Agricultural reforms and 'growth miracles' : evidence from China

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Abstract

Poor countries are overwhelmingly agrarian while rich countries are not. Early growth theorists put capital accumulation at the heart of this transition. More recent cross-country evidence finds a limited role for capital accumulation, though country specific growth accounting exercises suggest suggest importance in some instances (e.g. Young 1995). Because these countries are often poor initially, savings from the agricultural sector provide a potentially important source of capital. In this paper I exploit China's unique institutional environment and 1978-84 agricultural reforms, to show that agricultural surpluses were an important source of capital in early reform-era China. By liberalising the planting of cash crops, market oriented reforms beginning in 1978 favoured farmers with land suited to these crops, while geographic capital and labour market frictions limited the extent to which local economic shocks dissipate through the rest of the economy. I use the GAEZ soil productivity data, to identify counties with a comparative advantage in cash crops which, combined with the timing of the reforms, provides a source of plausibly exogenous variation in agricultural output. I then show that counties experiencing larger increases in agricultural output also had faster post-reform growth in non-agricultural output, with a medium run elasticity of 0.7. Patterns of agricultural employment, savings, investment, firm entry and factor utilisation are consistent with a model where higher agricultural surpluses increased the supply of capital for non-state enterprises, but not with alternative mechanisms.
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1 Introduction

The world's poorest countries are overwhelmingly agrarian. Agriculture accounts for more than 80% of employment in the poorest 20% of countries compared to just 6% in the richest 20% (Restuccia et al., 2008). The high share of employment in agriculture does not reflect relatively high agricultural productivity in developing countries, on the contrary, the poorer countries are, the lower their relative agricultural productivity (Duarte and Restuccia, 2010, Gollin et al., 2013). As countries develop, the agricultural sector gets both relatively more productive and relatively less important.

Lewis (1954), and other early growth theorists, put capital accumulation at the heart of the development process. Developing countries were characterised as having large pools of underemployed labour in a subsistence (agricultural) sector, which would be gradually drawn into the capital intensive modern (non-agricultural) sector as capital was accumulated.[1] As the agricultural sector constitutes a large share of the least developed countries output, rural savings provide a potentially important source of capital in these countries. Increases in agricultural productivity may also increase the supply of capital and, ultimately, the output of the non-agricultural sector.

Other authors have argued for linkages through the labour market or the demand for non-agricultural output.[2] However, in spite of a rich theoretical tradition, empirical evidence linking growth in the agricultural sector to that of the rest of the economy is very limited — Gollin (2010) provides a recent review — and the best identified papers focus on linkages through the local labour market.[3] In this paper, I use data from Chinese counties to show that the agricultural sector can be an important source of capital in the early stages of development.

China is an ideal setting to explore the role of agriculture as a source of capital to the non-agricultural sector for several reasons. First, China undertook agricultural reforms between 1978 and 1984 which resulted in substantial increases in agricultural productivity. These increases were not evenly distributed across space. Instead, as I will demonstrate, they varied systematically with the suitability of land for growing cash crops because pre-reform agricultural institutions limited the production of cash crops. This provides plausibly exogenous variation in agricultural output growth. Second, as in almost all poor countries, at the onset of the reforms agriculture was a significant share of the Chinese economy, making up 71% of employment and 28% of output. The large size of the agricultural sector makes linkages to the non-agricultural sector both more economically important and easier to identify empirically. Third, geographic capital market frictions meant that "local money stay[ed] local" (Naughton, 2007, p.279)

[1] More recent cross-country evidence has not been kind to this view, finding that the accumulation of capital has limited explanatory power in understanding cross-country income differences (Easterly and Levine, 2001, Caselli, 2005). On the other hand, decompositions of the growth of various fast growing East Asian economies, have indicated that the accumulation of factors, in particular capital can in many cases explain much of these countries growth (Kim and Lau, 1994, Young, 1995, Collins and Bosworth, 1996, Young, 2003).

[2] See e.g. Rosenstein-Rodan (1943), Schultz (1953), Rostow (1960), Johnston and Mellor (1961), Murphy et al. (1989), Matsuyama (1992), Echevarria (1997), Kongsamut et al. (2001) and Ngai and Pissarides (2007).

[3] See Foster and Rosenzweig (2004), Hornbeck and Keskin (2012) and Bustos et al. (2013) which exploit sub-national variation in agricultural output in India, the US and Brazil respectively. 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. — agricultural productivity improvements weakly reduce industrial output.

and limited the extent to which savings could dissipate through the rest of the economy. Fourth, institutional factors such as the *hukou* internal passport system also limited labour mobility. These geographic frictions allow the exploration of linkages through the supply of capital using much finer geographic variation than would normally be possible.

Areas suited to cash crops benefited more from the reforms because pre-reform rural institutions strongly encouraged the planting of grain. Farming communes were forced to be self-sufficient in grain, were required to meet quotas for grain deliveries to the state and faced political pressure to overproduce grain. In addition to decommunalising agriculture, the reforms relaxed each of these constraints. Thus, while all of China benefited from decommunalisation (McMillan et al., 1989, Lin, 1992), parts of China suited to cash crops also benefited from new freedoms to plant these crops.

I am able to identify linkages through the supply of capital because geographic capital market frictions in China prevent capital flowing freely across space. These 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 SOEs demands for capital, non-state firms access to the formal financial sector was limited. Despite being the fastest growing part of the Chinese economy, they were forced to rely on local sources of capital, including, savings of family and friends, retained profits, and loans from local governments or rural credit cooperatives. The reliance on these sources of capital restores the geographic link between savings and investment that is observed across countries but not across sub-national regions.[4] Labour mobility was also limited. The *hukou* internal passport system increased the cost of migration, particularly until the mid 1990's (Chan and Zhang, 1999) and, in relative terms, the number of migrant workers was low. These capital and labour market frictions make Chinese counties much more comparable to (small) countries than similar sized administrative divisions elsewhere.

Because the benefits of agricultural reforms varied across space, the main empirical strategy used is difference-in-differences. I identify counties with a comparative advantage in cash crops using the GAEZ global database of theoretical crop yields which provides theoretical crop yields at a high spatial resolution. Counties with a strong comparative advantage in cash crops are the 'treated' counties, while those with comparative advantage is in grain act as the 'control'. I combine the agricultural productivity data with a newly digitised panel of economic data covering 561 non-metropolitan counties in 8 provinces between 1965 and 2008. The relatively long panel allows me to consider both the short run effects of the reforms as well as the subsequent dynamics.

As mentioned, linkages through the capital market are by no means the only possible linkage between the agricultural and non-agricultural sectors. If specialisation in cash crops were labour saving then non-agricultural output could increase due to

[4]For evidence of capital market frictions across countries one can begin with the extensive literature inspired by 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.

an increase in the supply of labour.[5] Alternatively, higher rural incomes could result in increased local demand for non-agricultural output.[6] These channels are unlikely to be important in my setting. Specialisation in cash crops does not appear to have been labour saving — Taylor (1988) finds that the cultivation of most cash crops in China was more labour intensive than the cultivation of grains, and that the labour intensity of grain production fell by more than that of grains in the wake of China's agricultural reforms. The strength of the demand channel is also likely to be limited by counties openness. The demand channel works by increasing the relative price of non-agricultural output, but because counties are small, the supply of non-agricultural 'imports' is likely to be elastic. Indeed, as Matsuyama (1992) showed, the logic of models linking agricultural productivity to growth does not apply in an open economy.

Nevertheless, to guide the empirical work, I provide a simple model of agricultural and non-agricultural output in Chinese counties. The model is Lewisian in the sense that capital is only used by the non-agricultural sector, but unlike in the Lewis model, the wage is determined competitively. This allows improvements in agricultural productivity increase or decrease agricultural demand for labour depending on the agricultural production function. The model also nests the possibility of linkages via increases in the supply of capital (to the non-state firms which lack access to national capital markets) or the demand for non-agricultural output.

The model makes clear that the behaviour of economic aggregates such as non-agricultural output, savings and investment are not generally sufficient to determine which linkages dominate. However, along other dimensions there are stark differences. For instance, if local savings are key then the relative price of capital will fall, particularly for non-state firms who are reliant on local capital markets. If the key linkage is through a fall in the agricultural demand for labour, increases in agricultural and non-agricultural output are accompanied by a fall in the share of the labour force working in agriculture and a decline in the relative cost of labour. If the key linkage is through local demand, then more open counties will benefit less as an increase in demand dissipates more widely.

The empirical analysis thus has three main components. First, I show that counties with a comparative advantage in cash crops had larger post-reform increases in agricultural output than counties with a comparative advantage in grain. A 1 standard deviation increase in my measure of comparative advantage is associated with around a 20% increase in post-reform agricultural output. This increase appears to be permanent, and is fairly constant over the whole post-reform period suggesting a one time increase in agricultural productivity due to the improved allocation of crops to land. Back of the envelope calculations suggest that specialisation increased agricultural output by 10-16% between 1978-85, or around one-fifth of the total increase in agricultural output. Importantly, there was no difference in the growth of agricultural output in counties with and without a comparative advantage in cash crops prior to the reforms — they were following parallel trends. Furthermore, in all specification I include a full set of county and province-by-time fixed effects which mean that I am only exploiting within province variation. These results differ from previous studies which do not find significant gains from specialisation (Lin, 1992, Lin and James, 1995). I show that this

[5] Bustos et al. (2013) provide theoretical conditions and empirical evidence on this.

[6] A large theoretical literature discusses these effects, for relatively recent contributions see e.g. Murphy et al. (1989), Echevarria (1997), Kongsamut et al. (2001), Ngai and Pissarides (2007).

difference can be explained by these previous studies use of highly aggregated province level data. When I repeat my analysis using province (rather than county) level data, the gains from specialisation are neither economically nor statistically significant.[7] In addition to my results on aggregate agricultural output, I also show that counties suited to cash crops increase the share of cash crops in their output (in tons) — as would be expected if farmers were specialising.

Second, I show that counties with a comparative advantage in cash crops also increased their savings after the reforms. The increase in savings was followed by an increase in investment, and finally in non-agricultural output. As with agricultural output the growth of these variables was almost identical in counties with and without a comparative advantage in cash crops prior to the reforms. Using comparative advantage in cash crops interacted with the timing of the reform as an instrument for agricultural output I estimate a medium run elasticity of around 0.7. Counties with a comparative advantage in cash crops had substantially faster post-reform growth in savings and investment. The positive effect of agricultural output on the non-agricultural sector is long lasting — non-agricultural output, savings and investment are relatively higher in counties with a comparative advantage in cash crops in 2008, the last year in my data, although the difference may have peaked in the late 1990's or early 2000's.

Third, I present several additional pieces of evidence which suggest that the identified effect on the non-agricultural sector was primarily due to specialisation in cash crops increasing rural savings and the supply of capital. First, I show that the share of labour working in the agricultural sector increased in areas with a comparative advantage in cash crops which is inconsistent with specialisation in cash crops being labour saving. Second, I show that after the reforms non-state firms—who lack access to national capital markets—used relatively more capital in counties with a comparative advantage in cash crops. No such effect was observed for state owned firms. Capital appears to be relatively cheap for non-state firms in places suited to cash crops. Third, I show that linkages were stronger in 'more open' counties. As higher rural incomes will increase demand *less* in more open counties, this suggests that the demand channel was not the primary factor behind the observed link between agricultural and non-agricultural output.

As Lewis might have predicted, in China higher agricultural surpluses led to higher savings, capital accumulation and non-agricultural output. Despite this, the cross country evidence is not in general supportive of capital accumulation being the primary explanation of international income differences (Easterly and Levine, 2001, Caselli, 2005) and the empirical literature linking savings and growth is also inconclusive (Carroll and Weil, 1994, Attanasio et al., 2000, Aghion et al., 2006). Nevertheless, decompositions of the growth of many of the fastest growing countries including Japan, South Korea, Taiwan, Singapore and, of course, China frequently find that a significant share of growth can be explained by capital accumulation (Kim and Lau, 1994, Young, 1995, 2003, Collins and Bosworth, 1996). These countries also tend to share China's high savings rates and returns to capital. More enlightened economic policies are surely the

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

most important factor in these countries' industrialisation, nevertheless, conditional on these policies, their growth had a decidedly Lewisian flavour.

In another parallel to China, many of these fast growing countries also undertook successful agricultural reforms around the start of their periods of rapid growth. Post-war land reforms in Japan, South Korea and Taiwan redistributed land to peasants and are thought to have increased agricultural productivity. More recently, the decommunalisation of agriculture in Vietnam in the mid 1980's is also thought to have dramatically increased agricultural output and raised the curtain for a sustained period of rapid growth that continues to this day. Far more speculatively, the industrial revolution itself was preceded by the parliamentary enclosures movement which redefined property rights over common land and increased agricultural yields.[8] In each of these cases larger agricultural surpluses induced by the reforms could have increased the supply of capital to the non-agricultural sector just as improvements in agricultural productivity did in China.

The remainder of the paper proceeds as follows; Section 2 provides relevant institutional background to the reforms, credit markets and labour markets; Section 3 presents a simple model of the reforms; Section 4 outlines my empirical strategy and describes the data; Section 5 describes the effect of comparative advantage on agricultural output; Section 6 describes the effect of comparative advantage on non-agricultural output and presents empirical results indicating this growth was primarily due to capital accumulation; Section 7 concludes.

2 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.

2.1 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 principle 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 paid for their contribution to agricultural production primarily 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' which was based on factors such as household size. The remaining grain, and any cash, was distributed according to work points which tended to be allocated primarily through days worked and by type of job. As a result, incentives to provide effort on communal lands were very weak. It is perhaps telling that, in the mid 1960's,

[8] See Dore (1959), Jeon and Kim (2000) and Thorbecke (1979) or Ranis (1979) for Japan, Korea and Taiwan respectively. Pingali and Xuan (1992) for the effects of decommunalisation on Vietnamese agriculture. See e.g. Allen (1992) or Overton (1996) for evidence on the effect of the enclosure movement.

[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).

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). The policy 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 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 there 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) — where 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 respectively pre-reform. Despite these large relative increases in the supply of cash crops, there were not corresponding reductions in the relative price of these crops (see Table 1). This suggests large windfalls for areas with a comparative advantage in cash crops who were able to begin specialising as a consequence of the reform.

2.2 Capital market frictions

China's financial sector, which is dominated by the state owned banking system, has been distorted by it's bias towards state owned firms. From the early 1980's onwards, soft loans largely replaced the direct budgetary support 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 (Brandt and Zhu, 2000, Huang, 2003, Lardy, 1998).

The consequences of this financial favouritism can be directly observed by compar-

ing 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) collect 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 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 primarily provided by Rural Credit Cooperatives, which tended to raise and provide capital over a limited geographic area and are "poorly integrated into financial markets" (Park and Sehrt, 2001, p. 3) resulting in "local money stay[ing] local" (Naughton, 2007, p. 279). Despite their 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 do not do a good job of equalising capital market returns across space. In a similar vein, Boyreau-Debray and Wei (2005) show that there is *less* consumption risk sharing across provinces in China than there is across OECD countries and that the Feldstein and Horioka (1980) (FH) test of capital market integration — that changes in savings ought to be uncorrelated to changes in investment — is decisively rejected both before and after the reform.

In Figure 1 I include the results of my own FH regressions, with coefficients estimated for each year from 1952-2010 and associated 95% confidence intervals.[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 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

[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, Ningxiaand 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.

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 always 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 it 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.

2.3 Labour mobility and the *hukou* system

Labour mobility has also been restricted 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 labour flowing to the 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 remain (Chan and Zhang, 1999).

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*

[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.

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 difficult and costly and greatly increased the cost of migration for rural residents.

As a result, the number of migrants in China is low. In the 1% sample of the 1990 population census, just 3.3% of the population lived in a different place to where they had five years previously. Migration increased somewhat later in the reform era. Using an approximately representative retrospective survey De Brauw et al. (2002) find 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. These figures suggest that while migration is low in the years immediately following agricultural reforms it is potentially of concern from the mid 1990's onwards as restrictions were eased. In the results, I will show that areas with and without a comparative advantage cash crops had relatively similar rates of post-reform population growth. That my results are robust to controlling for differential population growth. And, that in 1990 the share of migrants in the population was uncorrelated with comparative advantage in cash crops. These results suggest that specialisation in cash crops did not induce significant migrant flows.

3 Theoretical Framework

To guide the empirical work, I present a simple model of agricultural and non-agricultural production at the county level. The model is Lewisian in the sense that only the non-agricultural sector uses labour, however unlike in the Lewis model, labour markets are competitive and workers in all sectors earn their marginal products. The non-agricultural sector includes both state and non-state firms, allowing me to capture the differential implications of the financial sector frictions described in the preceding section.

3.1 Setup

The unit of analysis is the county i. Each county is populated by L individuals and labour is immobile. Counties are also endowed with 1 unit of land which is used only in the agricultural sector, R.

When combined with labour, land can be used to produce grain, G, or cash crops, CC. All counties have the same productivity in grain $A_{G,i} = 1$, but productivity in cash crops $A_{CC,i}$ varies. Hence, $A_{CC,i}$ is both the counties absolute productivity and its comparative advantage in cash-crops. Counties are otherwise identical in all respects.

Counties also have a non-agricultural sector. Representative state, S, and non-state, NS, firms produce a homogenous non-agricultural good taking all prices as given.

3.2 Production in the agricultural sector

A representative farmer owns the counties unit of land, b, which, in combination with labour, l, can be used to grow cash crops or grain with production technology

$$y_c = f(A_c l_c, b_c) \tag{1}$$

where $c \in \{G, CC\}$ and A_c is the (labour augmenting) soil productivity of the farmers land in the production of crop c.[14] Let f be twice differentiable, subject to constant returns to scale, and strictly increasing and concave in both of its arguments.

The farmer sells her output on national markets for price p_c. During the cultural revolution, and through most of the 1980's, the vast majority of agricultural output was sold to central government at fixed prices. Even after this period, agricultural commodities are highly tradable. Consequently, farmers in all counties face the same 'world prices' p_c. I make make the further normalisation to prices and quantities such that $p_R = p_{CC} = p_G = 1$.[15]

Prior to the reforms rural institutions forced farmers to grow grain.[16] To capture this, I assume that the farmer must plant $b_G \geq \gamma$ of her land with grain. Pre-reform $\gamma = 1$; all counties must plant only grain.[17] Post-reform $1 < \gamma < 1$; farmers are less constrained in their planting decisions. The representative farmer takes all prices as given and maximises profits

$$\pi_A = \max_{l_c, b_c} \; y_G + y_{CC} - w(l_G + l_{CC}) \;\; \textbf{s.t.} \;\; b_G \geq \gamma, \; b_G + b_{CC} \leq 1$$

As counties differ only in their comparative advantage in cash crops, pre-reform agricultural labour demand, $L_R = l_G + l_{CC}$, and output, Y_R, do not depend on A_{CC}.

Post-reform, if $A_{CC} < 1$, then farmers fully specialise in grain, while if $A_G \geq 1$, farmers specialise in cash crops and $b_{CC} = \gamma$. It is easy to show that equilibrium output of crop c, $y_c(A_c, w)$, is (weakly) increasing in A_c and decreasing in the wage. Labour demand is decreasing in the wage $l_c(A_c, w)$. The effect of A_{cc} on the demand for labour

[14]The assumption of labour augmenting soil productivity is analytically convenient as it allows for higher productivity in A_c to increase or decrease the demand for labour (depending on f). If productivity is Hicks-neutral, higher productivity always increases the demand for labour in specialising counties. If productivity is land augmenting, the effect on the demand for labour depends on the cross-derivative of f; labour demand is increasing if, as seems plausible, land and labour are complements.

[15]The setup of the model will prevent any substantive role for post-reform shifts in the relative price of agricultural goods. Nevertheless, there was little change in the relative price of cash crops with respect to grain post-reform (see Table 1 for National Bureau of Statistics price indices or see Sicular (1988) for quota prices).

[16]I am abstracting from the effect of the introduction of the Household Responsibility System (HRS) on agricultural output. In my data, in the last 'pre-reform' year, 1978, almost no counties are treated, whereas in the first 'post-reform' year, 1985, almost all counties are treated by HRS. Consequently I lack the variation required to explore the effects of the introduction of HRS, although numerous previous papers do consider this question. With regards to specialisation, provided that specialisation in cash crops did not reduce the returns to effort, the introduction of HRS would have been complementary.

[17]Although this assumption is extreme, even where cash crops were planted (a selected sample of counties that skews towards those with comparative advantage in cash crops), physical production of those crops was low prior to the reforms (see Table 2).

depends on f. In particular, for given b_c demand for labour is increasing in A_c if

$$A_c l_c + \frac{f_1(A_c l_c, b_c)}{f_{11}(A_c l_c, b_c)} < 0 \tag{2}$$

Specialisation in cash crops can increase or decrease the demand for labour. In the comparative statics I focus on cases where labour demand is monotonic in the range of A_c.

3.3 Production in the non-agricultural sector

Production in the non-agricultural sector is conducted by a state and non-state sector $j \in \{S, NS\}$ each of which is modelled as consisting of a representative firm. Both sectors produce a homogeneous final good which is freely traded at price p_M. In the first instance, I assume that firms in all counties face the same prices, however, to explore linkages through higher demand for non-agricultural goods I will later allow for the possibility that higher agricultural output increases the price faced by firms. This is equivalent to assuming that the supply of non-agricultural imports is not perfectly elastic.

Each sector is produces according to aggregate production function $g_j(L, K)$ where g which is concave and homogeneous of degree $1/\lambda_j < 1$ in L and K — each sector has decreasing returns to scale. The decreasing returns could represent a fixed sector specific supply of managerial of political capital. Alternatively, the model is isomorphic to one where a fixed stock of monopolistically competitive firms face demands with elasticity $\frac{\lambda}{\lambda-1}$. Demands of this type are frequently derived from Dixit-Stiglitz type preferences where $\epsilon = \frac{\lambda}{\lambda-1}$ is the elasticity of substitution between varieties. Each sector thus has aggregate cost function

$$c(w, r, y,) = y^{\lambda} c_j^*(w, r) \tag{3}$$

where c^* is a twice differentiable 'unit cost function'. In addition to the assumptions of homogeneity and differentiability I impose a mild technical restriction on λ and c^* such that

$$\frac{c_{j,12}^* c^*}{c_{j,1}^* c_{j,2}^*} = \sigma_j(w, r_j) < \frac{\lambda_j}{\lambda_j - 1} \; \forall \; w, r > 0 \tag{4}$$

where $c_{j,1}^*$ is the derivative of the cost function with respect to w and other terms are defined analogously. The left hand side is the Hicksian Elasticity of Substitution, $\sigma_j(w, r)$, so Equation 4 restricts the substitutability of capital and labour relative to the responsiveness of costs to output. This ensures that when the wage (rental rate) increases, the increase in demand for capital (labour) per unit of output is more than offset by the decrease in output, so overall demand for capital (labour) by the firm falls.

To get a sense of how likely Equation 4 is to hold, consider that Berkowitz et al. (2014) estimate that $1 < \sigma < 2$, while Cobb-Douglas technology, which forms the basis of much applied work, implies $\sigma = 1$.[18] While we do not have good estimates of λ, as

[18]There is also a large literature in macroeconomics that seeks to estimate the aggregate elasticity of substitution. Estimates vary widely, but are generally between 0.5 and 1.5. See Chirinko (2008) for a

mentioned above the model is isomorphic to one with a fixed stock of monopolistically competitive firms and Dixit-Stiglitz type consumers where $\epsilon = \frac{\lambda}{\lambda-1}$ is the elasticity of substitution between varieties. A large number of papers in International Trade estimate this elasticity with estimates falling the range $3 < \epsilon < 10$.[19] As there is no overlap in the range of commonly estimated parameters it seems plausible that this condition will hold.

Each sectors representative firm takes all prices as given and maximises profits

$$\pi_j(r_j, w) = \max_{Y_j} \; p_M Y_j - \left(Y_j\right)^{\lambda} c_j^*(w, r)$$

it is easy to show that profits and output are decreasing in factor prices and increasing in p_M. Demand for capital and labour are each decreasing in both w and r.[20]

3.4 Equilibrium

In equilibrium factor markets clear. The labour market clearing condition is

$$L_{R,i} + L_{S,i} + L_{NS,i} = L \tag{5}$$

it is important to reiterate that labour supply is assumed not to respond to agricultural productivity in the medium run. In the empirical section, I will verify that, over a 5 to 20 year period, this approximates conditions in Chinese counties.

I explore two possibilities for capital markets. As a baseline I assume that capital markets are frictionless and that both state and non-state firms face perfectly elastic supplies of capital at the 'world' market rate $r_{NS} = r_S = \tilde{r}$.[21] Alternatively, I allow for the possibility of geographic capital market frictions described in Section 2.2 and let the non-state sector instead obtain capital from a fixed stock $K(Y_R)$ which may depend on the output of the agricultural sector. This allows for direct linkages between the agricultural sector and the non-state sector through the supply of capital. Capital market clearing in the non-state sector becomes

$$K_{NS,i} = K(Y_{A,i}) \tag{6}$$

while the state sector continues to face a perfectly elastic supply of capital at rate $\tilde{r}$ reflecting its preferential access to the national banking system.

3.5 Comparative statics

I consider three sets of comparative statics.[22] In the baseline case, labour is immobile but all other markets are frictionless and face 'world' prices. I then explore the consequences

review of this literature. Oberfield and Raval (2014) provides recent estimates for the US, Chile Columbia and India ranging from 0.71 (US) to 1.11 (India).

[19]See e.g. Broda and Weinstein (2006).

[20]To see this use Shepherd's Lemma to obtain conditional factor demands from the cost function (Equation 3) and differentiate. For a factors own price both resulting terms are clearly negative. For the alternative price there are two offsetting effects. Equation 4 guarantees the negative effect dominates.

[21]Qualitatively identical comparative statics are obtained if State and non-State firms face different 'world' market rates.

[22]The proofs of the comparative statics are straightforward and contained in the Appendix A

of geographic capital market frictions in the non-state sector by fixing the supply of capital as described above. Finally I consider the possibility of linkages through the demand channel by allowing the non-agricultural price to vary with agricultural output and 'openness'. In all cases, because all counties are forced to plant only grain prior to reform, and counties are identical other than through their suitability for cash crops, all counties have identical agricultural and non-agricultural output, factor prices and labour allocations prior to reform. Thus the post-reform comparative statics with respect to suitability in cash crops provide the comparative statics in terms of levels and growth rates.

Baseline case: frictions only in the labour market

In the baseline case labour is immobile but there are no other frictions. The post-reform comparative statics with respect to comparative advantage in cash crops are thus straightforward. If Equation 2 holds, and higher agricultural productivity increases the demand for labour, then agricultural output, the wage, and the share of labour in the agricutural sector are increasing in comparative advantage in cash crops. Non-agricultural output, and the amount of capital used decrease. These comparative statics are reversed if higher agricultural productivity decreases the demand for labour.

Introducing capital market frictions

I introduce the capital market frictions faced by the non-state sector by assuming that non-state firms face a fixed supply of capital $K(Y_R)$ which is increasing in agricultural output (i.e. $K'(Y_R) > 0$). This allows for linkages between the agricultural and non-agricultural sector through the supply of capital.In this case, in addition to the comparative statics described above, higher agricultural productivity increases the wage, the output of the non-state sector, the share of labour in the non-agricultural sector and the cost of capital faced by non-state firms.

Introducing increases in local demand

Many models of structural transformation emphasise the importance of higher rural incomes increasing the demand for non-agricultural goods and, in an imperfectly open economy, the relative price of non-agricultural output.[23] However, as showed by Matsuyama (1992) in an open economy these links break down as higher agricultural productivity simply leads to higher exports of agricultural goods and higher imports of non-agricultural goods without effecting prices. To capture the role of demand linkages and openness, I allow the price of non-agricultural goods to vary with agricultural output but the extent to which it varies depends on a counties openess, ξ. In particular I assume that $p_M(Y_R, \xi)$ is increasing in Y_R but that the increase is decreasing in 'openess' $\frac{\partial^2 p_M}{\partial Y_R \partial \xi} < 0$. For simplicity I assume that ξ has no direct effect on prices. This captures the idea that a suburb of Shanghai is likely to have a larger set of traded goods than a remote part of Gansu and that consequently higher rural demand is less likely to stimulate local manufacturing in suburban Shanghai.

[23] see e.g. Murphy et al. (1989), Echevarria (1997), Kongsamut et al. (2001), Ngai and Pissarides (2007)

Thus, linkages through local demand increase real and nominal non-agricultural output, the share of labour in the non-agricultural sector, the wage and capital utilisation where the supply of capital is elastic or the rental rate on capital where it is not. All of these effects are weakened in more open counties.

Empirical implications

Regardless of the channels linking the agricultural and non-agricultural sectors, being allowed to plant cash crops increases agricultural output in places which would like to do so. The share of cash crops in output is also increasing in comparative advantage in cash crops.

The effect on the non-agricultural sector is in most cases indeterminate, however, in the empirical results I will show that areas with a comparative advantage in cash crops also had relative increases in their non-agricultural output and investment (a proxy for capital used). These aggregate results are consistent with all the channels described above and hence do not indicate the channel of primary importance. The model does however provide a number of testable predictions which may help uncover the how the sectors were linked

1. If specialisation in cash crops is labour saving (Equation 2 does not hold) then the share of labour in agriculture must fall as the other channels also reduce the share of labour in agriculture — If the share of labour in agriculture increases specialisation in cash crops cannot be labour saving;
2. Non-state firms in areas with a comparative advantage in cash crops should face cheaper capital if there are geographic capital market frictions and higher agricultural surpluses increased the supply of local capital;
3. If the demand channel is important, then increases in non-agricultural output are greater in more remote (less open) places where higher local demand has a stronger effect on local prices.

Finally, although the model does not specify how higher agricultural output gets translated into an increase in the supply of capital to the non-state sector an increase in savings is the most natural mechanism.[24]

4 Empirical Strategy and Data

For my main results on economic aggregates I use a difference-in-differences strategy where comparative advantage in cash crops is the continuous treatment variable. My estimating equation is

$$Y_{ivt} = \alpha_i + \delta_{vt} + \gamma_1 CA_i^N \times D1985_t + \gamma_2 CA_i^N \times Post85_t + \varepsilon_{ivt} \tag{7}$$

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 and for all years after 1985

[24]It is not however entirely essential. An alternative model featuring moral hazard induced credit market frictions could also result in higher capital utilization in areas with a comparative advantage in cash crops without requiring a large increase in saving, if entrepreneurs were required to self-finance at least a portion of their projects. See e.g. Banerjee and Newman (1993); some of the literature on inequality and growth summarized in Benabou (1996); or, Buera and Shin (2013) and Moll (2014) for more recent theoretical treatments.

respectively. Thus γ_1 provides the short-run effect of having a comparative advantage in cash crops on my outcome and γ_2 the medium-run. CA_i^N is my (normalised) measure of comparative advantage, 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 level[25] and the province-time level.[26] 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.

The inclusion of individual fixed-effects controls for any time invariant characteristics of counties, while province-time fixed effects flexibly control for province specific shocks, including but not limited to, provincial polices, prices and economic performance. The inclusion of province-by-time fixed-effects mean that I identify the post-reform benefit of having a comparative advantage in cash crops using only *within province* variation in comparative advantage. 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 the same in counties with and without a comparative advantage in cash crops.

I do not take this parallel-trends assumption for granted, and provide several pieces of evidence in its support. First, I use a specification including interactions of my treatment with each year in my data to show that, for each of my outcomes of interest, counties with and without a comparative advantage in cash crops were on parallel trends prior to the reforms prior to the reforms

$$Y_{ivt} = \alpha_i + \delta_{vt} + \sum_{s \neq 1978} \gamma_s \left(CA_i^N \times I_s \right) + \nu_{ivt} \tag{8}$$

in this specification, if the parallel trends assumption held prior to reform, $\gamma_t = 0 \; \forall \, t < 1978$. Second, I show that a counties' own comparative advantage in cash crops is more important for determining the benefits of specialisation in cash crops than the comparative advantage of its neighbours. This is important because it indicates that changes in agricultural output were not driven by shocks that were geographically correlated but otherwise unrelated to comparative advantage. Third, I estimate an auxiliary specification including a full set of county specific time trends. Finally, 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.

4.1 Data on comparative advantage

As described, parts of China with a comparative advantage in cash crops may have benefited more from agricultural reforms than areas with a comparative advantage in grain. In the model presented in Section 3, comparative advantage in cash crops was defined as the ratio of productivity in cash crops to productivity in grain (with suitably normalised prices). The empirical analogue of A_{CC} in location ι is therefore the ratio of

[25] The prefecture is the administrative unit between the county and the province.

[26] 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.

the value of output of the highest value cash crop divided by the highest value grain

$$CA_\iota = \frac{\max\{A_{c\iota} p_c\}_{c \in \mathbb{C}}}{\max\{A_{c\iota} p_c\}_{c \in \mathbb{G}}} \tag{9}$$

where CA_ι is comparative advantage, p_c is the price of crop c, 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 there are two prices given. 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 likely closer to the marginal price faced by farmers. I use prices from 1978 as being 'pre-reform' they are plausibly exogenous to post-reform production responses. There is little change in the relative price of cash crops and grains, either pre or post-reform (see Table 1), so not surprisingly the results are robust to alternative choices of price year. The results are also robust to the use of 'below quota' prices. These results are provided in the appendix.

Productivities $A_{c\iota}$ are obtained from the Food and Agriculture Organisation's Global Agro-Ecological Zones (GAEZ) database.[27] The GAEZ data provide agricultural productivities for a range of crops at a high spatial resolution.[28] 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. The productivities are based on agronomic models which give measures of potential crop yield based on climatic conditions, soil type, elevation and gradient.[29] 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. 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 A6). Figure 2 is a map of comparative advantage in 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 with grains these crops account for at least 80% of planted area in the early reform era. The 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 $\mathbb{G} = \{\text{Wheat, Rice, Maize, Soybeans}\}$

[27]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.

[28]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.

[29]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).

and the cash crops are $\mathbb{C} = \{\text{Rapeseed, Groundnut, Cotton}\}$.[30]

The above procedure provides a measure of comparative advantage 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 comparative advantage of a county is calculated as the simple average across all cell midpoints within the county $CA_i = n_i^{-1} \sum_{\iota \in i} CA_\iota$ where n_i is the number of fertile cell midpoints in county i.

In Section 5.2 I will use measures of comparative advantage for cotton and oilseeds specifically 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.[31] Although most provinces produced Anniversary Yearbooks, only a subset of them provided historical statistics at the county-level for periods both 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. While the geographic coverage is reasonably representative of much of China, it does not cover the North-East, a region that has experienced a relative decline, or the booming South Coast. The data also explicitly excludes most provincial capitals, which tend to be the largest cities, and so is much more rural than China as a whole. The dataset includes about 1/4 of Chinese counties and in 1978 covers a population of 217 million people (out of China's 963 million) — if these counties were an independent country, then in 1978 they would have been the fourth most populous in the world.[32]

In principle the data cover the whole PRC era beginning in 1949, however in practise 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.[33] The inclusion of three 'pre-reform' years, 1965, 1970 and 1978, allows me to

[30] 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. Furthermore, the planting of sorghum, millet and sesame is concentrated in southern China, which is underrepresented in my data.

[31] 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.

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

[33] For yearbooks published in 1999, where possible the data was supplemented with data from the University of Michigan's 'China Data Online' database.

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; Savings Deposits, as a proxy for saving; Investment in Fixed Assets; 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 comparative advantage.[34] I match this economic data to the administrative boundary data described above.[35] 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. As my data mostly excludes metropolitan counties, and does not include any of the provincial level cities, my counties are significantly more rural than China as a whole.[36] The Primary sector accounting for 55% of GDP (compared to 28% for China as a whole) in 1978. My results thus speak primarily to the development experiences of mid-size cities, towns and rural areas.

4.3 Firm level data

In order to explore whether the differential patterns of non-agricultural output I observe are due to additional activity in the state-owned or non-state sector I also exploit data 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 comparative advantage. 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 describe the variables constructed from this data in the appropriate sections of the results. Table 2, Panels B and C, summarise some of this data.

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

[35] 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.

[36] 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.

5 Agricultural Output

The simple model presented in Section 3 carried the following predictions

1. Post-reform increases in agricultural output are increasing in comparative advantage in cash crops;
2. Counties with a comparative advantage in cash crops will specialise in the production of these crops.

In this section I show that the data are consistent with both of these predictions.

5.1 Comparative advantage in cash crops and agricultural output

Table 3 reports results of regressions showing that counties with a comparative advantage in cash crops had larger post-reform increases in agricultural output. A one standard deviation increase in comparative advantage in 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 this increase was realised by 1985 suggesting that farmers adjusted their planting patterns fairly quickly following the reforms. To put the sizes of these effects into context, for the counties in my sample, real Primary GDP increased by 116% from 1978 to 1995.

As for many counties I do not observe Primary GDP in every year my data is unbalanced. To rule out the possibility that the results are due to changes in the composition of the sample, 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% level.

Figure 4 plots coefficients and 95% confidence intervals from a regression (Equation 8) estimating the effect of comparative advantage in cash crops for each year in my data — 1978 is the omitted year. 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. Furthermore, there is no obvious trend in coefficients over time. Counties with and without a comparative advantage in cash crops appear to have been following parallel trends prior to the reforms. Immediately after the reform, counties with a comparative advantage in cash crops enjoyed a large relative increase in agricultural output. These increases are sustained until 2008, the last year in my data. The post-reform coefficients are remarkably similar, suggesting that specialisation in cash crops led to a sustained one time increase in agricultural output.

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

In Column 5, I include the comparative advantage of the rest of the prefecture as well as a counties own comparative advantage.[37] If the gains are due to specialisation in cash

[37] The prefecture is the political unit above county but below province. The average prefecture contains around 8 counties. I calculate the comparative advantage in cash crops for the rest of the prefecture analogously to the calculation of that for counties. It is the mean comparative advantage in cash crops for productive cells in the prefecture which is not part of the county itself: $CA\ Rest\ of\ Prefecture_j =$

crops rather than some geographic shock approximately correlated with comparative advantage in cash crops, a county's own comparative advantage ought to be much more important than that of adjacent counties.[38] Thus, the inclusion of the comparative advantage of the rest of the prefecture provides a second placebo test. When the comparative advantage of neighbouring counties is also included, the coefficients on 'own comparative advantage' are almost unchanged, while those on that of the neighbours are small, do not have a consistent sign, and are statistically insignificant albeit. This is not indicative of my main results being driven by geographically correlated shocks.

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 re-estimate my results without including 1965. The results are almost identical to my baseline results.

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 value added from sectors such as mineral and gas production which could potentially confound the results. For a smaller number of counties I have data on Gross Agricultural Output, so to validate the use of Primary GDP, in Columns 8 and 9 I re-estimate my baseline specification with Log Gross Agricultural Output as the dependent variable. The results are very close to my baseline results.

In Column 10, the dependent variable is Log Rural Income per Capita. Again, the results are similar to my baseline results; increases in agricultural output were accompanied by a corresponding increase in rural incomes. The fact that similar results are obtained using both aggregate and per capita measures of agricultural output and rural incomes mitigates concerns over the role of differential migration. I provide additional direct evidence of limited migration in the next section.

Appendix E provides additional tests indicating robustness to a large number of potential confounders. These include, controlling for initial economic conditions, differences in geography, the presence of special economic zones, and proximity to major cities; the use of alternative inputs in the calculation of comparative advantage, and; the exclusion of data from any particular province.

Aggregate gains in agricultural output

Taking the model at face value, these estimates provide the *additional* increase in real agricultural output due to specialisation and not just a change in the distribution of output. Assuming this is indeed the case, I can use estimates similar to these to provide back of the envelope estimates of the aggregate increase in agricultural output due to specialisation between 1978 and 1985. These estimates serve both as a sense check on the size of my estimated coefficients and allow comparison to the previously estimated gains from decommunalisation in Lin (1992) and McMillan et al. (1989). Table 4 contains the estimates.[39]

$(n_l - n_j)^{-1} \sum_{i \in L \cap J^c} RVE_i$, where L and J are the set of cells in prefecture l and county j respectively, while n_l and n_j are their respective numbers of cell midpoints.

[38] One can think of reasons why their might be spillovers on output between counties, (e.g. learning spillovers or closeness to agricultural processing facilities), but these effects are likely to be small compared to the direct benefits of planting the right crop.

[39] Full details of how these estimates were calculated are provided in Appendix D

Panel A and B consider gains only in the areas where I have output data. Specialisation is estimated to have increased aggregate output by between 10 and 16 percent — or around one-fifth of the total increase in agricultural output. Panel C extrapolates these gains accross the whole of China based on counties comparative advantage and their share of the agricultural population in 1982. The estimates are similar. This suggests that the gains from specialisation were about two-thirds the size of the gains attributed to the introduction of the Household Responsibility System.

The large gains I find are consistent with Lardy (1983)'s arguments that pre-reform misallocation of crops to land imposed a substantial cost in terms of agricultural productivity. Gains from specialisation, help bridge a gap between the large gains in aggregate output identified by the previously mentioned studies of China's reform and the smaller effect on rice productivity found by 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 and 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 counties with a comparative advantage in cash crops. Secondly, where they used province level data, I use county level data, allowing me to exploit fine spatial variation in comparative advantage 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 the corresponding results. For ease of comparability with results exploiting only province level data, Column 1 restates my baseline findings. My main results are estimated using province-by-time fixed effects which are collinear with my variable of interest with province-level data. Instead, I provide two alternative specifications using wither either time fixed effects or time fixed effects and province specific time trends. Columns 2 & 3, re-estimate my county level results under these specifications for comparability with regressions using province level data. The estimated effect of comparative advantage in cash crops on agricultural output is similar in these specifications to my baseline results. 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. while Columns 6 and 7 use data from all available years. In all specifications based on province level data the estimated coefficients are neither economically or 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.[40] For these counties, I can test whether counties with a comparative advantage in cotton (oilseed) actually started growing more cotton (oilseed). To do this, I calculate the share of cotton (or oilseed) tonnage in joint tonnage of cotton (or 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 variable for the comparative advantage in cash crops, I also construct variables for comparative advantage in cotton and oilseeds with respect to grain as described in Section 4. If the pattern of production is shifting towards the one suggested by comparative advantage, counties with higher relative productivity in 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 appears to exclude counties that never produced cash crops and is thus not a random sample. As a consequence, I am identifying the increase specialisation only from counties who are relatively suited to cash crops. Indeed, counties for which I have data on the production of cotton and oilseeds had comparative advantages in cash crops 0.8 and 0.4 standard deviations higher than the average Chinese county. This most likely introduces some downward bias as counties which never produce cash crops, and hence do not increase their production of cash crops, are not observed but on average have a comparative advantage in grain.

Figure 5 plots the the coefficients associated with the effect of comparative advantage in 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% level in each year year). For oilseeds there is no differential trend in shares prior to reform. For cotton, areas with a stronger comparative advantage in cotton had a significantly higher share of cotton in 1965 than in 1970 or 78. This may be due to the slight liberalisation of agriculture between the Great Leap Forward and the Cultural Revolution.

Table 6 contains the results from these regressions. Columns 1-3 indicate that a 1 s.d. increase in the relative value of cotton production is associated with around a 1-2 percentage point increase in the share of cotton in joint cotton and grain tonnage, although the coefficients are not always statistically significant.[41] Columns 4-6 provide the results for oilseeds; a 1 s.d. increase in the relative value of oilseed production is associated with a 2 p.p increase in the share of cotton in joint cotton and grain tonnage.

[40] 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.

[41] 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 state-time level as in my main regressions, the standard errors associated with relative value of 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.

Both oilseeds, and especially cotton, have lower production per hectare than grain, so as the dependent variable is in terms of tonnage, the increase in the share of total planted area is significantly larger than the share of output tonnage. Unfortunately my data do not include a breakdown of planted area by crops. Columns 2 and 5 also include the comparative advantage of the 'other' cash crop in my data i.e. for cotton this means the comparative advantage in oilseeds. If the reallocation is taking place according to comparative advantage, the coefficient on this should be weakly negative; in all cases this is what I find. Higher productivity in oilseeds (weakly) reduces the share of cotton in output and higher productivity in cotton (weakly) reduces the share of oilseeds in output. Columns 3 and 6 omit data from 1965 in case the post great leap forward liberalisation is affecting the results.

An alternative explanation for the changes in crop shares (and output) is that it was due to differential yield growth, without any reallocation of land to crops. Suppose, quite plausibly, that counties with a comparative advantage in cotton were producing and planting more cotton prior to reform. If the productivity of cotton increased faster subsequent to the reforms — either due to high returns to effort or some change in production technology — then even with no reallocation of land, the value of agricultural output, and the share of cash crops in physical output, would increase fastest in areas with a comparative advantage in cotton. 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. Table 1 shows that differences between post-reform yield growth in cash crops and grains in the US and India was modest and the relative changes there are too small to obtain the change in crop patterns.[42]

6 Linkages to the Non-Agricultural Sector

After the reforms, counties with a comparative advantage in 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 faster increases 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 3 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 consistent which suggest that the increases in non-agricultural output identified were primarily due to higher agricultural surpluses increasing savings, the supply of capital, and finally non-agricultural output. Conversely, the results do not indicate that specialisation in cash crops was labour saving, or that there were significant linkages via local demand at the county level. Together the results indicate an important role for Lewis style capital accumulation in China's growth during the 1980's and 90's and suggest that larger agricultural surpluses induced by the reforms significantly increased the supply of capital to the non-state sector.

[42] 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%.

6.1 Non-agricultural output

Figure 6 and Table 7 contain my main reduced-form results for non-agricultural output; counties with a comparative advantage in cash crops had significantly faster post-reform growth.

Figure 6 plots coefficients and 95% confidence intervals from a regression estimating the effect of comparative advantage in cash crops, relative to 1978 (the omitted year), for each year in the data. A coefficient of 0.1 would indicate that a 1 s.d. increase in comparative advantage was associated with 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 reforms, counties with a comparative advantage in 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 the linkages identified in this paper were primarily due to higher agricultural surpluses increasing the supply of local capital. Surpluses from agriculture may have been a particularly important source of capital for more rural firms which were key to China's industrial output growth in the 1980's and early 1990's. Alternatively, the decline may reflect a lessening of geographic capital market frictions, possibly due to the banking sector reforms instituted in the 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 particularly in the light of my later results indicating that these linkages were primarily due to larger agricultural surpluses increasing the supply of local capital to non-state firms. First, key 'dual-track' reforms providing the non-state sector with access to intermediate goods markets were not introduced until 1984. Second, though reforms began in 1978, they were mostly implemented between 1981 and 1984 so there were only a few years of higher saving by 1985. 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 it was still small and most likely poorly measures relative to the state sector. Because my data aggregates the output of state and non-state firms, increases through the non-state sector may be 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% level. As in Figure 6, 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 of the effect of comparative advantage on non-agricultural output (Column 2); my results are not driven by changes in the composition of the sample over time. Including county specific time trends does not change the results and provides further support for the key parallel trends assumption (Column 3). In Columns 4 and 5, I re-estimate my baseline specification separately for Secondary and Tertiary GDP respectively. I obtain similar results for both sectors so, for the sake of brevity, I proceed using combined 'non-agricultural output'. To the extent that Secondary GDP (manufacturing and construction) is more tradable than Tertiary GDP (services), these sector specific results provide evidence against the hypothesis that the linkages identified were primarily due to higher demand for non-agricultural output as the effect would be stronger for non-tradable goods.

Appendix E provides a large number of robustness checks including robustness to initial economic conditions, geographic conditions, proximity to major cities, different ways of calculating comparative advantage, exclusion of any particular province, presence of special economic zones and differential population growth. The results are largely quantitatively and qualitatively unchanged.

Instrumental variables results

The identification of linkages between the agricultural and non-agricultural sectors is plagued by endogeneity issues, not least the scope for reverse causality. The reduced form results suggest a causal link between the agricultural and non-agricultural sector, with comparative advantage in cash crops 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 comparative advantage 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 E should allay these fears.

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) with respect to increases in agricultural output due to specialisation in cash crops in early reform era China. The extent to which this is likely to generalise to other contexts will depend on how similar the situations are and I provide some discussion of this in the conclusion.

Table 8 provides the results. Column 1 provides (endogenous) OLS estimates of the short run elasticity. The estimated coefficient is 0.3, which indicates a 1% increase in agricultural output is associated with a 0.3% increase in non-agricultural output. Columns 2 and 3 contain the corresponding IV results. The (unreported) first stages are almost identical to Table 3, Columns 1 and 2 respectively. Column 2, using the interaction of comparative advantage with a dummy for post-1978 as an instrument is my preferred specification as the strength of the first stage is stronger and, as this specification is exactly identified, the estimated coefficient is median unbiased (Angrist and Pischke, 2008). This specification indicates an elasticity of 0.7, significantly stronger than the OLS results. The estimates are significant at the 1% level. There are a number

of reasons why we might expect the IV estimates to be larger than those obtained using OLS. First, IV is likely to mitigate measurement error in the independent variable which is likely to bias the OLS estimates down. Second, increases in non-agricultural output could ordinarily crowd out agricultural output and introduce negative reverse causality. Third, increases in agricultural output at the start of the reform era could have had particularly strong linkages, perhaps due to the compounding effect of high returns on capital. Fourth, because the introduction of the reform is a one time factor which permanently increases agricultural output the IV estimates are a medium-run elasticity which could be quite different to the short run elasticity estimated by OLS.

In Columns 4 and 5 I address this last issue by repeating the estimation using 'long differences' between 1978 and 2000. The dependent variable is differenced log non-agricultural output and the independent variable is log agricultural output. The OLS estimates, indicate a medium run elasticity of around 0.4, slightly higher than the short run elasticity. The IV estimates indicate an almost unitary elasticity. The difference between the OLS and IV results does not appear to be due to them being estimated over different time horizons.

6.2 Savings and investment

Higher post-reform increases in agricultural output resulted in higher non-agricultural output. I will later provide supplementary evidence that suggests that linkages identified are primarily due to capital market frictions resulting in savings from agriculture being invested in the local non agricultural sector and "local money stay[ing] local" (Naughton, 2007, p. 279). 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 areas with a comparative advantage in cash crops also had faster post reform growth in household savings and investment in fixed assets.

Table 9 Column 1 provides the baseline results. For savings, a one standard deviation increase in the comparative advantage in cash crops is associated with 19% higher savings deposits (a stock) in 1985 and an average of 23% higher savings deposits from 1990-2008. The results are significant at the 10% level. Households appear to save 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 investment is associate with around a 35% increase in investment in fixed assets. This estimate is significant at the 1% level. Data on investment in fixed assets and, in particular, savings deposits, is less widely available than data on agricultural and non-agricultural output and so the precision of the estimates is reduced accordingly.

Figure 7 plots coefficients for interactions for each year from 1965-2008. The coefficients for savings mirror those for agricultural output, while those for investment 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 exist in order to make the coefficients more directly 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 Disentangling the mechanisms

In Section 3 I outlined three mechanisms that could potentially link speicialisation in cash crops to non-agricultural output. Higher demand from richer farmers, a reduction in agricultural labour demand, or an increase in rural savings. The results presented so far are broadly consistent with each of these mechanisms, however I derived a number of additional testable implications of the model that allow me to identify the channel of primary importance

1. If specialisation in cash crops is labour saving then the share of labour in agriculture must fall;
2. If higher agricultural surpluses increased the supply of capital to local firms, then the non-state firms affected by capital market frictions should face cheaper capital in areas with a comparative advantage in cash crops;
3. If increases in local demand are important, then comparative advantage in cash crops should have a stronger effect on post-reform non-agricultural output growth in more remote counties.

based on these implications, in this section I present additional results suggesting that the observed increases in agricultural output were primarily due to higher post-reform agricultural output increasing the supply of capital to the non-state sector.

Although I show that higher agricultural output resulted in faster growth in non-agricultural output by increasing the supply of capital, I cannot rule out the possibility that there were additional linkages I cannot identify with this data. The scope for identifying linkages due to higher rural incomes increasing the demand for non-agricultural output is limited because counties small size and relative openness to trade in goods limits the extent to which higher local demand will increase the relative price of non-agricultural output. Similarly, because the variation in agricultural output comes from specialisation in cash crops, the results do not directly speak to the effects of 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.

Agricultural labour shares

If growing cash crops is labour saving compared to growing grain, the agricultural share of the labour force should decline in areas specialising in cash crops. 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. This is not indicative that cash crops are likely to be significantly less labour intensive than grains. Nevertheless, in this section I use census data to directly test

whether the share of labour working in agriculture declines in areas with a comparative advantage in 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, hence the 'agricultural labour share'.[43] I link the data for the subset of counties which do not experience significant border changes.[44] I then regress the agricultural labour share (0-100 %) on my measure of comparative advantage in cash crops interacted with dummies for 1990 and 2000. As always I include a full set of province-time and county 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 comparative advantage in cash crops is associates with a 1.3-1.6 percentage point smaller decline in the agricultural labour share between 1982 and 1990. This decline is significant at the 5% level.[45] ith this differential constant between 1990 and 2000. These results suggest that specialisation in cash crops increased the return to working in agriculture with a corresponding (relative) increase in the share of labour employed. In Figure 4 we saw that the gains from speicialisation in cash crops were fully realised by 1990 so it is reassuring that we see no further increase in the agricultural labour share after this. 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.[46] The results are robust to all of these changes.

The share of labour in the agricultural sector declines in areas with a comparative advantage in cash crops however, if this decline was due to previously discouraged workers entering the labour force, this would not necessarily reduce the supply of labour to the non-agricultural sector. I test this by estimating the effect of comparative advantage in cash crops on the log labour force (Columns 5 & 6). There is not statistically or economically difference in growth of the labour force between 1982 and 1990 in areas with or without a comparative advantage in cash crops; in the short run increased labour supply could not have compensated for the increase in rural labour demand. In the absence of other compensating factors, non-agricultural output is likely to fall as it does in Foster and Rosenzweig (2004) and Bustos et al. (2013).

Factor prices and firms level factor utilisation

Higher agricultural surpluses increasing the the supply of capital to non-state firms had clear implications for factor prices in the theoretical framework outlined in Section

[43] 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.

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

[45] 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 also provide very similar results.

[46] 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.

3. Non-state firms in areas with a comparative advantage in cash crops ought to face lower costs of capital, while both state and non-state firms face higher labour costs. These predictions are reversed if, instead, the increase in non-agricultural output was due to a reduction in the agricultural demand for labour.

Unfortunately, I do not directly observe the factor prices faced by firms. However, by adding a little structure to the firms production function I can obtain an expression which allows factor prices to be inferred from a firm's total wage bill wl and capital utilisation k, both of which I do observe.[47] Suppose that firms 'unit cost' functions $c^*(w, r)$ are CES 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

$$\ln\left(\frac{wl}{k}\right) = \sigma \ln\left(\frac{1-\alpha}{\alpha}\right) + \sigma \ln(r) + (1-\sigma)\ln(w) \tag{10}$$

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 in this context. Consequently, if comparative advantage in cash crops increased the demand for labour (increasing the wage) but increased the supply of capital for non-state firms (reducing their rental rate), then all firms located in counties with a comparative advantage in cash crops will have lower wage-capital ratios, but non-state firms wage-capital ratios will be especially low.

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

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

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. CA_i is the comparative advantage in 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 comparative advantage 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 comparative advantage in cash crops other than through factors contained in the fixed-effect, differences in factor usage between firms located in counties with and without a comparative advantage in cash crops can be attributed to differences in factor prices.

Table 11 contains these results. For non-state firms, a one standard deviation in comparative advantage is associated with a reduction in the ratio of total wages to capital by around 8%. This is significant at the 1% level. The point estimate for state owned firms is much smaller, indicating a fall in the wage-capital ratio of 3%, and is

[47] Unfortunately, my data do not contain information on l, however given heterogeneity in worker quality the use of wl may be preferable anyway.

statistically insignificant (albeit imprecisely estimated). 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 comparative advantage in cash crops being associated with higher wages for state and non-state firms, and cheaper capital for non-state firms. This is the pattern of factor 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.[48]

Local demand and 'openness'

If higher agricultural output increases the local demand for non-agricultural output then unless the supply of non-agricultural output is perfectly elastic the relative price of non-agricultural output will increase, as will the output of the local non-agricultural sector. The supply of non-agricultural output, including imports, is likely to be more elastic in more open areas, so a given increase in demand will result in a smaller increases in price and local output — if the demand channel dominates, then non-agricultural output should increase more strongly in comparative advantage in less open areas.

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.[49] Clearly the location of International Airports in 2007 is endogenous to growth but likely captures most of China's major cities. The location of Historic Cities was determined at least 60 years before the reforms, but may 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 than isolated ares such as rural Gansu.

Table 12 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 interests, 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 higher demand will result in smaller price increases in more open economies, increases in the supply of a good will depress the results less. 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

[48]Note that if, counter to evidence, we assume that assuming that $0 < \sigma < 1$ then these results indicate that comparative advantage in cash crops is associated with lower wages and lower capital costs, which would suggest a figure of savings and increased supply of labour.

[49]For a description of this data see Appendix C.

as an increase in supply of capital would.

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. In general it is not clear whether nationwide linkages would be stronger or weaker than the ones identified here. 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 for non-agricultural output as it does in the closed economy models of structural transformation of Echevarria (1997), Kongsamut et al. (2001) 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.

6.5 Migration and population

As discussed in Section 2, the *hukou* system significantly restricted labour mobility in China, particularly before the end of grain rationing in 1994. However, if comparative advantage was nevertheless associated with substantial migration, the interpretation of my results would be quite different. I explore this possibility in three ways. First, I check whether counties with a comparative advantage in cash crops have a disproportionate number of migrants in the 1990 census. Second, I test whether counties with a comparative advantage in cash crops had faster post-reform growth in population. Third, I control directly for population in my main regressions. In no case is a substantial migration response evident.

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 use the location data in the census to link individuals to the comparative advantage of the county they reside in. I regress my migrant dummy on comparative advantage to test whether individuals are more likely to be migrants in counties suited to cash crops. Table 13 contains the results. Column 1 indicates that the probability of being a migrant and comparative advantage in cash crops are almost uncorrelated. Column 2 and Column 3 introduce province fixed effects, and then individual level controls for age, education status and gender. Migrant status and comparative advantage remain uncorrelated in both specifications. In all cases the estimated coefficients are small relative to the baseline probability of being a migrant.

In 1990 there was no detectable relationship between comparative advantage in cash crops and the number of resident migrants.

Population

Not observing differential migration in the cross-section does not necessarily mean there were no differential changes in migration over time. Alternatively, it is possible that increases in in-migration to counties with a comparative advantage in cash crops was perfectly offset by a decrease in out-migration. Although I do not observe migration in multiple years, counties with more in-migration will also tend to have faster population growth. The Anniversary Yearbooks contain population data for my panel of counties so I can test this directly. One disadvantage with this measure is that it is based on a mixture of surveys and *hukou* registrations. 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 likely undercounts migrants. An alternative measure, which I call 'imputed population', can be calculated using data on GDP and GDP per capita, both of which explicitly include migrants (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 comparative advantage 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 and are consistent with the findings of Marden (2014) who shows that larger post-reform increases in agricultural output were associated with higher fertility. 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 re-estimate my main results directly controlling for my measures of population. The coefficients on comparative advantage are, if anything, slightly larger than my baseline results which does not support the idea that the increase in output was primarily 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, the coefficients on imputed population are not statistically significant and close to zero. Given that these measures are supposed to better capture migration we might have expected the coefficients to be larger, especially in light of the fact that the two measures of population are extremely strongly 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.

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 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).

As with any empirical study, the context of the study is important for understanding the wider applicability of the results. As mentioned, accumulation of capital has also been cited as one factor behind the rapid growth of many of the fast growing East Asian economies. 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 who development happens. 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 cofounders 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.

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Appendices

A Proofs of Comparative Statics

To be added.

B Simulations of the Model

To be added.

C Additional Data Sources

C.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 comparative advantage is calculated in an almost identical fashion to that which I calculate county-level comparative advantage i.e. I take the simple average of comparative advantage in cash crops for each cell in the province. One minor difference is that instead of normalising using the provincial standard deviation of comparative advantage (0.3) I normalise using the county level standard deviation (0.4). This ensures that the coefficients refer to the same absolute change in comparative advantage and are thus directly comparable. Normalising by the provincial level comparative advantage would reduce the absolute size of my estimated coefficients in Table 5 Columns 4-7, strengthening the case that it is important to obtain data on comparative advantage at a fine level of spatial variation.

C.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 do not have this number exactly 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). 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).

C.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 are the set historical cities used by Banerjee et al. (2012) and the full set of treaty ports.[50] The location of international airports was obtained from the ACASIAN Data Centre's map of Chinese International Airports in 2007.

D Aggregate Gains

Table 4, contains back of the envelope estimates of the aggregate additional increase in agricultural output. I calculate this total increase in a number of different ways. Depending on the calculation specialisation increased agricultural output by 10-16% between 1978 and 1985; equivalent to between 1/6 and 1/4 of the total increase in agricultural output. This is approximately 2/3 the size of the increase directly attributed to the introduction of the Household Responsibility System (Lin, 1992).

These calculations are based on the fitted values from a number of different regression specifications. If we take the model seriously, the estimate coefficients provide estimates of the increase in agricultural output due to specialisation. For comparability with the previous literature exploring the reforms I focus only on the increase in agricultural output between 1978 and 1985 and the estimates are based on regressions using only these two years of data. As well as assuming the benefits of specialisation are linear in comparative advantage (as in my baseline specification), I also allow for gains to vary by least-squares groups, quartiles, tertiles.[51] In the linear case I assume counties below the 25th percentile of comparative advantage do not benefit at all from specialisation. When estimating gains by groups I assume the group with the lowest level of comparative advantage does not gain from specialisation.

In Panel A, I use the fitted values and regression coefficients to calculate fitted output in 1985 and counterfactual fitted output if there had been no specialisation. The results of this exercise indicate that agricultural output was between 12.7 and 15.0 percent higher than it otherwise would have been in 1985 due to specialisation.

The output data used in this paper is in nominal terms. However, because I include province-by-time FE and specify my regressions in logs, the treatment effects are net of price changes that are common within provinces. This is desirable from the perspective of interpretation, but makes the use of fitted values to calculate the *share* of the total

[50] 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.

[51] Because I extrapolate the gains across the whole of China below, the group cutoffs are defined as the percentiles for the whole of China, not those used in the estimating sample. The estimated gains do not change substantively if the groups are defined within sample.

increase in output due to specialisation problematic. One solution would be to apply the appropriate deflator to my primary GDP data. Unfortunately, the available primary GDP deflators are of dubious quality for this period and as the results of this exercise are very sensitive to the choice of the deflator, I do not report this figure for a log specification.

However, in Panel B, I report comparable results where agricultural output was included in levels. When estimated in levels, agricultural output is estimated to have been between 10.1 and 16.4 percent higher than it otherwise would have been in 1985 — quite similar to that when estimated in logs. Because the impact of inflation is now in the estimated coefficients, I can also calculate the share of the increase in output due to specialisation; between 16 and 25 percent in my sample counties.

The estimates in Panels A and B apply only to the counties for which I have agricultural output data. To compare the increase due to specialisation to the estimates of the increase in output due to the Household Responsibility System provided by Lin (1992) and McMillan et al. (1989) we need to extrapolate the gains from these counties to the entire country. Because I only observe agricultural output for some counties, to estimate national gains I make two further assumptions: (1) conditional on comparative advantage, gains due to specialisation are the same for counties not in my sample as for those in my sample; and (2), that each county in each province had a share of provincial 1978 agricultural output equal to its share of that province's 1982 agricultural population.

Under these assumptions, my results suggest that the reform-induced specialisation increased agricultural output across the whole of China by between 14.1 and 17.9 in 1985. These estimates are slightly higher than the estimated gains within my sample. Because my main data set is based on 1999 boundaries which are different to the 1982 census boundaries it is not possible to directly check the extent to which this is due to the use of agricultural population shares instead of agricultural output as opposed to different endowments of comparative advantage. However, I can calculate gains based on 1982 agricultural population shares for the provinces and prefectures in my dataset. When I do this the overall increases are similar to those obtained using fitted values; most of the difference is probably due to different endowments of comparative advantage.

Overall, reform induced specialisation appears to have increased agricultural output by around 13-15 percent in China in 1985 — about one-fifth of the total increase since 1978 and around 2/3 the increase attributed to the introduction of HRS. Given the time path of gains indicated in Figure 4, there was most likely a modest additional increase in agricultural output due to specialisation after 1985. Although the crudeness of the methodology suggests that we ought not to put too much weight on the exact figure, an increase of around 13-15% is both economically significant and consistent with Lardy (1983) who suggested that insufficient specialisation was significantly retarding agricultural output in the reform era.

E Robustness Checks

E.1 Geographic factors

Although there is considerable heterogeneity in comparative advantage in 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 the relative productivity of cash crops is a natural measure of the availability of gains from the reallocation of agricultural production towards comparative advantage 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, high absolute productivity in oilseeds could have meant that oilseed processing facilities were more likely to be founded in the area and, due to agglomeration effects, this may have translated into long term advantage. Table A1 includes regressions controlling for absolute productivities of grains and cash crops. My main results are almost unchanged while absolute advantage has no statistically significant 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. 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 comparative advantage. 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 A1 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.

E.2 Initial conditions

If initial economic conditions were correlated with comparative advantage, I could be erroneously attributing the effect of more favourable initial economic conditions, to the benefits of the reorientation of agriculture in line with comparative advantage. In Table A2 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 disportionate increase in the supply of capital to the non-agricultural sector.

In Table A3, 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.[52]

E.3 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 comparative advantage 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.[53] I also present results using the location of treaty ports and historic cities as an instrument for modern day locations of International Airports.

Table A4 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.

E.4 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 comparative advantage in cash crops either by chance, or because areas with a comparative advantage in 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 A5 includes the results of regressions including these as additional

[52] 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).

[53] Construction of this data is described in Appendix C

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.

E.5 Calculation of relative productivities and trimming

Table A6 re-estimates my main results with the relative productivity of 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.[54]

Changes in input intensity or prices used to calculate comparative advantage 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 re-estimate by baseline specification (Column 6). My results do not change significantly, assuaging fears that the results are due to outliers.

E.6 Omission of any particular province

Table A7 re-estimates 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 are no longer significant. Given the large number of counties and wide variation in comparative advantage in Hebei this is not entirely surprising.

[54]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 re-estimated excluding these counties but using irrigated

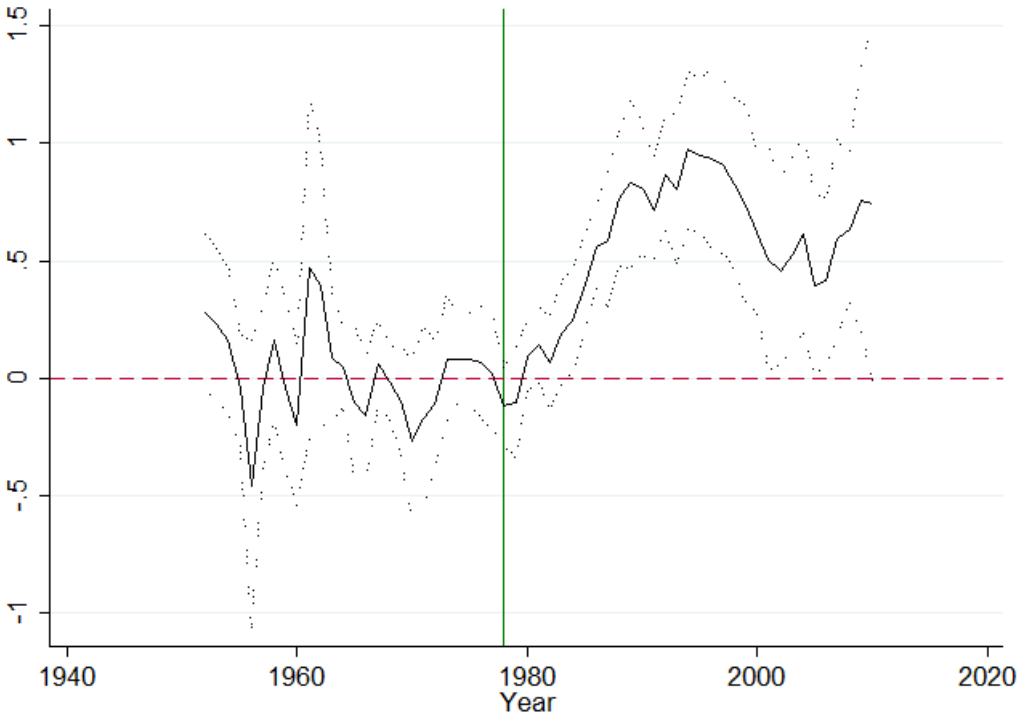


Figure 1: Coefficients on Feldstein-Horioka Regressions for 1952-2010: after the reforms there were substantial capital market frictions

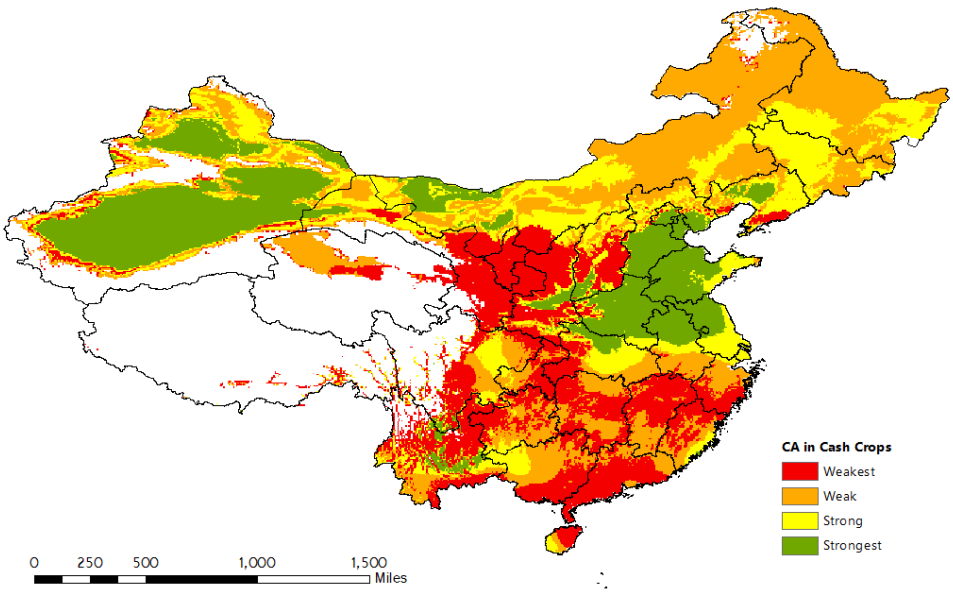


Figure 2: Comparative Advantage in Cash Crops ('greener' is stronger; four Jenks categories)

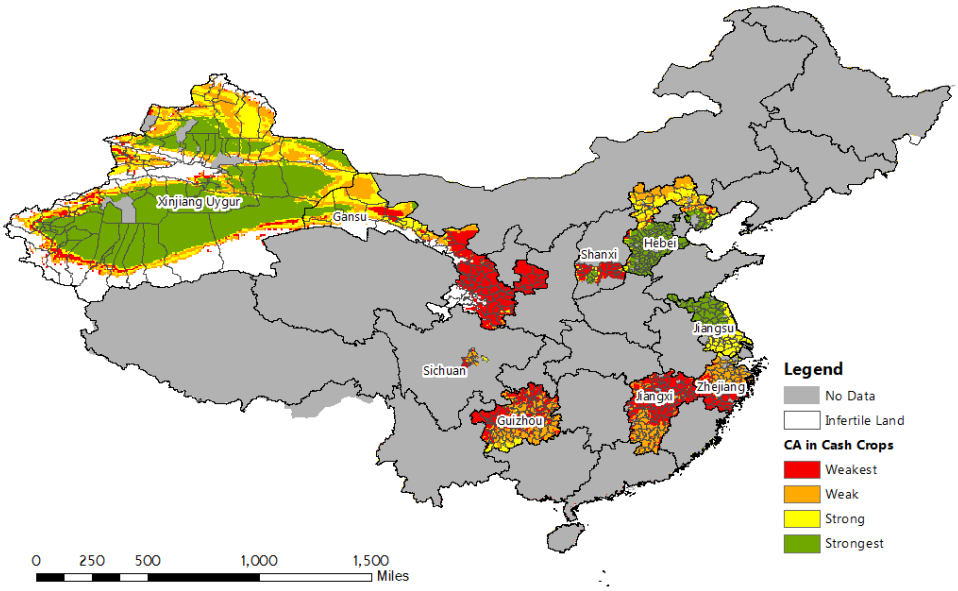


Figure 3: Data Availability: Counties in the Dataset, Shaded by CA in Cash Crops ('greener' is stronger)

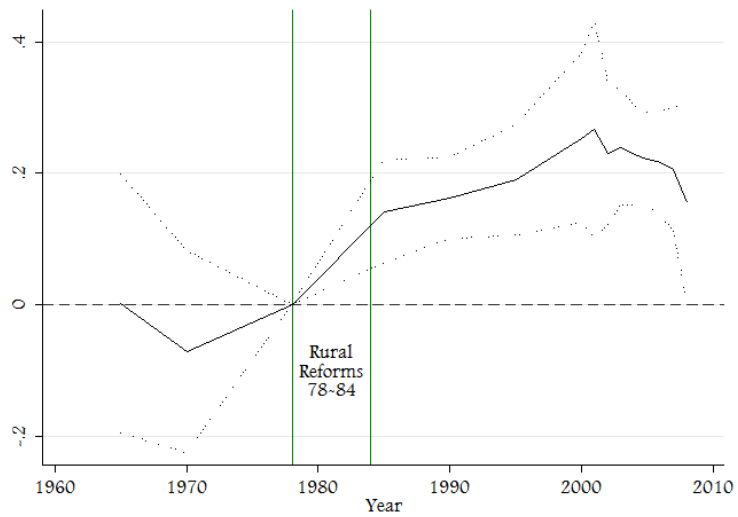
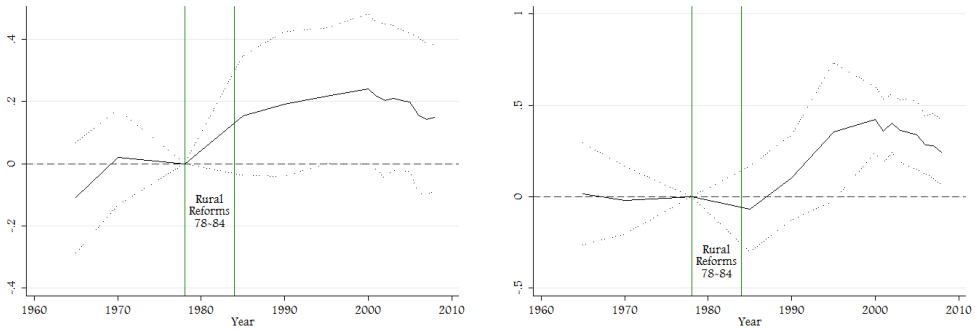


Figure 4: Coefficients of 'Year' × 'Comparative Advantage in Cash Crops' interactions (Dependent Variable: Ln Primary GDP)

A. Cotton B. Oilseeds

Figure 5: Comparative Advantage and the Share of Crops in Output

Figure 6: Coefficients of 'Year' × 'Comparative Advantage in Cash Crops' interactions (Dependent Variable: Ln non-Agricultural Output)



A. Savings Deposits of HH's B. Investment in Fixed Assets

Figure 7: Coefficients of 'Year' × 'Comparative Advantage in cash crops' Interactions

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
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 based on FAOSTAT. Cash Crops a simple average of indices of cotton, groundnuts and rapeseed (not USA) indices. Grains a simlpe 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 of Cotton in Output[1]	0.01	0.03	0.03	0.04
	(0.01)	(0.04)	(0.04)	(0.07)
Share of Oilseed in Output[1]	0.02	0.04	0.04	0.05
	(0.02)	(0.05)	(0.04)	(0.06)

B: (Surviving) Firms Per County from 1995 Industrial Census Founded Between...[5]

	Pre: 1966-1977	Post: 1978-1995
State Owned Firms	8.197	15.815
	(10.750)	(47.089)
non-state Firms	19.814	132.526
	(33.387)	(313.548)

C: Firm Level 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. In particular, coverage for Cotton, Oilseeds and Gross Agricultural Output is substantially less complete than for Population and GDP. Standard deviations in parentheses. Primary, Secondary and Tertiary GDP deflated by their respective national deflators. Savings and Investment deflated by the RPI.
(1) Share of Cotton (or Oilseed) in joint Cotton (or Oilseed) and Grain Tonnage (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 suprisingly, 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

agricultural productivities (these results not reported in tables).

Table 3: Agricultural Output

	Ln Primary GDP							*Ln Gross Ag. Y*		*Ln Rur. Ypc*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Comp. Adv in Cash	0.230***									
Crops × Post 78	(0.066)									
Comp. Adv in Cash		0.162***	0.181***	0.142**	0.141*	0.172***	0.131**	0.128*	0.169***	0.165***
Crops × 1985		(0.057)	(0.068)	(0.063)	(0.076)	(0.052)	(0.059)	(0.074)	(0.052)	(0.050)
Comp. Adv in Cash		0.236***	0.249***	0.203**	0.248**	0.245***	0.261***	0.215*	0.236***	0.215***
Crops × Post 85		(0.068)	(0.077)	(0.085)	(0.104)	(0.059)	(0.071)	(0.128)	(0.090)	(0.057)
Comp. Adv in Cash					0.111					
Crops rest of Prefecture × 1985					(0.266)					
Comp. Adv in Cash					-0.062					
Crops rest of Prefecture × Post 85					(0.274)					
Observations	8000	8000	6105	8000	7974	7583	4199	4199	4778	7335
Counties	561	561	407	561	559	561	382	382	446	534
County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province x Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County Trends				Yes						
Data Restrictions			Balanced			No 1965	As (8)	As (7)		

Robust standard errors clustered at the prefecture and province × time levels to allow for autocorrelation over time and space. *** p<0.01, ** p<0.05, * p<0.1. Comparative advantage in 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 1978. All specifications use data from 1965, 1970, 1978, 1985, 1990, 1995, 2000 & 2000-2008.

Table 4: Estimated Increases in Agricultural Output (1978-1985) from Change in Planting Patterns

	Gains from reallocation differ by ...			
	Least Squares Group (4)	Quartile	Tertile	Continuous
Zero Benefit Percentile	38	25	33	25
A. Gains calculated from fitted values (log specification)				
% Increase	13.1	15.0	13.6	12.7
B. Gains calculated from fitted values (levels specification)				
% Increase	16.4	15.9	12.6	10.1
Share of Total Increase	0.25	0.25	0.20	0.16
C. Gains imputed from 1982 agricultural employment (log specification growth)				
All China (%)	17.1	17.9	15.8	14.1
Sample Provinces (%)	14.1	15.6	14.3	11.6
Sample Provinces, no Cities (*Shi*) (%)	14.4	15.7	14.0	11.8

Table contains estimates total increase in agricultural output due specialisation. 'Zero percentile' is the percentile of county level comparative advantage in cash crops below which it is assumed that counties did not benefit at all from agricultural specialisation. Least Squares Groups divide counties into four groups which minimise the total within group squared deviations from mean group comparative advantage. Panel A and B are calculations based on fitted values from regressions where the outcome is specified in Logs and Levels respectively. Panel C imputes the increase based on coefficients obtained in Panel A weighted provincial Primary GDP in 1978 and county shares of provincial agricultural labour force in the 1982 population census.

Table 5: Agricultural Output: Level of Aggregation

	Ln Primary GDP (County)			*Ln Primary GDP (Province)*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Comp. Adv in Cash	0.230***	0.225***	0.150***	-0.000	0.047	0.022	0.031
Crops × Post 1978	(0.066)	(0.032)	(0.042)	(0.064)	(0.052)	(0.053)	(0.035)
Observations	8000	8000	8000	463	463	1862	1862
Groups	561	561	561	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 two-way cluster-robust standard errors clustered at the prefecture and province × time level. Columns 4-7 standard errors clustered at the provincial level. *** p<0.01, ** p<0.05, * p<0.1.

Columns 1-3 are estimated at the county level. Columns 4-7 at the province level. Comparative advantage in cash crops is the simple average of the ratio of the value of the 'best cash crop' to value of the 'best grain' averaged across every grid cell in the county (columns 1-3) or province (4-7), divided by the standard deviation of county level comparative advantages. Post78 is a dummy variable taking a value of 1 for all 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.

Table 6: The Pattern of Production

	Share of Cotton			*Share of Oilseeds*		
	(1)	(2)	(3)	(4)	(5)	(6)
Comp. Adv in Cotton × 1985	0.013*	0.015*	0.026***		-0.005*	
	(0.007)	(0.008)	(0.009)		(0.003)	
Comp. Adv in Cotton × Post85	0.011	0.014	0.024*		-0.001	
	(0.014)	(0.014)	(0.013)		(0.004)	
Comp. Adv in Oilseeds × 1985		-0.004		0.019**	0.017**	0.020**
		(0.010)		(0.008)	(0.008)	(0.008)
Comp. Adv in 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
State 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. Optimal share is predicted share of either Cotton (cols 1-3) or Oilseeds (cols 4-6) if farmers are revenue maximising and face the GAEZ productivities. Post85 is a dummy taking a value of 1 for all years after 1985, 1985 and 1970 are dummies for their respective years. All columns use data from 1970, 78, 85, 90, 95 and 2000-08. Panel A uses data from counties in Hebei, Jiangxi, Xinjiang which ever produce cotton. Panel B also uses data from Zhejiang and part of Sichuan.

Table 7: Non-Agricultural Output: Reduced Form Results

	Ln Non-Agricultural GDP			*Sec. GDP*	*Ter. GDP*
	(1)	(2)	(3)	(4)	(5)
Comp. Adv in Cash Crops × 1985	0.022	-0.016	0.022	0.023	0.009
	(0.031)	(0.023)	(0.046)	(0.064)	(0.035)
Comp. Adv in Cash Crops × Post 85	0.181**	0.167**	0.195**	0.197*	0.168***
	(0.072)	(0.081)	(0.083)	(0.106)	(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
State x Time FE	Yes	Yes	Yes	Yes	Yes
County Trends			Yes		
Data		Balanced			

Robust standard errors clustered at the prefecture and province × time levels to allow for autocorrelation over time and space. *** p<0.01, ** p<0.05, * p<0.1. Comparative advantage in 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. Post85 is a dummy taking a value of 1 for all years after 1985. 1985 and 1970 are dummies for their respective years. All columns other use data from 1965, 70, 78, 85, 90, 95, & 2000-08 and from counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan.

Table 8: Non-Agricultural Output: IV Results

	Ln Non-Agricultural GDP			Δ *Ln(Non-Ag Y)*$_{1978-2000}$	
	(1) OLS	(2) IV	(3) IV	(4) OLS	(5) IV
Ln Primary GDP	0.288***	0.729***	0.794***		
	(0.077)	(0.280)	(0.288)		
Δ Ln Primary GDP$_{1978-2000}$				0.372***	0.960***
				(0.094)	(0.203)
Observations	8023	7993	7993	532	530
Counties	563	561	561	532	530
First Stage as		Tab 3 (1)	Tab 3 (2)		
First Stage F		16.4	9.48		24.3
County FE	Yes	Yes	Yes		
State x Time FE	Yes	Yes	Yes		

Robust standard errors clustered at the prefecture and province $\times$ time levels to allow for autocorrelation over time and space (except for Columns 2 and 3, clustered at the prefecture level). *** p<0.01, ** p<0.05, * p<0.1. Comparative advantage in 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. Post85 is a dummy taking a value of 1 for all years after 1985. 1985 and 1970 are dummies for their respective years. All columns other use data from 1965, 70, 78, 85, 90, 95, & 2000-08 and from 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:				
Comp. Adv in Cash	0.185*	0.188*	0.180*	0.161
Crops × 1985	(0.100)	(0.106)	(0.102)	(0.123)
Comp. Adv in 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:				
Comp. Adv in Cash	-0.065	0.061	-0.076	-0.047
Crops × 1985	(0.136)	(0.112)	(0.162)	(0.146)
Comp. Adv in 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
State x Time FE	Yes	Yes	Yes	Yes
County Trends				Yes
Data		No Jiangsu	(A)=(B)	

Robust standard errors clustered at the prefecture and province × time levels to allow for autocorrelation over time and space (except for column 5, clustered at the prefecture level). *** p<0.01, ** p<0.05, * p<0.1. Comparative advantage in 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. Post85 is a dummy taking a value of 1 for all years after 1985. 1985 and 1970 are dummies for their respective years. 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*	
	(1)	(2)	(3)	(4)	(5)	(6)
Comparative Advantage	1.286**	1.261**	1.625**	1.507**	0.008	0.000
in Cash Crops × 1990	(0.603)	(0.574)	(0.600)	(0.552)	(0.008)	(0.007)
Comparative Advantage	1.067	0.996	1.754**	1.377*	-0.007	0.049
in Cash Crops × 2000	(0.802)	(0.785)	(0.817)	(0.694)	(0.031)	(0.030)
N	6425	6424	6424	6359	6424	6423
Counties	2142	2142	2142	2138	2142	2142
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Province-by-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
County Controls		Yes	Yes	Yes		Yes
Initial Labour Share			Yes	Yes		
Drop Outliers				Yes		
Mean Dep. Variable	74.6	74.6	74.6	74.9		

Robust standard errors clustered at the province level (29). *** p<0.01, ** p<0.05, * p<0.1. Comparative advantage in 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. The data used are the set of Chinese counties are the same in the 1982, 1990 and 2000 censuses excluding counties in Macao, Hong Kong and Tibet.

Table 11: Firms Factor Utilisation

	$\ln(\frac{wl}{k})$			
	(1)	(2)	(3)	(4)
Comparative Advantage in Cash Crops × non-SOE	-0.076***	-0.077***	-0.063***	-0.056***
	(0.019)	(0.018)	(0.021)	(0.020)
Comparative Advantage in 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. Comparative advantage in 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. Geographically the data covers all of China except for Tibet, Macao, Hong Kong, and cities whose metropolitan areas cover more than one district (about 200 counties in total). 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 5 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 12: Openness Interactions

	Ln Non-Primary GDP		
	(1) OLS	(2) OLS	(3) IV
Comp. Adv in Cash Crops × 1985	0.032	0.083**	0.050
	(0.041)	(0.037)	(0.049)
Comp. Adv in Cash Crops × 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 × CA × 1985	-0.043		-0.140*
	(0.047)		(0.080)
Ln Distance to Nearest Airport × CA × 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 × CA × 1985		-0.071**	
		(0.032)	
Ln Distance to Nearest Historical City × CA × Post 85		-0.088*	
		(0.052)	
Observations	7993	7993	7993
Counties	561	561	561
County FE	Yes	Yes	Yes
State x Time FE	Yes	Yes	Yes

Robust standard errors clustered at the prefecture and province × time levels to allow for autocorrelation over time and space (except for column 3, clustered at the prefecture level). *** p<0.01, ** p<0.05, * p<0.1. Comparative advantage in 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. Post85 is a dummy taking a value of 1 for all 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). Distance to Nearest Airport is distance between the county centroid and the nearest international airport in 1999. Distance to Historical City is distance from the nearest treaty port or historic city as in Banerjee et al. (2012). In column 3, distance to nearest international airport and the various interactions are instrumented for by distance to nearest historical city.

Table 13: Migration

	Migrant Dummy		
	(1)	(2)	(3)
Comparative Advantage in Cash Crops	-0.006	0.004	0.002
	(0.006)	(0.006)	(0.005)
People	1.05e+07	1.05e+07	1.05e+07
Province FE		Yes	Yes
Individual Controls			Yes
Migrant Share of Population	0.034	0.034	0.034

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). Indivdual 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. Standard errors clustered at the province level *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 14: Population

	Ln Population		*Ln Pop (Imputed)*		*Ln Primary GDP*		*Ln Non-Ag GDP*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Comp. Adv in 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)
Comp. Adv in 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				

Imputed population is the population of a county when it is inferred from GDP and GDP per capita i.e. $ImPop = \frac{GDP}{GDPpc}$. Comparative advantage in 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. Post85 is a dummy taking a value of 1 for all years after 1985. 1985 and 1970 are dummies for the respective years. All columns use data from 1965, 1970, 1978, 1985, 1990, 1995 & 2000-2008, and from counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and Changzhi prefecture (Shanxi). 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. Robust standard errors clustered at the prefecture and province × time levels to allow for autocorrelation over time and space *** p<0.01, ** p<0.05, * p<0.1.

Appendix Figures and Tables

Table A1: Geographical Conditions

	Ln Primary GDP			*Ln Non-Ag GDP*		
	(1)	(2)	(3)	(4)	(5)	(6)
Comp. Adv in Cash Crops × 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)
Comp. Adv in Cash Crops × 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 Value of Best Grain × 1985		-0.023			-0.092	
		(0.071)			(0.057)	
Ln Value of Best Grain × Post 85		0.061			-0.075	
		(0.064)			(0.090)	
Ln Value of Best non-Grain × 1985			-0.016			-0.080
			(0.069)			(0.053)
Ln Value of Best non-Grain × 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
State x Time FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors clustered at the prefecture and Province × time levels to allow for autocorrelation over time and space. *** p<0.01, ** p<0.05, * p<0.1. Comparative advantage in 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. Post85 is a dummy taking a value of 1 for all years after 1985. 1985 and 1970 are dummies for the respective years. All columns use data from 1965, 1970, 1978, 1985, 1990, 1995 & 2000-2008, and from counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan.

Table A2: Initial Economic Conditions

	Ln Primary GDP			*Ln Non-Ag GDP*		
	(1)	(2)	(3)	(4)	(5)	(6)
Comp. Adv in 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)
Comp. Adv in 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
State x Time FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors clustered at the prefecture and province × time levels to allow for autocorrelation over time and space. *** p<0.01, ** p<0.05, * p<0.1. Comparative advantage in 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. Post85 is a dummy taking a value of 1 for all years after 1985. 1985 and 1970 are dummies for the respective years. All columns use data from 1970, 1978, 1985, 1990, 1995 & 2000-2008, and from counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan.

Table A3: Initial Education

	Ln Primary GDP		*Ln Non-Ag GDP*	
	(1)	(2)	(3)	(4)
Comp. Adv in Cash Crops × 1985	0.152***	0.150***	0.013	0.015
	(0.058)	(0.056)	(0.030)	(0.031)
Comp. Adv in 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
State x Time FE	Yes	Yes	Yes	Yes

Robust standard errors clustered at the prefecture and province × time levels to allow for autocorrelation over time and space. *** p<0.01, ** p<0.05, * p<0.1. Comparative advantage in 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. Post85 is a dummy taking a value of 1 for all years after 1985. 1985 and 1970 are dummies for the respective years. County level education data obtained from the 1982 Population Census. The number of counties falls compared to the main regressions as counties with significant border changes between 1982 and 1999 are excluded. All columns use data from 1970, 1978, 1985, 1990, 1995 & 2000-2008, and from counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan.

Table A4: 'Openness' and Comparative Advantage

	Ln Primary GDP			*Ln Non-Agricultural GDP*		
	(1) OLS	(2) OLS	(3) IV	(4) OLS	(5) OLS	(6) IV
Comp. Adv in 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)
Comp. Adv in 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
State x Time FE	Yes	Yes	Yes	Yes	Yes	Yes
First Stage *F*			7.38			7.38

Comparative advantage in 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. 1985 and Post 1985 are dummy variables taking a value of 1 in the years 1985 and years after 1985 respectively. Distance to Nearest Historical city is the de-meaned crow-flies (Haversine) distance from the county centroid to the nearest Treaty Port or other Historic City (see Combes et al. (2013) or Banerjee et al. (2012) for more details). Distance to Nearest Airport is the de-meaned distance to the nearest International Airport in 2007 (Location of International Airports obtained from the ACASIAN data centre). In columns 3 and 6 distance from historic cities is used as an instrument for distance from the nearest international airport. All columns use data from 1965 1970, 1978, 1985, 1990, 1995 & 2000-2008, and from counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan. Robust standard errors clustered at the prefecture and province × time levels to allow for autocorrelation over time and space, except for IV regressions, clustered which are clustered at the prefecture level. *** p<0.01, ** p<0.05, * p<0.1.

Table A5: Special Economic Zones

	Ln Primary GDP		*Ln Non-Ag GDP*	
	(1)	(2)	(3)	(4)
Comp. Adv in Cash Crops × 1985	0.161***	0.162***	0.022	0.021
	(0.057)	(0.058)	(0.031)	(0.031)
Comp. Adv in 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
State x Time FE	Yes	Yes	Yes	Yes

Robust standard errors clustered at the prefecture and province × time levels to allow for autocorrelation over time and space. *** p<0.01, ** p<0.05, * p<0.1. Comparative advantage in 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. Post85 is a dummy taking a value of 1 for all years after 1985. 1985 and 1970 are dummies for the respective years. 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). All columns use data from 1970, 1978, 1985, 1990, 1995 & 2000-2007, and from counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan.

Table A6: 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:						
Comp. Adv in Cash	0.162***	0.017	0.151***	0.131***	0.139***	0.093*
Crops × 1985	(0.056)	(0.024)	(0.052)	(0.048)	(0.051)	(0.050)
Comp. Adv in Cash	0.236***	0.064**	0.227***	0.201***	0.210***	0.172***
Crops × Post 85	(0.068)	(0.033)	(0.063)	(0.060)	(0.063)	(0.066)
Observations	8000	7205	8000	8000	8000	7920
B. Ln Non-Ag GDP:						
Comp. Adv in Cash	0.022	0.014	0.022	0.018	0.020	0.022
Crops × 1985	(0.031)	(0.035)	(0.030)	(0.030)	(0.031)	(0.030)
Comp. Adv in Cash	0.181**	0.063*	0.172**	0.163**	0.170**	0.183***
Crops × Post 85	(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

Two way cluster-robust standard errors (Cameron et al., 2011) clustered at the prefecture and province × time level to allow for autocorrelation over time and space *** p<0.01, ** p<0.05, * p<0.1. Comparative advantage in cash crops 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. Post85 is a dummy taking a value of 1 for all years after 1985. 1985 and 1970 are dummies for the respective years. Column 1 contains my baseline results. All columns use data from 1970, 1978, 1985, 1990, 1995 & 2000-2008, and from counties in Gansu, Guizhou, Hebei, Jiangxi, Xinjiang, Zhejiang and parts of Shanxi and Sichuan. 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 particuarly unsuitable for analysis of agricultur in China (see Section E.5).

Table A7: 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									
Comp. Adv in 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)
Comp. Adv in 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									
Comp. Adv in 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)
Comp. Adv in 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									
Comp. Adv in 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)
Comp. Adv in 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									
Comp. Adv in 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)
Comp. Adv in 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

Comparative advantage in cash crops 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. 'Post 1985' and '1985' are dummies taking a value of 1 in all years after 1985 and 1985 respectively. All columns use data from 1965 1970, 1978, 1985, 1990, 1995 & 2000-2008. Two way cluster-robust standard errors (Cameron et al., 2011) clustered at the prefecture and province × time level to allow for autocorrelation over time and space. *** p<0.01, ** p<0.05, * p<0.1.