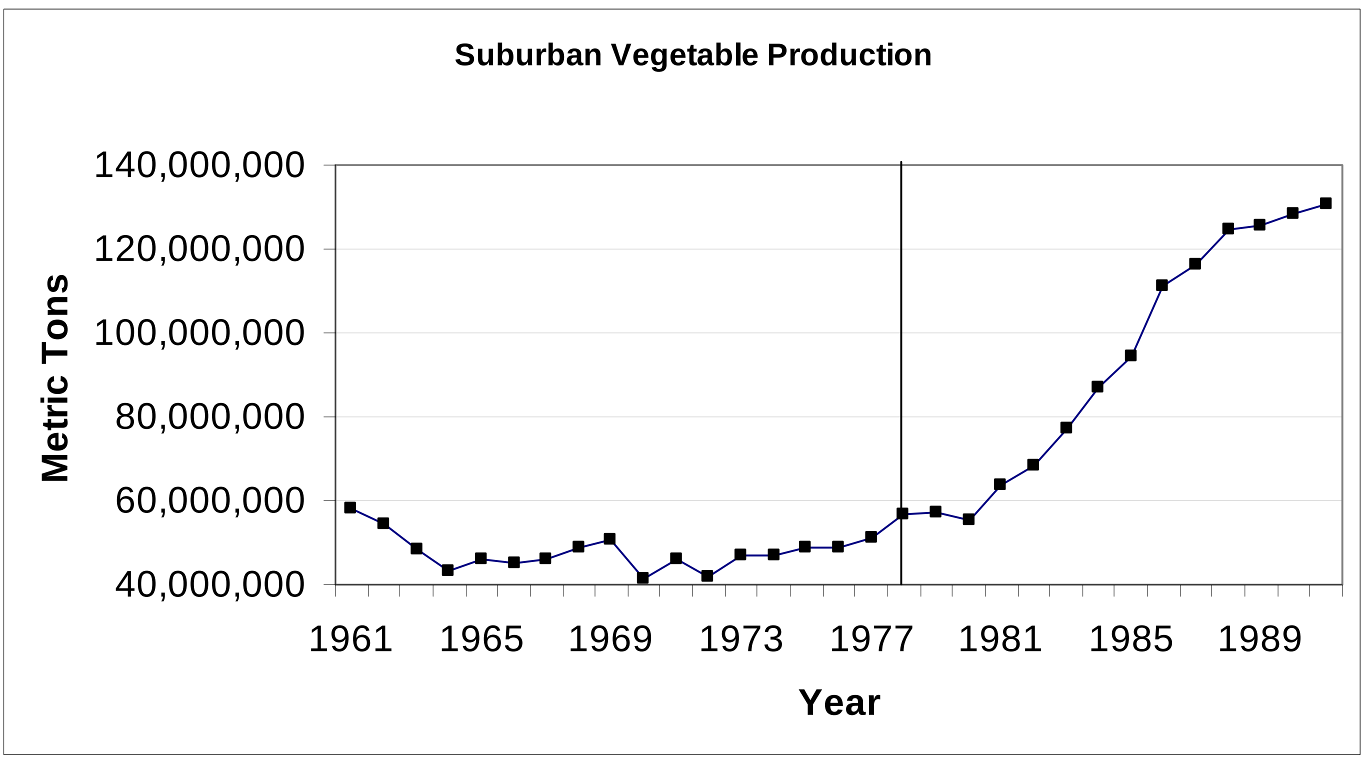


Chart 3A

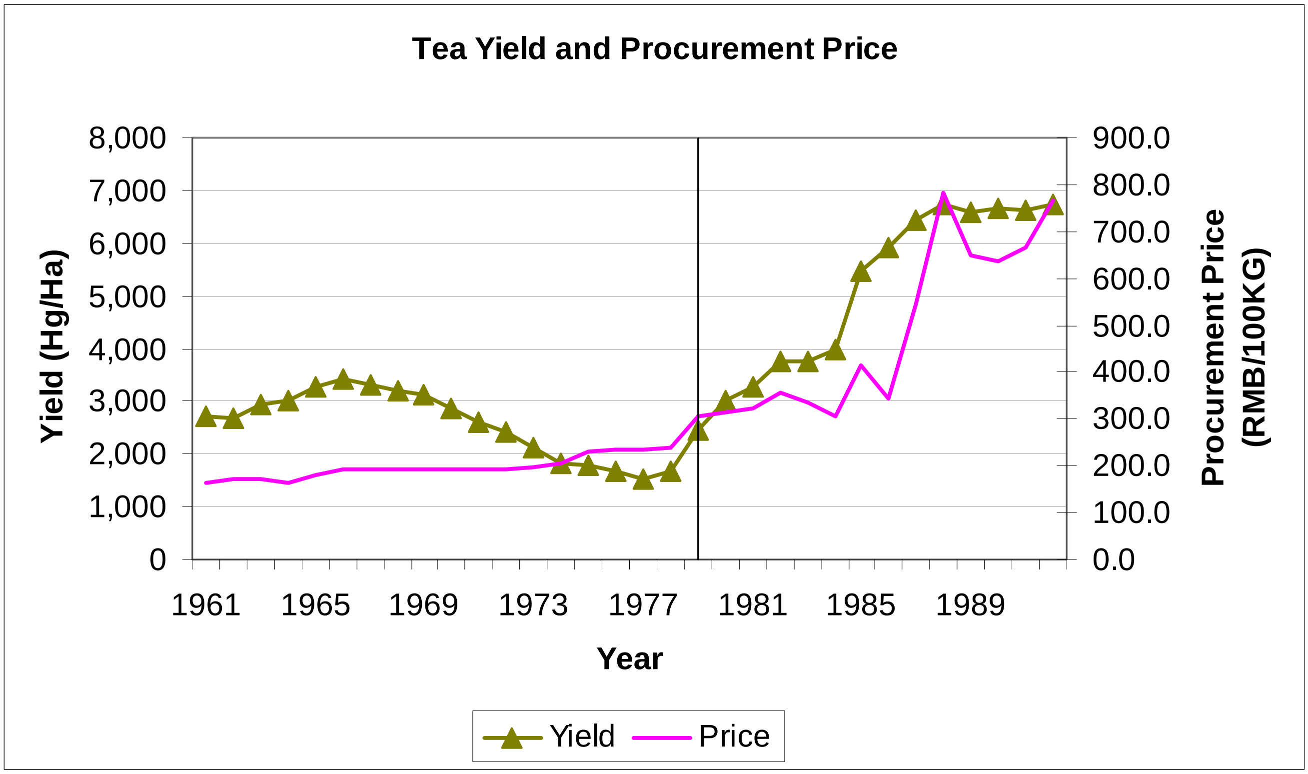


Chart 3B

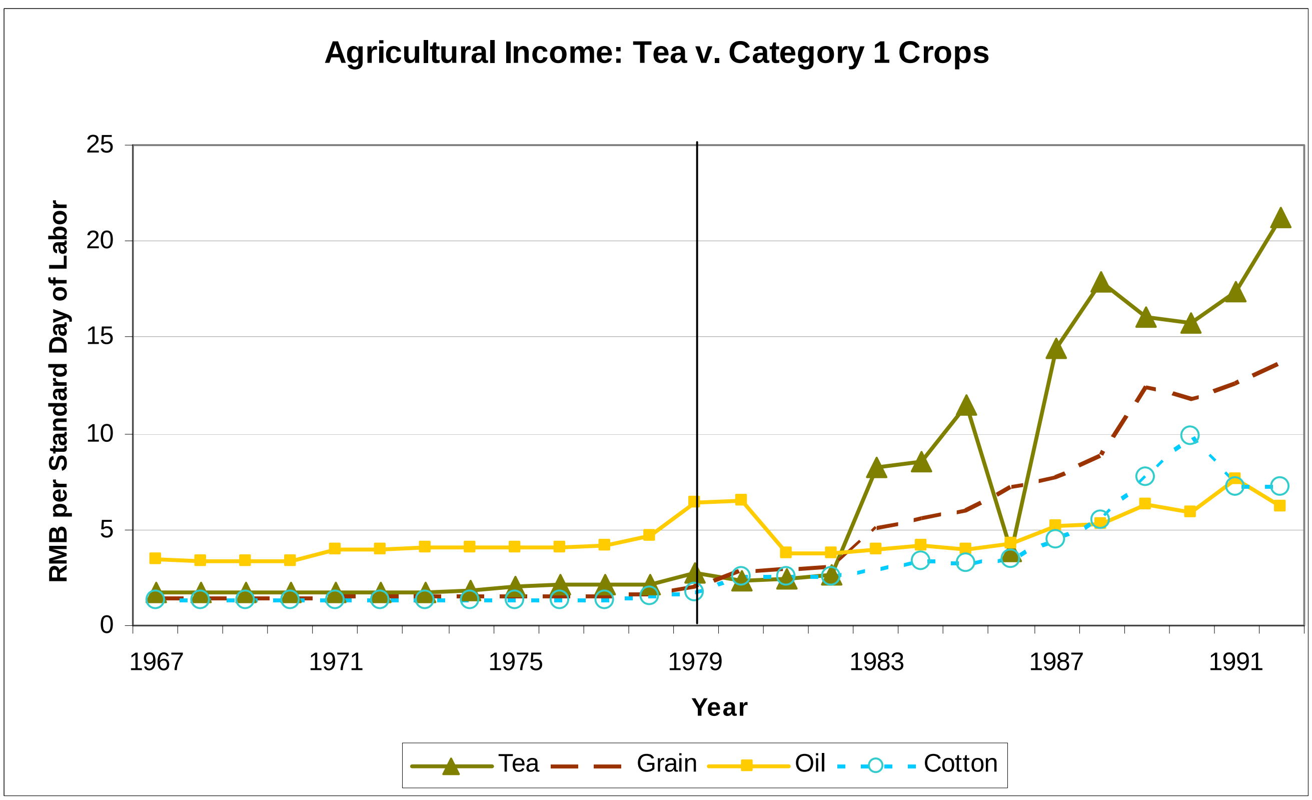


Chart 4A

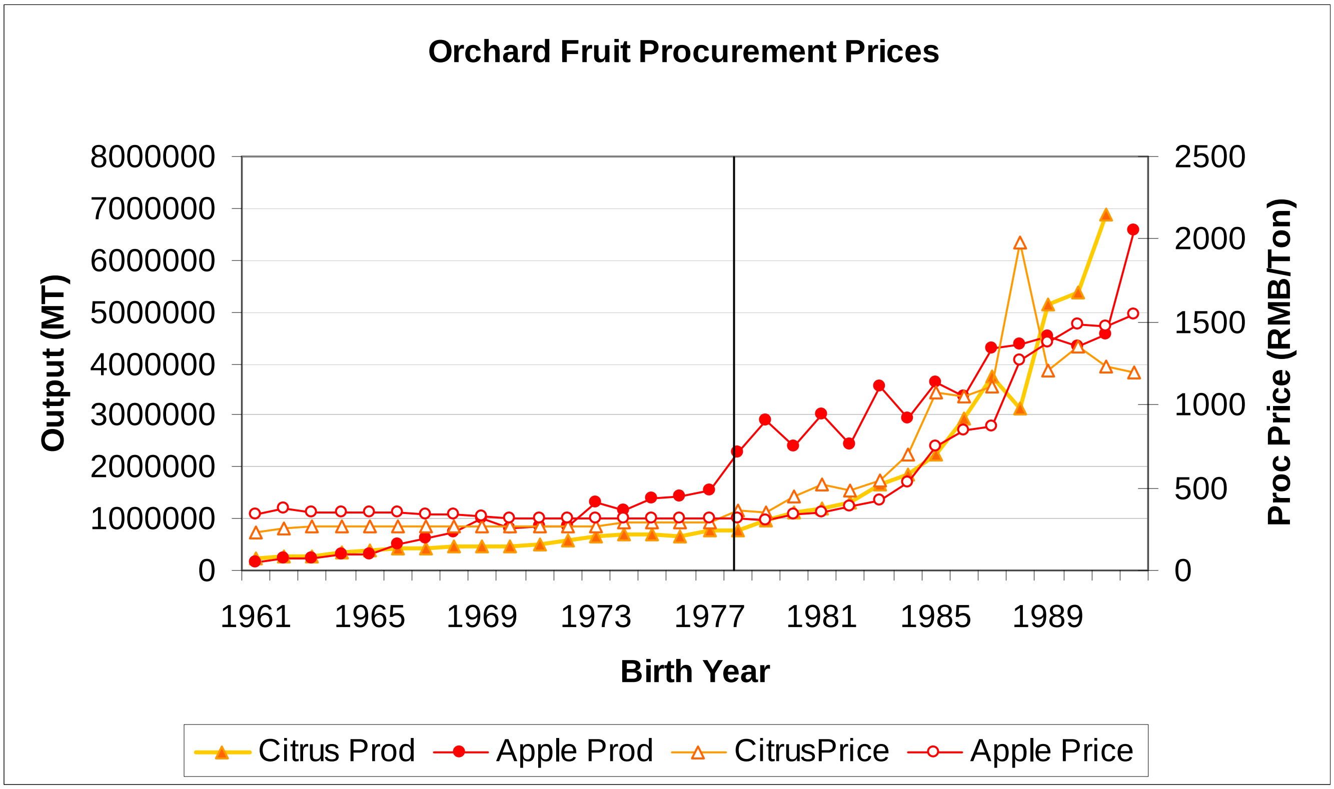


Chart 4B

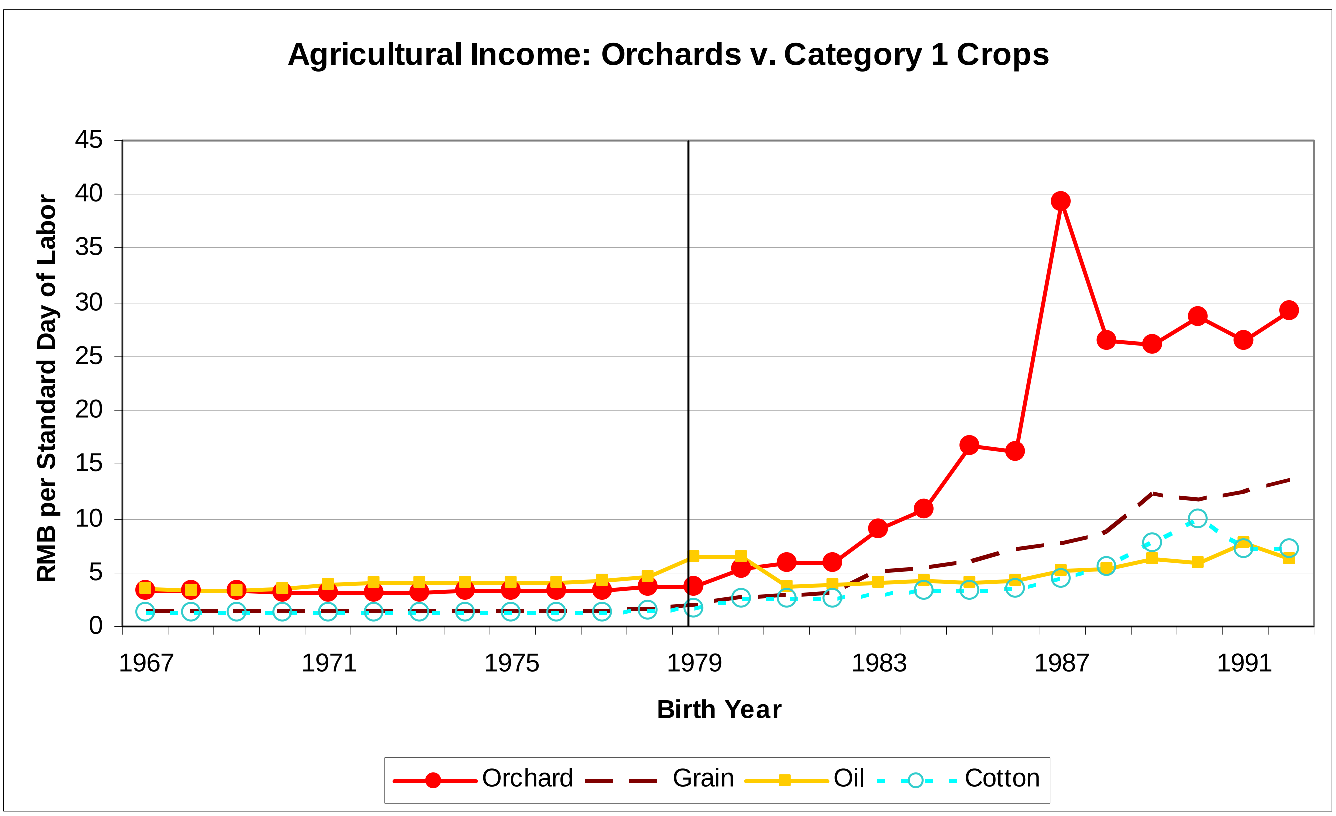


Chart 5

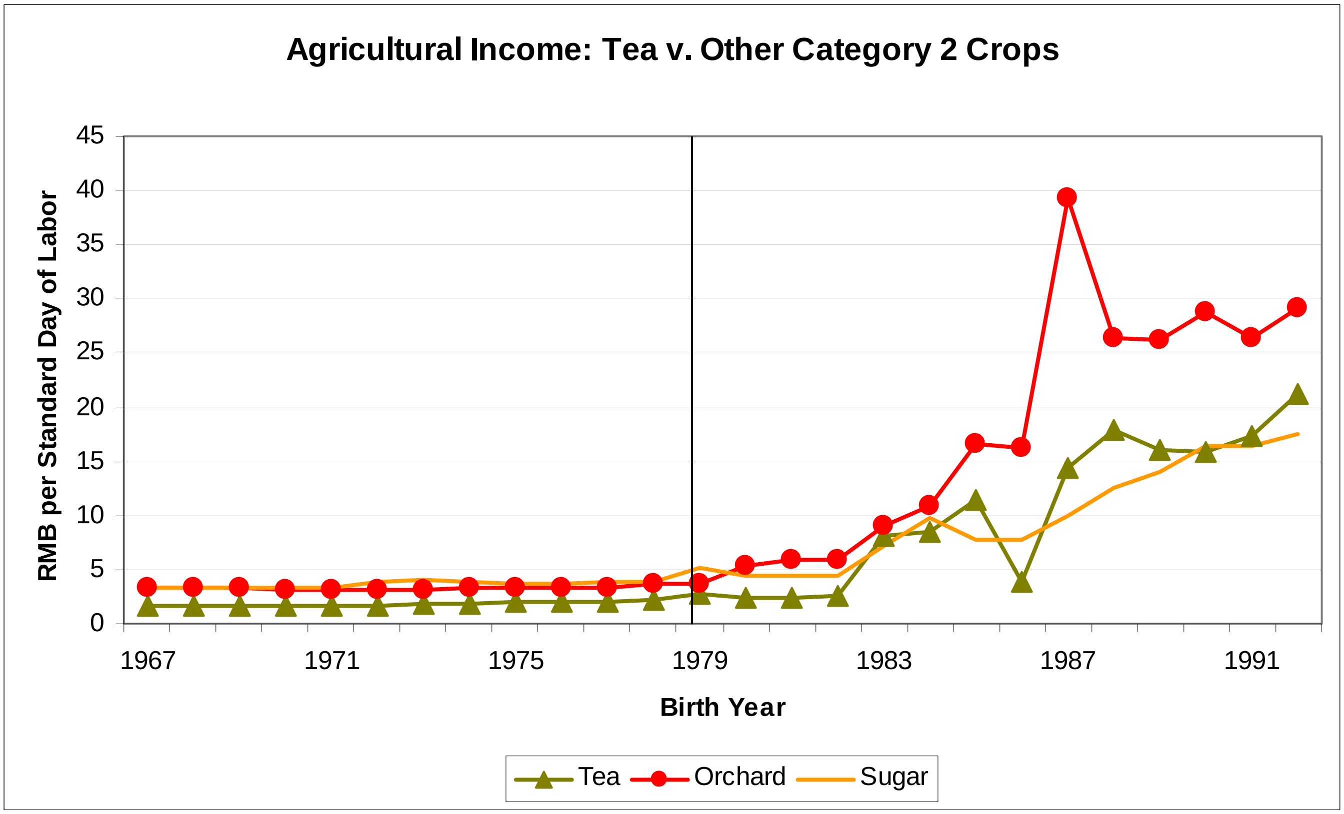


Chart 6A: The Effect of Category 1 and 3 Crops on Fraction of Males (Unrestricted)

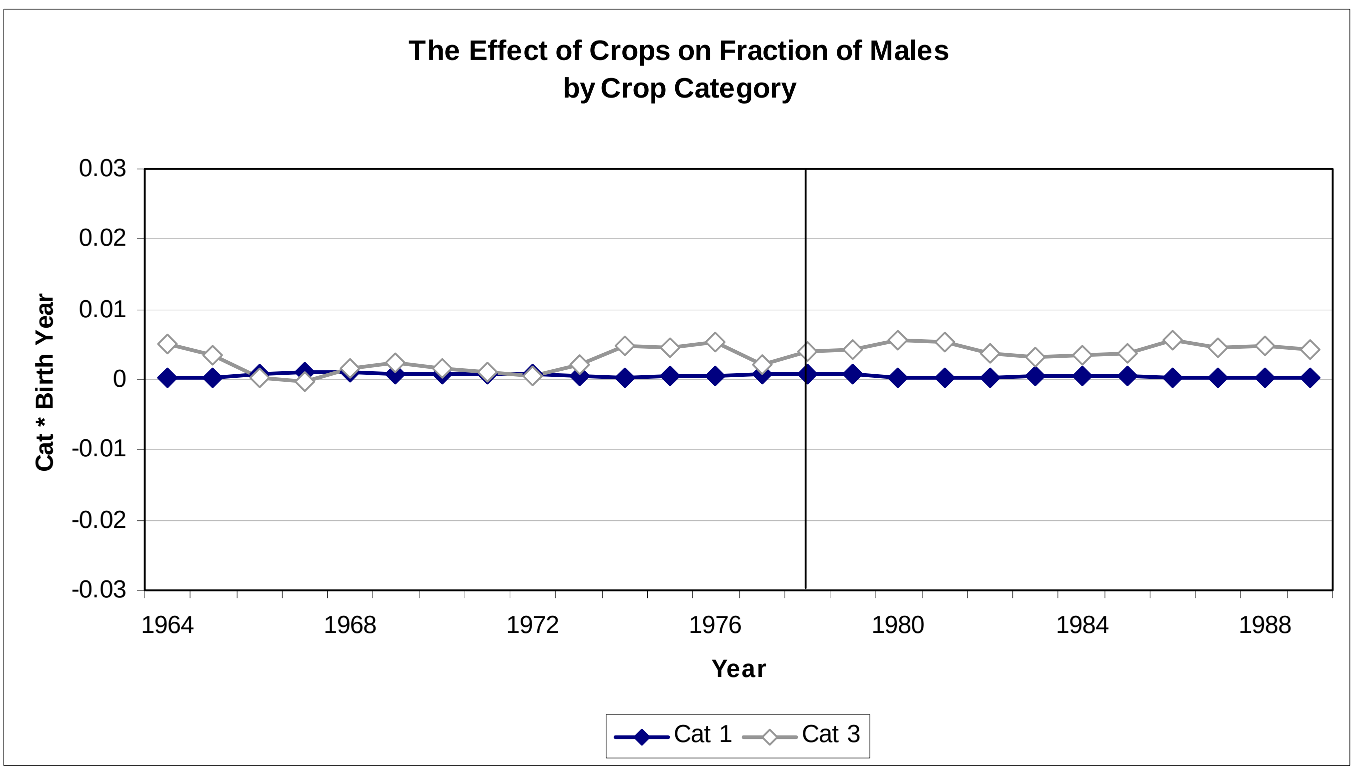


Chart 6B: The Effect of Tea on Fraction of Males (Unrestricted)

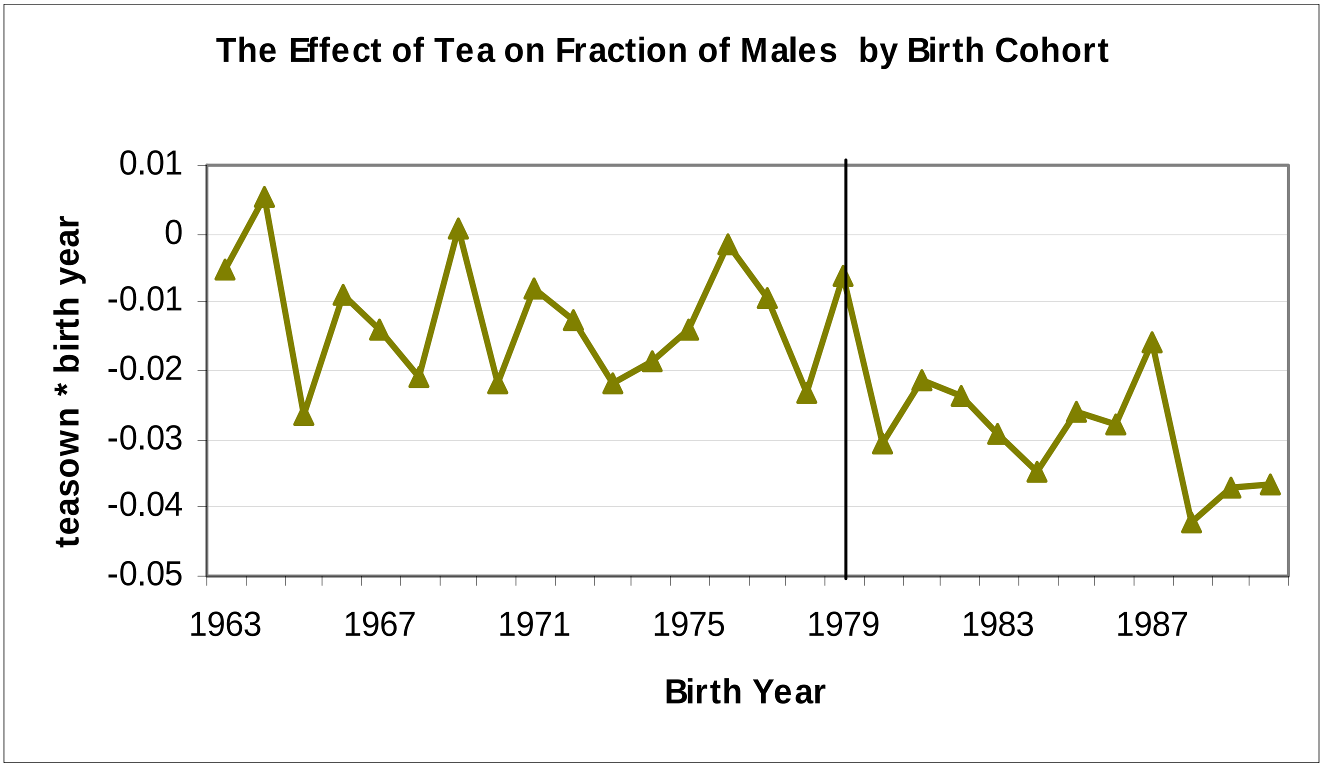


Chart 6C: The Effect of Orchards on Fraction of Males (Unrestricted)

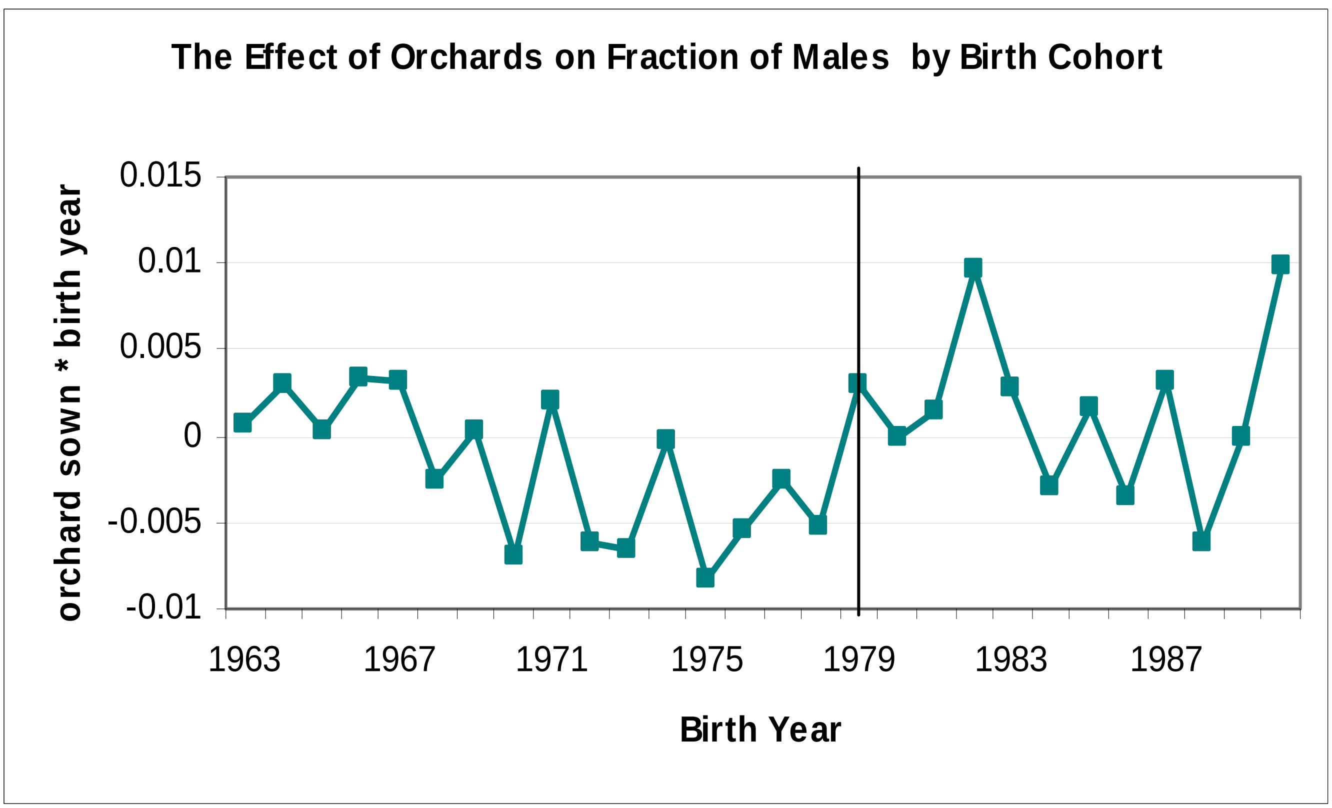


Chart 6D: The Effect of Cash Crops on Fraction of Males (Unrestricted)

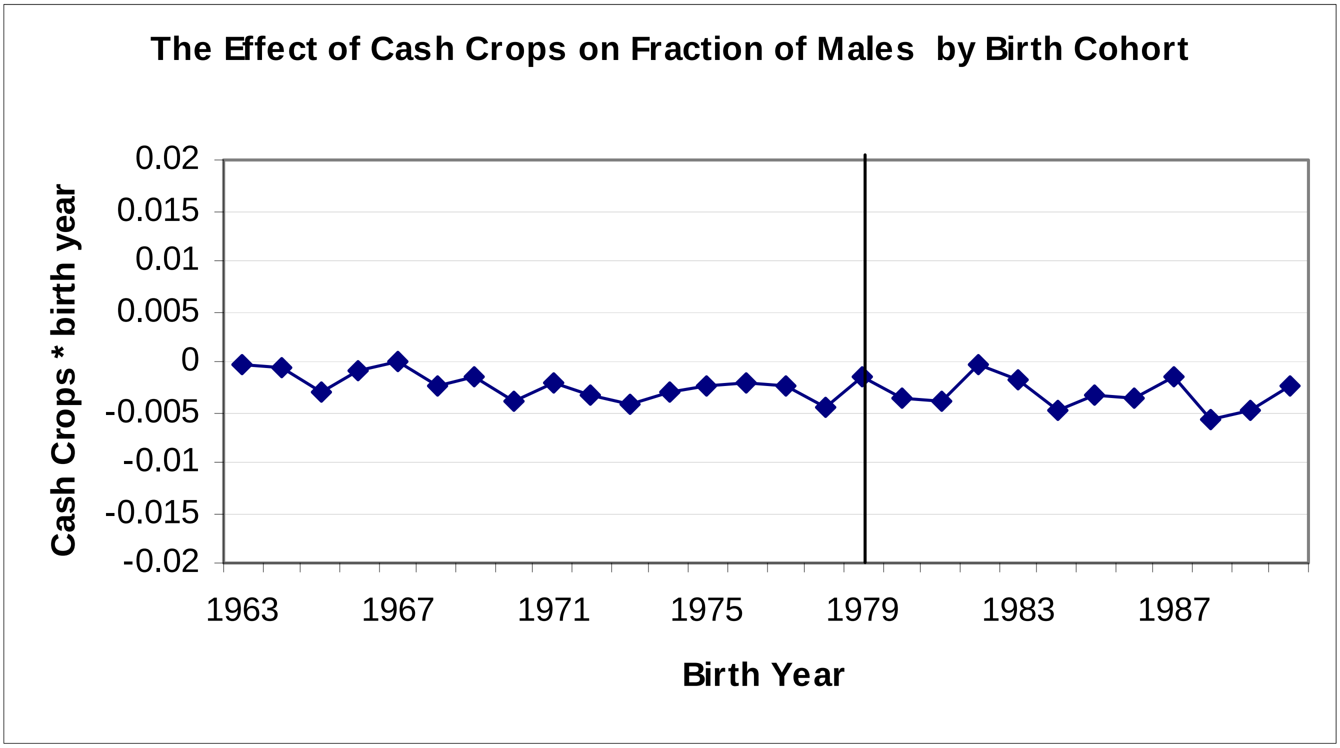


Chart 7

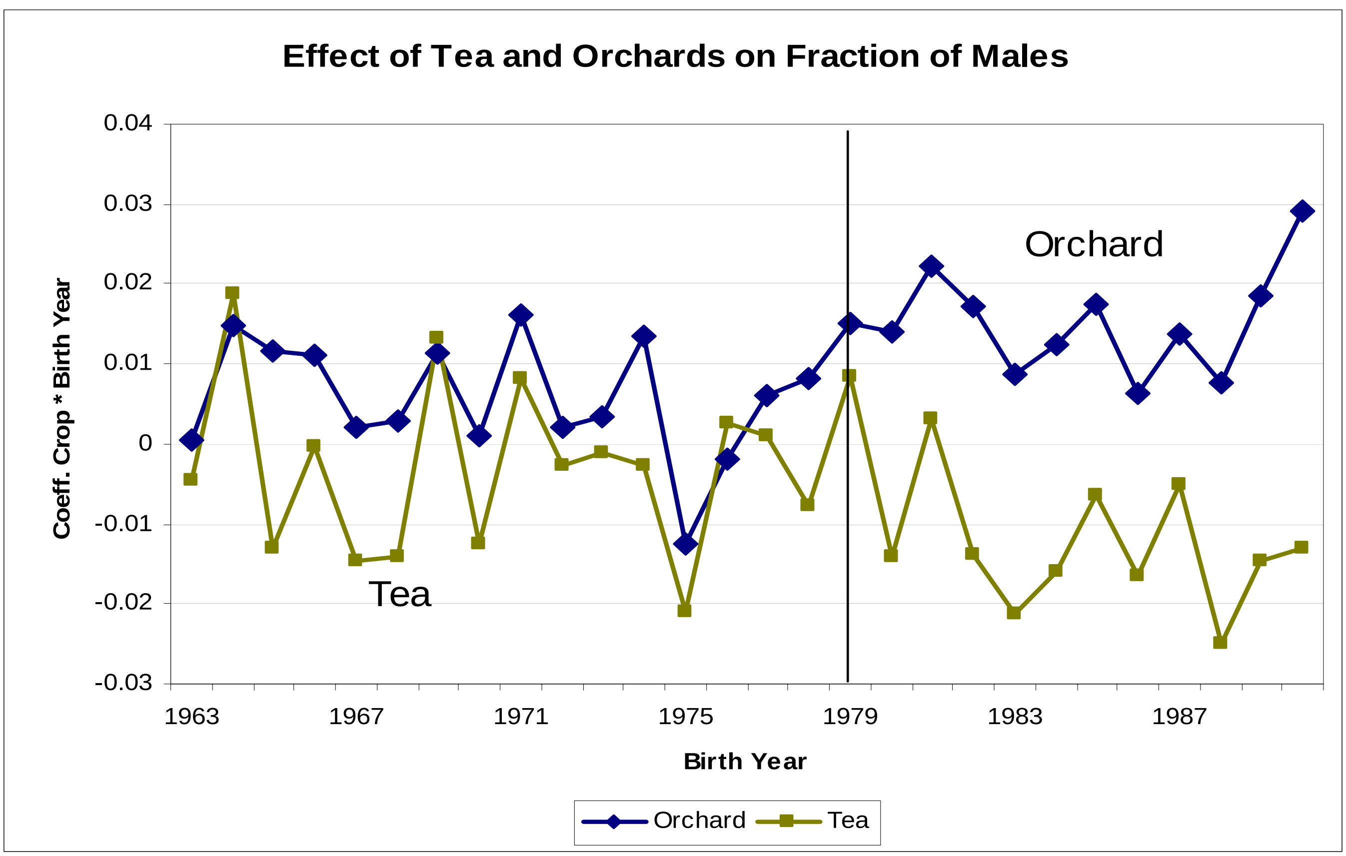


Chart 8A

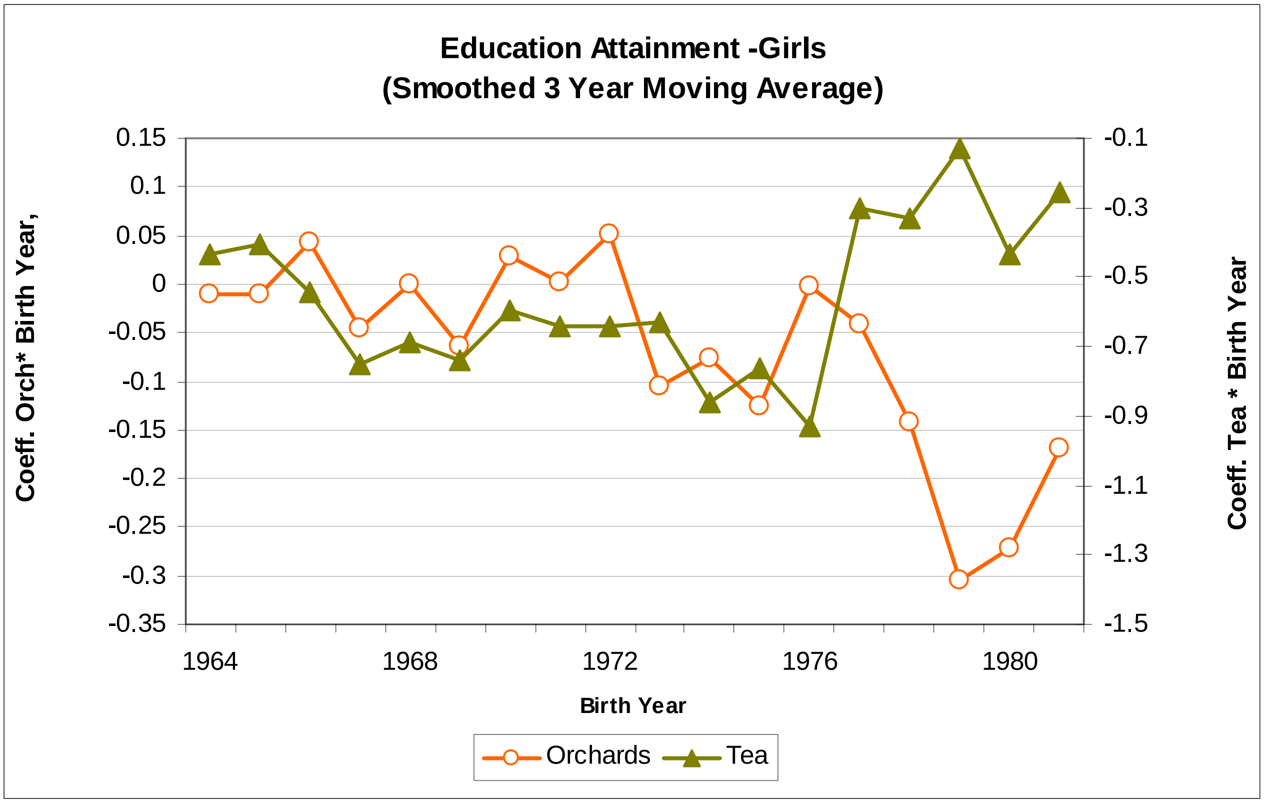


Chart 8B

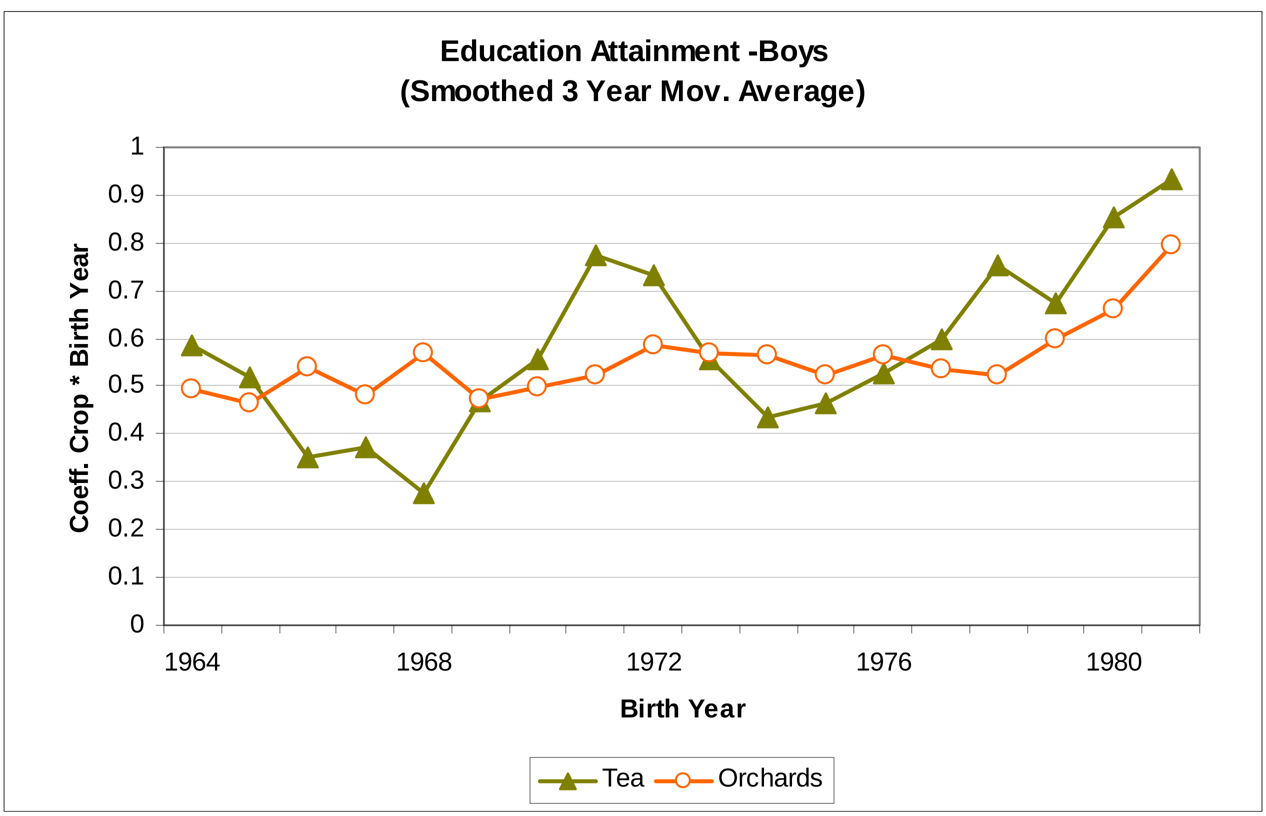
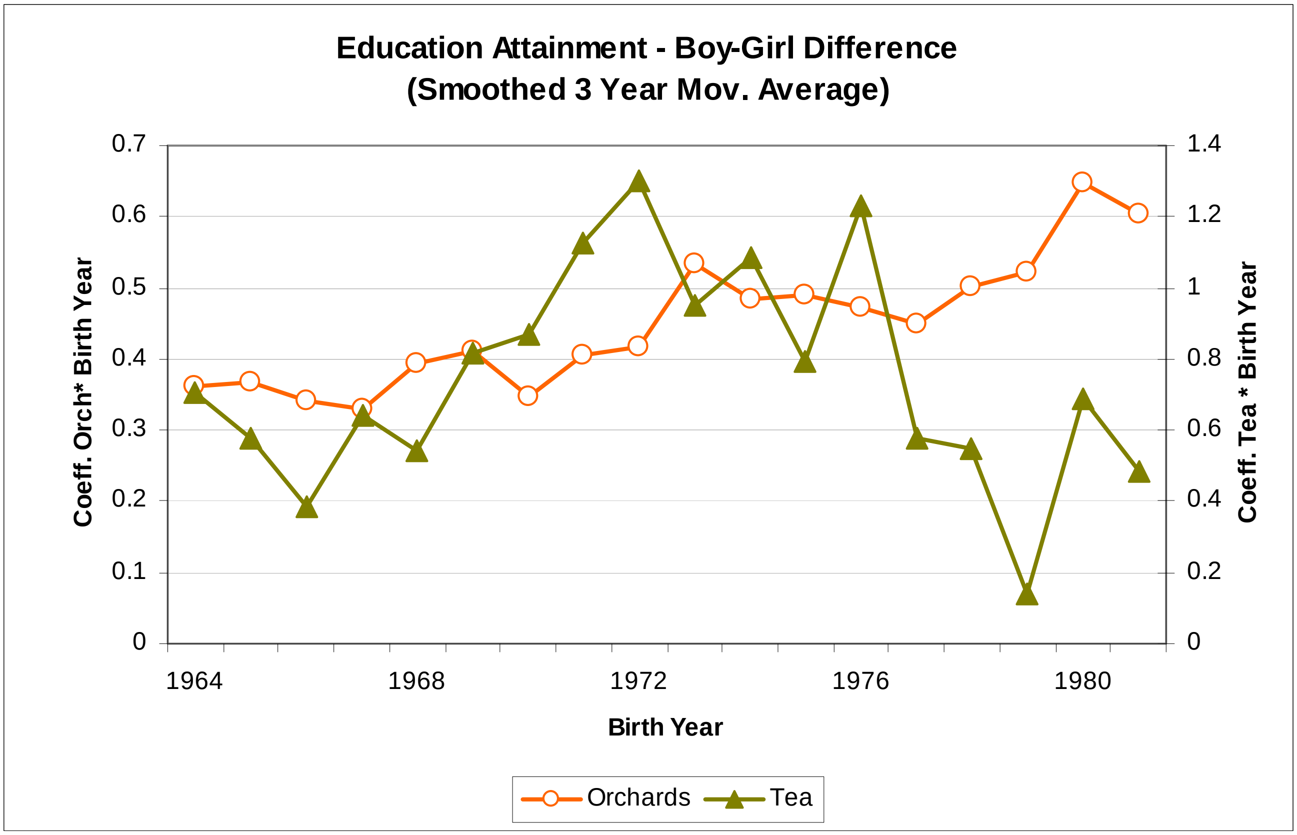


Chart 8C



Education Attainment - Boy-Girl Difference
(Smoothed 3 Year Mov. Average)
Coeff. Orch* Birth Year
Coeff. Tea * Birth Year
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1964
1968
1972
1976
1980
Birth Year
Orchards
Tea

Table 1: Descriptive Statistics – 1990 Population Census, 1997 Agricultural Census

	Counties that plant no tea			**Counties that plant some tea**		
	Obs	Mean	Std. Err.	Obs	Mean	Std. Err.
A. Demographic Variables						
Fraction male	41665	0.51	(0.0003)	10101	0.52	(0.0007)
Age	41665	14.00	(0.0410)	10101	14.00	(0.0833)
Han	41665	0.95	(0.0009)	10101	0.88	(0.0027)
De-collectivized	41665	0.99	(0.0002)	10101	0.99	(0.0004)
Household size	41665	5.22	(0.0132)	10101	5.16	(0.0261)
Married	23641	0.62	(0.0002)	7164	0.62	(0.0004)
Years of Education	32785	6.63	(0.0095)	7996	6.38	(0.0205)
(Female)	37653	4.70	(0.0082)	9465	4.39	(0.0148)
(Male)	37618	6.01	(0.0072)	9465	5.69	(0.0130)
Father's Education	40647	6.17	(0.0067)	10043	5.82	(0.0127)
Mother's Education	40655	4.53	(0.0082)	10054	4.33	(0.0146)
School Enrollment (Female)	40781	0.24	(0.0018)	10009	0.22	(0.0036)
School Enrollment (Male)	40636	0.27	(0.0019)	9977	0.25	(0.0038)
B. Industry of Occupation of Household Head						
Agricultural	41665	0.94	(0.0006)	10101	0.94	(0.0013)
Industrial	41665	0.04	(0.0005)	10101	0.04	(0.0009)
Construction	41665	0.01	(0.0001)	10101	0.00	(0.0002)
Commerce, etc.	41665	0.01	(0.0001)	10101	0.01	(0.0002)
C. Agricultural production and Land Use (Mu)						
Farmable land per household	23018	4.87	(0.0150)	10101	4.06	(0.0211)
Rice Sown Area	23018	1.66	(0.0106)	10101	2.55	(0.0106)
Garden Sown Area	23018	0.23	(0.0029)	10101	0.34	(0.0047)
Tea Sown Area	41665	0.00	0.0000	10101	0.15	(0.0034)
Orchard Sown Area	23018	0.20	(0.0029)	10101	0.16	(0.0034)

Sample of those born in during 1962-1990
Observations are birth year x county cells

Table 2: The Effects of Tea, Orchards and Cash Crops on Fraction of Males (Unrestricted)

	Dependent Variable: Fraction of Males					
	Tea (1)		Orchards (2)		All Cat. 2 Cash Crops (3)	
	Coeff.	Std. Err	Coeff.	Std. Err	Coeff.	Std. Err
Crop*1963	-0.005	(0.013)	0.001	(0.005)	0.000	(0.002)
Crop*1964	0.005	(0.023)	0.003	(0.006)	-0.001	(0.002)
Crop*1965	-0.026	(0.013)	0.000	(0.005)	-0.003	(0.002)
Crop*1966	-0.009	(0.014)	0.003	(0.005)	-0.001	(0.002)
Crop*1967	-0.014	(0.015)	0.003	(0.005)	0.000	(0.002)
Crop*1968	-0.021	(0.014)	-0.003	(0.005)	-0.003	(0.002)
Crop*1969	0.001	(0.015)	0.000	(0.005)	-0.001	(0.002)
Crop*1970	-0.022	(0.016)	-0.007	(0.007)	-0.004	(0.002)
Crop*1971	-0.008	(0.011)	0.002	(0.006)	-0.002	(0.002)
Crop*1972	-0.012	(0.010)	-0.006	(0.005)	-0.003	(0.002)
Crop*1973	-0.022	(0.011)	-0.007	(0.006)	-0.004	(0.002)
Crop*1974	-0.019	(0.014)	0.000	(0.005)	-0.003	(0.002)
Crop*1975	-0.014	(0.012)	-0.008	(0.007)	-0.002	(0.002)
Crop*1976	-0.002	(0.019)	-0.005	(0.006)	-0.002	(0.002)
Crop*1977	-0.010	(0.018)	-0.003	(0.005)	-0.002	(0.002)
Crop*1978	-0.023	(0.014)	-0.005	(0.006)	-0.004	(0.002)
Crop*1979	-0.006	(0.011)	0.003	(0.006)	-0.002	(0.002)
Crop*1980	-0.031	(0.015)	0.000	(0.005)	-0.004	(0.002)
Crop*1981	-0.021	(0.015)	0.001	(0.006)	-0.004	(0.002)
Crop*1982	-0.024	(0.011)	0.010	(0.005)	0.000	(0.002)
Crop*1983	-0.029	(0.015)	0.003	(0.005)	-0.002	(0.002)
Crop*1984	-0.035	(0.018)	-0.003	(0.005)	-0.005	(0.002)
Crop*1985	-0.026	(0.016)	0.002	(0.005)	-0.003	(0.002)
Crop*1986	-0.028	(0.014)	-0.003	(0.005)	-0.004	(0.002)
Crop*1987	-0.016	(0.016)	0.003	(0.005)	-0.001	(0.002)
Crop*1988	-0.042	(0.012)	-0.006	(0.006)	-0.006	(0.002)
Crop*1989	-0.037	(0.019)	0.000	(0.005)	-0.005	(0.002)
Crop*1990	-0.037	(0.018)	0.010	(0.006)	-0.003	(0.002)

All regressions include controls for Han, county fixed effects and birth year fixed effects.
Standard errors clustered at county level.

Table 3: Difference-in-Difference Estimates

Dependent Variable : Fraction of Male				
	(1)	(2)	(3)	(4)
Tea * Post	-0.008		-0.007	-0.007
	(0.002)		(0.002)	(0.002)
Orchard * Post		0.011	0.009	0.009
		(0.003)	(0.003)	(0.003)
Han				0.059
				(0.013)
Observations	49082	49082	49082	49082
R-squared	0.12	0.12	0.12	0.12

All regressions include county fixed effect and controls for post and cash crops.
Post = 1 for cohorts born 1979-1990.
Standard Errors clustered at county level.

Table 4: The Effect of Tea, Orchards and Cash Crops by Birth Year

Dependent Variable: Fraction of Males						
	Tea (1)		Orchards (2)		Cat 2 Cash Crops (3)	
	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Crop * 1963	-0.005	(0.016)	0.001	(0.009)	0.000	(0.002)
Crop * 1964	0.019	(0.026)	0.015	(0.010)	-0.001	(0.002)
Crop * 1965	-0.013	(0.016)	0.012	(0.009)	-0.003	(0.002)
Crop * 1966	0.000	(0.016)	0.011	(0.009)	-0.001	(0.002)
Crop * 1967	-0.015	(0.018)	0.002	(0.009)	0.000	(0.002)
Crop * 1968	-0.014	(0.017)	0.003	(0.009)	-0.003	(0.002)
Crop * 1969	0.013	(0.018)	0.011	(0.009)	-0.001	(0.002)
Crop * 1970	-0.013	(0.019)	0.001	(0.010)	-0.004	(0.002)
Crop * 1971	0.008	(0.014)	0.016	(0.011)	-0.002	(0.002)
Crop * 1972	-0.003	(0.014)	0.002	(0.010)	-0.003	(0.002)
Crop * 1973	-0.001	(0.013)	0.003	(0.010)	-0.004	(0.002)
Crop * 1974	-0.003	(0.017)	0.014	(0.010)	-0.003	(0.002)
Crop * 1975	-0.021	(0.016)	-0.012	(0.011)	-0.002	(0.002)
Crop * 1976	0.003	(0.023)	-0.002	(0.012)	-0.002	(0.002)
Crop * 1977	0.001	(0.021)	0.006	(0.009)	-0.002	(0.002)
Crop * 1978	-0.008	(0.016)	0.008	(0.009)	-0.004	(0.002)
Crop * 1979	0.009	(0.014)	0.015	(0.010)	-0.001	(0.002)
Crop * 1980	-0.014	(0.017)	0.014	(0.009)	-0.004	(0.002)
Crop * 1981	0.003	(0.018)	0.022	(0.010)	-0.004	(0.002)
Crop * 1982	-0.014	(0.014)	0.017	(0.010)	0.000	(0.002)
Crop * 1983	-0.021	(0.018)	0.009	(0.008)	-0.002	(0.002)
Crop * 1984	-0.016	(0.021)	0.012	(0.009)	-0.005	(0.002)
Crop * 1985	-0.006	(0.019)	0.017	(0.009)	-0.003	(0.002)
Crop * 1986	-0.016	(0.017)	0.006	(0.009)	-0.004	(0.002)
Crop * 1987	-0.005	(0.018)	0.014	(0.009)	-0.001	(0.002)
Crop * 1988	-0.025	(0.015)	0.008	(0.009)	-0.005	(0.002)
Crop * 1989	-0.015	(0.022)	0.019	(0.009)	-0.005	(0.002)
Crop * 1990	-0.013	(0.023)	0.029	(0.011)	-0.002	(0.002)

Regression controls for Han, county fixed effects and birth year fixed effects.

Table 5: Linear Trend and 2SLS Estimates

	Dependent Variables				
	Fraction of Males		Tea	Fraction of Males	
	(1)	(2)	(3)	(4)	(5)
	OLS	OLS	1st	IV	IV
Tea * Born 1979-1990	-0.013	-0.012		-0.072	-0.011
	(0.006)	(0.005)		(0.031)	(0.007)
Slope * Born 1979-1990			0.26		
			(0.057)		
Linear Trend	No	Yes	Yes	No	Yes
Observations	45613	45613	37756	37756	37756
R-squared	0.13	0.2	0.82	0.05	0.16

All regression include county fixed effects and controls for Han, orchards, cash crop, and birth cohort.

Table 6: The Effect of Tea, Orchard and Cash Crops on Education Attainment

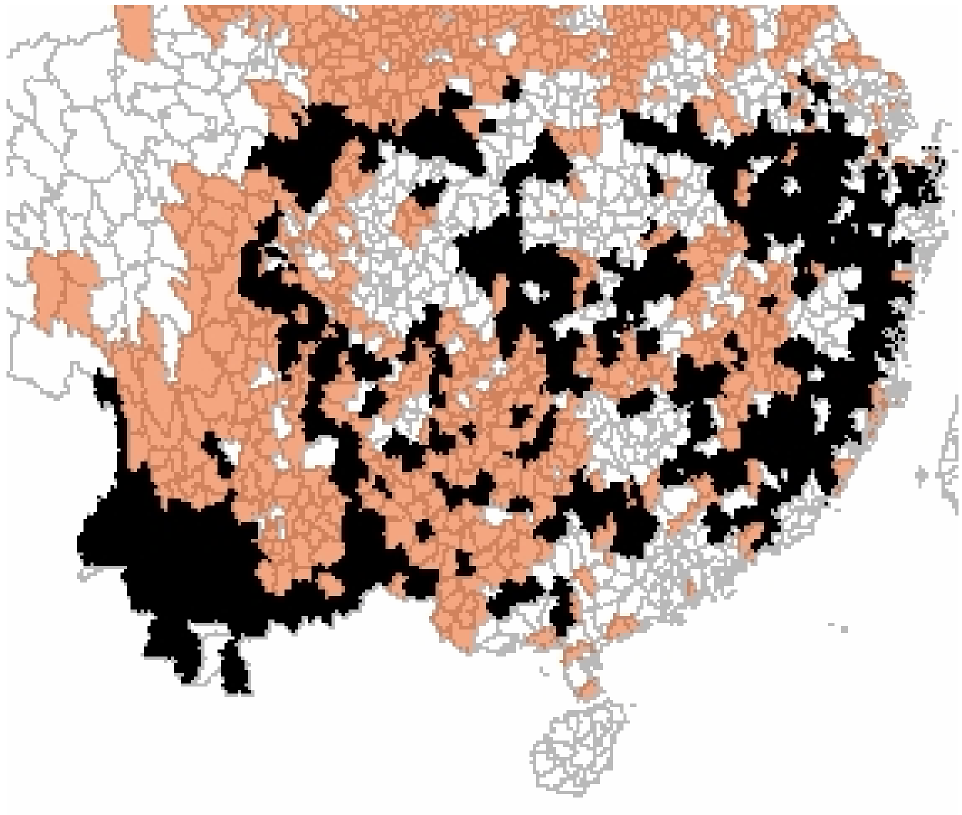
Dependent Variable: Years of Education				
	(1)	(2)	(3)	(4)
	All	Female	Male	Diff
Tea * Post	0.155	0.200	0.115	-0.082
	(0.042)	(0.055)	(0.048)	(0.06)
Orchard * Post	-0.092	-0.182	-0.006	0.140
	(0.036)	(0.048)	(0.04)	(0.055)
Cat2 * Post	-0.025	-0.027	-0.021	0.005
	(0.03)	(0.03)	(0.03)	(0.04)
Fraction Han	0.655	0.656	0.566	-0.205
	(0.079)	(0.111)	(0.088)	(0.091)
Observations	68522	33538	34984	58314
R-squared	0.37	0.48	0.34	0.14

All regressions include controls for Han, county fixed effects and birth year fixed effects.
All standard errors clustered at the county level.
Post = 1 if Born after 1973

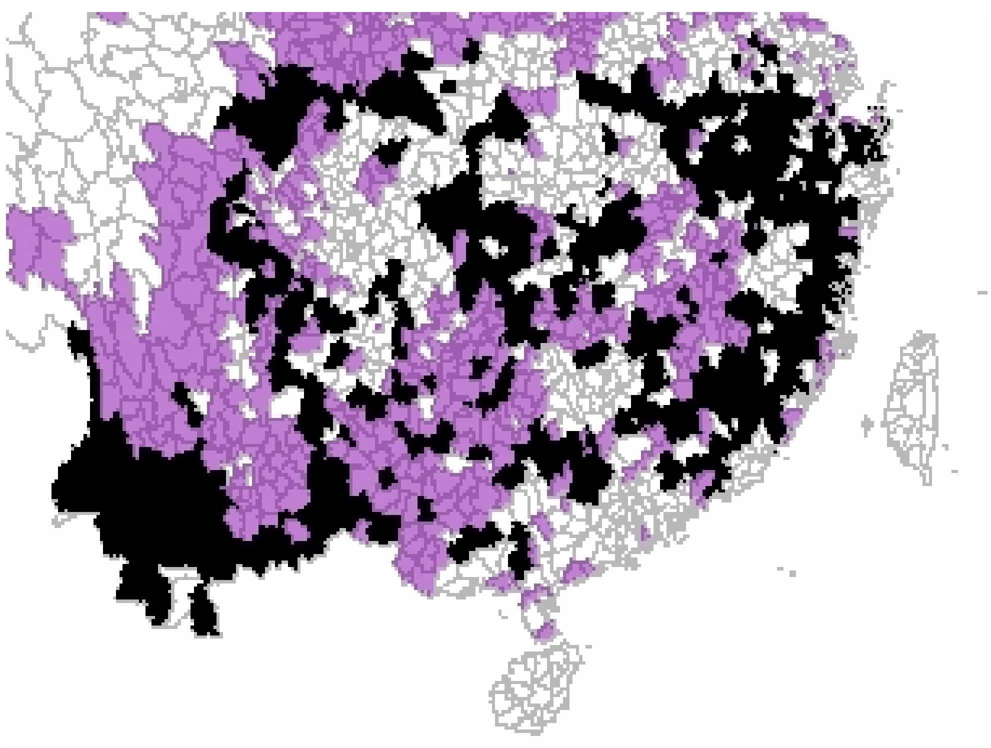
Map 1A: Tea Planting Counties in China.

Darker shades correspond to more tea planted per household.

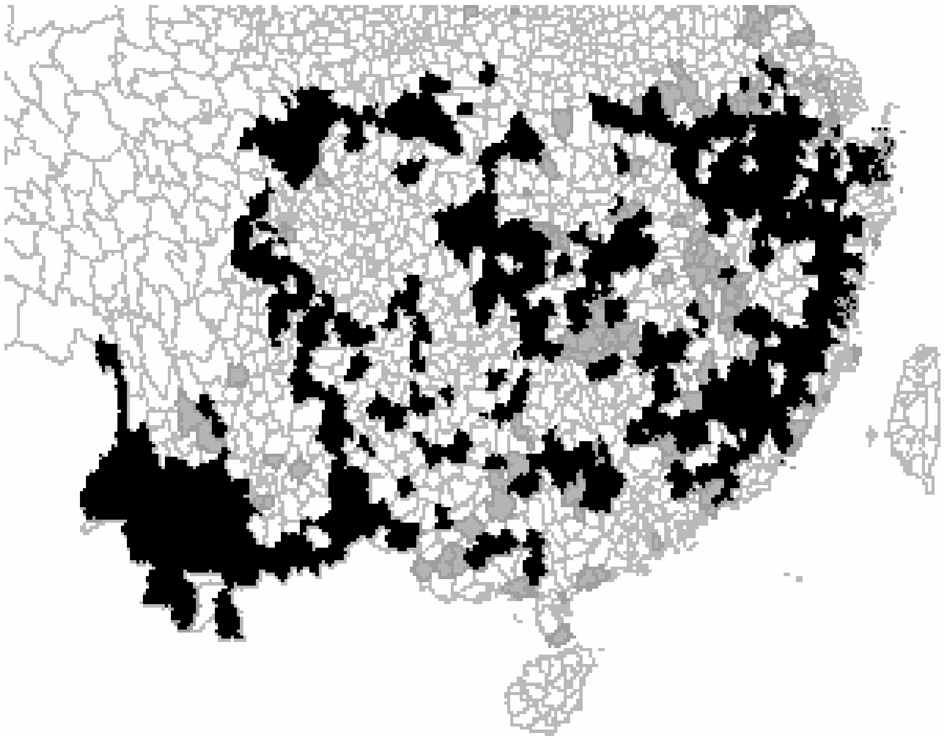
Map 1B: Garden and Tea Production



Map 1C: Orchard and Tea Production

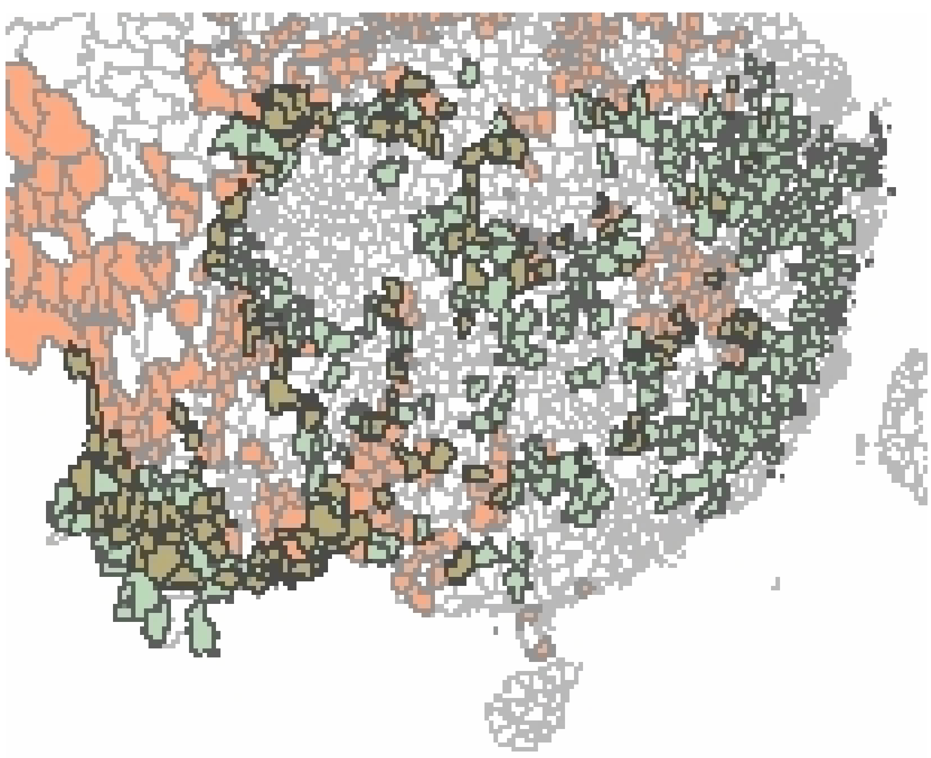


Map 1D: Fish Production and Tea Production

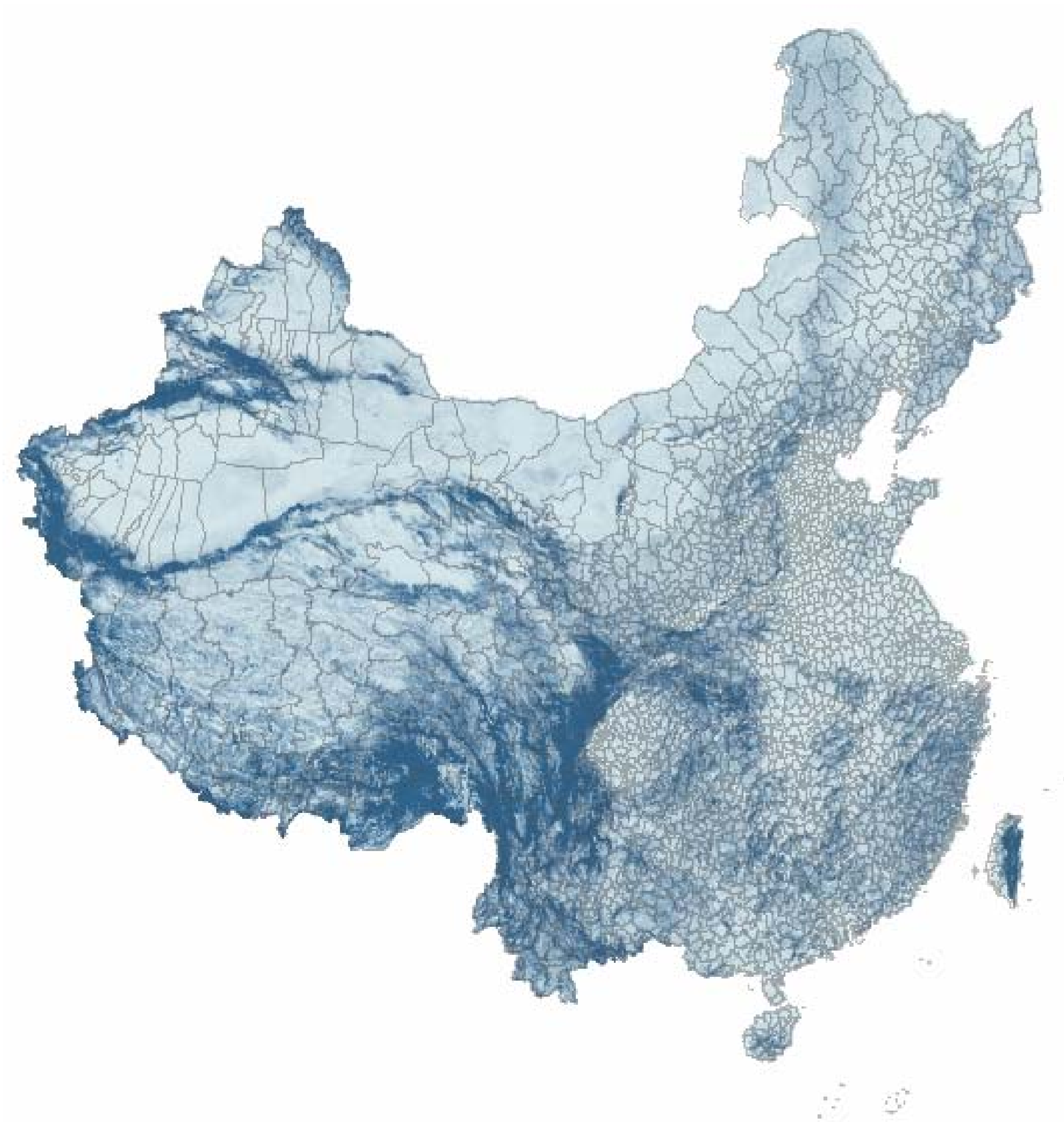


Map 1E: Agricultural Density and Tea Production

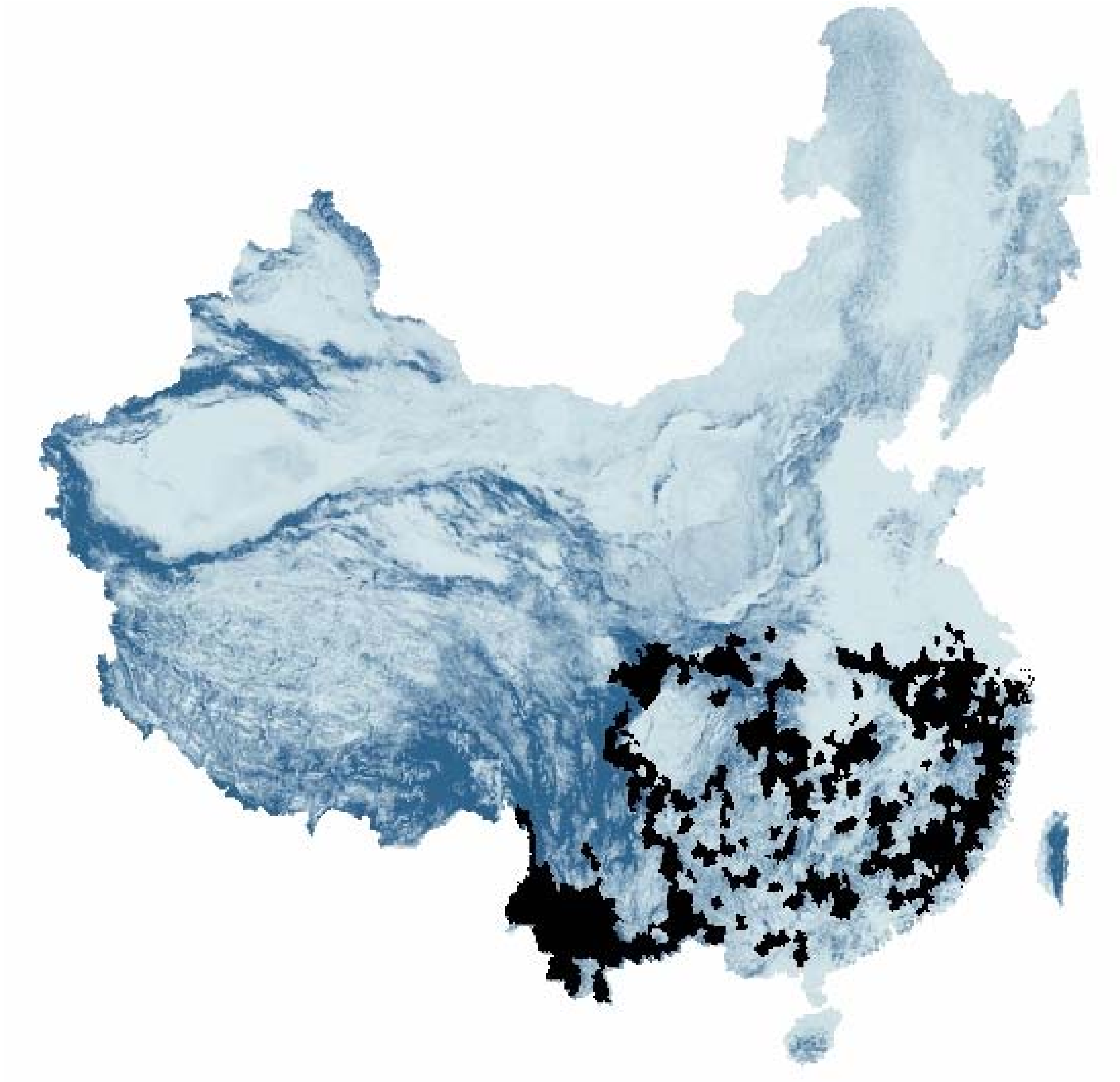
Counties where the average land per household exceeds 4 mu.



Map 2: Slope



Map 3: Correlation between Tea and Slope



Appendix

Table A1: Descriptive Statistics of 2000 Population Census (Birth Year x County Cells)

	Tea==0			**Tea>0**		
	Obs	Mean	Std. Err.	Obs	Mean	Std. Err.
Fraction of Male	81774	53.31%	0.0017	25290	53.56%	0.0031
Fraction of Han	81774	93.47%	0.0008	25290	86.05%	0.0019
Years of Education	81774	7.14	0.0110	25290	6.89	0.0198
Male-Female Edu	58590	0.55	0.0071	18034	0.55	0.0141
Fraction with Tap Water	81441	31.39%	0.0012	25182	37.60%	0.0021

Cohorts born 1962-1986

Table A2-1: The Effect of Tea, Orchard and Cash Crops on Education Attainment (Part 1)

	Dependent Variable: Years of Education					
	All			Girls		
	Tea	Orchard	Cash Crop	Tea	Orchard	Cash Crop
Crop * 1963	-0.168	0.150	-0.043	-0.806	-0.148	0.104
	(0.402)	(0.167)	(0.110)	(0.695)	(0.269)	(0.185)
Crop * 1964	0.308	0.237	-0.108	-0.107	-0.013	-0.006
	(0.329)	(0.144)	(0.085)	(0.542)	(0.223)	(0.149)
Crop * 1965	0.019	0.388	-0.125	-0.397	0.130	0.109
	(0.321)	(0.156)	(0.103)	(0.576)	(0.250)	(0.171)
Crop * 1966	-0.230	0.086	0.030	-0.713	-0.147	0.160
	(0.362)	(0.153)	(0.099)	(0.604)	(0.248)	(0.172)
Crop * 1967	-0.152	0.472	-0.136	-0.527	0.145	0.016
	(0.315)	(0.171)	(0.096)	(0.659)	(0.254)	(0.154)
Crop * 1968	-0.312	0.199	-0.088	-1.014	-0.134	0.085
	(0.380)	(0.159)	(0.099)	(0.512)	(0.226)	(0.148)
Crop * 1969	-0.212	0.297	-0.023	-0.525	-0.010	0.101
	(0.402)	(0.159)	(0.089)	(0.611)	(0.225)	(0.144)
Crop * 1970	0.055	0.209	-0.099	-0.676	-0.047	0.038
	(0.297)	(0.144)	(0.089)	(0.456)	(0.230)	(0.147)
Crop * 1971	0.051	0.400	-0.134	-0.582	0.145	0.081
	(0.385)	(0.163)	(0.114)	(0.645)	(0.237)	(0.155)
Crop * 1972	0.030	0.308	-0.102	-0.673	-0.092	0.044
	(0.312)	(0.172)	(0.102)	(0.552)	(0.248)	(0.161)
Crop * 1973	0.033	0.381	-0.144	-0.675	0.103	-0.087
	(0.499)	(0.184)	(0.130)	(1.048)	(0.313)	(0.219)
Crop * 1974	-0.203	0.114	-0.036	-0.547	-0.325	0.124
	(0.446)	(0.162)	(0.105)	(0.623)	(0.255)	(0.170)
Crop * 1975	-0.448	0.362	-0.027	-1.354	-0.005	0.078
	(0.420)	(0.168)	(0.098)	(0.648)	(0.267)	(0.156)
Crop * 1976	0.141	0.250	-0.095	-0.387	-0.047	0.090
	(0.563)	(0.165)	(0.095)	(0.715)	(0.257)	(0.149)
Crop * 1977	-0.356	0.301	-0.042	-1.051	0.048	0.085
	(0.452)	(0.200)	(0.108)	(0.786)	(0.297)	(0.163)
Crop * 1978	0.640	0.247	-0.238	0.528	-0.128	-0.068
	(0.295)	(0.201)	(0.094)	(0.509)	(0.300)	(0.138)
Crop * 1979	0.226	0.064	-0.110	-0.469	-0.348	0.049
	(0.318)	(0.168)	(0.103)	(0.548)	(0.275)	(0.158)
Crop * 1980	-0.121	0.453	-0.245	-0.442	-0.046	-0.183
	(0.392)	(0.219)	(0.129)	(0.661)	(0.340)	(0.229)
Crop * 1981	0.408	0.366	-0.174	-0.395	-0.031	-0.044
	(0.401)	(0.184)	(0.121)	(0.655)	(0.291)	(0.197)
Crop * 1982	0.729	0.453	-0.148	0.063	-0.040	0.113
	(0.357)	(0.172)	(0.102)	(0.615)	(0.247)	(0.151)
Observations		57338			28065	
R-Squared		0.39			0.51	

All regressions include controls for Han and county and birth year fixed effects.

Standard errors are clustered at the county level.

Table A2-2: The Effect of Tea, Orchard and Cash Crops on Education Attainment (Part 2)

Dependent Variable: Years of Education						
	Boys			Male-Female Difference		
	Tea	Orchard	Cash Crop	Tea	Orchard	Cash Crop
Crop * 1963	0.627	0.399	-0.169	0.926	0.293	-0.128
	(0.386)	(0.182)	(0.122)	(0.744)	(0.303)	(0.218)
Crop * 1964	0.721	0.492	-0.214	0.960	0.454	-0.257
	(0.393)	(0.178)	(0.091)	(0.657)	(0.319)	(0.223)
Crop * 1965	0.410	0.590	-0.302	0.231	0.339	-0.378
	(0.324)	(0.186)	(0.116)	(0.522)	(0.278)	(0.180)
Crop * 1966	0.423	0.310	-0.131	0.547	0.312	-0.251
	(0.438)	(0.192)	(0.105)	(0.679)	(0.327)	(0.209)
Crop * 1967	0.221	0.716	-0.241	0.371	0.372	-0.249
	(0.293)	(0.181)	(0.106)	(0.644)	(0.316)	(0.195)
Crop * 1968	0.476	0.423	-0.246	1.002	0.308	-0.263
	(0.492)	(0.187)	(0.102)	(0.542)	(0.279)	(0.173)
Crop * 1969	0.137	0.565	-0.155	0.254	0.499	-0.229
	(0.439)	(0.226)	(0.117)	(0.588)	(0.352)	(0.213)
Crop * 1970	0.795	0.431	-0.213	1.200	0.426	-0.283
	(0.437)	(0.166)	(0.093)	(0.520)	(0.285)	(0.192)
Crop * 1971	0.744	0.500	-0.261	1.147	0.117	-0.249
	(0.412)	(0.203)	(0.129)	(0.638)	(0.321)	(0.202)
Crop * 1972	0.784	0.641	-0.219	1.036	0.673	-0.302
	(0.352)	(0.209)	(0.118)	(0.514)	(0.311)	(0.199)
Crop * 1973	0.668	0.620	-0.181	1.711	0.461	-0.034
	(0.629)	(0.211)	(0.134)	(1.146)	(0.362)	(0.227)
Crop * 1974	0.218	0.447	-0.169	0.108	0.470	-0.098
	(0.531)	(0.204)	(0.109)	(0.599)	(0.341)	(0.179)
Crop * 1975	0.413	0.626	-0.121	1.430	0.523	-0.279
	(0.398)	(0.200)	(0.103)	(0.543)	(0.351)	(0.192)
Crop * 1976	0.762	0.501	-0.245	0.839	0.482	-0.326
	(0.619)	(0.189)	(0.116)	(0.784)	(0.318)	(0.204)
Crop * 1977	0.400	0.567	-0.144	1.415	0.418	-0.198
	(0.447)	(0.212)	(0.103)	(1.350)	(0.374)	(0.217)
Crop * 1978	0.638	0.535	-0.368	-0.521	0.452	-0.164
	(0.417)	(0.216)	(0.112)	(0.751)	(0.351)	(0.184)
Crop * 1979	1.226	0.471	-0.262	0.744	0.633	-0.189
	(0.391)	(0.215)	(0.109)	(0.527)	(0.408)	(0.188)
Crop * 1980	0.162	0.787	-0.304	0.188	0.481	-0.016
	(0.568)	(0.255)	(0.143)	(1.018)	(0.441)	(0.314)
Crop * 1981	1.175	0.730	-0.296	1.124	0.825	-0.335
	(0.481)	(0.201)	(0.126)	(0.578)	(0.356)	(0.220)
Crop * 1982	1.461	0.864	-0.359	0.135	0.507	-0.312
	(0.573)	(0.225)	(0.107)	(0.931)	(0.347)	(0.171)
Observations		29273			48758	
R-Squared		0.38			0.16	

All regressions include controls for Han and county and birth year fixed effects.

Standard errors are clustered at the county level.