The agricultural roots of industrial development: 'forward linkages' in reform era China

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Abstract

A classic literature argues that improvements in agricultural productivity result in higher non-agricultural output, particularly at low levels of development. The proposed mechanisms for these 'forward linkages' vary, but centre on either increases in the supply of factors, especially labour and capital, or demand externalities in product markets. Regardless of the mechanism, the empirical evidence for substantial forward linkages from agriculture is limited. In this paper, I show that in reform-era China there were substantial forward linkages. I exploit the fact that China's 1978-84 agricultural reforms were more beneficial to farmers with land suited to cash crops to provide plausibly exogenous variation in agricultural productivity. Then, using a newly digitised panel of economic data for 561 counties, I trace the growth of agricultural and non-agricultural output over forty years. Higher agricultural output was associated with significantly faster subsequent growth in non-agricultural output. I estimate 15 and 25 year elasticities of 1.2 and 0.8. I am able to identify these linkages because China is subject to substantial geographic capital and labour market frictions. These frictions limit the equalisation of prices across space and keep local shocks local. I use the predictions of a simple two sector model, which nests the possibility of linkages through demand externalities and the supply of capital or labour, to provide evidence that the linkages identified were primarily due to higher agricultural surpluses increasing the supply of capital to local firms.
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1 Introduction

The process of development entails not only higher incomes but also fundamental changes in the structure of the economy. The importance of agriculture declines as first manufacturing, then services, increase in importance (see e.g. Kuznets, 1957). Perhaps because of the initial dominance of agriculture, a classic literature argues that agricultural development is either a prerequisite to industrial development, or that it carries important 'forward linkages' to manufacturing and services (Rosenstein-Rodan, 1943; Schultz, 1953; Lewis, 1954; Rostow, 1960). This view has been influential with policymakers, with the World Bank (2007, p.7) stating that "success stories of agriculture as the basis for growth at the beginning of the development process abound" citing England, Japan, India, Vietnam and China as examples of agriculture led growth. Perhaps surprisingly then, causal empirical evidence in favour of substantial positive linkages from agriculture is limited (Gollin, 2010, provides a recent review).

Though several authors have argued in favour of positive forward linkages from agriculture, each provides their own explanation of how these linkages arise. The three most common channels suggested are the classical ones. First, if agricultural productivity improvements reduce the demand for agricultural labour—and labour cannot migrate—the wage faced by non-agricultural firms will fall and non-agricultural output will increase through the *labour channel*. Second, if agricultural productivity improvements increase rural savings—and capital is immobile—the rental rate faced by non-agricultural firms will fall and non-agricultural output will increase through the *capital channel*. Third, if agricultural productivity improvements increase the demand for non-agricultural goods—and imports are not easily available—the price of non-agricultural goods will rise and non-agricultural output will increase through the *demand channel*.[1]

One thing that each of these channels have in common, is that to be observable locally, there must be frictions to the flow of labour, capital or goods. As in Matsuyama (1992), in an open economy, (local) linkages from agriculture to the non-agricultural sector will be small or even negative. The effect of openness may be why robust evidence of substantial positive linkages from agriculture is in such short supply.

For credible identification of linkages from agriculture, we would like plausibly exogenous variation in agricultural productivity (and the associated limited set of potential confounders). This type of variation is more easily obtained within countries—comparing counties or districts—than across countries themselves. Unfortunately though, unlike countries, counties and districts are relatively open to flows of goods, people and capital—preventing the observation of these linkages at the local level. Not surprisingly, the best identified papers have focussed on relatively short run linkages through local labour markets.[2]

[1]The *demand channel* in particular is often highlighted in the macroeconomic structural transformation literature. See, in particular Ngai and Pissarides (2007), but also Murphy et al. (1989), Echevarria (1997), Kongsamut et al. (1997). Acemoglu and Guerrieri (2008) provide a model of structural change driven by capital accumulation. Labour saving improvements in agricultural technology are considered in Bustos et al. (2013).

[2]See Foster and Rosenzweig (2004) and Bustos et al. (2013) which exploit sub-national variation in agricultural output in India and Brazil. These papers find that unless improvements in agricultural technology are labour saving—as in the case of the introduction of genetically modified soybeans in Bustos et al.—improvements in agricultural productivity crowd out the industrial sector.

In this paper, I exploit a natural experiment provided by China's 1978-84 agricultural reforms, to show that improvements in agricultural productivity were an important contributory factor to China's subsequent non-agricultural output growth. A long panel of newly digitised county level data allows me to track growth in 561 counties for more than forty years. The beneficial effects were long lasting: a 1% increase in post-reform agricultural output is associated with 1.2% and 0.8% higher non-agricultural output fifteen and twenty-five years later. This paper thus provides the first quasi-experimental evidence of significant positive forward linkages between the agricultural and non-agricultural sectors. In providing this evidence, I benefit from several features of China's economy.

First, China's agricultural reforms provide a plausibly exogenous source of variation in agricultural productivity. Prior to the reforms, rural institutions strongly encouraged the planting of grain. Farming communes were forced to be self-sufficient in all foodstuffs, meet quotas for grain deliveries to the state, and faced political pressure to produce in excess of their quotas. Farming was also organised along communal lines, which adversely affected farmers incentives to maximise output. The reforms decommunalised agriculture and relaxed the constraints on the production of cash crops. So, while all farmers could benefit from the improved incentives provided by decommunalisation (McMillan et al., 1989; Lin, 1992), those with land suited to cash crops gained an additional benefit from the freedom to plant these crops. My empirical strategy exploits differences in the suitability of land for growing cash crops to provide variation in agricultural output growth.

Second, there were substantial geographic frictions preventing the free movement of labour and capital in China. The capital market frictions were primarily due to the Chinese financial system's institutional bias towards state owned enterprises (SOEs). In the reform era, soft loans at below market rates replaced direct budgetary support as the primary means of subsidising SOEs. In order to satisfy the capital requirements of SOEs, non-state firms access to the formal financial sector was curtailed. Non-state firms were instead forced to rely on capital raised from 'local' sources, such as the savings of family and friends, retained profits, and loans from local governments or rural credit cooperatives. Non-state firms reliance on local sources of capital meant that 'local money stay[ed] local' (Naughton, 2007, p.279) and restored the geographic link between savings and investment that is observed across countries but rarely across sub-national regions.[3] China also had a relatively immobile labour force during the 1980's and early 1990's. The *hukou* internal passport system increased the cost of migration (Chan and Zhang, 1999) and, relative to the size of the population, the number of migrant workers was low. These capital and labour market frictions make Chinese counties much closer to (small) countries than comparable administrative divisions elsewhere and allow the identification of linkages through both the *capital* and *labour channel*. However, although China may have had substantial internal barriers to trade

[3]For evidence of capital market frictions across countries one can begin with the extensive literature beginning with Feldstein and Horioka (1980). For evidence of the absence of capital market frictions with countries in a similar vein see Sinn (1992) who looks at US States, Helliwell and McKitrick (1999) for Canadian Provinces, Paweenawat and Townsend (2009) for Thai villages and Dekle (1996); Iwamoto and Van Wincoop (2000) for Japan. China, of course, provides an exception in this literature: using a similar approach to the previous papers, Boyreau-Debray and Wei (2005) find evidence of substantial cross-province capital market frictions in China.

at the province level (Young, 2000; Poncet, 2003), the barriers at the county level were probably less significant; I may not be able to identify linkages through the *demand channel*.

Third, in the years following the reforms, China was growing rapidly from a low base. China's growth in the 1980's thus provides an example of an economy in the early stages of industrialisation—precisely the stage of development that linkages from the agricultural sector have been been argued to be strongest. In a similar vein, at the onset of the reforms agriculture was a significant share of the Chinese economy, representing 71% of employment and 28% of output at the national level (and even more in the counties in my data).[4] The large size of the agricultural sector makes linkages to the non-agricultural sector both more economically important and easier to identify.

To guide the empirical analysis, and help understand how improvements in agricultural productivity led to higher non-agricultural output, I provide a simple two-sector model which allows for forward linkages through the *labour*, *capital* and *demand channels* described above. Increases in savings, investment and non-agricultural output are consistent with each of the channels, however, differences in other moments of the data are more revealing.

Because the benefits of agricultural reforms varied across space, the main empirical strategy used is difference-in-differences. I identify counties which are 'suited to cash crops' using high resolution data on theoretical crop yields from the Food and Agriculture Organisation's Global Agro-Ecological Zones database. Counties are deemed suited to cash crops if their productivity in cash crops is high relative to grain. I combine the agricultural productivity data with a newly digitised panel of economic data for 561 non-metropolitan counties in 8 provinces between 1965 and 2008. The relatively long panel allows consideration of both short and medium run effects. The large number of counties allows me to include a full set of county and province-by-time fixed effects, which flexibly control for preexisting differences between counties and differential trends by provinces. The inclusion of these fixed effects mean I exploit only within province variation—I am not comparing booming coastal China with the backwards interior. The empirical analysis has three parts.

First, I show that counties more suited to cash crops had faster post-reform growth in agricultural output. A 1 standard deviation increase in my measure of suitability is associated with around a 20% increase in post-reform agricultural output. This increase appears to be permanent, and is fairly constant from 1990 onwards, suggesting that improving the allocation of crops to land caused a one time increase in agricultural output. Back of the envelope calculations suggest that specialisation increased agricultural output by 9-15% between 1978-85 (around one-sixth of the total increase). Although suitability for cash crops was associated with faster post-reform growth in agricultural output it was uncorrelated with pre-reform growth. Counties were following parallel trends. While I find large gains from specialisation, previous studies have not (Lin, 1992; Lin and James, 1995). The difference in findings may be due to the more disaggregated data used in this study. When I repeat my analysis using only province level data—the level of aggregation used in previous studies—the gains from specialisation are neither economically nor statistically significant.[5] I also show that consistent with

[4] Aggregate figures (for 1978) obtained from the China Data Centre at the University of Michigan.

[5] The difference between aggregating at the county or province level is roughly equivalent to the

specialisation, counties suited to cash crops increased the physical share of cash crops in their output.

Second, I show that counties suited to cash crops also had faster post-reform growth in non-agricultural output. Using suitability for cash crops as an instrument for agricultural output, I estimate 15 and 25 year elasticities of 1.2 and 0.8. I also show that counties suited to cash crops had substantially faster post-reform growth in savings and investment. The growth of savings, investment and non-agricultural output were all uncorrelated with suitability for cash crops prior to the reform; as with agricultural output, counties were following parallel trends in each of these variables. These results suggest there were substantial forward linkages from agriculture in early reform era China.

Third, while the model makes clear that the behaviour of economic aggregates such as non-agricultural output, savings and investment will not in general reveal *how* higher agricultural productivity increased agricultural output, it does suggest other moments in the data that will be more revealing. Linkages through the *labour channel* entail a decline in the share of labour working in agriculture. But in the data, the share of labour in agriculture increases in counties suited to cash crops. Linkages through the *demand channel* are stronger in counties less open to trade in goods. But in the data, linkages are weaker in less open counties. Linkages through the *capital channel* imply that firms who lack access to national capital markets face cheaper capital and in the data, non-state firms make factor choices as if they do have access to cheaper capital in counties suited to cash crops. (No such effect is observed for state owned firms which have access to the national banking system and hence do not need to raise capital locally.) The data are consistent with the institutional details: both suggest the linkages identified are primarily through the *capital channel*.

In China, higher agricultural surpluses led to higher savings, capital accumulation and, ultimately, non-agricultural output. However, cross country evidence suggests capital accumulation has little power to explain international income differences (Easterly and Levine, 2001; Caselli, 2005). The empirical literature linking savings and growth is also inconclusive (Carroll and Weil, 1994; Attanasio et al., 2000; Aghion et al., 2006). On the other hand, decompositions of the growth of many of the fast growing Asian countries, including Japan, South Korea, Taiwan, Singapore and, of course, China do suggest an important role for capital accumulation (Kim and Lau, 1994; Young, 1995, 2003; Collins and Bosworth, 1996). This paper provides additional support for the proposition that capital accumulation was an important factor in these countries growth. More enlightened policies were surely essential to these countries' industrialisation but, conditional on these policies, the accumulation of capital played an important role.

In another parallel to China, many these Asian countries also undertook successful agricultural reforms around time they began to industrialise. Post-war land reforms in Japan, South Korea and Taiwan redistributed land to peasants and are thought to have increased agricultural output (Dore, 1959; Thorbecke, 1979; Jeon and Kim, 2000). More recently, the decommunalisation of agriculture in Vietnam in the mid 1980's

difference between aggregating at the county or state level in the US. There are approximately 80 county level administrative divisions in the average Chinese province and around 60 counties in the average US state.

dramatically increased agricultural output (Pingali and Xuan, 1992) and raised the curtain for a sustained period of rapid growth that continues to this day. In each of these cases, increases in agricultural output due to the reforms could have increased the supply of capital to the non-agricultural sector—just as it did in China.

The remainder of the paper proceeds as follows; section 2 presents a simple two-sector model of agricultural and non-agricultural output; section 3 provides institutional background to China's agricultural reforms and reform era credit and labour markets; section 4 outlines my empirical strategy and describes the data; section 5 provides results for the agricultural sector showing counties suited to cash crops benefitted disproportionately from the reforms; section 6 provides results showing that there were positive linkages between the agricultural and non-agricultural sectors, and that these linkages were primarily through the capital channel; section 7 concludes.

2 Conceptual Framework

To guide the subsequent analysis, I provide a simple two-sector model of production at the county level. The county is endowed with 1 unit of land and L units of labour. Both land and labour are homogenous, immobile and unchanging over time.

Each county also has a stock of savings, $S_t \geq 0$, which evolves according to

$$S_{t+1} = s(Y_t + (1 + r_t)S_t - (r_t + \delta)K_t) \tag{1}$$

where r_t is the interest rate on savings, and $\delta \in (0, 1)$ is the depreciation rate. Savings in the next periods are a constant share $0 < s < 1$ of a counties current period stock of savings and and income (net of capital costs).[6]

Output, $y_t^j \geq 0$, is produced in agricultural and non agricultural sectors $j \in \{A, N\}$. Both sectors produce with constant returns to scale

$$y_t^A = \Psi_H f^A(\Psi_L L_t^A, \Psi_B B_t) \tag{2}$$
$$y_t^N = f^N(L_t^N, K_t) \tag{3}$$

where f^j are twice differentiable, strictly increasing, strictly concave productions functions with $f_2^N \to 0$ as $K_t \to \infty$, where f_2^N is the derivative of f^N with respect to its second argument. (The marginal product of capital approaches 0 in the limit.) Production requires strictly positive quantitates of both factors so $f^j(0, \cdot) = 0$ and $f^j(\cdot, 0) = 0$. Note that while both sectors use labour L_t^j, only the agricultural sector uses land, B_t, and only the non-agricultural sector uses capital, K_t. I assume that the f^j's are such that labour is always used in both sectors if $K_t > 0$.

I consider Hicks-Neutral Ψ_H, labour augmenting Ψ_L and land augmenting Ψ_B agricultural technologies. I define an improvement in agricultural technology as 'labour

[6] A savings function of this type can be a consequence of dynastic single period lived representative consumer with warm-glow preference $C_t^{1-s} S_{t+1}^s$ in the manner of Andreoni (1990). This type of preferences are used in Banerjee and Newman (1993) and many other models of growth.

saving' if, holding factors constant, it reduces the marginal product of labour, i.e.

$$\frac{\partial MPL_t}{\partial \Psi_q} = \frac{\partial}{\partial \Psi_q} \Psi_H \Psi_L f_1^A(\Psi_L L_t^A, \Psi_B B_t) < 0 \tag{4}$$

The conditions for an improvement in agricultural technology to be labour saving are quite specific. If the improvement in agricultural technology is labour augmenting, it is labour saving when the elasticity of labour demand with respect to the wage is less than 1.[7] If agricultural technology is land augmenting, it is labour saving when land and labour are substitutes and $f_{12}^A(\Psi_L L_t^A, \Psi_B B_t) < 0$. Hicks-Neutral improvements in agricultural technology are never labour saving.

Each sector maximises periodic profits taking prices as given, and solves

$$\max_{L_t^j, K_t, B_t} = p_t^j y_t^j - w_t L_t^j - (r_t + \delta) K_t - z_t B_t \tag{5}$$

where p_t^j, w_t and z_t are output prices, wages and land rental rates. Market clearing in labour and land markets imply that

$$L = L_t^N + L_t^A \tag{6}$$

$$1 = B_t \tag{7}$$

The prices p_t^j and rental rates r_t depend on whether agricultural and non-agricultural output and/or capital are freely tradable. If they are, then prices are equal to the 'world' prices and $p_t^j = \tilde{p}^j \, \forall \, t, j$ and/or $r_t = \tilde{r}$. To prevent the stock of capital growing without bound in an open economy, let $s(1 + \tilde{r}) < 1$.

If the county is closed to capital flows then the supply of capital is no longer perfectly elastic at rate $(r_t + \delta)$. Instead capital market clearing is given by

$$S_t = K_t \tag{8}$$

If agricultural and non-agricultural output are not tradable, I instead assume they are inputs into the production of a tradable final good. (We can think of the final good as being used for capital and consumed.) This is a little bit artificial, but allows counties to service their external debt while still retaining the forces from closed economy models of demand led structural transformation. The final good is produced by a competitive final goods sector with constant returns to scale production function $g(y_t^A, y_t^N)$. Without loss of generality, assume that the final good sector is the numeraire sector. Whether agricultural and non-agricultural output are tradable or non-tradable, real output is $Y_t = p_t^A y_t^A + p_t^N y_t^N$.

If agricultural and non-agricultural output are perfect substitutes, then $g(y_t^A, y_t^N) = \eta^A y_t^A + \eta^N y_t^N$, and so if $\eta^j = \tilde{p}^j$, the economy is equivalent to one where agricultural

[7] To see this, note that we are holding B constant so the production function can be written as a function of just labour $\hat{f}^A(\Psi_L L)$. Defining $\hat{L} = \Psi_L L$, the first order conditions of the firms problem and implicit function theorem give labour demand as $\hat{L}^d(\frac{w}{\Psi_L})$. Using $L = \hat{L}^d / \Psi_L$ and noticing that $\frac{\partial \hat{L}^d}{\partial \Psi_L} = -\frac{w}{A}\frac{\partial \hat{L}^d}{\partial w}$, take derivatives and rearrange to obtain $\frac{\partial L}{\partial \Psi_L}\frac{\Psi_L}{L} = -(1 + \frac{\partial L}{\partial w}\frac{w}{L})$. This condition can also be stated in terms of f, in which case an improvement in labour augmenting agricultural technology is labour saving if $f_{11}^A(\Psi_L L_t^A, \Psi_B B_t)\Psi_L L_t^A + f_1^A(\Psi_L L_t^A, \Psi_B B_t) < 0$ i.e. if the production function is relatively concave.

and non-agricultural output are tradable. In this special case, the relative price of non-agricultural output is unaffected by agricultural productivity. To highlight the potential effects of the *demand channel*—which I presented as increasing the relative price of non-agricultural output—let us instead assume that that g is Leontief. Output of the final good is

$$Y_t = g(y_t^A, y_t^N) = \min\{\eta^A y_t^A, \eta^N y_t^N\} \tag{9}$$

with $\eta^j > 0$. Not surprisingly, in this setting increases in agricultural productivity will increase non-agricultural output.[8]

The comparative statics with respect to agricultural productivity thus depend on three factors. Whether the increase in agricultural productivity is labour saving; whether capital flows freely, and; whether agricultural and non-agricultural output are freely tradable.

As a baseline, I consider the comparative statics of a county which is open to flows of capital, trade in agricultural and non-agricultural output, and where the increase in agricultural technology is not labour saving. This is the case of a small open economy and a 'normal' improvement in production technology—the conditions that probably apply in most studies of local agricultural productivity shocks.

In the baseline case, agricultural technology improvements always crowd out non-agricultural output. I then consider three additional cases where precisely one of the forward linkages discussed in the introduction are in effect. These additional cases highlight what increases in non-agricultural output due to the *labour*, *demand* and *capital channels* look like. These cases also highlight why exploiting subnational data can limit our ability to identify forward linkages from agriculture.

2.1 Comparative statics

I explore the effect of increases in agricultural technology on the steady state values of several variables. I define the steady-state as being reached when $S_t = S_{t+1} = S_{SS}\ \forall t \geq t_{SS}$. As there are no other dynamic considerations when this point is reached all other variables are also constant. All proofs are straightforward and provided in the appendices.

Comparative Statics 1 (Baseline)**.** *If $p_t^j = \tilde{p}^j\ \forall\, t, j$ (free trade in agricultural and non-agricultural output), $r_t = \tilde{r}\ \forall\, t$ (capital is perfectly mobile), and (4) does not hold (agricultural technology is not labour saving) then an improvement in agricultural technology Ψ_q has the following effects on the steady state*

(a) Agricultural output y^A, the share of labour in the agricultural sector L^A/L and savings S increase.

(b) The wage w and capital rental rate $r_t = \tilde{r}$ are unchanged.

(c) Non-agricultural output y^N, the share of labour in the non-agricultural sector, L^N/L, and capital employed K fall.

[8] There are, of course, an intermediate set of production functions, where the effect on non-agricultural output depends on the substitutability between agricultural and non-agricultural output, but the relative price of non-agricultural output always increases.

In the baseline case improvements in agricultural technology decrease the size of the non-agricultural sector for exactly the reasons outlined in Matsuyama (1992): the returns to working in the agricultural sector have increased. The comparative statics of the baseline case are consistent with the findings of Foster and Rosenzweig (2004), who explore the consequences of improved yields in green revolution India. Despite this, in the empirics, I will show that improvements in agricultural technology were associated with increases in non-agricultural output which suggest that there were positive effects through one or more of the following channels.

2.1.1 Labour channel

To consider linkages through the *labour channel* assume improvements in agricultural technology are labour saving. As in the baseline, the county remains open to flows of capital and trade in agricultural and non-agricultural output.

Comparative Statics 2 (Labour Channel)**.** *If $p_t^j = \tilde{p}^j \; \forall \, t, j$ (free trade in agricultural and non-agricultural output), $r_t = \tilde{r} \; \forall \, t$ (capital is perfectly mobile), and (4) holds (agricultural technology is labour saving) then an improvement in agricultural technology Ψ_q has the following effects on the steady state*

(a) agricultural output y^A, non-agricultural output y^N, capital employed K and savings S increase;

(b) the wage w and capital rental rate $r_t = \tilde{r}$ are unchanged;

(c) the labour in the agricultural sector L^A/L falls.

When the agricultural demand for labour declines, the non-agricultural sector expands and imports capital from elsewhere. The differential effects of labour saving and non-labour saving improvements in agricultural technology were explored empirically in Bustos et al. (2013) and their results are consistent with the differences between the baseline and *labour saving* comparative statics.

2.1.2 Capital Channel

To consider linkages through the *capital channel*, let us once again assume improvements in agricultural technology are not labour saving. However, unlike in the baseline case let the county be closed to capital flows so that market clearing condition (8) holds.

Comparative Statics 3 (Capital Channel)**.** *If $p_t^j = \tilde{p}^j \; \forall \, t, j$ (free trade in agricultural and non-agricultural output), (8) holds (capital is immobile and accumulated locally), and (4) does not hold (agricultural technology is not labour saving) then an improvement in agricultural technology Ψ_q has the following effects on the steady state*

(a) capital utilised K, savings S and the wage w increase;

(b) the rental rate on capital falls r;

(c) the effect on non-agricultural output y^N and the share of labour in the agricultural sector L_A/L is indeterminate.

For non-agricultural output there are two offsetting effects: competition for labour from the agricultural sector reduces non-agricultural output, but higher savings increase the supply of capital. If the second effect dominates then non-agricultural output increases.

2.1.3 Demand Channel

To consider linkages through only the *demand channel*, let us consider an economy where capital flows freely and improvements in agricultural technology are not labour saving. However, unlike in the baseline case, let the price of agricultural and non-agricultural output be determined locally by the demand of the local final goods sector. Agricultural and non-agricultural output are non-tradable.

Comparative Statics 4 (Demand Channel)**.** *If p_t^j are the equilibrium prices, where demand comes from a profit maximising price taking final goods sector which maximises $Y_t - p_t^A y_t^A - p_t^N y_t^N$ and the production function for Y_t is (9) (no trade in agricultural and non-agricultural output), $r_t = \tilde{r} \; \forall \, t$ (capital is perfectly mobile), and (4) does not hold (agricultural technology is not labour saving) then an improvement in agricultural technology Ψ_q has the following effects on the steady state*

(a) agricultural output y^A, non-agricultural output y^N, the price of non-agricultural output p^N, the wage w and capital K increase;

(b) the rental rate on capital $r_t = \tilde{r}$ is unchanged;

(c) the price of agricultural output p^A declines;

(d) the effect on the share of labour in the agricultural sector L_A/L is indeterminate.

Because agricultural and non-agricultural output are perfect complements in the production of the final good higher agricultural output increases the relative price of non-agricultural output and hence non-agricultural output itself. This is a version of the mechanism central to Ngai and Pissarides (2007). Related mechanisms are also considered in a large number of other papers in the macroeconomic structural transformation literature (see e.g. Matsuyama, 1992; Echevarria, 1997; Kongsamut et al., 1997). If counties are closed, higher agricultural output can increase non-agricultural output even in the absence of increases in the supply of capital and labour.

2.2 Empirically disentangling the channels

The empirical results will show that higher agricultural output resulted in higher non-agricultural output. The model suggests two approaches to identifying whether the increase was primarily through the *labour*, *capital* or *demand channels*.

First, a careful evaluation of capital market institutions, internal barriers to trade and the nature of the agricultural productivity shock, will be indicative. If capital or goods are able to flow freely across county lines, we are unlikely to observe linkages through the *capital* or *demand channels*. If the increase in agricultural technology—here the ability to specialise in cash crops—seems likely to increase the demand for labour, we are unlikely to observe linkages through the *labour channel*.

Second, we can use differences in the comparative statics to suggest informative tests. While, increases in non-agricultural output, savings and investment are consistent with any of the channels, other moments in the data may be revealing. In particular:

1. Linkages through the *labour supply channel* reduce the share of labour in agriculture;

2. Linkages through the *demand channel* have stronger effects on non-agricultural output in more closed places;

3. Linkages through the *capital channel* result in cheaper capital.

In section 6, I provide empirical results based on these moments which suggest increases in non-agricultural output were primarily through the *capital channel*. These results will be reinforced by the institutional details provided in the next section.

3 Institutional Background

In this section, I provide a brief overview of Chinese agricultural institutions in the run up to, and aftermath of, China's 1978-84 agricultural reforms. I will also discuss the extent to which capital and labour market institutions restricted factor mobility and whether specialising in cash crops was likely to have been labour saving. I conclude by outlining some of the most important reforms to the non-agricultural sector.

3.1 Rural institutions and agricultural reform

During the cultural revolution (1966-78), and to a greater or lesser extent from the mid 1950's onwards, Chinese agricultural institutions were characterised by four principal distortions.[9]

First, all land was state-owned and agricultural production was organised collectively via the commune system. Most land was farmed by 'production teams' of 20-30 households. Peasants were primarily paid for their contribution to agricultural production in grain rations although some cash was also distributed. The specifics vary, but typically around 60-70 percent of the grain allocation was distributed according to 'basic need' based upon factors such as household size. The remaining grain, and any cash, was distributed according to work points which tended to be allocated according to days worked and type of job. As a result, incentives to provide effort on communal lands were very weak. It is perhaps telling that during the 1960's, yields on 'private plots'—where the farming household was the residual claimant—were twice as high as those achieved on communal farms (Burki, 1969).

Second, the state pursued a policy of grain self-sufficiency. From 1965, 'rural areas were still allowed to produce economic crops or raise animals, but only after they had achieved basic self-sufficiency in food grains' (Lardy, 1983, p. 49). Self-sufficiency was enforced by a state monopoly on trade in agricultural produce, which prevented rural households from purchasing grain. One manifestation of this policy was that

[9] What follows draws on the large existing literature on Chinese agriculture. In particular Lardy (1983), Perkins (1988), Sicular (1988), Oi (1991), Lin (1992) and Huang (1998).

inter-provincial trade in grain effectively ceased with the share of (non-exported) grain traded across provincial lines falling from 3.4% in the 1950's to 0.1% by 1978 (Lardy, 1983, p. 51).

Third, the state further promoted grain production by encouraging payments of agricultural taxes in grain, providing most counties with quotas for grain deliveries and linking the political success of rural party cadres to the production of grain.

Finally, prices for agricultural goods were kept low to facilitate the transfer of surplus from the rural agricultural sector to the state industrial sector. Low prices further reduced the incentive for agricultural production beyond peasants' immediate needs.

Following the death of Mao in 1976, and the ascent of Deng Xiaoping's more economically liberal government in 1978, China began its long process of Reform and Opening Up. The agricultural sector was the first to undergo substantial reforms. Lin (1992) describes three main channels of reform: (1) the communal system was phased out and replaced with the Household Responsibility System (HRS) under which households were assigned plots of land to farm for periods of up to 15 years and made the residual claimant on surplus output; (2) markets for agricultural goods were (somewhat) liberalised, rural periodic markets were reinstated, grain procurement quotas reduced in some areas and self-sufficiency policies relaxed; and (3) price reform—to stimulate production, state procurement prices for agricultural goods were raised substantially and the bonus for above quota deliveries was increased.

In response to the reforms, agricultural output growth increased dramatically. Output of grain increased by 5 percent per-year from 1978-85 compared to 2.4 percent per-year between 1952 and 1978. Output of cash crops increased even more rapidly: cotton by 19.2 percent per-year, sugar by 12.3 percent and oil-crops by 14.8 percent, compared to 2, 4.5 and 0.8 percent per year pre-reform. Despite the large relative increase in the production of cash crops there was little change in their relative price (see table 1). Consequently, in addition to benefiting from HRS, farmers with land suitable for growing cash crops may have enjoyed large windfalls from specialising in their production.

Planting cash crops instead of grain was, however, unlikely to have been labour saving. Taylor (1988) calculates labour utilisation per hectare (in China) for various crops in 1978 and 1985. He finds that utilisation is similar for grains and oilseeds but somewhat higher for cotton. As switching to cash crops thus probably increased the agricultural demand for labour, non-agricultural output is unlikely to have increased through the *labour channel*.

3.2 Capital market frictions

China's financial sector, which is dominated by the state owned banking system, has been distorted by its bias towards state owned firms. From the early 1980's onwards, soft loans largely replaced the direct budgetary support that state-owned enterprises previously enjoyed. These loans were provided at below market rates. In order to satisfy the state owned sectors demand for capital, non-state firms were largely excluded from China's formal financial markets (Lardy, 1998; Brandt and Zhu, 2000; Huang, 2003).

The consequences of this financial favouritism can be directly observed by comparing the return on capital earned by state and non-state firms. For most years since 1978, Brandt and Zhu (2010) find a wedge between the return to capital in the state owned and non-state owned sector of more that 40 *percentage points*. Similarly, Dollar and Wei (2007) present survey data from 2001 and 2002, indicating that the return on capital is decreasing in the state's ownership share, and that collective and private enterprises have returns on capital approximately 45 percentage points higher than state owned enterprises.

Excluded from the formal banking system, non-state firms turned to other sources of capital. Compared to state owned firms, non-state firms were much more reliant on sources of capital that were raised locally. Retained profits, loans from local government (who also faced hard budget constraints), and the savings of family and friends were particularly important (Byrd and Lin, 1990; Allen et al., 2005; Oi, 1999). Even when non-state firms were able to access bank loans, these were usually provided by Rural Credit Cooperatives, which raised and provided capital over a limited geographic area and were 'poorly integrated into financial markets' (Park and Sehrt, 2001, p. 3) resulting in 'local money stay[ing] local' (Naughton, 2007, p. 279). Despite this low level of integration, Rural Credit Cooperatives were important financial institutions in rural areas. In 1995, they captured more than 60% of rural households savings deposits and 85% of their loans were made to households or rural enterprises (survey evidence in Brandt et al., 1997) so increases in rural savings play a potentially important role in expanding rural credit.

Perhaps as a consequence of these frictions, China appears to be subject to substantial *geographic* capital market frictions. Estimated returns on capital differ enormously between the regions, provinces and cities of China (Bai et al., 2006; Dollar and Wei, 2007), suggesting that capital markets are unable to equalise the return on capital across space. In a similar vein, Boyreau-Debray and Wei (2005) show that there is *less* consumption risk sharing between Chinese provinces than between OECD countries. Boyreau-Debray and Wei also show that China fails the Feldstein and Horioka (1980) (FH) test of capital market integration: changes in provincial savings are highly correlated with investment.

In figure 1 I include the results of my own FH regressions, which estimate coefficients and associated 95% confidence intervals for each year between 1952-2010.[10] A coefficient of 0 indicates perfect capital mobility while a coefficient of 1 indicates complete immobility. Unlike Boyreau-Debray and Wei, I do not find evidence of substantial frictions prior to the reforms.[11] However, after the reforms there are strong geographic

[10]Recall that the original FH regression was $i_v = \alpha + \beta s_v + \epsilon_v$ where i_v and s_v were the investment and savings share of GDP in province v respectively. I have estimated this on panel data with a full set of individual and time fixed effects i.e. $i_{vt} = \alpha_v + \delta_t + \sum_{t=1952}^{2010} \beta_t (s_{vt} \times I_t) + \varepsilon_{vt}$. For comparability with Boyreau-Debray and Wei (2005), and to ensure balance, I exclude Jianxi, Guangdong, Hainan, Sichuan, Chongqing, Ningxia and Tibet. Only the exclusion of Tibet materially changes the results and this is due to a huge increase in the Investment share of Tibetan GDP in the 2000's (up to above 100% of provincial GDP). Standard errors are clustered at the province level. Note, technically my measure of saving from the national accounts is incorrect as it doesn't include fiscal transfers, however fiscal transfers in China are extremely small relative to other countries (Wang and Herd, 2013) so their exclusion ought not to be too problematic.

[11]This is because my inclusion of time fixed effects control for national trends more flexibly than their controls. I can replicate their analysis almost exactly (modulo data revisions) and show that their results disappear with the inclusion of a full set of time fixed effects.

frictions. The apparent post-reform increase in immobility is perhaps not surprising. Prior to the reforms, almost all investment was done by state-owned firms which had access to the banking system, state funds, and were subject to the whims of national development strategy. Consequently there were few barriers to capital mobility. After the reforms, an increasing share of investment was undertaken by non-state firms which were shut out of the formal financial sector and, as I have argued, had to rely on more local sources of capital.

These types of frictions have been invoked to explain several unusual features of the Chinese economy. Song et al. (2011) argues that the bias of the financial sector towards SOE's can explain the apparent paradox of high external savings in the face of high domestic returns on capital. Banerjee et al. (2012) suggest that their findings on the role of transportation infrastructure in China are supportive of a model where capital (and labour) are less mobile than goods. Finally, the findings of this paper—that rapid growth in agricultural output resulted in faster local growth in non-agricultural output, higher savings, higher investment and higher ratios of capital to labour (but only in the non-state sector)—are hard to explain in the absence of geographic capital market frictions.

In having substantial internal geographic capital market frictions, the regions of China are much more like countries than comparable regions elsewhere. A large body of work in international macroeconomics rejects cross-border capital market integration across countries, but cannot usually do so subnationally. For instance, capital mobility is almost always rejected by variants of the FH test described above when applied across countries. However, when the FH is applied within countries—anywhere other than China—the results are universally consistent with financial market integration.[12] Chinese capital market frictions thus provide a unique opportunity to explore the role of savings and investment using subnational variation.

3.3 Labour mobility and the *hukou* system

There were also restrictions on labour mobility for much of the PRC era. Because planners had prioritised urban industrial development and favoured urban residents—guaranteeing jobs, housing, public services and food—large imbalances between rural and urban living standards emerged. To prevent more migration to cities than could be absorbed, the *hukou* 'internal passport' system was developed.[13] The *hukou* provided each Chinese citizen with a place of registration and a classification as either 'agricultural' or 'non-agricultural'. Until 1998, children inherited their mothers *hukou* classification. Changing *hukou* status was difficult and costly, although easier for workers with university degrees and in demand skills. Reforms beginning in the late 1980's and continuing through the 1990's, such as the introduction of the 'blue' temporary urban *hukou*, somewhat liberalised migration but substantial barriers remained (Chan and Zhang, 1999).

[12] See e.g. Sinn (1992) who looks at US States, Helliwell and McKitrick (1999) for Canadian Provinces, Paweenawat and Townsend (2009) for Thai villages and Dekle (1996); Iwamoto and Van Wincoop (2000) for Japan.

[13] See Cheng and Selden (1994) for a complete description of the origins of the *hukou* system and Chan and Zhang (1999) for a discussion of its reform in the 1990's.

The *hukou* system was enforced by tying access to public goods to place of registration. For urban residents this meant retirement benefits, health care, education, subsidised housing and access to jobs in state-owned enterprises; while for rural residents this principally meant the entitlement to farmland. In addition to public goods, *hukou* status determined access to state provided goods, at least until the end of rationing in 1993. Citizens with urban *hukou*'s were entitled to purchase staple goods such as grain, cooking oil, meat and sugar; whereas holders of rural *hukou*'s were expected to provide for themselves. Obtaining these goods outside the ration system was expensive, greatly increasing the cost of migration for the rural population.

As a result, the number of migrants in China was low. In the 1% sample of the 1990 population census, just 3.3% of the population lived in a different county to where they had five years previously. The comparable figure for the US is 25%, while in India 2.7% of the population move district *each year* despite districts being significantly larger than counties.[14] These low figures are not an artefact of the procedures used to collect China's census data. A retrospective survey conducted by De Brauw et al. (2002) finds that just 4% of the rural labour force were migrant workers in 1981, this increased to a little below 6% by 1990, 10% by 1995 and almost 16% in 2000. In the years following the reforms, migration was very low, although it increased during the 1990's, and so may be of concern later in my sample period. In the results, I will thus be careful to show that there was little differential migration and population growth in areas suited to cash crops, as well as that the results are unchanged by controlling for population growth.

3.4 The non-agricultural sector in the reform era

Agriculture was not the only sector to undergo substantial reforms. From 1978 onwards, restriction on the activities of the non-state sector were progressively lifted as China's economy became more market oriented. As this paper focusses on linkages between agriculture and the rest of the economy any linkages observed must be understood in the context of the reforms to the non-agricultural sector. My results will indicate that the linkages I observe were primarily due to an increase in the supply of capital to the non-state sector. As the reforms to the non-agricultural sector increased the productivity of this sector substantially, these reforms most likely increased the value of additional rural savings and hence the strength of the linkages.

While the possible complementarity between agricultural and non-agricultural reforms provide important contextual background for interpreting the size of the linkages uncovered, the presence of non-agricultural reforms also constitute a potential confounding factor for my empirical strategy (which, as will be discussed below, compares counties more or less suited to cash crops). If non-agricultural reforms were also more beneficial to counties relatively suited to cash crops, then my results will overstate the strength of the linkages from the agricultural sector.[15] It is thus worth briefly outlining

[14]Figures from the US from 1980 and 1985 Current Population Survey available through IPUMS. More recent rounds of the CPS do not separate moves across county lines from moves within counties and are thus not comparable. Figures from India from the 64th round of the National Sample Survey (2007).

[15]Note, that this is in fact two threats: (1) non-agricultural reforms could have been more beneficial to counties with some characteristic correlated with suitability for cash crops, e.g. initial population density or education levels, (2) that growing cash crops was somehow directly beneficial to the growth of the

the main pillars of reforms to the non-agricultural sector. As in my results linkages are clearly observable by 1990, I focus on the first stage of the reforms between 1979-92.

Prior to the reforms, China was a planned economy in which state owned enterprises played a dominant role. The state had a monopoly in many sectors of the economy. From 1979, many sectors were opened up to 'non-state' firms with agricultural processing being an important early sector. Large numbers of non-state firms entered the newly opened sectors, many of which were collective enterprises (although there is some debate over just how 'collective' these firms were, Huang 2008). Regardless of the extent to which these firms were collective, they were broadly profit maximising and subject to hard budget constraints (Oi, 1999). Because industrial output was initially low, prices were substantially above marginal cost in the early days of reform and profits were high.

While agricultural reforms allowed non-state firms access to agricultural inputs and their derivatives, the planning system limited access to many intermediate goods which limited the growth of the non-state sector in the early days. The introduction of the 'dual-track' system from 1984 alleviated this problem (Naughton, 1996). The dual track system meant that state firms retained rights to allocations of resources at low government prices (and the accompanying responsibility to deliver a certain quantity of output at low government prices) but weer allowed to produce off-plan at market prices for inputs and outputs. This meant that for many state owned firms, marginal production decisions were taken at market prices, and meant that non-state firms could access inputs from strategic sectors reserved for state owned firms. Furthermore, because quotas and resource allocations for SOE's were fixed (in absolute terms) from 1984-87, and declined thereafter to almost nothing by 1995. Thus, because overall output was increasing rapidly, the share of output directly planned by the state declined dramatically (Naughton, 2007, Fig. 4.1).

The consequences of these reforms, in partnership with reforms to the agricultural sector, were dramatic. The real industrial output of non-State firms increased by 15.6% per year between 1978-90 while the output of the state owned sector grew at 7.6% per year. However despite the rapid growth of the non-state sector, state-owned firms produced the majority of Chinese industrial output until 1998.[16]

4 Empirical Strategy and Data

In the previous section, I argued that China's agricultural reforms were likely to have disproportionately benefited counties with land suitable for growing cash crops. While all counties gained from the incentive effects of the introduction of the Household Responsibility System, counties suited to cash crops could also benefit from new freedoms to plant these crops. Thus, the principal empirical strategy used is difference-in-differences with 'suitability for cash crops' as a continuous treatment variable. My estimating equation is

$$Y_{ivt} = \alpha_i + \delta_{vt} + \beta_1(SCC_i^N \times D1985_t) + \beta_2(SCC_i^N \times Post85_t) + \varepsilon_{ivt} \quad (10)$$

non-agricultural sector through a channel other than *labour*, *capital* or *demand*.

[16] Authors calculations based on University of Michigan China Data Centre aggregate output data.

where α_i and δ_{vt} are county and province-by-time fixed effects respectively. $D1985_t$ and $Post85_t$ are dummy variables taking values of one in 1985 or all years after 1985 respectively. Thus β_1 provides the short run effect of suitability for cash crops on my outcome and β_2 the medium run. SCC_i^N is my (normalised) measure of suitability for cash crops, the calculation of which is described below. Y_{ivt} is my outcome of interest. In most specifications, I use the two-way cluster robust errors of Cameron et al. (2011) and cluster the standard errors at the prefecture and province-time levels.[17] This allows for autocorrelation of errors over time and space amongst immediate neighbours, and over space for counties in the same province while also providing a sufficient number of clusters to obtain reliable standard errors.[18]

The inclusion of individual fixed effects controls for any time invariant characteristics of counties. Province-by-time fixed effects flexibly control for province specific shocks, including but not limited to, provincial polices, prices and economic performance. The inclusion of these fixed effects mean that I identify the post-reform benefit of suitability for cash crops using only within province variation; I am not comparing booming Zhejiang to dusty Gansu. Thus, my identification assumption is: in the absence of the agricultural reforms, within a province, the growth in my outcomes of interest would have been uncorrelated with suitability for cash crops.

I provide several pieces of evidence in support of this parallel trends assumption. First, I use a specification including interactions of my treatment with each year in my data to show that the growth of each of my outcomes of interest was uncorrelated with suitability for cash crops prior to the reforms

$$Y_{ivt} = \alpha_i + \delta_{vt} + \sum_{s \neq 1978} \beta_s \left(SCC_i^N \times I_s \right) + \nu_{ivt} \tag{11}$$

In this specification, if the parallel trends assumption held prior to reform then $\beta_s = 0 \; \forall s < 1978$. Second, I show that my estimates are stable in the face of alternative fixed effect specifications which, for instance, indicates that any unobserved confounding factors are correlated with suitability in the same way within provinces as across provinces. Third, I show that my results are robust to the inclusion of county specific time trends. These time trends flexibly control for differential log-linear growth rates by county. Fourth, I show that my results are robust to controlling for a wide range of preexisting geographic and economic characteristics, as well as the placement of Special Economic Zones. Finally, I show that the results are robust to the omission of any of the provinces in my data, and to alternative ways of calculating my measure of suitability for cash crops. For brevity, the results of many of these robustness checks are contained in the Appendices.

[17] The prefecture is the administrative unit between the county and the province, on average a prefecture contains 7-8 counties and a province contains an average of 10 prefectures. The 'physical share of crops' regressions in section 5.2 are clustered at the county level due to the smaller sample size and corresponding reduction in number of clusters. Regressions on firm entry, firm factor utilisation and agricultural labour shares are clustered at the provincial level as data is available for the whole of China.

[18] Given the dataset, I believe that this is the 'correct' level to cluster at. However, the statistical significance of the results does not rely on clustering at this level. Clustering at lower levels, or along a single dimension, results in smaller standard errors (as is usual) and so the reported errors are in some sense conservative. Similarly, the use of errors with the spatial error correlation specified à la Conley (1999) also result in smaller errors two-way clustered errors employed here.

4.1 Suitability for cash crops

The key variable for the empirical analysis is a measure of a counties suitability for cash crops. In the model presented in section 2, the freedom to plant cash crops would enter the production function as a change in one or more of the productivity parameters. I will construct a measure of suitability using the Food and Agriculture Organisation's Global Agro-Ecological Zones (GAEZ) which provides theoretical estimates of gross physical output per hectare under optimal growing conditions at a high spatial resolution.[19] Although it is not clear precisely how the GAEZ productivities map into the agricultural production function, it is perhaps most appealing to think of them as Hicks-Neutral productivity shifters. In this case, farmers will want to switch to cash crops when the (price weighted) yield of cash crops is greater than that of grain, and the benefits of switching will be increasing in the difference in productivities.

Thus as a proxy for the gains from specialising in cash crops, I define suitability for cash crops in location ι as the ratio of the (price weighted) yield of cash crops to that of grain

$$SCC_{\iota} = \frac{\max\{\hat{\Psi}_{c\iota} p_c\}_{c \in \mathbb{C}}}{\max\{\hat{\Psi}_{c\iota} p_c\}_{c \in \mathbb{G}}} \tag{12}$$

where p_c is the price of crop c, $\hat{\Psi}$ is the GAEZ predicted yield and $\mathbb{C}$ and $\mathbb{G}$ are the set of cash crops and grains respectively.

I obtain prices from Sicular (1988) who provides government prices for a range of crops during the cultural revolution and the early reform era. For most crops Sicular provides two prices, a low 'below quota' price for deliveries of crops that were required by the central government and a higher 'above quota' price which applied to deliveries in excess of those mandated. In my baseline results, I use the 'above quota' price as this is the marginal price faced by farmers where quotas were non-binding, however, the results are robust to the use of below quota prices instead. There is little pre or post-reform change in the relative price of cash crops and grains (see table 1), so it is not surprising that the results are also robust to the use of prices from years other than 1978. In my main results I use prices from 1978 which have the virtue of preceding the change in agricultural output which followed the reforms.

Productivities $\hat{\Psi}_{c\iota}$ are obtained from the GAEZ database.[20] The GAEZ data provide agricultural productivities for a number of crops at a high spatial resolution. The productivities are based on agronomic models which give measures of potential crop yield based on climatic conditions, soil type, elevation and gradient.[21] One advantage of a model-based measure of agricultural productivity is that, unlike directly observed yields, the productivities at a given location are exogenous to other economic activity.

[19]There are 138'000 cells in China. In Beijing a cell represents an area about 6.5km square, cells are larger towards the equator, so in Shanghai a cell is approximately 8km square. All counties in China contain the midpoint of at least one cell, and counties at the 5th, 50th, and 95th percentile contain 6, 27 and 199 cells respectively.

[20]The GAEZ data has been used in a number of studies in economics, including the Costinot and Donaldson (2014) study of the gains from agricultural market integration in the US and the Nunn and Qian (2011) study of the effect of the potato on population densities in Europe.

[21]The GAEZ yields are based on the 'dry' weight of crops obtained i.e. shelled peanuts, cotton lint, dried grains etc. Conversely, the Chinese price and output data relates mostly to wet yields. Consequently, other than for peanuts where the prices I have are for shelled peanuts, I convert the GAEZ productivities from 'dry' to 'wet' using the conversion factors supplied in the documentation (Fischer et al., 2012, p. 98).

Along with the geographic and climatic conditions, the inputs of farmers such as labour, fertiliser and irrigation will also affect agricultural yields. In light of this, the GAEZ database includes productivities based on various scenarios for intensity of inputs and use of irrigation. As irrigation is widespread in China, I use the productivities based on 'intermediate inputs' and 'irrigation', however my results are robust to the use of other scenarios (see appendix table A7). Figure 2 is a map depicting land suitability to cash crops for the whole of China; significant variation exists both across and, crucially for my empirical strategy, within provinces.

Following Lin and James (1995), I restrict the set of cash crops to cotton and oilseeds. These are the the most important non-grain crops in China and, along with grains, these crops account for at least 80% of planted area in the early reform era. The specific set of oilseeds and grains that I can consider is determined by the availability of the soil productivity and price data described above. The grains used are $\mathbb{G} = \{\text{Wheat, Rice, Maize, Soybeans}\}$ and the cash crops are $\mathbb{C} = \{\text{Rapeseed, Groundnut, Cotton}\}$.[22]

The above procedure provides a measure of suitability at the gridcell level while my economic data is at the county level. To link the GAEZ data to the economic data, I use the ACASIAN Data Centre's geo-referenced county level administrative boundaries for all of China's 2341 counties in 1999. The suitability of a county is calculated as the simple average across all cell midpoints within the county $SCC_i = n_i^{-1} \sum_{\iota \in i} SCC_\iota$ where n_i is the number of fertile cell midpoints in county i.

In section 5.2, I will use measures of suitability specifically for cotton and oilseeds, rather than for cash crops generally. The construction of each of these variables is directly analogous to my main measure using the appropriate subset of $\mathbb{C}$.

4.2 Economic data

County-level economic data on economic aggregates are primarily drawn from the set of Anniversary Yearbooks published to mark the 50th and 60th anniversaries (1999 and 2009) of the People's Republic of China (PRC). Counties are the fourth level of administration in China (after State, Provincial and Prefectural level administrations) and the finest at which I could obtain economic data.[23] Although most provinces produced Anniversary Yearbooks, only a subset of them provided historical statistics at the county-level before and after the reforms. In all, I have comparable output data for the non-metropolitan areas of Gansu, Guizhou, Hebei, Jiangxi, Xinjiang and Zhejiang, and for some prefectures Sichuan and Shanxi (561 counties). For some variables, such as population I also have data for Jiangsu. The data coverage is highlighted in figure 3. The geographic coverage is reasonably representative of much of China but it does not cover the North-East, a region that has experienced a relative decline, or the booming

[22]In the Chinese agricultural data, soybeans are classified as a grain and were thus subject to the same quotas and encouragement as other grains. However, classifying soybeans as an cash crop does not significantly affect my results. There are a number of less widely grown 'grains' (sorghum, millet and potatoes) and an oilseed (sesame) that are omitted because I lack data on prices and/or productivities. These omitted grains and oilseeds constitute around 10% of total grain and oilseed planted areas in China as a whole but less in the counties for which I have data as the planting of sorghum, millet and sesame is concentrated in southern China where my data coverage is limited.

[23]Throughout the paper the term 'counties' refers to all county-level administrative divisions. This also encompasses county level cities (which generally include urban and rural areas), districts, autonomous counties, banners and autonomous banners.

South Coast. The counties in the data are also more rural than China as a whole as the data explicitly excludes most provincial capitals, which tend to be the largest cities. The dataset include about a quarter of Chinese counties and in 1978 and cover a population of 217 million people. If these counties were an independent country, then in 1978 they would have been the fourth most populous in the world.[24]

In principle the data cover the whole PRC era beginning in 1949, however in practice, data coverage varies by both province and variable and is increasingly sparse in the early years of the PRC. To ensure the data is reasonably balanced I use data only from years where data is widely available: 1965, 1970, 1978, 1985, 1990, 1995, and 2000-08.[25] The inclusion of three 'pre-reform' years, 1965, 1970 and 1978, allows me to demonstrate that, prior to the reforms, the key parallel trends assumption was satisfied. The aggregate data used are Primary GDP and Gross Agricultural Output, as measures of agricultural output; non-Primary GDP, as a measure of non-Agricultural Output; rural income per capita; Savings Deposits, as a proxy for saving; Investment in Fixed Assets;[26] and Population. I also use physical production (in tonnes) of grain, cotton and oilseeds where the data is available to show that the pattern of production also changed in line with suitability for cash crops.[27] I match this economic data to the administrative boundary data described above.[28] To the best of my knowledge, this is the first paper to exploit the county level data contained in the Anniversary Yearbooks, however, Wang (2012) uses prefecture level data from the same sources in her study of the effect of China's Special Economic Zones.

Panel A of table 2 provides summary statistics for the main economic aggregates used for 1978, 85, 90 and 95. There are several features of the data that are worth noting. First, the economic aggregates grew extremely rapidly in the period studied. Between 1978 and 1990, real Primary GDP (my main measure of agricultural output) increased by almost 70%; real Secondary and Tertiary GDP (my main measure of non-agricultural output) almost quadrupled; real savings deposits increased more than tenfold; and real investment in fixed assets increased sixfold.[29] As my data largely excludes metropolitan counties, and does not include any of the provincial level cities, my counties are more rural than China as a whole. In 1978, the Primary sector accounted for 56% of my counties GDP, compared to 28% for China as a whole. In 1978 the counties in my sample were similarly industrialised to the least developed countries in sub-Saharan Africa.

[24]After, the rest of China, India and the USA

[25]Where possible, data from yearbooks published in 1999 was supplemented with data from the University of Michigan's 'China Data Online' database to bring the data to 2008.

[26]It is worth noting that Investment in Fixed Assets combines purchases of new and used capital and so does not capture 'investment' as it is normally understood by economists.

[27]For cotton, this is parts of Hebei, Xinjiang, Jiangsu. For oilseeds parts of Hebei, Xinjiang, Jiangsu, Zhejiang and one prefecture in Shanxi.

[28]In some cases, changes in county borders between 1999, the year of my boundary data, and 2009, the year of some of my yearbook data, necessitate the merging of counties to ensure a consistent match between borders and economic data.

[29]There is some debate over the reliability of the deflators used by China's National Bureau of Statisitics (see Young (2003) for a discussion) so these figures should be considered indicative rather than definitive. In the empirical analysis I use log nominal variable and province-time fixed effects which means that I am automatically controlling for differential price changes across provinces. Consequently, the lack of reliable deflators is not crucial for my purposes.

4.3 Additional data sources

I supplement the data described above with additional data from several other sources including various province level economic data, county level data from China's 1982, 1990 and 2000 Population Censuses, and micro data from China's 1995 Third Industrial Census and 1990 Population Census. These and other additional sources of data are introduced when needed in the results sections and more details are provided in appendix B.

5 Agricultural Output

China's agricultural reforms improved effort incentives and liberalised the planting of cash crops. Improved incentives benefited farmers across China, but the freedom to plant cash crops was probably more beneficial to farmers with land suitable for those crops. In this section, I show that this was indeed the case.

5.1 Suitability for cash crops and agricultural output

Table 3 reports results of regressions showing that counties suited to cash crops had larger post-reform increases in agricultural output. A one standard deviation increase in my measure of suitability for cash crops is associated with 23% higher Primary GDP (my main proxy for agricultural output) between 1985-2008 (column 1). This increase is statistically significant at the 1 percent level. In column 2, my baseline specification, I show that around two-thirds of the increase in output was realised by 1985. Farmers were quick to take advantage of the reforms. To put these effect sizes into context, for the counties in my sample, real Primary GDP increased by 116% between 1978-95.

The province-time fixed effects allow for differential price changes across province but not within province. This could be problematic if the price of agricultural output increased faster in counties suited to cash crops. In the 1980's, most agricultural output was sold at fixed government prices which mitigates concerns over differential price increases across space within a given crop. Furthermore, there were only modest changes in the relative price of different crops, and these would be disadvantageous to counties suited to cash crops (table 1). Thus, at the very least, differential changes in value added up to 1985 ought to provide a lower bound for the differential changes in real output. For later periods, trends in relative prices are less clear. The price of cotton and oilseeds increased compared to wheat, but fell compared to rice and maize.[30] Terms of trade improvements may explain some of the additional increase in output after 1985.

For many counties I do not observe Primary GDP in every year; my data is unbalanced. To rule out the possibility that changes in the composition of the sample drive the results, I reestimate my baseline specification using only counties for which I observe Primary GDP in every year (column 3). The estimated coefficients are almost unchanged and remain significant at the 1 percent level.

By estimating separate coefficients for each year in the data, we can observe the differential growth in agricultural output in counties more or less suited to cash crops

[30] The price of cotton and oilseeds fell dramatically compared to soybeans (following Chinese conventions a grain in my analysis) however soybeans is only the 'best grain' in my calculation of suitability in a few places due to it's low initial price.

over time. Figure 4 plots these coefficients and the associated 95% confidence intervals (estimating Equation 11). The coefficients on the pre-reform years provide a placebo test of the parallel trends assumption; they are all statistically insignificant and close to zero. Furthermore, there is also no obvious trend in the value of the coefficients prior to reform. Counties more or less suited to cash crops were following parallel trends. Immediately after the reforms, counties suited to cash crops enjoyed a large relative increase in agricultural output. These increases are sustained until 2008, the last year in my data. We cannot reject the null that all coefficients from 1990 onwards are equal, suggesting that specialisation in cash crops led to a one time increase in agricultural output.

As an additional test of the parallel trends assumption, I include county specific time trends for all 561 counties (table 3 column 4). These time trends flexibly control for any (log) linear differences in agricultural output growth across counties. My estimated coefficients are almost identical to those in my baseline specification and are significant at the 5 percent level.

Even though counties followed parallel trends in agricultural output before the reforms, it is still possible that suitability for cash crops was spatially correlated with other post-reform shocks. I address this concern by providing a large number of robustness checks and alternative specifications in the appendices. First, I show that the estimated coefficients are stable in the face of several alternative fixed effects specifications. This indicates that any unobserved confounders must be correlated with suitability for cash crops after the reforms in the same way within prefectures, within provinces and within the whole of China. Second, I control for the effect of a large number of pre-reform characteristics which may have become more valuable in the reform era including GDP per-capita, agricultural share of GDP, population density, education, distance to major cities and airports, ruggedness of terrain and absolute productivity in cash or grain crops. The results are quantitatively and qualitatively unchanged. I also show that my results are robust to alternative ways of calculating suitability for cash crops and that they do not rely on variation provided by any one province.

Chinese rural institutions were (somewhat) liberalised between the end of the Great Leap Forward (1963) and the start of the Cultural Revolution (1966). The first year in my data, 1965, is in this period. As a precaution, I reestimate my results without including 1965 (column 5). The results are almost identical to my baseline results.

I have assumed a linear relationship between suitability for cash crops and post-reform agricultural output growth. If the relationship were non-linear, my regressions would be mis-specified. In figure 5 panel A, I provide smoothed local polynomial plot, with 95% confidence bands, of the residuals from regressions of suitability for cash crops and growth in agricultural output on province fixed effects. I.e. the variation in suitability and growth not explained by province specific factors. The relationship between agricultural output growth and suitability for cash crops was approximately linear for the periods 1965-78, 1978-85, -95 and -2005. The flat relationship between growth and suitability between 1965-78 provides an additional visual representation of parallel trends prior to the reform. The positive slope for the periods after the reforms indicates the benefits of specialisation in cash crops.

The results thus far use Log Primary GDP as a proxy for agricultural output. In addition to agricultural value added, Primary GDP also includes the potentially confounding value added of other sectors such as mineral and gas extraction. For a smaller number of counties I have data on Gross Agricultural Output, so to validate the use of Primary GDP, I reestimate my baseline specification with Log Gross Agricultural Output as the dependent variable (columns 7 and 8). The results are similar to my baseline results. Primary GDP appears to be a good proxy for agricultural output. In column 9, I estimate the effect of suitability for cash crops on Log Rural Income per Capita. Rural incomes increased similarly to Gross Agricultural Output and Primary GDP.

Aggregate gains in agricultural output

If we are willing to assume that these estimates are real increases in agricultural output due to specialisation in cash crops, rather than reallocations of output across space, then the estimated coefficients can be used to construct a back of the envelope estimates of the total increase in agricultural output due to specialisation. This type of estimate can provide a sense check of the plausibility of the estimated coefficients and allows comparison to the gains from specialisation attributed to decommunalisation by McMillan et al. (1989) and Lin (1992).

I focus on increases in agricultural output between 1978 and 1985 for three reasons. First, the potentially confounding effect of relative price changes is minimised over this period; there is only a small across the board decline in the relative price of cash crops. Second, in the next section, I will show that by 1985 there is little effect on non-agricultural output, whereas after this non-agricultural output increased substantially in counties suited to cash crops. Higher non-agricultural output could potentially increase or decrease agricultural output, but I wish to focus primarily on the gains from specialisation. Third, focusing on 1978-85 facilitates comparison to previous estimates of the gains from decommunalisation which were usually estimated over the period 1978-84.

To estimate the aggregate gains, I reestimate my baseline specification using only data from 1978 and 1985. The estimated coefficient is 0.14, slightly smaller than the coefficient of 0.16 obtained for 1985 in my baseline specification. As my coefficient is a diff-in-diff coefficient, we cannot be sure whether the coefficient captures increases in output all the way through the distribution. However, given relative prices are unchanged, there is no particular reason why counties unsuited to cash crops would be actively harmed by the freedom to plant cash crops. Nevertheless, I will make the conservative assumption that although no counties were actively harmed, the counties least suited to cash crops gained no benefit. County i's assumed increase in agricultural output due to specialisation is $d_i = \beta \times \max\{SCC_i^N - P_x(SCC^N), 0\}$, where SCC_i^N is the normalised suitability for cash crops, $P_x(SCC^N)$ is the suitability for cash crops of the county at the percentile x below which there are assumed to be no gains and β is effect of comparative advantage on the growth of agricultural output. I consider three 'zero gains percentiles' for x: 10, 25 and 40.[31]

I use this estimate of the increase in gains in two ways. To estimate the total increase

[31]For consistency with the extrapolated gains for the whole of China, I I use the percentiles of all Chinese counties, not just the ones used to estimate b. However, these percentiles are extremely similar and so their use do not substantively change the estimates.

in agricultural output due to specialisation in my data I combine estimates, $\hat{d}_i$, with the fitted values of my regression. Table 4, panels A and B contain the estimates. When the gains are estimated based on coefficients on regressions of Ln Agricultural Output on suitability, I estimate that, for the counties in my data, specialisation increased aggregate agricultural output by between 9.0 and 15.3 percent. My preferred estimate, based on no gains below the 25th percentile of suitability, indicates that specialisation increased output by 11 percent. When I do the same exercise using agricultural output in levels, I obtain a similar estimated increase of 10.1 percent. The advantage of levels estimation is that I can estimate the share of the total increase in agricultural output without the use of unreliable Chinese agricultural price deflators. In my data 16% of the increase in agricultural output between 1978 and 1985 was due to specialisation.[32]

In panel C, I extrapolate these gains across the whole of China using the comparative advantage of all counties. Each county is assumed to have had a d_i log point increase in agricultural output due to specialisation. I then take a weighted average of the counties increase where the weights are based on the imputed share of national agricultural output in 1978.[33] Specialisation is estimated to have increased agricultural output by 14.2 percent across the whole of China, three percentage points more than that estimated for counties in my main data set using the fitted values. If I 'extrapolate' my results only to counties in the provinces and prefectures in my main data set, the estimated gains are similar to those indicated by the fitted values. The rest of China appears to have been slightly better placed to gain from specialisation than the counties in my data.

The large gains I find are consistent with Lardy (1983), who argued that the pre-reform misallocation of crops to land imposed a substantial cost in terms of agricultural productivity. Speicialisation increased agricultural output by around two-thirds the amount usually attributed attributed to the introduction of the Household Responsibility System. (Although we would expect the two parts of the reform to be complementary.) Gains from specialisation help bridge a gap between the large gains in aggregate output attributed to the reforms by McMillan et al. and Lin (1992), and the smaller effect on rice yields in Huang and Rozelle (1996). They are also consistent with the large gains from economic integration of US agriculture estimated by Costinot and Donaldson (2014) who find that integration of agricultural markets increased the value agricultural output by 1.5 percent *per annum* for most of the last 130 years.

The importance of fine spatial variation

Gains from reallocation appear to have been of economic significance, yet previous empirical studies have not been able to identify them (Lin, 1992; Lin and James, 1995). My empirical methodology differs from that used in previous studies in two principal ways. Firstly, the measures of potential or realised gains are different. Where they use changes in the shares of cash crops planted, or historical patterns of crop production, I use the GAEZ global database of theoretical agricultural productivities to identify

[32]The increase in agricultural output due to specialisation when using log estimates is $\frac{\sum_i \exp(\hat{d}_i)}{\sum_i \exp(\hat{y}_{1985} - \hat{d}_i)}$, when in levels $\frac{\sum_i \check{d}_i}{\sum_i \check{y}_{1985} - \check{d}_i}$, the share of the increase when in levels is $\frac{\sum_i \check{d}_i}{\sum_i \check{y}_{1985} - \check{y}_{1978}}$

[33]The weight w_{ij} paced on county i in province j is $w_{ij} = ProvinceShareOfNationalPrimaryGDP_j \times CountyShareofProvincialAgriculturalPopulation_{ij}$.

land suitable for growing cash crops. Secondly, where they used province level data, I use county level data. I am therefore able to exploit much finer spatial variation in suitability than previous studies and to include a richer set of fixed effects. While I lack the data to replicate their methodologies at the county level, I am able to replicate my own methodology with province level data.

Table 5 contains results based on province level data and comparable results from my county level data.[34] My baseline specification includes province-by-time fixed effects which are collinear with my variable of interest using province-level data. To avoid this collinearity, I provide two additional specifications. The first uses only time fixed effects, the second adds province specific time trends. Columns 2 and 3 provide county level estimates of the effect of suitability on post-reform agricultural output for these specifications; the results are similar to my baseline findings (restated in column 1).

Columns 4-7 report results obtained using province level data. Columns 4 and 5 restrict the set of years to those used in the county level analysis. Columns 6 and 7 use data from all available years. Regardless of restrictions on years, or specification, the estimated coefficient on suitability for cash crops is neither economically nor statistically significant. These results highlight the importance of using data at the right level of spatial disaggregation.

5.2 Change in the pattern of agricultural production

For a subset of counties, my data includes physical production, in tons, of grain, cotton and oilseed.[35] For counties with this data, I can test whether counties suited to growing cotton (or oilseed) actually grew more cotton (or oilseed) after the reforms. To do this, I calculate the share of cotton (oilseed) tonnage in joint tonnage of cotton (oilseed) and grain

$$Share_{ivt,c} = \frac{T_{ivt,c}}{T_{ivt,c} + T_{ivt,G}}$$

where $T_{ivt,c}$ is the tonnage of crop c at time t in county i and province v. Analogously to the construction of my measure of suitability for cash crops, I also construct variables for suitability to cotton and oilseeds with respect to grain as described in section 4. If the pattern of production is shifting towards the one suggested by crop suitability, counties more suited to cotton (oilseed) ought to increase the share of cotton (oilseed) in their output.

It is important to note that the set of counties for which I have data on the physical production of cash crops include only counties that produce that crop. The data appear to exclude counties that never produced cash crops, and is thus not a random sample. As a consequence, I am identifying increased specialisation only from counties relatively suited to cash crops. Indeed, counties for which I have data on the production of cotton and oilseeds had suitabilities for cash crops 0.8 and 0.4 standard deviations

[34] Because the province level data has observations available for each year, I provide results for specifications where post 1978 is the treatment period rather than estimating the effects for 1985 and 1990 onwards separately.

[35] I observe output of grain, cotton and oilseed for most counties in Hebei, Jiangxi and Xinjiang. I also observe output of grain and oilseed for most counties in Zhejiang and Chengdu prefecture in Sichuan.

higher than the average Chinese county. As the production and planting of cash crops increased rapidly after the reform, the result of this is likely to bias the estimated coefficients towards zero, as the places with zero growth in cash crop production seem to be excluded from the data and have low suitability for cash crops.

Figure 6 plots the the coefficients associated with the effect of suitability for cotton and oilseeds on the share of their respective physical outputs for each year in the data. For both cotton and oilseeds, the physical share of output increases after the reforms (although the increase is not statistically significant at the 5 percent level in many years). For oilseeds there is no differential trend in shares prior to reform. For cotton, areas more suited to its production had a significantly higher share of cotton in 1965 than in 1970 or 1978. This may be due to the slight liberalisation of agriculture between the Great Leap Forward and the Cultural Revolution, although this is not evident in the main results for agricultural output.

Table 6 contains similar results. Columns 1-3 provide the results for cotton; a 1 standard deviation increase in suitability for cotton is associated with around a 1-2 percentage point increase in the share of cotton in output. The coefficients are not always statistically significant.[36] Columns 4-6 provide the results for oilseeds; a 1 standard deviation increase in the relative value of oilseed production is associated with a 2 percentage point increase in the share of cotton in joint cotton and grain tonnage. Columns 2 and 5 also include suitability to the 'other' cash crop in my data i.e. for cotton this means oilseeds. The estimated coefficients are weakly negative, which is what I would expect if farmers are specialising. Columns 3 and 6 omit data from 1965 in case the post great leap forward liberalisation is affecting the results. As figure 6 would suggest, the estimated effect on the share of cotton increases.

Both oilseeds, and especially cotton, have a lower yield (by weight) than grain. The average GAEZ predicted cotton yield in tons in Jiangxi, Hebei and Xinjiang—the provinces for which data on cotton production is available—is 1/12 that of the average predicted grain yield, while the average reported realised yield of cotton (in 1978) is 1/8 that of grain.[37] The respective figures for oilseeds are 1/2 and 1/3. Although the land converted to cash crops is likely to be more suited to cash crops than the average, a 2 percentage point increase in the share of output in tons, is nevertheless likely to equate to a significantly larger change in land use.

An alternative explanation for the changes in crop shares, and output, is that yields grew faster for cash crops, without any reallocation of land to crops. If counties suited to cotton were producing and planting more cotton prior to reform, and cotton yields grew faster than wheat yields after the reforms, then these counties would have faster growth in agricultural output and increase the share of cotton in their output. Yields in China are endogenous to the reform, if the average suitability of land used to grow cash crops increased faster than that for grain then the reforms themselves would cause a relative change in yields. However, yields outside of China are more plausibly exogenous.

[36] Because of the limited availability of physical production data, errors are clustered at the county level instead of the prefecture and province-time level to ensure that the errors are consistently estimated. If two-way clustering is included at the prefecture and province-year level as in my main regressions, the standard errors associated suitability for cotton interacted with 1985 are much smaller for columns 1-3, while the standard errors associated with the post interactions are significantly larger. Results available on request.

[37] Data on realised yields from the University of Michigan's China Data Centre.

Table 1 shows that differences between post-reform yield growth in cash crops and grains in the US and India was modest and too small to explain the differential growth observed.[38]

6 Linkages to the Non-Agricultural Sector

After the reforms, counties suited to growing cash crops began specialising and, as a consequence, enjoyed faster growth in agricultural output. In this section I will show that these counties also had more rapid growth in non-agricultural output. I will show that the increases in non-agricultural output were accompanied by higher savings and investment. As discussed in section 2, these aggregate increases are consistent with higher agricultural output increasing non-agricultural output through several channels. Thus, I will provide several pieces of supplementary evidence which suggest that the increases in non-agricultural output identified were primarily due to the *capital channel*. Higher agricultural surpluses increased rural savings, the supply of capital, and hence non-agricultural output. Conversely, the results do not indicate that specialisation in cash crops was labour saving, or that there were significant county-level linkages via local demand. These findings are consistent with China having significant geographic capital market frictions as described in section 3.

6.1 Non-agricultural output

Figure 7 and table 7 contain my main reduced-form results for non-agricultural output. Counties suited to growing cash crops had significantly faster post-reform growth.

Figure 7 plots coefficients and 95% confidence intervals from a regression estimating the effect of suitability for cash crops in each year (1978 is the omitted year). A coefficient of 0.1 would indicate that a 1 s.d. increase in suitability was associated with an approximately 10% increase in non-agricultural output. The coefficients on the pre-reform years provide a placebo test of the parallel trends assumption. All the coefficients on the pre-reform years are insignificant and close to zero with no discernible trend over time. Subsequent to the reforms, counties suitable for growing cash crops enjoyed significantly faster non-agricultural output growth.

The estimated cumulative differential increase in output peaked in the early 2000's and declined thereafter. The reason for this apparent decline are beyond the scope of this paper. However, it is worth noting that share of rural enterprises in industrial output peaked in the late 1990's, as large export oriented and foreign invested firms became increasingly important (Huang, 2008). I will later provide evidence that these increases in non-agricultural output were primarily due to higher agricultural surpluses increasing the supply of local capital. It is possible that this capital was particularly important for rural firms which were key to China's industrial output growth in the 1980's and early 1990's but less so to the urban firms which were key to China's subsequent growth. Alternatively, the decline may reflect a lessening of geographic capital market frictions, possibly due to the banking sector reforms instituted in the

[38] In 1978, for the counties where I have data, cotton and oilseeds were were 1% and 1.7% of grain output respectively and even at the ninetieth percentile of output share, cotton was only 2.2% of grain tonnage and oilseeds only 3.7%.

wake of the Asian financial crisis. This second hypothesis is also consistent with the apparent reduction in geographic capital market frictions shown in figure 1.

It is important to note that in 1985, the first post-reform year for which I have data, the differential growth in non-agricultural output is small (but positive) and statistically insignificant. There are several factors that make a failure to find an increase in 1985 unsurprising. First, the 'dual-track' reforms, which provided non-state firms with access to many intermediate goods markets, were not introduced until 1984. Second, I will later show that the increase in non-agricultural output was due to an increase in the supply of capital, if capital accumulation takes time then 1985 may be to soon to see its full effects. Third, if, as I will show, specialisation increased the demand for agricultural labour, the short run effect of reforms on the non-agricultural sector could be negative until sufficient capital accumulates to offset the higher wages faced. Fourth, although the non-state sector was growing very rapidly, in 1985 its output was still a small, and most likely poorly measured, share of total output. Increases in non-state output may thus have been hard to detect as early as 1985.

Table 7 contains my main reduced form results for the non-agricultural output. In my baseline specification, a one-standard deviation increase in a counties comparative advantage is associated with 19% higher non-agricultural output between 1990-2008. This estimate is significant at the 5 percent level. As in figure 7, the estimated effect in 1985, immediately after the reforms, is small and statistically insignificant. Although the later increase is large, it must be seen in the context of the, on average, nine-fold increase in real non-agricultural output enjoyed by my counties between 1978-95. When I restrict the sample to a balanced panel of counties I obtain very similar estimates (column 2); the results are not due to changes in the composition of the sample over time. Including county specific time trends also has no effect on the estimated coefficients and provides further support for the key parallel trends assumption (column 3).

While there were parallel trends in non-agricultural output before the reforms, it is still possible that suitability for cash crops was spatially correlated with other post-reform shocks. I address this concern by providing a large number of robustness checks and alternative specifications in the appendices. First, I show that the estimated coefficients are stable in the face of several alternative fixed effects specifications. These indicate that any unobserved confounders must be correlated with suitability for cash crops after the reforms in the same way within provinces as within the whole of China. Second, I control for the effect of a large number of pre-reform characteristics which may have become more valuable in the reform era including GDP per-capita, agricultural share of GDP, population density, education, distance to major cities and airports, ruggedness of terrain and absolute productivity in cash or grain crops. The results are quantitatively and qualitatively unchanged. I also show that my results are robust to alternative ways of calculating suitability for cash crops and that they do not rely on variation provided by any one province.

As with agricultural output, I have assumed a linear relationship between suitability for cash crops and growth. In figure 5 panel B I provide a smoothed local polynomial plot, with 95% confidence bands, of the residuals from regressions of suitability for cash crops and growth in non-agricultural output on province fixed effects. The relationship between non-agricultural output growth and suitability for cash crops was approximately linear for the periods 1965-78, 1978-85, -95 and -2005. The flat relationship between growth and suitability between 1965-78 provides an additional visual representation of parallel trends prior to the reform.

In columns 4 and 5, I reestimate my baseline specification with Secondary and Tertiary GDP as separate outcomes. I obtain similar results for both sectors, so for the sake of brevity, I proceed using combined 'non-agricultural output'. Depending on ones priors, obtaining similar coefficients in regressions of both Secondary and Tertiary GDP could be evidence for or against more than one mechanism. If the output of the secondary and tertiary sectors were differentially tradable then the *demand channel* would effect the less tradable sector more strongly. Alternatively, if secondary output was more capital intensive, then we would expect the *capital channel* to increase secondary output more. However, if state-owned firms were relatively dominant in the secondary sector then the *capital channel* would increase tertiary output more, as fewer tertiary firms would have access to the national banking system. The fact we obtain similar coefficients is thus not particularly informative of why non-agricultural output increased.

Instrumental variables results

The identification of linkages between the agricultural and non-agricultural sectors is ordinarily plagued by endogeneity issues, not least the scope for reverse causality. The reduced form results suggested a causal link between agricultural and non-agricultural output, and that suitability for cash crops is a potential instrument for agricultural output. For this instrument to be a valid, it must only affect non-agricultural output through agricultural output. The primary concern in this regard, is that suitability for cash crops is correlated with some other characteristic that became increasingly important in the reform era. However, the large number of robustness checks provided for the reduced form results in appendix C should allay these fears.

I implement the IV regressions using 'long difference' specifications of the form

$$Ln(y^{NA}_{iT}) - Ln(y^{NA}_{i1978}) = \delta_v + \beta(\widehat{Ln(y^{A}_{iT}) - Ln}(y^{A}_{i1978})) + \varepsilon_{iv} \tag{13}$$

where Y^{NA}_{iT} is non-agricultural output in year T and δ_v is a province fixed effect. As this specification includes province fixed effects, I am once again exploiting only within province variation.

As with all instrumental variable specifications, we must be clear in stating exactly what it is we are identifying. In this case the 'local average treatment effect' is the elasticity of non-agricultural output (at the county level, over a given time period) with respect to increases in agricultural output due to post-reform specialisation in cash crops. The extent to which this is likely to generalise to other contexts will depend on how similar the situations are. I provide some discussion of this in the conclusion.

I estimate the results over two time periods, 1978-1995 and 1978-2005. Given the pattern of coefficients in figure 7—in particular the apparent decline in the effect on non-agricultural output from the early 2000's—both sets of results are probably medium run elasticities. Table 8 columns 1 and 4 provide the (endogenous) OLS estimates. The estimated elasticities are 0.34 and 0.26, indicting a 1% increase in agricultural output is associated with around a 0.3% increase in non-agricultural output. Columns 2 and

5 contain the results of the first stage regressions—not surprisingly, suitability for cash crops is strongly correlated with the growth of primary GDP. Columns 3 and 6 contain the IV estimates indicating elasticities of 1.2 and 0.8 over 15 and 25 year periods. These estimates are significant at the 1 percent level. There are a number of reasons why we might expect the IV estimates to be larger than those obtained using OLS. First, IV will mitigate the effect of the (possibly substantial) measurement error in the independent variable, which generally introduces downward bias into OLS estimates. Second, increases in non-agricultural output could ordinarily crowd out agricultural output and introduce negative reverse causality. Third, increases in agricultural output could have been particularly valuable at the start of the reform era, perhaps due to the compounding effect of high returns on capital.

6.2 Savings and investment

Higher post-reform increases in agricultural output resulted in higher manufacturing and service sector output. I will later provide supplementary evidence that suggests that linkages identified are primarily due savings from agriculture being invested in the local non-agricultural sector. However, for this to be the case, it ought to be that higher agricultural output did, in fact, result in higher savings and investment. In this section, I show that counties with land suitable for growing cash crops also had faster post-reform growth in both household savings and investment in fixed assets.

Table 9 column 1 provides the baseline results. A one standard deviation increase in suitability for cash crops is associated with 19% higher savings deposits (a stock) in 1985 and 23% higher savings deposits for the period 1990-2008. The results are significant at the 10 percent level. Households appear to have saved a significant portion of the surplus generated by specialisation in cash crops. For investment in fixed assets (a flow), there was no differential increase in investment in 1985, but from 1990-2008, a one standard deviation increase in suitability is associated with a 35% increase in investment. This estimate is significant at the 1 percent level. Data on investment in fixed assets and, in particular, savings deposits, is less widely available than data on agricultural and non-agricultural output which reduces the precision of the estimates.

Figures 8 and 9 plots the estimated coefficient on suitability for each year in my data. The coefficients for savings deposits mirror those for agricultural output, while those for investment in fixed assets look more like those for non-agricultural output. The increase in savings precedes the increase in investment and non-agricultural output, which is consistent with a larger agricultural surplus being used to finance non-agricultural investment, and the likely limited capacity of the non-state sector to absorb capital in the early reform era. For both savings deposits and investment in fixed assets, there is no evidence of differential trends prior to the reforms, lending further support to the parallel trends assumption.

For both savings and investment, in table 9 column 2, I drop observations from Jiangsu to improve comparability with my main results. In column 3, I restrict the sample to county-year observations where data for both savings deposits and investment in fixed assets are available, making the coefficients more comparable. Column 4 includes county specific time trends to flexibly control for differential (log) linear trends. In no case do the estimated coefficients change substantively.

6.3 How did non-agricultural output increase?

In section 2, I outlined three classic channels through which higher agricultural productivity could result in higher non-agricultural output. Under the *labour channel* labour, saving technology improvements reduced the agricultural demand for labour and thus the wage. Under the *demand channel*, increases in rural incomes resulted in higher demand for non-agricultural output. Under the *capital channel*, higher rural incomes increased rural savings and the supply of capital to local firms.

Although the results presented so far are consistent with any of these channels, the institutional details provided in section 3 indicated that any increases in non-agricultural output are most likely due to the *capital channel*. In this section I complement the institutional analysis by testing three implications of the model:

1. Linkages through the *labour channel* reduce the share of labour in agriculture;

2. Linkages through the *demand channel* have stronger effects on non-agricultural output in more closed places;

3. Linkages through the *capital channel* result in cheaper capital.

The results of these tests are inconsistent with the identified increases in non-agricultural output being primarily due to the *labour* or *demand channels*, but are consistent with the *capital channel*.

6.3.1 Agricultural labour shares

If growing cash crops is labour saving compared to growing grain—and non-agricultural output increases through the *labour channel*—the agricultural share of the labour force must decline in areas specialising in cash crops (relative to those suited to grain). As discussed in section 3.1, the aggregate data on labour use per hectare indicates that switching to cash crops probably wasn't labour saving. Nevertheless, in this section I use census data to directly test whether the share of labour working in agriculture declined in counties suited to cash crops.

Using county level data from the 1982, 1990 and 2000 population censuses, I calculate the share of the labour force employed in farming, forestry, animal husbandry, and fisheries, henceforth the 'agricultural labour share'.[39] I merge the data from the three censuses dropping counties with significant border changes.[40] I then regress the agricultural labour share (in percentage points) on my measure of suitability for cash crops interacted with dummies for 1990 and 2000. As always, I include a full set of county and province-time fixed effects so I am exploiting only using within province variation.

Table 10, columns 1-4, contains the results of these regressions. A one standard deviation increase in suitability is associated with a 1.3 to 1.6 percentage point increase

[39] Although 1982 is somewhat after the beginning of the reforms they are generally not considered complete until 1984. In 1981, the Household Responsibility System was in place in 45% of counties, this increased to 80% in 1982. To the extent that some adjustment had already taken place before 1982 this is likely to bias my estimates towards zero, however I do not know the county level timing of the roll out of HRS so this is a possible confounding factor.

[40] See appendix B for details of how the data were merged over time.

in the agricultural labour share between 1982 and 1990. This increase is significant at the 5 percent level.[41] As the estimated increase in the agricultural labour share is obtained using difference-in-differences, the increase is relative to a substantial national decline in the agricultural labour share.

Most of the growth in agricultural output due to specialisation in cash crops had occurred by 1990. In the absence of further gains from specialisation, there is no reason to expect any further increase in the agricultural labour share. Thus the additional change in the agricultural labour share between 1990 and 2000 provides a pseudo-placebo test of the parallel trends assumption. Consistent with parallel trends, the estimated additional change is statistically insignificant and close to 0. The other columns of table 10 introduce additional controls. In column 2, I introduce controls for initial income per capita, literacy and population density. In column 3, I also control for the initial share of labour in agriculture. In column 4, I drop extreme values of my outcome variable.[42] The results are robust to all of these changes.

The agricultural labour share increased in counties suited to cash crops, however, if this increase was due to previously discouraged workers entering the labour force, this would not necessarily reduce the supply of labour to the non-agricultural sector. In columns 5 and 6, I test whether the size of the labour force increased in counties suitable for cash crops. There was no statistically or economically significant difference in growth of the labour force between 1982 and 1990. The absence of differential changes in the labour force is also not indicative of substantial migration or population responses to specialisation in cash crops. I provide additional results on population and migration below.

Although the number of workers in the non-agricultural sector declined in areas suited to cash crops, if the level of human capital increased the number of effective workers need not have declined. The only measure of human capital I observe in a (reasonably) consistent fashion is the literacy rate, which I again obtain from the population censuses.[43] In columns 7 and 8, I provide results indicating that their was a slight relative increase in human capital in areas suited to cash crops; a 1 standard deviation increase in suitability is associated with around a 1 percentage point increase in the literacy rate. This is small relative to the aggregate increase in literacy—between 1982 and 1990 the literacy rate increased on average by 9 percentage points and between 1990 and 2000 an additional 14 percentage points. It thus seems unlikely that an additional 1 percentage point improvement in the literacy rate can explain the large increase in output.

These results are inconsistent with the predictions of the *labour channel*, specialisation in cash crops was not labour saving. In the absence of other compensating factors, non-agricultural output would have fallen as it did after the introduction of

[41] I report standard errors clustered at the province level. There are 29 provinces so this is fewer than ideal number of clusters. Very similar results with errors clustered at prefecture level are available on request. Results from a two-period first difference specification (i.e. 1982-90 or 1982-00) with wild-bootstrapped clustered SE's (Cameron et al., 2008) are also available and provide very similar results.

[42] Extreme values are the observations yielding the 1% largest squared residuals from a regression of the outcome variable on province-time and county fixed effects.

[43] The literacy rate is based on the population over 12 in the 1982 census and the population over the age of 15 in the 1990 and 2000 census. It is hoped that the increase in literacy due to this definitional change is uncorrelated with suitability for cash crops.

high yielding rice varieties in Foster and Rosenzweig (2004) and genetically modified maize in Bustos et al. (2013).

6.3.2 'Openness'

If higher agricultural output increased non-agricultural output through the *demand channel*, the increases would have been stronger in less open places where higher demand could not easily be satisfied with imports. Because counties are small, and thus fairly open, then the effect of the demand channel is *a priori* likely to be limited. Nevertheless, I test this directly using two proxies for 'openness', distance from either Historic Cities or International Airports in 2007.[44] Clearly the location of International Airports in 2007 is endogenous to growth, however their locations capture most of China's major cities.[45] The locations of Historic Cities was determined at least 60 years before the reforms—and are thus plausibly exogenous to post reform growth—but provide a less complete description of the set of important cities. In either case, the idea is that places closer to large cities, such as suburban counties of Shanghai, are more open to trade in goods than isolated areas, such as rural Xinjiang.

Table 11 contains the results. Regardless of the proxy for openness, the results are similar. Reassuringly the direct effect of distance to cities is negative—more isolated counties grew more slowly after the reforms. The sign on the interactions, our variables of interest, is also negative, and for historic cities, statistically significant. If anything, positive linkages between the agricultural and non-agricultural sectors were *stronger* in more open counties. This is the opposite of what one would expect if induced demand was the primary channel linking the agricultural and non-agricultural sectors.

It is worth noting that, just as increases in the demand for a good will result in smaller price increases in more open economies, increases in the supply of a good will result in smaller declines in price. Seen in this light, the negative coefficients on distance from major cities provide additional support for channels which increase the supply of non-agricultural output (as the *capital channel* would).

6.3.3 Factor prices and factor utilisation

The institutional details provided in section 3 suggested that any increases in non-agricultural output would most likely be due to the *capital channel*. The results in the previous two subsections have been consistent with this, the increases do not appear to have been due to specialisation in cash crops being labour saving, or increasing the demand for locally produced non-agricultural output.

In the *capital channel*, higher agricultural output increases savings and decreases the cost of capital. In section 3.2, I argued that only non-state firms raised capital locally, while state-owned firms had access to national capital markets. Thus, we should expect the cost of capital to fall primarily for non-state firms. (State-owned firms may, however, face higher wages.)

Unfortunately, I do not directly observe the factor prices faced by firms. However, by assuming a production function, I can obtain an expression which allows factor prices

[44] For a description of this data see appendix B.

[45] Additional results for seaports are available on request.

to be inferred from a firm's total wage bill wl and capital utilisation k, both of which I do observe.[46] Suppose a price taking firm has a CES production function, with elasticity of substitution σ, and the weight on labour α, then, obtaining conditional factor demands, rearranging and taking logs, provides the following expression for factor utilisation

$$\ln\left(\frac{wl}{k}\right) = \sigma \ln\left(\frac{1-\alpha}{\alpha}\right) + \sigma \ln(r) + (1-\sigma)\ln(w) \tag{14}$$

which says that the ratio of the wage bill to capital is increasing in the rental rate. Furthermore, if $\sigma > 1$ it is also decreasing in the wage. Recent estimates for China (Karabarbounis and Neiman, 2014) and Chinese firms (Berkowitz et al., 2014) suggest that σ is indeed significantly greater than 1. Consequently, if counties suitable for cash crops experienced an increase in the demand for labour (increasing the wage) but also an increase in the supply of capital for non-state firms (reducing their rental rate), then all firms located in these counties ought to use relatively more capital, but non-state firms especially so.

I test this using the firm level data from the 1995 Industrial Census. For each firm, I calculate the ratio of labour costs (wages + welfare expenses + labour and unemployment insurance) to the value of fixed capital net of depreciation. I then estimate variants of the following equation

$$\ln\left(\frac{wl}{k}\right)_{ijk} = \gamma_{jk} + \beta_1 SOE_i + \beta_2(SCC_i \times nonSOE_i) + \beta_3(SCC_i \times SOE_i) + \epsilon_{ijk}$$

where SOE_i and $nonSOE_i$ are dummy variables taking a value of 1 if firm i is a state owned or non-state enterprise respectively. SCC_i is the suitability for growing cash crops of the county in which the firm is located. γ_{jk} is a province-by-industry fixed effect, which allows for the weight on capital (α) in the production function to vary by provinces and industry. The inclusion of these fixed effects means that, in my least demanding specification, I am only using variation in suitability between firms in the same province *and* in the same 4 digit industry. Providing firms; (1) have the assumed CES production function, and; (2) that α is not correlated with suitability for cash crops other than through factors contained in the fixed effect, then β_2 and β_3 capture differences in factor prices.

Table 12 contains the results. For non-state firms, a one standard deviation increase in suitability is associated with a reduction in the ratio of total wages to capital of 8%. This is significant at the 1 percent level. The point estimate for state owned firms is much smaller, indicating a fall in the wage-capital ratio of 3%, and is statistically insignificant. By way of comparison, state owned firms are found to have a total wage to capital ratio 33% lower than non-state firms in the same industry, which is consistent with the lower cost of capital they are known to face. Reassuringly, the estimated coefficients are stable in the face of more demanding fixed effect specifications and to the trimming of extreme capital labour ratios.

These results are consistent with all firms facing higher wages and non-state firms facing cheaper capital in counties suitable for cash crops. This is the pattern of factor

[46] My data do not contain information on l, however due to unobserved heterogeneity in worker quality the use of wl may be preferable anyway.

prices expected if specialisation in cash crops increased the agricultural demand for labour and the supply of capital to non-state firms. As with the results on the share of labour working in agriculture, they are not indicative of specialisation reducing the demand for agricultural labour (which would be expected to reduce the wage).[47]

6.4 From county to national level linkages

As these results are obtained using county level data it is natural to ask what we learn about the effect of the reforms at a national level. It is unclear whether aggregate linkages would be stronger or weaker than the ones identified for counties. In spite of geographic capital market frictions, it is inevitable that some capital will have leaked out of counties and so we might expect stronger linkages. Similarly, at the national level higher agricultural output could increase non-agricultural output by increasing the demand, as it does in the closed economy models of structural transformation of Echevarria (1997), Kongsamut et al. (1997) and Ngai and Pissarides (2007). On the other hand, the counties in my sample are significantly more rural than China as a whole and the elasticity of non-agricultural output with respect to agricultural output may be quite different when agriculture is 25% of output than when it is 50%. It has also been suggested that early growth in non-state output provided a beneficial first mover advantage by allowing firms to use early monopoly profits to build up a stock of capital (Naughton, 2007). If this were the case, at least some of the identified effect would merely be a reallocation of output across space. Given the high returns to capital in China, and the observed increase in savings, it seems unlikely that this explains all the observed effect.

Relatedly, because the increases in agricultural output here are due to specialisation they do not directly speak to the effect of increases in agricultural output due to decommunalisation. While decommunalisation is also likely to have increased rural savings, the effect on agricultural demand for labour may have been quite different. Indeed, Taylor (1988) finds that the number of days worked per hectare of rural land fell by an average of 30% after the decommunalisation of agriculture—increases in agricultural output due to decommunalisation may have been labour saving. If they were, forward linkages from the decommunalisation of agriculture will have been stronger than the linkages due to specialisation.

6.5 Migration and population

As discussed in section 3, the *hukou* system significantly restricted labour mobility in China, particularly before the end of grain rationing in 1994. However, if in spite of this there was substantial migration to counties suitable for growing cash crops, the interpretation of my results would be quite different. In particular, the results would be much less likely to indicate an overall increase in output, and more likely to indicate a reallocation of output across space. We saw in section 6.3.1, that there was no differential change in the size of the labour force. Furthermore, if there had been substantial migration, we might expect capital to be relatively expensive in counties

[47] These results, although not those on the share of labour in agriculture, are consistent with labour saving agricultural technology improvements if $0 < \sigma < 1$.

suited to cash crops. The results of section 6.3.3 indicated capital was relatively cheap. In this section I provide three additional pieces of evidence indicating limited migration. First, I show that individuals living in counties suited to cash crops were no more likely to have been migrants in 1990 than individuals in counties suited to grain. Second, I show that counties suited to cash crops had similar post-reform growth in population (although by 2008 their population had increased somewhat relative to counties suited to grain). Third, I control directly for population in my main regressions.

6.5.1 Migration

The 1990 Population Census includes a question on where each individual lived in the middle of 1985. I use this question to divide the 1% sample into 'migrants' and 'non-migrants'. I then assign each person the suitability for cash crops of the county they live in. To test whether there are relatively more migrants in areas suited to cash crops I regress migrant status on suitability. Table 13 contains the results. Column 1 indicates that migrant status and suitability are essentially uncorrelated. Columns 2 and 3 introduce province fixed effects, and then individual level controls for age, education status and gender—migrant status and suitability remain uncorrelated. According to the 1990 census, their is no relationship between migrant status and suitability for cash crops.

6.5.2 Population

The absence of differential migration in the cross-section does not necessarily mean there were no differential changes in migration over time. It is algebraically possible that increased in-migration was perfectly offset by a decreased out-migration. This would result in more rapid population growth. My main dataset contains a measure of population based on a mixture of surveys and *hukou* registrations. However, because there are barriers to changing *hukou* registration (although these are less severe for rural-rural migration which we are primarily concerned with here), this measure probably undercounts migrants. So, as a complement to the official measure of population, I create an alternative measure, 'imputed population', by dividing GDP by GDP per capita. As both GDP and GDP per capita explicitly include the economic activity of all migrants, imputed population should capture fully capture their numbers (Desmet and Rossi-Hansberg, 2013). I test for differential population growth using both the raw measure of population and imputed population.

Table 14 provides the results. A one standard deviation increase in my measure of suitability is associated with 5% higher population or 8% higher imputed population from 1990-2008 (columns 1 and 3). These are small increases relative to the observed increases in agricultural and non-agricultural output in my baseline results. These results are not robust to the inclusion of county specific time trends (columns 2 and 4) which suggests that the increases observed may reflect modest differential trends in population growth.

Because the result indicate a modest population response, in columns 5-8 I reestimate my main results directly controlling for my measures of population. The coefficients on suitability are, if anything, slightly larger than in my baseline specification. The increase in output in counties suited to cash crops was not due to differential population growth. As one would expect, the measures of population provided directly in the yearbooks are associated with higher agricultural and non-agricultural output. Surprisingly though, the coefficients on imputed population are close to 0 and statistically insignificant. Given that these measures are supposed to better capture migration we might have expected larger coefficients, especially as the two measures of population are highly correlated. It is possible that the procedure for inferring population in this way introduces additional error in the population figures, and that the accompanying attenuation bias more than offsets the benefit of counting migrants.

6.6 Other Explanations

The results of the large number of robustness checks previously discussed suggest that the results are unlikely to have be driven by some other correlated shock. However, it is possible that areas that specialised in cash crops, were better placed to benefit from other reforms *due to their specialisation in cash crops*. Given the institutional details discussed in section 3.4 two possibilities seem particularly worthy of further explanation.

6.6.1 Political favouritism and state-owned output

First, because the state-owned sector produced more than half of China's industrial output until 1998 (although likely a smaller share of services and construction), it's production remained important. Furthermore, although the importance of profits in the state owned sectors objective function increased through the 1980's and especially from the early 1990's onwards, the sector as a whole was still under political control. Because of this, it is possible that the growth in non-agricultural output ended up being in counties suited for cash crops for political reasons; perhaps as a reward to local leaders for good performance in the agricultural sector. In this case, my results would overstate the strength of linkages. (The opposite is of course also possible; the state owned sector could have been used to equalise incomes across space and my results would understate the true strength of the linkages.)

Given the state's power over SOEs, we would expect any political favoritism to manifest through increases in state owned output. (Whereas because only non-state firms are forced to raise capital locally, increases through the supply of capital would be expected to increase the output of the non-state sector.) Unfortunately, I do not observe a breakdown of output over time by ownership type at a disaggregated level. However, using the 1995 industrial census, I can create a measure of firm entry over time at the county level; albeit one for which survivor bias may be problematic.

The 1995 Industrial Census records the founding date of firms. I use this to count the number of (surviving) State and non-State firms started pre-reform (1966-1978) and post-reform (1979-1995) in each county.[48] I then use this data to test whether counties with a comparative advantage in cash crops experienced differential growth of entry of (surviving) firms after the reform. The estimating equation is

$$\Delta Y_{ivk} = \alpha_{jv} + \beta_1(SCC_i \times non - SOE_{ik}) + \beta_2(SCC_i \times SOE_{ik}) + \epsilon_{ijk}$$

[48] Changing the definition of 'pre' and 'post' does not significantly change the results. The first year of the 'pre' period (1966) was chosen as it was the start of the cultural revolution.

where α_{vk} is a province-by-ownership type fixed effect allowing for differential growth in the number of firm starts at the province level for both State and non-State firms; SCC_i is my measure of suitability; and, SOE_{ik} is a dummy taking a value of one for observations relating to the growth of State Owned firm starts. The first is the difference in log firm starts in the State or non-State sector before and after the reform.[49] Because there are a number of zeros in the data, the second is a dummy variable taking a value of 1 if the growth in firm starts is above the median.[50] The errors are clustered at the province level to allow for spatially correlated errors Because of the relatively small number of clusters, I also provide wild-bootstrapped p-values.

Table 15 contains the results. Areas suited to cash crops cash crops have a relative decrease in the number of State-owned firms entering after the reforms. The number of non-State firm starts increases, albeit by a statistically insignificant amount. The problematic nature of creating a panel of firm entry data using only surviving firms mean we must be careful not to over interpret the results. Nevertheless, the relative decline in entry of state-owned firms is not indicative of counties suited to cash crops benefiting from substantial political patronage.

6.6.2 Learning by doing, textiles and downstream industries

The first sectors to be opened up to non-state firms were agricultural processing sectors. These early agricultural processing firms were quickly followed by firms in downstream industries. Given the importance of the textile and garment industry in reform era China, one might worry that these firms ended up overwhelmingly locating in areas relatively suited to cash crops. Then, either learning by doing in textiles or experience in manufacturing could have resulted in this initial advantage multiplying.

If this were the case, we would expect firms in cotton and oilseed processing and downstream industries to be located in counties suited to cash crops. Although I cannot observe the output of specific industries over time, the 1995 industrial census provides a post-reform snapshot. For each county I calculate the sum of sales of firms located in industries which are downstream of cotton and oilseeds—the cash crops used to calculate my measure of suitability.[51] I divide this by the sum of all sales of firms in that county, to calculate the share of a county's manufacturing firms sales that are of cash crop derivatives. Table 16 column 1 indicates that the share of manufacturing output in cash crop processing industries is higher in counties with land more suited to cash crops. These important sectors are located close to their raw materials.[52]

Note, however, that while my measure of suitability gives the relative productivity in cash crops, which is likely to be the key determinant of the farmers planting decision,

[49] I.e. an observation would be $Y_{ivk} = \ln(STARTSPOST_{ivk})$-$\ln(STARTSPRE_{ivk})$ where i is the county, v is the province and k is the type of firm (either state or non-State).

[50] In the calculation of growth in firm starts, when there are no firm starts in either period I code growth as 1 while when there are 0 starts in the first period and a positive number in the second the growth in starts is top coded. This provides a figure for growth in starts for all counties.

[51] Cotton and oilseed processing sectors are 1321 Edible Vegetable Oil, 1322 Inedible Vegetable Oil, 1322 Inedible Vegetable Oil, 1454 Seasoning Oil, 1711 Cotton Ginning 1721 Cotton Spinning, 1722 Cotton Weaving, 1723 Cotton, Printing and Dyeing, 1724 Cotton Products, 1725 Cotton Thread, 1726 Cotton Cord Fabric, 1729 Other Cotton Goods, 1781 Cotton Knitwear.

[52] Because the data is right skewed and there are a large number of counties which produce no cash crop derivatives, I estimate this relationship using a pseudo-Poisson Maximum Likelihood estimator. The coefficients are semi-elasticities.

it is only partly related to the absolute productivity, which will be an important determinant of the local availability of large quantities of agricultural inputs. In column 2, I show that (log) absolute productivity in cash crops is also a strong predictor of the location of cotton and oilseed processing industries. In fact, when you allow for both absolute productivity and my measure of suitability only absolute productivity is predictive of the location of firms (column 3). Thus, if my results are driven by places relatively suited to cash crops enjoying access to inputs in the earliest years of the reforms and a corresponding first mover advantage, we would expect absolute productivity to also strongly predict non-agricultural output growth.

Columns 4-6 indicate that in fact it is suitability for cash crops, i.e. relative productivity, rather than absolute productivity, which is predictive of subsequent growth. Column 4 restates by baseline results. Column 5 includes only absolute productivity; absolute productivity at best weakly predicts subsequent non-agricultural output growth. Column 6, includes both suitability for cash crops and absolute productivity. Only suitability positively predicts subsequent growth in this specification. Given that firms in industries directly downstream from cash crops are clustered primarily in locations with high absolute productivity, it seems unlikely that the early opening is responsible for the rapid growth of counties suited to cash crops.

7 Conclusion

Chinese reforms beginning in 1978 have been described as being perhaps responsible for 'the greatest increase in economic well-being within a 15-year period in all of history' (Fischer, 1994, p. 131). In this paper I have shown that successful reforms to the agricultural sector had positive and long-lasting forward linkages to the non-agricultural sector in the early reform era. I exploited the predictions of a simple theoretical model, and several supplementary data sources to provide evidence that the linkages identified were primarily due to higher agricultural surpluses increasing the supply of capital to non-state firms.

In China, high savings rates were an important factor in China's reform era growth, and because of the large size of the agricultural sector in the early 1980's rural savings made possible by larger agricultural surpluses were likely an important part of this. The importance of savings—of which rural savings must be an important part in primarily agricultural economies—was central to classic models of growth such as the Lewis or Harrod-Domar models, but has since fallen out of favour. Indeed, Easterly and Levine titled their 2001 review of the empirical growth literature 'What have we learned from a decade of empirical research on growth? It's Not Factor Accumulation'. The results of this paper suggest that it sometimes *is* capital accumulation. In this respect, it complements a growth accounting literature that finds that much of the growth in many fast growing East Asian economies can in fact be explained by capital accumulation (Kim and Lau, 1994; Young, 1995; Collins and Bosworth, 1996; Young, 2003). Interestingly, many of these countries including Japan, Korea, Taiwan and Vietnam, also undertook successful agricultural reforms around the start of their periods of rapid growth. In each of these cases, agricultural surpluses may have been an important source of capital for the non-agricultural sector.

While enormous progress has been made in understanding the effectiveness of specific development interventions, less progress has been made in understanding what happens as an economy begins to industrialise. This paper took an applied micro approach to a macro-development question. By exploiting specific features of Chinese institutions, a simple model of linkages, and a range of supplementary evidence, I was able both to identify positive linkages and understand why these linkages occurred. The paper highlights the benefits of having spatially disaggregated data, which increases the number of observations without blowing up the number of confounders as country level data would, as well as a theoretically motivated set of additional empirical tests to disentangle the mechanism. The rich county level data used in this paper is also likely to be valuable for future empirical work, and highlighting the existence of this data provides an additional contribution.

References

Acemoglu, D. and Guerrieri, V. (2008). Capital deepening and nonbalanced economic growth. *Journal of Political Economy*, 116(3).

Aghion, P., Comin, D., and Howitt, P. (2006). When does domestic saving matter for economic growth?

Allen, F., Qian, J., and Qian, M. (2005). Law, finance, and economic growth in China. *Journal of financial economics*, 77(1):57–116.

Andreoni, J. (1990). Impure altruism and donations to public goods: a theory of warm-glow giving. *The economic journal*, pages 464–477.

Attanasio, O. P., Picci, L., and Scorcu, A. E. (2000). Saving, growth, and investment: a macroeconomic analysis using a panel of countries. *Review of Economics and Statistics*, 82(2):182–211.

Bai, C.-E., Hsieh, C.-T., and Qian, Y. (2006). The return to capital in China.

Banerjee, A., Duflo, E., and Qian, N. (2012). On the road: Access to transportation infrastructure and economic growth in China.

Banerjee, A. V. and Newman, A. F. (1993). Occupational choice and the process of development. *Journal of political economy*, pages 274–298.

Berkowitz, D., May, H., and Nishiokaz, S. (2014). Can state owned enterprises restructure? theory and evidence from China. *Unpublished Preliminary Manuscript*.

Boyreau-Debray, G. and Wei, S.-J. (2005). Pitfalls of a state-dominated financial system: The case of China.

Brandt, L., Giles, J., and Park, A. (1997). Giving credit where credit is due: the changing role of rural financial institutions in China.

Brandt, L. and Zhu, X. (2000). Redistribution in a decentralized economy: growth and inflation in China under reform. *Journal of Political Economy*, 108(2):422–439.

Brandt, L. and Zhu, X. (2010). Accounting for China's growth.

Burki, S. J. (1969). A study of Chinese communes 1965. *A study of Chinese communes 1965.*

Bustos, P., Caprettini, B., and Ponticelli, J. (2013). Agricultural productivity and structural transformation. evidence from Brazil. *Mimeo.*

Byrd, W. A. and Lin, Q. (1990). *China's rural industry: Structure, development, and reform*. Oxford University Press.

Cameron, A. C., Gelbach, J. B., and Miller, D. L. (2008). Bootstrap-based improvements for inference with clustered errors. *The Review of Economics and Statistics*, 90(3):414–427.

Cameron, A. C., Gelbach, J. B., and Miller, D. L. (2011). Robust inference with multiway clustering. *Journal of Business & Economic Statistics*, 29(2).

Carroll, C. D. and Weil, D. N. (1994). Saving and growth: a reinterpretation. In *Carnegie-Rochester Conference Series on Public Policy*, volume 40, pages 133–192. Elsevier.

Caselli, F. (2005). Accounting for cross-country income differences. *Handbook of economic growth*, 1:679–741.

Chan, K. W. and Zhang, L. (1999). The hukou system and rural-urban migration in China: Processes and changes. *China Quarterly*, pages 818–855.

Cheng, T. and Selden, M. (1994). The origins and social consequences of China's hukou system. *The China Quarterly*, 139:644–668.

Collins, S. M. and Bosworth, B. P. (1996). Economic growth in East Asia: accumulation versus assimilation. *Brookings papers on economic activity*, pages 135–203.

Combes, P.-P., Démurger, S., Li, S., et al. (2013). Urbanisation and migration externalities in China.

Conley, T. G. (1999). Gmm estimation with cross sectional dependence. *Journal of econometrics*, 92(1):1–45.

Costinot, A. and Donaldson, D. (2014). How large are the gains from economic integration? theory and evidence from us agriculture, 1880-2002. *Mimeo*.

De Brauw, A., Huang, J., Rozelle, S., Zhang, L., and Zhang, Y. (2002). The evolution of China's rural labor markets during the reforms. *Journal of Comparative Economics*, 30(2):329–353.

Dekle, R. (1996). Saving-investment associations and capital mobility on the evidence from japanese regional data. *Journal of International Economics*, 41(1):53–72.

Desmet, K. and Rossi-Hansberg, E. (2013). Urban accounting and welfare. *The American Economic Review*, 103(6):2296–2327.

Dollar, D. and Wei, S.-J. (2007). Das (wasted) kapital: firm ownership and investment efficiency in China.

Dore, R. (1959). Land reform in Japan.

Easterly, W. and Levine, R. (2001). What have we learned from a decade of empirical research on growth? It's not factor accumulation: Stylized facts and growth models. *World Bank Economic Review*, 15(2):177–219.

Echevarria, C. (1997). Changes in sectoral composition associated with economic growth. *International Economic Review*, pages 431–452.

Feldstein, M. and Horioka, C. (1980). Domestic saving and international capital flows. *The Economic Journal*, 90(358):314–329.

Fischer, G., Nachtergaele, F., Prieler, S., Teixeira, E., Tóth, G., van Velthuizen, H., Verelst, L., and Wiberg, D. (2012). Global agro-ecological zones (gaez v3. 0)–model documentation. *International Institute for Applied systems Analysis (IIASA), Laxenburg. Rome, Italy: Austria and the Food and Agriculture Organization of the United Nations (FAO).*

Fischer, S. (1994). Structural factors in the economic reforms of China, Eastern Europe, and the former Soviet Union. *Economic Policy*, pages 131–135.

Foster, A. D. and Rosenzweig, M. R. (2004). Agricultural productivity growth, rural economic diversity, and economic reforms: India, 1970–2000*. *Economic Development and Cultural Change*, 52(3):509–542.

Gollin, D. (2010). Agricultural productivity and economic growth. *Handbook of agricultural economics*, 4:3825–3866.

Helliwell, J. F. and McKitrick, R. (1999). Comparing capital mobility across provincial and national borders. *Canadian Journal of Economics*, pages 1164–1173.

Huang, J. and Rozelle, S. (1996). Technological change: Rediscovering the engine of productivity growth in China's rural economy. *Journal of Development Economics*, 49(2):337–369.

Huang, Q., Rozelle, S., Lohmar, B., Huang, J., and Wang, J. (2006). Irrigation, agricultural performance and poverty reduction in China. *Food Policy*, 31(1):30–52.

Huang, Y. (1998). *Agricultural Reform in China*. Cambridge University Press.

Huang, Y. (2003). *Selling China: Foreign direct investment during the reform era*. Cambridge University Press.

Huang, Y. (2008). *Capitalism with Chinese characteristics: Entrepreneurship and the state*, volume 1. Cambridge UniversityPress.

Iwamoto, Y. and Van Wincoop, E. (2000). Do borders matter? evidence from japanese regional net capital flows. *International Economic Review*, 41(1):241–290.

Jeon, Y.-D. and Kim, Y.-Y. (2000). Land reform, income redistribution, and agricultural production in korea. *Economic Development and Cultural Change*, 48(2):253–268.

Karabarbounis, L. and Neiman, B. (2014). The global decline of the labor share. *The Quarterly Journal of Economics*, 129(1):61–103.

Kim, J.-I. and Lau, L. J. (1994). The sources of economic growth of the east asian newly industrialized countries. *Journal of the Japanese and International Economies*, 8(3):235–271.

Kongsamut, P., Rebelo, S., and Xie, D. (1997). Beyond balanced growth. *NBER Working Paper 6159 (later ReStud, 2001)*.

Kuznets, S. (1957). Quantitative aspects of the economic growth of nations: Ii. industrial distribution of national product and labor force. *Economic Development and Cultural Change*, pages 1–111.

Lardy, N. R. (1983). *Agriculture in China's modern economic development*. Cambridge University Press.

Lardy, N. R. (1998). *China's unfinished economic revolution*. Brookings Institution Press.

Lewis, W. A. (1954). Economic development with unlimited supplies of labour. *The manchester school*, 22(2):139–191.

Lin, J. Y. (1992). Rural reforms and agricultural growth in China. *The American Economic Review*, pages 34–51.

Lin, J. Y. and James, G. W. (1995). China's regional grain self-sufficiency policy and its effect on land productivity. *Journal of Comparative Economics*, 21(2):187–206.

Matsuyama, K. (1992). Agricultural productivity, comparative advantage, and economic growth. *Journal of Economic Theory*, 58(2):317–334.

World Bank (2007). *World development report 2008: Agriculture for development*. World Bank.

McMillan, J., Whalley, J., and Zhu, L. (1989). The impact of China's economic reforms on agricultural productivity growth. *The Journal of Political Economy*, pages 781–807.

Murphy, K. M., Shleifer, A., and Vishny, R. W. (1989). Income distribution, market size, and industrialization. *The Quarterly Journal of Economics*, 104(3):537–64.

Naughton, B. (1988). The Third Front: defence industrialization in the Chinese interior. *The China Quarterly*, 115:351–386.

Naughton, B. (1996). *Growing out of the plan: Chinese economic reform, 1978-1993*. Cambridge university press.

Naughton, B. (2007). *The Chinese economy: Transitions and growth*. MIT press.

Ngai, L. R. and Pissarides, C. A. (2007). Structural change in a multisector model of growth. *The American Economic Review*, 97(1):429–443.

Nunn, N. and Puga, D. (2012). Ruggedness: The blessing of bad geography in africa. *Review of Economics and Statistics*, 94(1):20–36.

Nunn, N. and Qian, N. (2011). The potato's contribution to population and urbanization: Evidence from a historical experiment. *The Quarterly Journal of Economics*, 126(2):593–650.

Oi, J. C. (1991). *State and peasant in contemporary China: The political economy of village government*, volume 30. University of California Press.

Oi, J. C. (1999). *Rural China takes off: Institutional foundations of economic reform*. Universityof California Press.

Park, A. and Sehrt, K. (2001). Tests of financial intermediation and banking reform in China. *Journal of Comparative Economics*, 29(4):608–644.

Paweenawat, A. and Townsend, R. M. (2009). Villages as small open economies. *Work. Pap., Univ. Chicago*.

Perkins, D. H. (1988). Reforming China's economic system. *Journal of Economic Literature*, 26(2):601–645.

Pingali, P. L. and Xuan, V.-T. (1992). Vietnam: Decollectivization and rice productivity growth. *Economic Development and Cultural Change*, pages 697–718.

Poncet, S. (2003). Measuring Chinese domestic and international integration. *China Economic Review*, 14(1):1–21.

Rosenstein-Rodan, P. N. (1943). Problems of industrialisation of Eastern and South-eastern Europe. *The Economic Journal*, 53(210/211):202–211.

Rostow, W. W. (1960). *The stages of economic growth: A non-communist manifesto*. Cambridge University Press.

Schultz, T. W. (1953). *The economic organization of agriculture*. McGraw-Hill New York.

Sicular, T. (1988). Agricultural planning and pricing in the post-Mao period. *The China Quarterly*, 116(1):671–705.

Sinn, S. (1992). Saving-investment correlations and capital mobility: On the evidence from annual data. *The Economic Journal*, pages 1162–1170.

Song, Z., Storesletten, K., and Zilibotti, F. (2011). Growing like China. *The American Economic Review*, 101(1):196–233.

Taylor, J. R. (1988). Rural employment trends and the legacy of surplus labour, 1978-86. *The China Quarterly*, 116:736–66.

Thorbecke, E. (1979). Agricultural development. *Economic Growth and Structural Change in Taiwan: The Postwar Experience of the Republic of China*, pages 132–205.

Wang, J. (2012). The economic impact of special economic zones: Evidence from Chinese municipalities. *Journal of Development Economics*.

Wang, X. and Herd, R. (2013). The system of revenue sharing and fiscal transfers in China.

Young, A. (1995). The tyranny of numbers: confronting the statistical realities of the East Asian growth experience. *The Quarterly Journal of Economics*, 110(3):641–680.

Young, A. (2000). The razor's edge: distortions and incremental reform in the People's Republic of China. *The Quarterly Journal of Economics*, 115(4):1091–1135.

Young, A. (2003). Gold into base metals: Productivity growth in the People's Republic of China during the reform period. *Journal of Political Economy*, 111(6):1220–1261.

Appendices

A Proofs of Comparative Statics

Proof of Comparative Statics 2: Baseline. As capital is mobile there are no transition dynamics for any variables other than savings. All other variables adjust immediately to their steady state values. Constant returns to scale imply that the unit cost function of the non-agricultural sector is of the form $c^N(w_t, r_t)$. Competition implies that $c^N(w_t, r_t) = p_t^N$. As the economy is open to trade in goods and capital flows $r_t = \tilde{r}$, $p_t^N = \tilde{p}\ \forall t$ then $w_t = \bar{w}\ \forall t$. Shephard's Lemma implies that $L^N = y^N c_1^N(\bar{w}, \tilde{r})$, the output of the non-agricultural sector is linear in the supply of labour and by the same argument so is capital. A non-labour saving increase in agricultural productivity increases the marginal product of labour in the agricultural sector for a given labour allocation. As land is fixed, L_{ss}^A must increase to equalise the marginal product of labour with the wage. Thus, agricultural output increases, the share of labour in the agricultural sector increase and non-agricultural output and capital decrease. By Envelope Theorem $Y_t = p^A yA_t + p^N yN_t$ is also increasing in productivity. At the steady state $S_t = S_{t+1}$ so rearranging Equation 1 provides $S_{ss} = \frac{s(Y_{ss}-(\tilde{r}+\delta)K_{ss})}{1-s(1+\tilde{r})}$ as output increases and capital decreases, steady state savings must also increase. □

Proof of Comparative Statics 2: Labour Channel. The proof is largely as for the baseline comparative statics. However, a labour saving increase in Ψ_q decreases the marginal product of labour in agriculture for a given labour allocation. As land is fixed, L_{ss}^A must increase until $MPL_t^A = \bar{w}$. Thus L^N, y^N and K^N increase. By Envelope Theorem $Y_{ss} - (\tilde{r}+\delta)K_{ss}$ increases, so steady state savings must also increase. □

Proof of Comparative Statics 3: Capital Channel. With local capital market clearing imposed (Equation 8) the savings accumulation Equation 1 becomes capital accumulation condition

$$K_{t+1}((K_t) = s(Y_t(K_t) + (1-\delta)K_t) \tag{15}$$

The supply of labour and land are fixed so output, $Y_t(K_t)$, is an increasing function of K_t. The agricultural sector uses only land and labour, so $Y(0) > 0$. I have assumed that f^N is strictly concave and that the marginal product of capital converges to 0 as $K \to \infty$, so in the limit Y_t does not increase in K. As $s(1-\delta) < 1$ there is a steady state K_{ss} such that $K_{t+1} > K_t$ for all $K_t < K_{ss}$ and $K_{t+1} < K_t$ for all $K_t > K_{ss}$. Consequently, there is a unique stable steady state where $K_{ss} = \frac{sY_{ss}}{1-s(1-\delta))}$.

The economy is a sequence of static equilibria. Using the labour market clearing condition, output in the economy is

$$Y_t = \max_{L_t^N} \tilde{p}^A \Psi_H f^A(\Psi_L(L - L_t^N), \Psi_B B_t) + \tilde{p}^N f^N(L_t^N, K_t) \tag{16}$$

plugging the solution L_t^N back in and applying envelope theorem we obtain $\frac{\partial Y_t}{\partial \Psi_q} > 0$. Output is increasing in agricultural productivity for any K_t. Combined with Equation 15, this implies that K_{ss} is also increasing in Ψ_q.

Total differentiation of the first order conditions of the maximisation problem provide conditions for L_{ss}^N to be increasing in labour augmenting land, augmenting and Hicks-Neutral increases in agricultural technology

$$p_A \Psi_H f_1^A \left(1 + \Psi_L (1 - L_N) f_{11}^A\right) - p_N f_1^N f_{12}^N \frac{\partial K_{ss}}{\partial \Psi_L} < 0 \tag{17}$$

$$p_A \Psi_H \Psi_L f_{12}^A - p_N f_1^N f_{12}^N \frac{\partial K_{ss}}{\partial \Psi_B} < 0 \tag{18}$$

$$p_A \Psi_L f_1^A - p_N f_1^N f_{12}^N \frac{\partial K_{ss}}{\partial \Psi_B} < 0 \tag{19}$$

whether each inequality holds depends on f^A and f^N. When agricultural technology is not labour saving there are two effects: higher agricultural technology increases the returns to agriculture but higher savings draws labour into the non-agricultural sector, the effect on the labour force is the net of these two forces.

Changes in non-agricultural output can be decomposed as $\frac{d}{d\Psi_q} y_N = \frac{\partial y_N}{\partial L} \frac{\partial L}{\partial \Psi_q} + \frac{\partial y_N l}{\partial K} \frac{\partial K}{\partial \Psi_q}$. The second part is always positive, so non-agricultural output increases if the demand for labour in the agricultural sector doesn't increase too much.

Holding factors constant, the marginal product of labour in both sectors has increased. Hence the wage increases. Because the non-agricultural sector is competitive and has constant returns to scale in equilibrium $c^N(w_t, r_t) = p_t^N$. Prices are fixed and costs are increasing in both factors so the rental rate r on capital must fall.

□

Proof of Comparative Statics 4: Demand Channel. As capital is mobile there are again no dynamics for other than for the stock of savings. In any equilibrium

$$\eta^A y_t^A = \eta^N y_t^N \tag{20}$$

Holding all factor allocations constant, an increase in Ψ_q increases the output of the agricultural sector but has no effect on non-agricultural output. As y_t^A and y_t^N are both strictly and continuously increasing in L it is feasible to reduce L_t^A and increase the output of the non-agricultural sector and the overall level of output. Both y_t^A and y_t^N must increase.

The final good is the numeraire so competition in the final goods market implies that

$$p^F = \frac{p_t^A}{\eta^A} + \frac{p_t^N}{\eta^N} = 1 \tag{21}$$

holding p_t^A and p_t^N constant, an increase in Ψ_q increases the output of the agricultural sector and decreases that of the non-agricultural sector (as in the baseline comparative statics). However in equilibrium the output of both sectors increases. As both sectors output are increasing in their own price, p_t^j, the relative price of non-agricultural output must increase.

Competition in the non agricultural sector implies $c^N(w_t, \tilde{r}) = p_t^N$. As capital mobility fixes $\tilde{r}$ the wage must increase. By Shephard's Lemma, $K_t^N = y_t^N \frac{\partial c^N(w_t, \tilde{r})}{\partial \tilde{r}}$ so

$$\frac{\partial K_t^N}{\partial \Psi_q} = \frac{\partial y_t^N}{\partial \Psi_q}\frac{\partial c^N(w_t,\tilde{r})}{\partial \tilde{r}} + y_t^N \frac{\partial^2 c^N(w_t,\tilde{r})}{\partial \tilde{r}\partial w_t}\frac{\partial w_t}{\partial \Psi_q} \tag{22}$$

which is > 0 as all terms are positive; capital utilised increases. A similar expression can be obtained for labour, but the overall effect depends on whether the increase due to higher productivity is offsets the reduction due to the wage. □

B Additional Data Sources

B.1 Province level data

Province level Primary GDP data for the provincial level regressions was obtained from the University of Michigan Data Center for all years between 1949-2011 and for all provinces other than Hong Kong and Macau. Provincial level suitability for cash crops is calculated in an almost identical fashion to that which I calculate county-level suitability i.e. I take the simple average of suitability for cash crops for each cell in the province. One minor difference is that instead of normalising by the standard deviation of provincial suitability (0.3) I use the county level standard deviation (0.4). This ensures that the coefficients refer to the same absolute change in suitability and are thus directly comparable. Normalising by the provincial level suitability would reduce the absolute size of my estimated coefficients in table 5 columns 4-7.

B.2 County level census data

Geocoded county level census data for 1982, 1990 and 2000 were obtained from the University of Michigan China Data Center for all counties outside Hong Kong, Macao and Tibet. Because boundaries of some counties change over time to link the counties I took the following steps. First, I calculated the centroids for all counties in all years. Second, for each year, I count the number of centroids contained within a counties polygon for each of the other years. I then discard all counties where this number is not equal to one for both years. I then merge the three datasets together and drop all counties for which data do not exist for all three years. This eliminates counties which were split or merged as well as counties with large border changes, however some minor border may changes may remain. The remaining number of counties is 2142 (compared to 2310 in 1982, more in later censuses). The same procedure is used to link the education data in the the 1982 census to the 1999 borders I use for my main data set (33 of 561 counties dropped).

B.3 Geographic data on 'openness' (proximity to historic cities and airports)

Distance to nearest Historic City and nearest International airport was defined for each county as the distance from the county centroid to the centroid of nearest the Historic City or International Airport. The distances were calculated using the Python *geopy* package and the *distance* module. This calculates the distance between points based on the Vincenty formula which assumes the earth is an Oblate Spheroid and so allows for the curvature of the earth. To the extent to which travel time differs from geogrpahic distance this will introduce some error. Unfortunately, I am not aware of good maps of China's transport network for the cultural revolution era and calculating travel times based on present day transport networks is undesirable for obvious reasons. The set of historic cities in section 6.3.2 are the set historical cities used by Banerjee et al. (2012) and the full set of treaty ports. These are Beijing, Tianjin, Qinhuangdao, Taiyuan, Manzhouli, Shengyang, Luda, Niuzhuang, Changchun, Jilin, Hunchun, Harbin, Qiqihar, Suifenhe, Aihui, Shanghai, Nanjing, Suzhou, Dongha, Zhenjiang, Hangzhou, Ningbo, Wenzhou, Wuhu, Fuzhou, Xiamen, Sanduao, Nanchang, Chiujiang, Jinan, Qingdao, Yantai, Weihai, Hankou, Yichang, Shashi, Changsha, Yueyang, Changde, Guangzhou, Shantou, Sanshui, Nanning, Wuzhou, Beihai, Longzhou, Qiongshan, Chongqing, Chengdu, Guiyang, Kunming, Tengchong, Simao, Mengzi, Xian and Lanzhou. I believe this list of Cities was originally compiled by Banerjee et al. The location of international airports was obtained from the ACASIAN Data Centre's map of Chinese International Airports in 2007.

B.4 Firm level data

Firm level data was obtained from the Third Industrial Census (1995). This data contains detailed micro-data for more than 510,000 medium and large enterprises—all firms with independent accounting systems. These firms account for 85% of the value of industrial output and encompass the vast majority of state owned enterprises, but will provide less complete coverage of non-state firms which tend to be smaller. The data contain information on a wide number of variables including the founding date, location and the ownership type of firms as well as profits, wages paid and capital used. I use the county the firms are located in to link them with my data on county level suitability for cash crops. I exclude firms from Tibet, Macao, Hong Kong as well as firms in cities whose metropolitan areas cover more than one county level administrative unit (about 200 county level administrative units). I also exclude firms with obvious reporting errors.[53] Table 2, Panels B summarise some of this data.

C Robustness Checks

C.1 Alternative fixed effect specifications

My main results are estimated using a specification including county and province-by-time fixed effects. This specification means that I am only working off within-province variation. The results are, however, robust to the choice of fixed effects. Table A1 re-estimates the reduced form results for agricultural and non-agricultural output using increasingly demanding fixed effect specifications.

In Column 1, I estimate

$$Y_{ivt} = \alpha + \delta_t + \beta_0 SCC_i^N + \beta_1(SCC_i^N \times D1985_t) + \beta_2(SCC_i^N \times Post85_t) + \varepsilon_{ivt} \tag{23}$$

[53] I drop firms that are missing their start dates, firms whose total gross assets are less than their fixed assets, firms missing an ID and firms without strictly positive sales.

this specification does not include county fixed effects so one must include SCC_i^N directly to allow for pre-existing differences in suitability. This specification also includes only time-fixed effects. Panel A provides results for the agricultural sector, B the non-agricultural sector. For both sectors the coefficients on the interaction terms are similar to my baseline results, although a modest effect on non-agricultural output is now perhaps apparent by 1985. The pre-reform correlation between suitability and agricultural and non-agricultural output indicated by the coefficient on suitability is minimal.

In Column 2, I add county fixed effects and estimate

$$Y_{ivt} = \alpha_i + \delta_t + \beta_1(SCC_i^N \times D1985_t) + \beta_2(SCC_i^N \times Post85_t) + \varepsilon_{ivt} \tag{24}$$

the results are very similar to my baseline results (restated in Column 3) although a modest effect on non-agricultural output is now perhaps apparent by 1985.

In Column 3, I provide my baseline results (Equation 10), estimated using province-by-time fixed effects. The similarity of my baseline results to those obtained using a less demanding specification are reassuring as they indicate that any unobserved confounder ought to be correlated with suitability for cash crops in the same way across provinces as it is between provinces.

In Column 4, I include the results of a specification including very demanding prefecture-by-time fixed effects. The prefecture is the administrative unit between the county and the province, on average a prefecture contains 7-8 counties (and a province contains an average of 10 prefectures). This means that we are exploiting variation only between immediate neighbors—because suitability for cash crops is serially correlated, on 12% of the variation in suitability exists within prefectures. Because counties are not perfectly closed, the existence of spillovers between neighbouring counties may limit our ability to identify the effect of specialisation and linkages form agriculture.

For agricultural output, the confounding effect of spillovers appears minimal. The estimated coefficients in this specification are once again similar to my baseline results. This is consistent with a world where the primary determinant of how profitable planting cash crops is (relative to planting grain) is how productive your land is; a plausible scenario.

Unlike the results for agricultural output, the non-agricultural results are not robust to the inclusion of prefecture-by-time fixed effects. Given the nature of the linkages, this is not surprising. My results indicate that the increase in non-agricultural output is driven by an increase in the supply of local capital. While there are geographic frictions in local capital markets, they are not prefect at the county level. In particular, rural credit cooperatives, the most important destination for rural savings and an important source of loans for rural non-state firms may operate across county lines. Because of this, the effect on non-agricultural output is likely to extend beyond the immediate county and to it's neighbours. Spillovers to agricultural output are likely to be much more limited. The results of (unreported) Spatial-Durbin Panel estimates support this intuition; spillovers are much stronger for non-agricultural output.

C.2 Geographic factors

Although there is considerable heterogeneity in suitability for cash crops across China, it is possible that agricultural productivities are correlated with some other factors that also became increasingly advantageous in the reform era. In this section I explore two possible factors that could potentially be doing just that: absolute productivity and ruggedness of terrain.

While suitability for cash crops is a natural measure of the availability of gains from specialisation in cash crops it is, by construction, correlated with the absolute productivity of grain and cash crops. It is possible that the absolute levels of productivity are in fact what were important subsequent to reform. For instance, in appendix section I showed that high absolute productivity in cash crops strongly influenced the location of cash crop processing facilities. If the processing of cash crops was particularly valuable, for instance due to strong learning by doing, this may have translated into long term advantage. Table A2 provides results of regressions with controls for time varying effects of absolute productivities of grains and cash crops. My main results are almost unchanged and absolute advantage has no statistically significant time varying effect on either agricultural or non-agricultural output.

In the pre-reform era, the Chinese economy was heavily planned, thus placement of industry was not always driven by economic considerations. For instance, the 'Third Front' program encouraged the development of industrial capacity in mountainess interior regions of China for national security reasons (Naughton, 1988). In the reform era, the market had an increasing role. In general, more rugged terrain is unfavourable for economic activity (see e.g. Nunn and Puga 2012). It makes the transportation of goods more challenging and increases building costs. It also has a direct effect on agricultural productivity and is one of the inputs to the GAEZ data that use to construct my measure of suitability to cash crops. It is possible that ruggedness is more unfavourable for cash crops than grains, and thus that the effect of cash crops on subsequent productivity is simply coming through the increased benefit of low transport and construction costs. To check for this, I calculate the share of land that is 'Low Gradient' or 'High Gradient' in each county using the GAEZ data on gradient. A cell is defined as flat, if its median gradient lies in the bottom three categories (less than 5°), and hilly if its median gradient lies in one of the top three categories (more than 16°). Share of terrain betwen 5° and 16° is the ommitted category. Table A2 includes the results of regressions using these additional controls interacted with year. The coefficients on terrain gradient are insignificant and not of consistent sign. The coefficients on my main results are somewhat less precisely estimated, but very similar to my baseline results an remain statistically significant at the 10% level.

C.3 Initial conditions

If initial economic conditions were correlated with suitability for cash crops, I could be erroneously attributing the effect of more favourable initial economic conditions to the benefits of specialisation. In table A3 I include interactions with initial GDP per capita, the share of agriculture in GDP and initial population density. My main results are unaffected, however the coefficients on the interactions with initial agricultural share of GDP are positive and significant. As China experienced a large increase in agricultural productivity across the board, these counties may also have had a disproportionate increase in the supply of capital to the non-agricultural sector.

In table A4, I combine my data with data on education from the 1982 population census. Because of boundary changes, between 1982 and 1999, I am forced to drop 73 counties from my sample. For the remaining counties, controlling for 'initial' levels of eduction do not substantively change my main results. However, areas with higher initial levels of education did grow significantly faster following the reforms.[54]

C.4 Access to markets

In the reform era, China has traded more with itself and more with the rest of the world. If my measure of suitability is correlated with closeness to major markets I may be picking up this, rather than the beneficial effects of higher agricultural outptut.

To proxy for a counties 'openness' I calculate the log crow flies distance from each counties centroid to the nearest point in one of two proxies for major cities. The first proxy is the location of International Airports in 2007. As many airports have been built since the end of the Cultural Revolution, their location is endogenous to our outcome of interest, as would be other contemporary measures of city size or importance. To mitigate this I follow Combes et al. (2013) and use the location of historic cities and treaty ports as my second proxy. These cities were all established by 1920 and their location is thus more plausibly exogenous.[55] I also present results using the location of treaty ports and historic cities as an instrument for modern day locations of International Airports.

Table A5 contains the results of regressions with these additional controls. My main results remain unchanged. Counties further away from airports and historic cities did experience lower growth in non-agricultural output. No significant differential pattern exists for agricultural output. Although these coefficients should not be considered causal the general pattern is reassuring.

C.5 Special Economic Zones

Wang (2012) shows that the creation of Special Economic Zones (SEZs) in China was followed by faster TFP growth and investment from abroad. SEZs are place based policies which typically provide a package of investment incentives and more liberal economic policies designed to encourage export-based manufacturing. Because of the geographic nature of of SEZs it is possible that their placement was correlated with a suitability for cash crops either by chance, or because areas suited to cash crops had already had some success in manufacturing. Either way, SEZs could be the true driver of some or all of the growth in non-agricultural output. To test this I use the the data from Wang (2012) to construct two measures of a county's exposure to special economic zones. The first, is the number of SEZs in the same prefecture as the county (in the previous year). The second is a dummy variable taking a value of one when there are one or more SEZs in the same prefecture (in the previous year). Table A6

[54] If I estimate coefficients on the 1982 levels of education for each year of the data (not-reported), the post-reform growth appears to be a continuation pre-reform trend (ignoring the clear endogeneity of 1982 education to pre 1982 growth).

[55] Construction of this data is described in appendix B

includes the results of regressions including these as additional controls—the main results are unchanged and there is no clear pattern of coefficients on my SEZ variables. Unfortunately I only have data on SEZs at the prefecture level, which introduces some measurement error in exposure to SEZs at the county level.

C.6 Calculation of relative productivities and trimming

Table A7 reestimates my main results with suitability for cash crops calculated in a number of different possible ways.

Column 1 restates my main results. Column 2 substitutes 'rain-fed' GAEZ productivites for my preferred irrigated ones. The coefficients decline in magnitude but generally remain statistically significant. It is worth noting that China is one of the most heavily irrigated countries in the world, and cash crops, wheat and rice are particularly widely irrigated. To whit, (Huang et al., 2006) finds that 95% of cotton area, 69% of peanut area, 95% of rice area and 61% wheat area are irrigated. The intensive use of irrigation in China makes the GAEZ rain-fed productivities relatively uninformative about Chinese agricultural productivities. It is thus not surprising that the estimated coefficients are severely attenuated. One illustration of this induced error is the fact that the use of rain-fed agricultural inputs results in 54 counties, principally in the desert areas of Xinjiang and Gansu, being classified as agriculturally unproductive due to lack of rain-fall. However, despite their unsuitability for rain fed agriculture, these counties do have substantial levels of agricultural production.[56]

Changes in input intensity or prices used to calculate suitability do not affect the results. Column 3 uses 'high input' productivities in place of the standard intermediate level of inputs. Columns 4 and 5 use intermediate inputs combined with 1978 below quota prices and 1985 above quota prices respectively. My results are not sensitive to these choices.

Finally, to rule out the possibility that the data is driven by outliers, I trim the 1% of largest outliers from the data by running a regression including only the fixed effects. I then drop the 1% of observations with the largest absolute errors and reestimate by baseline specification (column 6). My results do not change significantly, assuaging fears that the results are due to outliers.

C.7 Omission of any particular province

Table A8 reestimates my main results omitting each province used in turn. This may be of particular interest for the Western provinces of Gansu and, especially, Xinjiang where a significant portion of agricultural production takes place on military farms. Note that because of incomplete data coverage, not every regression in this table actually drops data compared to my baseline specification. For instance, I do not observe a breakdown of GDP into Primary and non-Primary for Jiangsu so the results for these variables 'omitting Jiangsu' restate by baseline results. In general the exclusion of any one province does not substantively change the results. The exclusion of Hebei does increase the size of the standard errors, and for investment in fixed assets the results

[56]Note that the change in coefficients is not being driven by the exclusion of these counties; my baseline results are almost unchanged if they are reestimated excluding these counties but using irrigated agricultural productivities. Results not reported.

are no longer significant. Given the large number of counties and wide variation in suitability for cash crops in Hebei this is not entirely surprising.

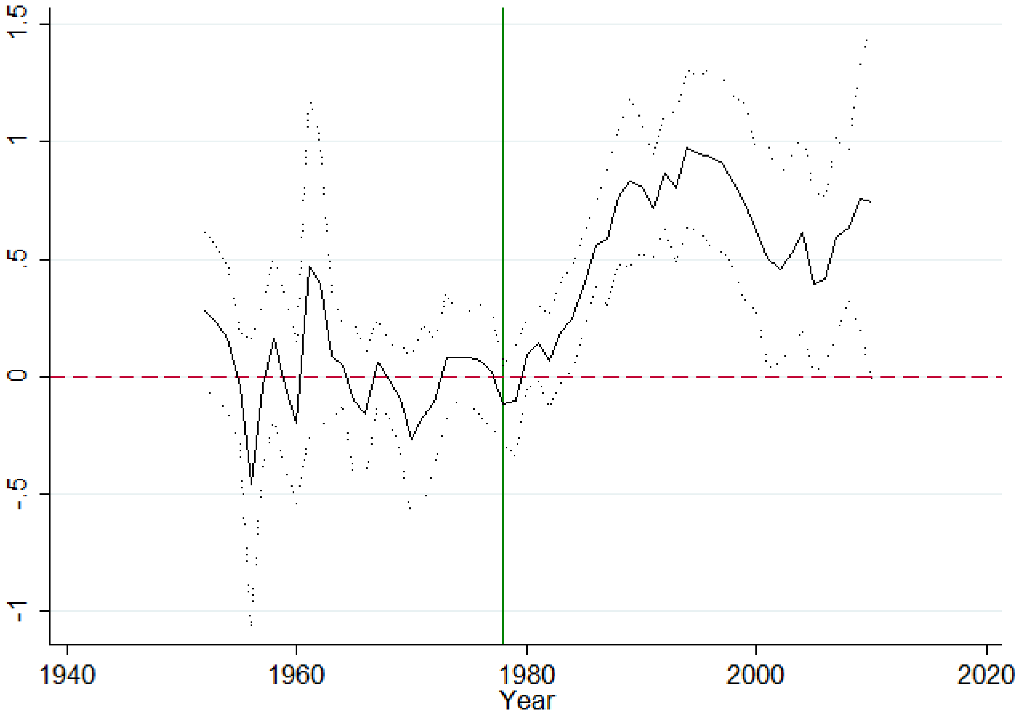


Figure 1: Coefficients on Feldstein-Horioka Regressions for 1952-2010: after the reforms there were substantial capital market frictions

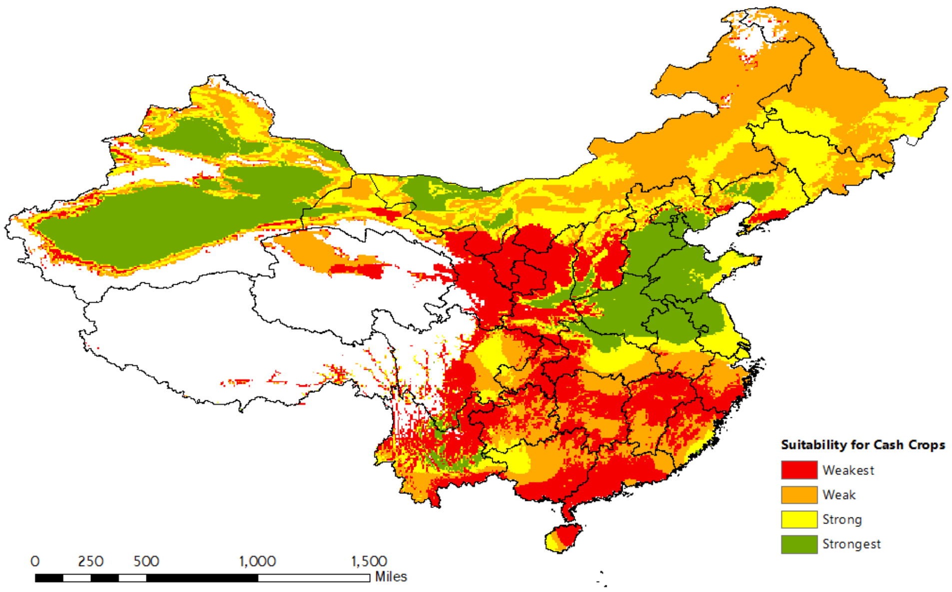


Figure 2: Suitability for Cash Crops

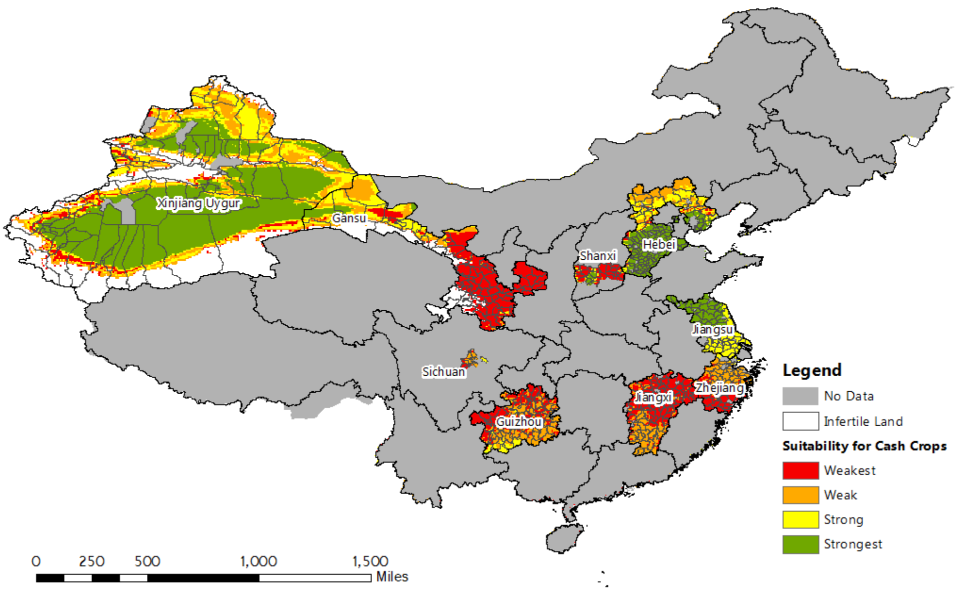


Figure 3: Data Coverage

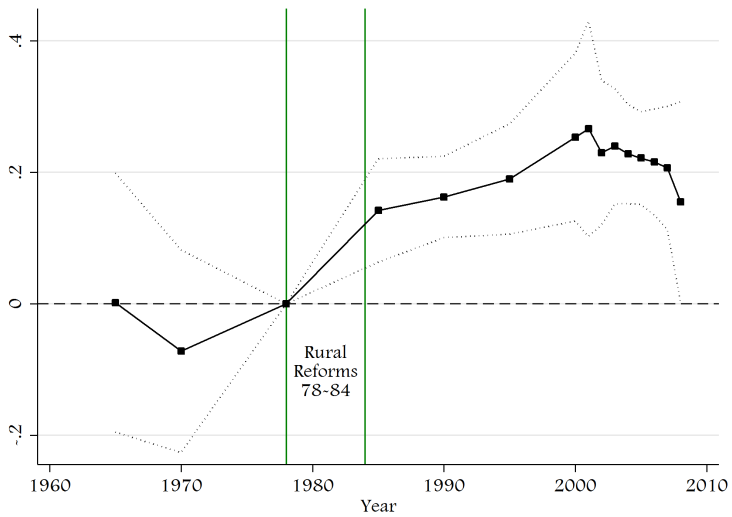


Figure 4: Coefficients of 'year' × 'Suitability for Cash Crops' (dependent variable: Ln Primary GDP)

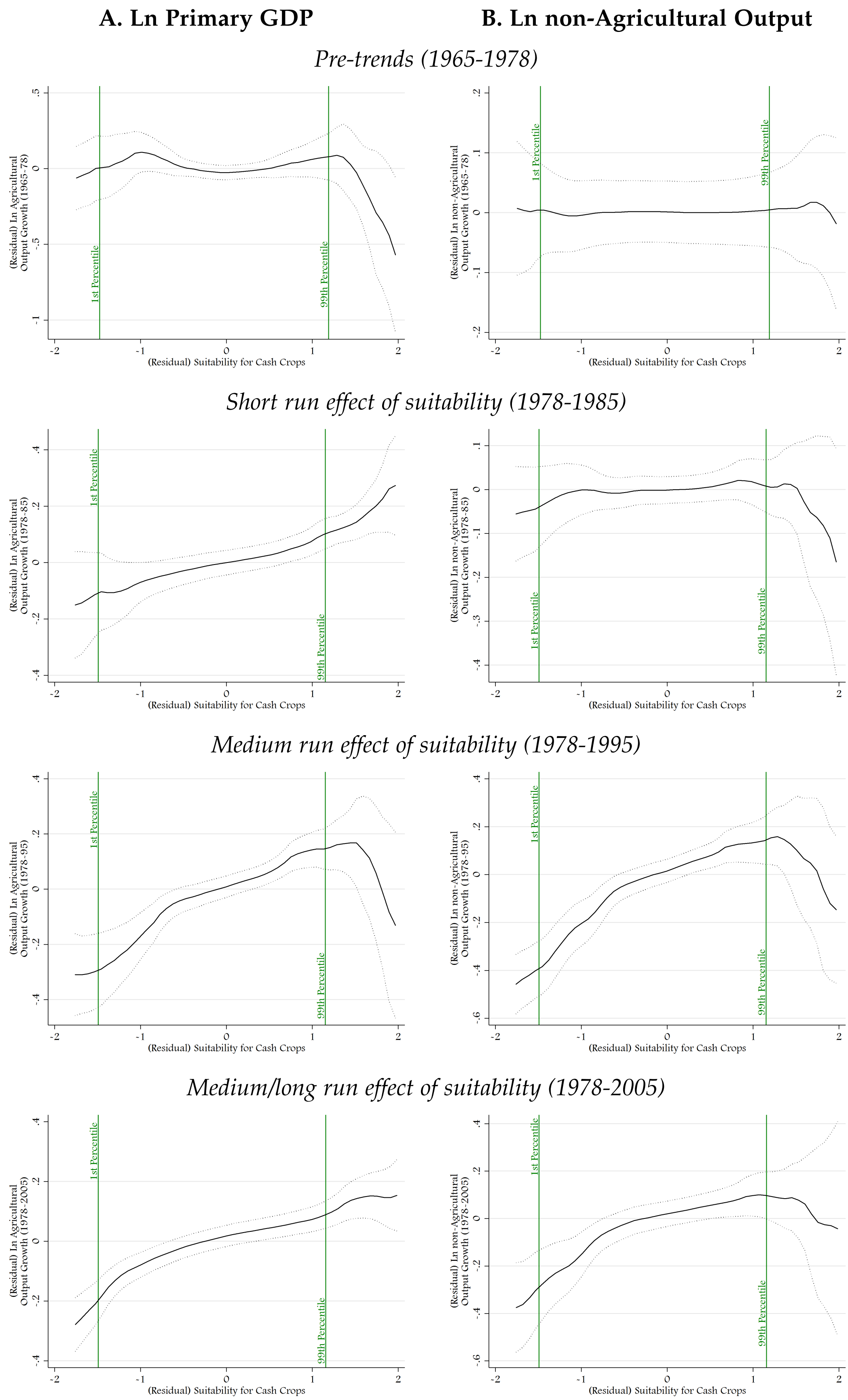
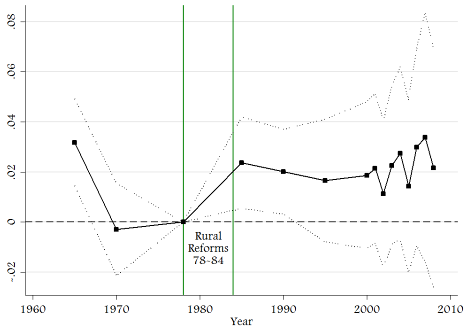
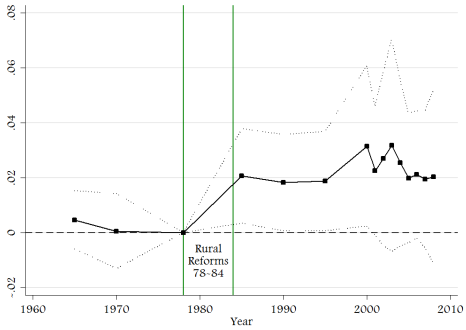


Figure 5: Smoothed Polynomial relationship between Suitability for Cash Crops and Growth of Outcome of Interest (residuals after controlling for province level changes)



A. dep. var: Cotton Share



B. dep. var: Oilseeds Share

Figure 6: Coefficients of 'year' × 'Suitability for Cotton (Oilseeds)'

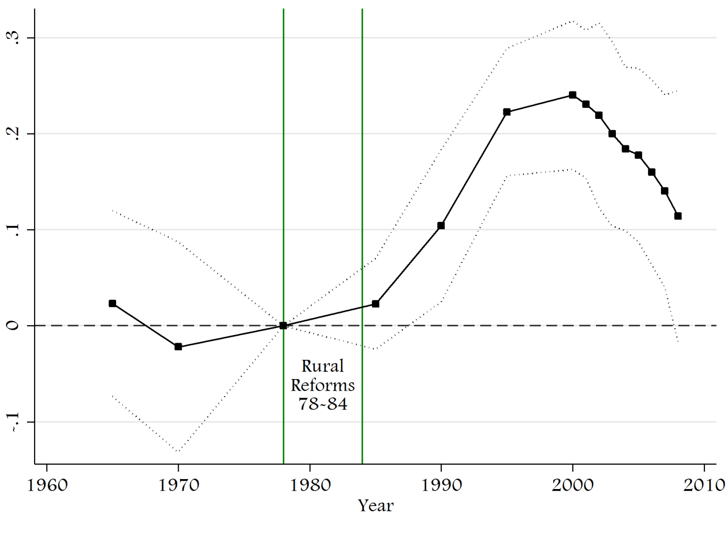


Figure 7: Coefficients of 'Year' × 'Suitability for Cash Crops' (dependent variable: Ln Non-agricultural Output)

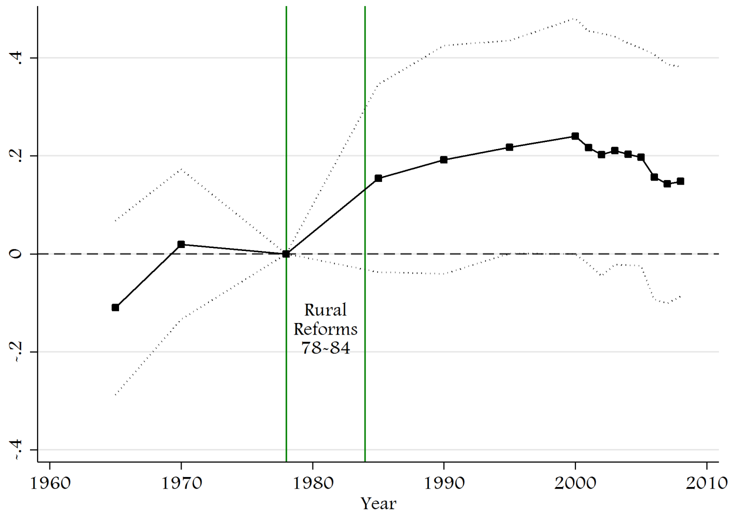


Figure 8: Coefficients of 'Year' × 'Suitability for Cash Crops' (dependent variable: Ln Savings Deposits of HH's)

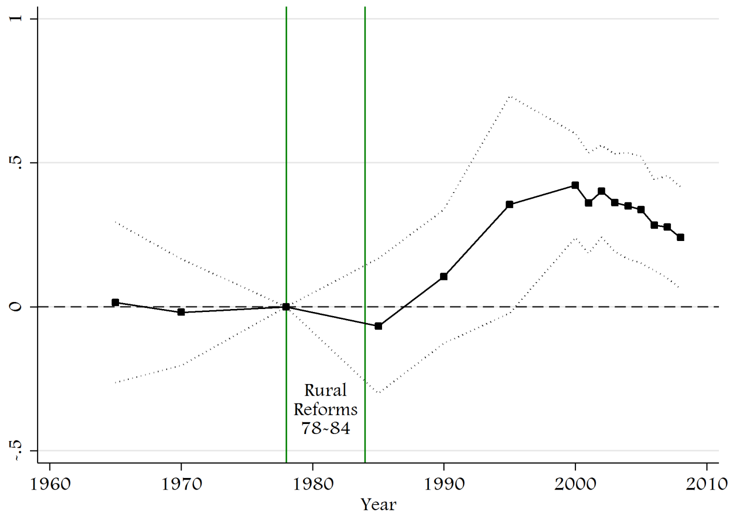


Figure 9: Coefficients of 'Year' × 'Suitability for Cash Crops' (dependent variable: Ln Investment in Fixed Assets)

Table 1: Selected Price and Yield Indices (1978=1)

	1965	1970	1978	1985	1990	1995	2000
	Grain Purchasing Prices						
Rice	0.87	0.99	1.00	1.67	2.92	6.32	
Wheat	0.87	1.00	1.00	1.71	2.39	5.28	
Maize	0.84	1.00	1.00	1.72	2.78	6.75	
Soybeans	0.62	0.73	1.00	2.55	4.17	7.91	
	Cash Crop Purchasing Prices						
Oilseeds	0.77	0.77	1.00	1.58	2.54	4.68	
Cotton	0.80	0.89	1.00	1.53	2.74	6.27	
	Aggregate Price Indices						
RPI	1.02	0.97	1.00	1.28	2.07	3.97	4.34
Agricultural Output	0.89	0.93	1.00	1.67	2.73	5.28	
Rural Industrial Products		1.02	1.00	1.11			
	Yield Indices: India						
Average Grain Crops	0.69	0.79	1.00	1.13	1.31	1.42	1.53
Average Cash Crops	0.83	0.89	1.00	1.16	1.42	1.48	1.39
	Yield Indices: USA						
Average Grain Crops	0.87	0.94	1.00	1.11	1.15	1.25	1.36
Average Cash Crops	0.83	0.88	1.00	1.16	1.12	1.12	1.17

Source for Prices: China Statistical Yearbooks, except Rural Industrial Products from Lin (1992).

Source for Yields: Three year moving average yield indices calculated from FAO-STAT data. Cash Crops a simple average of indices of cotton, groundnuts and rapeseed (not USA) indices. Grains a simple average of rice, wheat, maize and soybean yields.

Table 2: Selected Summary Statistics

A: Anniversary Yearbook Data

	1978	1985	1990	1995
Population (1,000's)	350.0	374.8	407.2	426.2
	(262.4)	(276.3)	(300.1)	(311.3)
Primary Share of Nominal GDP[4]	0.56	0.52	0.48	0.42
	(0.15)	(0.16)	(0.16)	(0.17)
Primary GDP[2]	3601	5073	6045	7799
(1978 Prices)	(2810)	(3883)	(4517)	(6297)
Secondary & Tertiary GDP[3]	3570	8504	14340	32131
(1978 Prices)	(6406)	(13607)	(21408)	(54504)
Savings Deposits	995	4646	11668	23452
(1978 Prices)	(1303)	(4934)	(12408)	(25863)
Investment in Fixed Assets	639	2512	3517	10584
(1978 Prices)	(1062)	(4678)	(6209)	(19597)
$Share_{it}$ of Cotton[1]	0.01	0.03	0.03	0.04
	(0.01)	(0.04)	(0.04)	(0.07)
$Share_{it}$ of Oilseed[1]	0.02	0.04	0.04	0.05
	(0.02)	(0.05)	(0.04)	(0.06)

B: Data from 1995 Industrial Census[5]

	State-owned	Non-state
Number of Firms	69,782	336,331
Gross Industrial Output (1,000Y)	30252	7331
	(297049)	(65158)
Net Value of Fixed Assets	25184	2744
	(260782)	(61616)
Labour Compensation[6]	3988	561
	(33185)	(3552)

Not all variables are observed for all counties and years. In particular, coverage for cotton and oilseed shares is substantially less complete than for other variables. Standard deviations in parentheses. Primary, Secondary and Tertiary GDP deflated by their respective national deflators. Savings and Investment deflated by the RPI.

(1) $Share_{ivt,c} = \frac{T_{it,c}}{T_{it,c}+T_{it,G}}$ where T is tonnage production of cash crop, c, or grain, G. (2) This is my main measure of agricultural output. (3) This is my measure of non-agricultural output. (4) This is the simple average of primary shares. The next two rows indicate the weighted average is somewhat lower. Not surprisingly, counties with larger economies tend to be less rural. (5) These data are calculated form the 1995 Census of Industries which covers all firms with independent accounting systems. I exclude firms from Tibet, Macao and Hong Kong. I also exclude firms from cities whose metropolitan areas cover more than one district (about 200 counties in total). (6) Wages + Welfare Expenses + Labour and Unemployment Insurance

Table 3: Agricultural Output

	Ln Primary GDP						*Ln Gross Ag. Y*		*Ln Rur. Ypc*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Suitability for Cash Crops × Post 78	0.230***								
	(0.066)								
Suitability for Cash Crops × 1985		0.162***	0.181***	0.142**	0.172***	0.131**	0.128*	0.169***	0.165***
		(0.057)	(0.068)	(0.063)	(0.052)	(0.059)	(0.074)	(0.052)	(0.050)
Suitability for Cash Crops × Post 85		0.236***	0.249***	0.203**	0.245***	0.261***	0.215*	0.236***	0.215***
		(0.068)	(0.077)	(0.085)	(0.059)	(0.071)	(0.128)	(0.090)	(0.057)
Observations	8000	8000	6105	8000	7583	4199	4199	4778	7335
Counties	561	561	407	561	561	382	382	446	534
County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province x Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County Trends				Yes					
Data Restrictions			Balanced		No 1965	As (8)	As (7)		

Robust standard errors two-way clustered at the prefecture and province-by-time levels to allow for autocorrelation over time and space (*** p<0.01, ** p<0.05, * p<0.1). Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Interaction terms are dummies for 1985, years after 1985, or years after 1978. Data covers non-municipal counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan for 1965, 1970, 1978, 1985, 1990, 1995, 2000 & 2000-2008.

Table 4: Estimated aggregate increases in agricultural output (1978-1985) from specialisation in cash crops

No gains below percentile...	10	25	40
A. Gains calculated from fitted values (log specification)			
% Increase	15.3	11.0	9.0
B. Gains calculated from fitted values (levels specification)			
% Increase	14.0	10.1	8.3
Share of Total Increase	0.22	0.16	0.14
C. Gains imputed from 1982 agricultural employment and suitability for cash crops (log specification)			
All China (%)	18.3	14.2	11.8
Sample Provinces (%)	15.6	11.5	9.6
Sample Provinces, no Cities (*Shi*) (%)	15.8	11.7	9.8

The 'no gains below percentile' is the percentile of county level suitability for cash crops below which it is assumed that counties did not benefit at all from agricultural specialisation. I assume that above this percentile the gains from specialisation increase linearly in suitability for cash crops (log linearly Panels A & C). In panel C I take the weighted average expected increase in agricultural output due to specialisation in cash crops.

Table 5: Agricultural Output: Level of Aggregation

	Ln Primary GDP (County)			*Ln Primary GDP (Province)*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Suitability for Cash Crops $\times$ Post 1978	0.230*** (0.066)	0.225*** (0.032)	0.150*** (0.042)	-0.000 (0.064)	0.047 (0.052)	0.022 (0.053)	0.031 (0.035)
Observations	8000	8000	8000	463	463	1862	1862
Counties	561	561	561				
Provinces				31	31	31	31
County FE	Yes	Yes	Yes				
Province FE				Yes	Yes	Yes	Yes
Time FE		Yes	Yes	Yes	Yes	Yes	Yes
Province x Time FE	Yes						
Province Trends			Yes		Yes		Yes
Years				Restricted	Restricted	1949-2011	1949-2011

Columns 1-3 robust standard errors two-way clustered at the prefecture and province-by-time levels; columns 4-7 robust standard errors clustered at the provincial level (*** p<0.01, ** p<0.05, * p<0.1). Columns 1-3 estimated using county level data. Columns 4-7 estimated using more aggregated province level data. Suitability for cash crops is the (standardised, county or province average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Interaction term is a dummy years after 1978. Columns 1-5 use data for 1965, 1970, 1978, 1985, 1990, 1995 & 2000-2008 (the years which county level data is widely available). County level data is from non-metropolitan counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan. Province level data is for the whole of China excluding Macao and Hong Kong.

Table 6: The Pattern of Production

	Share of Cotton			*Share of Oilseeds*		
	(1)	(2)	(3)	(4)	(5)	(6)
Suitability for Cotton × 1985	0.013*	0.015*	0.026***		-0.005*	
	(0.007)	(0.008)	(0.009)		(0.003)	
Suitability for Cotton × Post85	0.011	0.014	0.024*		-0.001	
	(0.014)	(0.014)	(0.013)		(0.004)	
Suitability for Oilseeds × 1985		-0.004		0.019**	0.017**	0.020**
		(0.010)		(0.008)	(0.008)	(0.008)
Suitability for Oilseeds × Post		-0.032		0.021*	0.021*	0.023*
		(0.020)		(0.011)	(0.012)	(0.012)
Observations	3505	3505	3277	5266	5266	4919
Counties	281	281	280	366	366	366
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Province x Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Data			No 65			No 65

Robust standard errors clustered at county level (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). Suitability for cotton (oilseed) is the (standardised, county average) ratio of the value of output of cotton (oilseed) to the value of output of the best grain crop. Interaction terms are dummies for 1985, years after 1985. Share of cotton or oilseed is $Share_{ivt,c} = T_{it,c}(T_{it,c} + T_{it,G})^{-1}$ where T is tonnage production of cash crop, c, or grain, G. Data from cotton or oilseed producing counties in Hebei, Jiangxi, Xinjiang, and oilseed producing counties in Zhejiang and part of Sichuan, for 1965, 1970, 1978, 1985, 1990, 1995, 2000 & 2000-2008.

Table 7: Non-Agricultural Output: Reduced Form Results

	Ln Non-Agricultural GDP			*Sec. GDP*	*Ter. GDP*
	(1)	(2)	(3)	(4)	(5)
Suitability for Cash Crops × 1985	0.022 (0.031)	-0.016 (0.023)	0.022 (0.046)	0.023 (0.064)	0.009 (0.035)
Suitability for Cash Crops × Post 85	0.181** (0.072)	0.167** (0.081)	0.195** (0.083)	0.197* (0.106)	0.168*** (0.057)
Observations	7993	6060	7993	7999	7993
Counties	561	404	561	561	561
First Stage as					
First Stage F					
County FE	Yes	Yes	Yes	Yes	Yes
Province x Time FE	Yes	Yes	Yes	Yes	Yes
County Trends			Yes		
Data		Balanced			

Robust standard errors two-way clustered at the prefecture and province-by-time levels to allow for autocorrelation over time and space (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Interaction terms are dummies for 1985 or years after 1985. Data covers non-municipal counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan for 1965, 1970, 1978, 1985, 1990, 1995, 2000 & 2000-2008.

Table 8: Non-Agricultural Output: Long Differenced IV Results

	$\Delta_{1978-1995}$			$\Delta_{1978-2005}$		
	(1) OLS	(2) 1st St.	(3) IV	(4) OLS	(5) 1st St.	(6) IV
Δ Ln Primary GDP	0.344***		1.168***	0.264***		0.804***
	(0.066)		(0.261)	(0.074)		(0.303)
Suitability for Cash Crops		0.222***			0.180***	
		(0.045)			(0.068)	
Counties	538	538	538	528	528	528
First-Stage *F* (AP)			22.75			36.37
Province FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors clustered at the prefecture level (*** p<0.01, ** p<0.05, * p<0.1). Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Data covers non-municipal counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan.

Table 9: Savings and Investment

	(1)	(2)	(3)	(4)
A. Ln Savings Deposits by Households:				
Suitability for Cash	0.185*	0.188*	0.180*	0.161
Crops × 1985	(0.100)	(0.106)	(0.102)	(0.123)
Suitability for Cash	0.224*	0.263*	0.270**	0.225*
Crops × Post 85	(0.121)	(0.134)	(0.128)	(0.133)
Observations	5859	5012	4148	5859
Counties	420	359	405	420
B. Ln Investment in Fixed Assets:				
Suitability for Cash	-0.065	0.061	-0.076	-0.047
Crops × 1985	(0.136)	(0.112)	(0.162)	(0.146)
Suitability for Cash	0.318***	0.415***	0.378***	0.302*
Crops × Post 85	(0.104)	(0.077)	(0.122)	(0.170)
Observations	6639	6286	4148	6639
Counties	572	511	405	572
County FE	Yes	Yes	Yes	Yes
Province x Time FE	Yes	Yes	Yes	Yes
County Trends				Yes
Data		No Jiangsu	(A)=(B)	

Robust standard errors two-way clustered at the prefecture and province-by-time levels to allow for autocorrelation over time and space (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Interaction terms are dummies for 1985 or years after 1985. All columns other use data from 1965, 70, 78, 85, 90, 95, & 2000-08 and, unless otherwise specified, from counties in Hebei, Jiangsu, Jianxi, Xinjiang & Zhejiang (Panel A) and also from Gansu and Guizhou (Panel B).

Table 10: Agricultural Labour Utilisation

	Agricultural Labour Share (0-100%)				*Ln Labour Force*		*Literacy Rate (%)*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Suitability for Cash Crops × Post	1.286**	1.261**	1.625**	1.507**	0.008	0.000	1.109**	1.103**
	(0.603)	(0.574)	(0.600)	(0.552)	(0.008)	(0.007)	(0.484)	(0.459)
Suitability for Cash Crops × 2000	-0.219	-0.265	0.129	-0.130	-0.015	0.049	0.323	0.839
	(0.557)	(0.615)	(0.603)	(0.440)	(0.030)	(0.029)	(0.917)	(0.726)
Observations	6425	6424	6424	6359	6424	6423	6426	6424
Counties	2142	2142	2142	2138	2142	2141	2142	2142
County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County Controls		Yes	Yes	Yes		Yes		Yes
Initial Labour Share			Yes	Yes				
Drop 'Outliers'				Yes				

Robust standard errors clustered at the province (29) level (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Interaction terms are dummies for post 1982 or the year 2000. County controls add additional controls including interactions of initial Ln Population Density, Ln Income Per Capita and Ln Literacy Rate (except columns 7-8). There is a change in the definition of literacy rate between 1982 and 1990. In 1982 it is the share of the population aged over 12 who are literate. In 1990 and 2000 it is the share of the population over 15 who are literate. The comprise the set of Chinese counties in the county level population census data, excluding Macao, Hong Kong and Tibet, whose borders do not change substantially between 1982 and 2000.

Table 11: Openness Interactions

	Ln Non-Primary GDP		
	(1) OLS	(2) OLS	(3) IV
Suitability for Cash Crops (SCC) × 1985	0.032	0.083**	0.050
	(0.041)	(0.037)	(0.049)
Suitability for Cash Crops (SCC) × Post 85	0.189***	0.253***	0.211***
	(0.065)	(0.069)	(0.065)
Ln Distance to Nearest Airport × 1985	-0.143**		-0.192**
	(0.059)		(0.095)
Ln Distance to Nearest Airport × Post	-0.212***		-0.221*
	(0.065)		(0.129)
Ln Distance to Nearest Airport × SCC × 1985	-0.043		-0.140*
	(0.047)		(0.080)
Ln Distance to Nearest Airport × SCC × Post 85	-0.079		-0.178*
	(0.053)		(0.092)
Ln Distance to Nearest Historical City × 1985		-0.113**	
		(0.049)	
Ln Distance to Nearest Historical City × Post 85		-0.130*	
		(0.071)	
Ln Distance to Nearest Historical City × SCC × 1985		-0.071**	
		(0.032)	
Ln Distance to Nearest Historical City × SCC × Post 85		-0.088*	
		(0.052)	
Observations	7993	7993	7993
Counties	561	561	561
County FE	Yes	Yes	Yes
Province x Time FE	Yes	Yes	Yes

Robust standard errors two-way clustered at the prefecture and province-by-time levels to allow for autocorrelation over time and space (*** p<0.01, ** p<0.05, * p<0.1). Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Time interaction terms are dummies for 1985 or years after 1985. Distance interactions are (demeaned) ln crow flies distance to nearest airport or nearest historic city. In column 3, distance to nearest international airport and the various interactions are instrumented for by distance to nearest historical city. Data covers non-municipal counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan for 1965, 1970, 1978, 1985, 1990, 1995, 2000 & 2000-2008.

Table 12: Firms Factor Utilisation

	$\ln(\frac{wl}{k})$			
	(1)	(2)	(3)	(4)
Suitability for Cash Crops × non-SOE	-0.076***	-0.077***	-0.063***	-0.056***
	(0.019)	(0.018)	(0.021)	(0.020)
Suitability for Cash Crops × SOE	-0.026	-0.033	-0.022	-0.017
	(0.030)	(0.033)	(0.031)	(0.028)
State Ownership	-0.421***			
	(0.055)			
Firms	384167	384167	384167	376905
Prov × Industry FE	Yes			
Prov × Industry × SOE FE		Yes		
P × I × SOE × Large × Age FE			Yes	Yes
Trimmed (1-99)				Yes

Robust standard errors clustered at the province (30) level (*** p<0.01, ** p<0.05, * p<0.1). Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop for the county where the firm is located. The data covers all manufacturing firms with independent accounting systems in 1995. I exclude firms from Tibet, Macao, Hong Kong, cities whose metropolitan areas cover more than one district (about 200 counties in total) as well as firms with clear data irregularities. Industry is the 4 digit Chinese SITC classification. I restrict the set of firms to those with strictly positive gross output, wages and capital. For the purpose of the fixed effects, 'Large' firms are firms with sales revenues in excess of 5 million Yuan. 'Age' groups firms by age into 6 categories: 0-1, 2-5, 6-10, 11-16, 17-25 and 26+. Trimmed (1-99) indicates that the first and last percentile of the outcome data has been omitted.

Table 13: Migration

	Migrant Dummy		
	(1)	(2)	(3)
Suitability for Cash Crops	-0.006 (0.006)	0.004 (0.006)	0.002 (0.005)
Individuals	10.5m	10.5m	10.5m
Province FE		Yes	Yes
Individual Controls			Yes
Migrant Share of Population	0.034	0.034	0.034

Robust standard errors clustered at the province level (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). Data from 1990 census micro-data. Migrant Dummy takes a value of 1 if individuals place of residence in mid-1985 was not their current place of residence in the 1990 census. Individuals who don't report a place of residence in 1985 are excluded (primarily children under 5). Individual controls are 'Year of Birth', a set of dummies for 7 education levels (Illiterate or semi-literate, Primary school, Junior middle school, Senior middle school, Technical school, Junior-college, and University) and a dummy for gender.

Table 14: Population

	Ln Population		*Ln Pop (Imputed)*		*Ln Primary GDP*		*Ln Non-Ag GDP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Suitability for Cash Crops × 1985	-0.003	-0.022	-0.005	-0.040	0.180***	0.171***	0.032	0.047
	(0.019)	(0.019)	(0.026)	(0.030)	(0.058)	(0.051)	(0.034)	(0.034)
Suitability for Cash Crops × Post 85	0.047**	-0.005	0.081**	0.001	0.239***	0.278***	0.168**	0.215***
	(0.023)	(0.021)	(0.041)	(0.032)	(0.070)	(0.057)	(0.071)	(0.070)
Ln Population					0.395***		0.575***	
					(0.148)		(0.186)	
Ln Population (Imputed)						0.057		0.126
						(0.127)		(0.178)
Observations	8984	8984	6859	6859	7813	6491	7806	6491
Counties	621	621	588	588	559	527	559	527
County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province x Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County Trends		Yes		Yes				

Robust standard errors two-way clustered at the prefecture and province-by-time levels to allow for autocorrelation over time and space (*** p<0.01, ** p<0.05, * p<0.1). Imputed population is the population of a county when it is inferred from GDP and GDP per capita i.e. $ImputedPopulation_i = GDP_i/GDPpc_i$. Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Interaction terms are dummies for 1985 or years after 1985. Data covers non-municipal counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and Changzhi prefecture (Shanxi) 1965, 1970, 1978, 1985, 1990, 1995, 2000 & 2000-2008. Columns 1-4 also use data from counties in Jiangsu. Columns 1, 2, 5 & 6 also use data from Chengdu (Sichuan) and Linfen (Shanxi) prefectures.

Appendix Tables

Table 15: Entry of Firms

	$\Delta \ln(NewFirms)$	*New Firms* $>$ *Median*
	(1)	(2)
Suitability for Cash Crops	0.022	0.004
$\times$ non-SOE $\times$ Post	(0.064)	(0.031)
	[0.736]	[0.876]
Suitability for Cash Crops	-0.077	-0.069**
$\times$ SOE $\times$ Post	(0.047)	(0.027)
	[0.106]	[0.050]
N	4002	4206
Province $\times$ SOE FE	Yes	Yes

$\Delta Ln(NewFirms)$ is the log difference in the number of surviving firms started post-reform compared to the number started pre-reform. The 'More Firms Starts Dummy' is a dummy variable taking a value of 1 if the percentage increase in firm starts was above the median for firms of that ownership type. Counties with 0 firms starts both pre and post-reform are assigned a growth of 1. Counties with no firm starts pre-reform and a positive number post reform are assigned the maximum growth in firms starts. Pre-reform is the cultural revolution era 1966-1978, post-reform is from 1979-1995. The data cover the whole of China China except for Tibet, Hong Kong, Macau and municipal areas that span more than one county level administrative unit (around 200 counties). Robust standard errors clustered at the province (30) level in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Wild-bootstrapped p values in square brackets

Table 16: Is the processing of cash crops concentrated in places relatively suited to them?

	Share of Cash Crop Processing in manufacturing output			*Ln Non-Agricultural GDP*		
	Pseudo Poisson-MLE			OLS (FE)		
	(1)	(2)	(3)	(4) Baseline	(5)	(6)
Suitability for Cash Crops (Relative)	0.566***		0.279			
	(0.184)		(0.228)			
Ln Absolute Yield in Cash Crops		1.368***	0.824**			
		(0.356)	(0.388)			
Suitability for Cash Crops (Relative) × 1985				0.022		0.074
				(0.031)		(0.052)
Suitability for Cash Crops (Relative) × Post 85				0.181**		0.218**
				(0.072)		(0.097)
Ln Absolute Yield in Cash Crops × 1985					-0.037	-0.080
					(0.041)	(0.053)
Ln Absolute Yield in Cash Crops × Post 85					0.089	-0.057
					(0.070)	(0.082)
Counties	2104	2101	2101	7993	7993	7993
Province FE	Yes	Yes	Yes			
County FE				Yes	Yes	Yes
Province x Year FE FE				Yes	Yes	Yes

Columns 1-3 estimated using pseudo-Poisson regressions due to the skewness of the outcome and large numbers of zeros in the data. Robust standard errors clustered at the province (30) level in columns 1-3 and two-way clustered at the prefecture and province-by-time levels to allow for autocorrelation over time and space columns 4-6 (*** p<0.01, ** p<0.05, * p<0.1). 'Suitability for Cash Crops' is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop for the county where the firm is located. 'Suitability for Cash Crops (relative)' is my baseline measure of suitability. It is the (standardised, county average) value of the yield of the best cash crop per hectare. The outcome variable in columns 1-3 uses the 1995 Industrial Census, to calculate county-specific sums of sales of firms in sectors whose major inputs are cash crops e.g. 1711 'cotton ginning' or 1454 'seasoning oil', and divides it by the sales of all firms. Thus, the outcome will be higher in counties which are relatively specialised in processing cash crops. The list of sectors deemed to be cash crop processing is provided in footnote 51 (appendix section C.2). Columns 4-6 use my main data set covering non-municipal counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan for 1965, 1970, 1978, 1985, 1990, 1995, 2000 & 2000-2008.

Table A1: Robustness of results to alternative FE specifications

	(1)	(2)	Baseline (3)	(4)
A. Ln Primary GDP				
Suitability for Cash Crops	0.137	0.151***	0.162***	0.087
× 1985	(0.110)	(0.037)	(0.056)	(0.101)
Suitability for Cash Crops	0.217***	0.232***	0.236***	0.229*
Crops × Post 1985	(0.066)	(0.033)	(0.068)	(0.117)
Suitability for Cash Crops	-0.002			
	(0.080)			
Observations	8000	8000	8000	8000
Counties	561	561	561	561
B. Ln Non-Agricultural GDP				
Suitability for Cash Crops	0.081	0.099*	0.022	-0.014
× 1985	(0.110)	(0.055)	(0.031)	(0.074)
Suitability for Cash Crops	0.225***	0.245***	0.181**	0.032
× Post 1985	(0.082)	(0.066)	(0.072)	(0.089)
Suitability for Cash Crops	0.044			
	(0.081)			
Observations	7993	7993	7993	7993
Counties	561	561	561	561
County FE		Yes	Yes	Yes
Year FE	Yes	Yes		
Province x Year FE			Yes	
Prefecture x Year FE				Yes

Robust standard errors two-way clustered at the prefecture and province-by-time levels to allow for autocorrelation over time and space (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Interaction terms are dummies for 1985, years after 1985, or years after 1978. Data covers non-municipal counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan for 1965, 1970, 1978, 1985, 1990, 1995, 2000 & 2000-2008.

Table A2: Geographic Conditions

	Ln Primary GDP			*Ln Non-Ag GDP*		
	(1)	(2)	(3)	(4)	(5)	(6)
Suitability for Cash Crops (Relative) × 1985	0.164**	0.168***	0.170**	-0.038	0.052	0.074
	(0.071)	(0.059)	(0.067)	(0.046)	(0.041)	(0.052)
Suitability for Cash Crops (Relative) × Post 85	0.167*	0.216***	0.198**	0.154*	0.205**	0.218**
	(0.087)	(0.080)	(0.093)	(0.086)	(0.082)	(0.097)
Share of Low Gradient Land × 1985	0.093			0.121		
	(0.143)			(0.111)		
Share of Low Gradient Land × post	0.171			-0.043		
	(0.163)			(0.210)		
Share of High Gradient Land × 1985	0.079			-0.063		
	(0.135)			(0.064)		
Share of High Gradient Land × post	-0.048			-0.130		
	(0.110)			(0.145)		
Ln Absolute Yield in Grain × 1985		-0.023			-0.092	
		(0.071)			(0.057)	
Ln Absolute Yield in Grain × Post 85		0.061			-0.075	
		(0.064)			(0.090)	
Ln Absolute Yield in Cash Crops × 1985			-0.016			-0.080
			(0.069)			(0.053)
Ln Absolute Yield in Cash Crops × Post 85			0.058			-0.057
			(0.056)			(0.082)
Observations	8000	8000	8000	7993	7993	7993
Counties	561	561	561	561	561	561
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Province x Time FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors two-way clustered at the prefecture and province-by-time levels to allow for autocorrelation over time and space (*** p<0.01, ** p<0.05, * p<0.1). Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Interaction terms are dummies for 1985 or years after 1985. Data covers non-municipal counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan for 1965, 1970, 1978, 1985, 1990, 1995, 2000 & 2000-2008.

Table A3: Initial Economic Conditions

	Ln Primary GDP			*Ln Non-Ag GDP*		
	(1)	(2)	(3)	(4)	(5)	(6)
Suitability for Cash Crops × 1985	0.170***	0.166***	0.173***	0.016	0.020	0.015
	(0.063)	(0.058)	(0.064)	(0.039)	(0.034)	(0.035)
Suitability for Cash Crops × Post 85	0.246***	0.231***	0.236***	0.196**	0.203***	0.180***
	(0.068)	(0.069)	(0.068)	(0.079)	(0.073)	(0.069)
Ln 1978 GDP per capita × 1985	-0.126**			-0.020		
	(0.057)			(0.103)		
Ln 1978 GDP per capita × Post 85	-0.133*			-0.196		
	(0.068)			(0.119)		
Ln 1978 Primary Share × 1985		0.065			0.079	
		(0.058)			(0.096)	
Ln 1978 Primary Share × Post 85		-0.083			0.327***	
		(0.058)			(0.104)	
Ln Population Density × 1985			-0.036			-0.002
			(0.023)			(0.023)
Ln Population Density × Post 85			-0.000			0.003
			(0.025)			(0.040)
Observations	7708	7749	7863	7701	7742	7856
Counties	535	538	549	535	538	549
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Province x Time FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors two-way clustered at the prefecture and province-by-time levels to allow for autocorrelation over time and space (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Interaction terms are dummies for 1985 or years after 1985. Data covers non-municipal counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan for 1965, 1970, 1978, 1985, 1990, 1995, 2000 & 2000-2008.

Table A4: Initial Education

	Ln Primary GDP		*Ln Non-Ag GDP*	
	(1)	(2)	(3)	(4)
Suitability for Cash Crops × 1985	0.152***	0.150***	0.013	0.015
	(0.058)	(0.056)	(0.030)	(0.031)
Suitability for Cash Crops × Post 85	0.221***	0.225***	0.175***	0.178**
	(0.069)	(0.069)	(0.067)	(0.072)
Ln(% Completed Middle School in 1982) × 1985	-0.014		0.380***	
	(0.100)		(0.116)	
Ln(% Completed Middle School in 1982) × Post 85	0.262**		0.508***	
	(0.127)		(0.143)	
Ln(Literacy Rate in 1982) × 1985		-0.053		0.385***
		(0.113)		(0.132)
Ln(Literacy Rate in 1982) × Post 85		0.185		0.590***
		(0.153)		(0.184)
Observations	7580	7580	7573	7573
Counties	528	528	528	528
County FE	Yes	Yes	Yes	Yes
Province x Time FE	Yes	Yes	Yes	Yes

Robust standard errors two-way clustered at the prefecture and province-by-time levels to allow for autocorrelation over time and space (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Interaction terms are dummies for 1985 or years after 1985. Educational outcomes from 1982 Population Census. Counties with significant border changes between 1982-1999. Data covers non-municipal counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan for 1965, 1970, 1978, 1985, 1990, 1995, 2000 & 2000-2008.

Table A5: 'Openness' and Suitability for Cash Crops

	Ln Primary GDP			*Ln Non-Agricultural GDP*		
	(1) OLS	(2) OLS	(3) IV	(4) OLS	(5) OLS	(6) IV
Suitability for Cash Crops × 1985	0.167***	0.151***	0.176***	0.019	0.035	0.016
	(0.055)	(0.053)	(0.039)	(0.038)	(0.032)	(0.036)
Suitability for Cash Crops × Post 85	0.232***	0.236***	0.235***	0.171***	0.195***	0.173***
	(0.069)	(0.067)	(0.059)	(0.066)	(0.070)	(0.064)
Ln Distance to Nearest Airport × 1985	0.017		0.179*	-0.153**		-0.167*
	(0.074)		(0.095)	(0.068)		(0.092)
Ln Distance to Nearest Airport × Post 85	-0.079		-0.003	-0.234***		-0.191
	(0.073)		(0.083)	(0.072)		(0.124)
Ln Distance to Nearest Historical City × 1985		0.072			-0.075	
		(0.046)			(0.054)	
Ln Distance to Nearest Historical City × Post 85		-0.000			-0.085	
		(0.042)			(0.073)	
Observations	8000	8000	8000	7993	7993	7993
Counties	561	561	561	561	561	561
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Province x Time FE	Yes	Yes	Yes	Yes	Yes	Yes
First Stage *F*			7.38			7.38

Robust standard errors two-way clustered at the prefecture and province-by-time levels to allow for autocorrelation over time and space (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Time interaction terms are dummies for 1985 or years after 1985. Distance interactions are (demeaned) ln crow flies distance to nearest airport or nearest historic city. In column 3, distance to nearest international airport and the various interactions are instrumented for by distance to nearest historical city. Data covers non-municipal counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan for 1965, 1970, 1978, 1985, 1990, 1995, 2000 & 2000-2008.

Table A6: Special Economic Zones

	Ln Primary GDP		*Ln Non-Ag GDP*	
	(1)	(2)	(3)	(4)
Suitability for Cash Crops × 1985	0.161***	0.162***	0.022	0.021
	(0.057)	(0.058)	(0.031)	(0.031)
Suitability for Cash Crops × Post 85	0.241***	0.240***	0.188***	0.186***
	(0.069)	(0.069)	(0.070)	(0.071)
Prefectural SEZ's (count)	0.003		0.007	
	(0.006)		(0.010)	
Prefectural SEZ's (dummy>0)		0.064		-0.021
		(0.068)		(0.082)
Observations	7449	7449	7444	7444
Counties	561	561	561	561
County FE	Yes	Yes	Yes	Yes
Province x Time FE	Yes	Yes	Yes	Yes

Robust standard errors two-way clustered at the prefecture and province-by-time levels to allow for autocorrelation over time and space (*** p<0.01, ** p<0.05, * p<0.1). Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Interaction terms are dummies for 1985 or years after 1985. Prefectural SEZ's (count) and (dummy) are respectively, the number of Special Economic Zones located in the same prefecture as the county and a dummy taking a value of 1 if there at least one Special Economic Zone in the same prefecture. Data on SEZ's obtained from Wang (2012). Data covers non-municipal counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan for 1965, 1970, 1978, 1985, 1990, 1995, 2000 & 2000-2008.

Table A7: Different Prices, Productivities and Outliers

	(1)	(2)	(3)	(4)	(5)	(6)
Price Year	1978	1978	1978	1978	1985	1978
Above or Below-Quota Prices	AQ	AQ	AQ	BQ	AQ	AQ
Irrigated or Rain Fed	IR	RF	IR	IR	IR	IR
Intermediate or High Inputs	INT	INT	HI	INT	INT	INT
Trimmed	-	-	-	-	-	99
A. Ln Agricultural GDP:						
Suitability for Cash Crops × 1985	0.162***	0.017	0.151***	0.131***	0.139***	0.093*
	(0.056)	(0.024)	(0.052)	(0.048)	(0.051)	(0.050)
Suitability for Cash Crops × Post 85	0.236***	0.064**	0.227***	0.201***	0.210***	0.172***
	(0.068)	(0.033)	(0.063)	(0.060)	(0.063)	(0.066)
Observations	8000	7205	8000	8000	8000	7920
B. Ln Non-Ag GDP:						
Suitability for Cash Crops × 1985	0.022	0.014	0.022	0.018	0.020	0.022
	(0.031)	(0.035)	(0.030)	(0.030)	(0.031)	(0.030)
Suitability for Cash Crops × Post 85	0.181**	0.063*	0.172**	0.163**	0.170**	0.183***
	(0.072)	(0.032)	(0.069)	(0.066)	(0.068)	(0.070)
Observations	7993	7198	7993	7993	7993	7912
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Province x Time FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors two-way clustered at the prefecture and province-by-time levels to allow for autocorrelation over time and space (*** p<0.01, ** p<0.05, * p<0.1). Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Interaction terms are dummies for 1985 or years after 1985. Data covers non-municipal counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan for 1965, 1970, 1978, 1985, 1990, 1995, 2000 & 2000-2008. Column 2 has data from fewer counties than the other columns as under rain-fed agriculture some counties are classified as entirely unproductive in the GAEZ data. It is worth noting that China is one of the most heavily irrigated countries in the world making the rain-fed agricultural productivity data particularly unsuitable for analysis of agriculture in China (see section C.6).

Table A8: Omitting Provinces

Omitted Province	(1) Jiangsu	(2) Zhejiang	(3) Jiangxi	(4) Sichuan	(5) Hebei	(6) Shanxi	(7) Guizhou	(8) Gansu	(9) Xinjiang
A. Ln Primary GDP									
Suitability for Cash	0.162***	0.171***	0.164***	0.165***	0.136	0.176***	0.169***	0.118**	0.196***
Crops × 1985	(0.052)	(0.055)	(0.053)	(0.056)	(0.089)	(0.045)	(0.055)	(0.055)	(0.068)
Suitability for Cash	0.236***	0.241***	0.234***	0.238***	0.186*	0.286***	0.253***	0.189**	0.241***
Crops × Post 85	(0.068)	(0.070)	(0.069)	(0.069)	(0.095)	(0.058)	(0.072)	(0.074)	(0.086)
Observations	7993	7169	6784	7819	6088	7567	6812	6917	6795
Counties	561	501	475	549	425	532	481	484	480
B. Ln Non-Primary GDP									
Suitability for Cash	0.039	0.031	0.044	0.040	0.045	0.054	0.051	0.024	0.028
Crops × 1985	(0.031)	(0.034)	(0.032)	(0.034)	(0.047)	(0.033)	(0.034)	(0.034)	(0.036)
Suitability for Cash	0.193***	0.187***	0.196***	0.194***	0.188**	0.218***	0.196***	0.161**	0.205**
Crops × Post 85	(0.069)	(0.071)	(0.070)	(0.070)	(0.079)	(0.069)	(0.073)	(0.080)	(0.081)
Observations	7993	7169	6784	7819	6088	7567	6812	6917	6795
Counties	561	501	475	549	425	532	481	484	480
C. Ln Savings									
Suitability for Cash	0.022	0.012	0.026	0.023	0.016	0.034	0.033	0.005	0.030
Crops × 1985	(0.032)	(0.033)	(0.033)	(0.034)	(0.045)	(0.035)	(0.035)	(0.034)	(0.036)
Suitability for Cash	0.181**	0.175**	0.184**	0.181**	0.169*	0.204***	0.183**	0.147*	0.203**
Crops × Post 85	(0.073)	(0.075)	(0.074)	(0.075)	(0.087)	(0.076)	(0.078)	(0.085)	(0.081)
Observations	5012	5039	4668	5859	3835	5859	5859	5859	4882
Counties	359	364	334	420	284	420	420	420	339
D. Ln Investment in Fixed Assets									
Suitability for Cash	0.061	-0.103	-0.065	-0.065	-0.167	-0.065	-0.050	-0.107	-0.066
Crops × 1985	(0.100)	(0.134)	(0.130)	(0.128)	(0.205)	(0.128)	(0.137)	(0.139)	(0.161)
Suitability for Cash	0.415***	0.285***	0.317***	0.318***	0.153	0.318***	0.334***	0.331***	0.311**
Crops × Post 85	(0.077)	(0.108)	(0.104)	(0.103)	(0.162)	(0.103)	(0.102)	(0.114)	(0.121)
Observations	6286	5811	6223	6639	4630	6639	5495	5582	5807
Counties	511	514	488	572	436	572	494	498	491
County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province x Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors two-way clustered at the prefecture and province-by-time levels to allow for autocorrelation over time and space (*** $p<0.01$, ** $p<0.05$, * $p<0.1$). Suitability for cash crops is the (standardised, county average) ratio of the value of output of the best cash crop to the value of output of the best grain crop. Interaction terms are dummies for 1985 or years after 1985. Data covers non-municipal counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan for 1965, 1970, 1978, 1985, 1990, 1995, 2000 & 2000-2008.