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Abstract:

Raising agricultural productivity in developing countries is often said to reduce poverty, though the empirical evidence is more nuanced. Productivity growth generates additional income and must benefit someone, though not necessarily the poor. It is conceivable that most, or even all of the benefits go to others. Using region-level data from Thailand, we study the relationship between agricultural productivity growth and rural poverty incidence. Our dependent variable is the annual rate of change in rural poverty incidence at the regional level between the years for which poverty data are available. Agricultural productivity is measured as the annual rate of change in regional agricultural productivity, covering the same time intervals as the poverty observations, but lagged one calendar year. Other control variables include regional non-agricultural incomes and the real price of food. The estimated coefficient on the change in agricultural productivity is negative and highly significant, implying that agricultural productivity growth does reduce rural poverty, holding other variables constant. Nevertheless, the poverty-reducing contribution of recent productivity growth is small. The poverty-reducing effects of long-term drivers of agricultural productivity growth are also studied using simulations based on the estimated model.

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Agricultural Productivity Growth and Poverty Reduction: Evidence from Thailand

Peter Warr and Waleerat Suphannachart

1. Introduction

‘It’s been proven that of all the interventions designed to reduce poverty, improving agricultural productivity is the best. All the other different economic activity—yes, it trickles down. But nothing as efficiently as in agriculture.’

Bill Gates, chairman of Microsoft Corporation and co-founder of the Bill and Melinda Gates Foundation, testimony to US Senate Committee, 2013.¹

Was Gates right? It seems intuitive that agricultural productivity growth will reduce poverty. But is that effect really larger than productivity growth in other sectors? In popular discussion of economic development, casual theorising is common, along the lines that: (a) in poor countries huge numbers of poor people are concentrated in agriculture, and (b) therefore, raising agricultural productivity must be the best way to reduce poverty. Although this account is plausible, generalised and *ad hoc* arguments like this are not necessarily reliable.

Productivity growth generates new income which must accrue to someone, but who? Does an increase in aggregate measured productivity within agriculture necessarily mean that the productivity of poor agricultural producers also increases? Suppose it does, but that the economic effect of that productivity growth is mainly to raise the return to land. If land ownership is unequal, the benefits might be concentrated on better-off (land owning) people, rather than the poor. Is it possible that in some instances non-poor groups, such as large landowners and possibly marketing agents, along with non-poor urban consumers, manage to capture most of the benefits? Is the increase in aggregate income generated by

¹ Available at: <<http://www.farmersfeedingtheworld.org/events/briefing-with-bill-gates/>> (accessed 7 October 2016).

measured agricultural productivity growth necessarily more effective in reducing poverty than other sources of income, or does this outcome depend on local circumstances? Finally, suppose a one unit increase in agricultural productivity growth (measured, say, as contribution to aggregate GDP) does indeed reduce poverty more than a comparable increase in productivity in other sectors. Which is ‘best’ surely depends also on the relative costs of achieving these productivity gains.

Two components to Gates’ proposition are: (i) productivity growth in agriculture does reduce poverty; and (ii) it does so more effectively than productivity growth in any other sector. In the empirical literature, there is abundant but not unanimous support for (i), but (ii) is actively contested. The proposition has potential implications for public expenditure allocation and private philanthropic funding. Vested interests are inevitable. The literature on this important issue also suffers from what Dercon and Gollin (2014, p. 474) call a “tendency toward generalization”. It is possible that the validity of (ii) varies between countries, within countries, and even over time, depending on the economic features of the productivity growth that occurs in the various sectors and the changing socio-economic characteristics of the society concerned, including the distribution of agricultural factor ownership.

We examine some of these questions empirically, focusing on Thailand, a middle-income developing country where measured poverty incidence has declined dramatically in recent decades. Since poverty in Thailand is heavily rural, the analysis focuses on poverty reduction within rural areas. The Thai experience is a highly successful example of rural poverty alleviation. To what extent, if any, did productivity growth in agriculture lead to the huge reductions in rural poverty that have occurred?

Section 2 distinguishes between agricultural output growth and agricultural productivity growth and briefly reviews the international empirical literature on the poverty-

reducing effects of both, relative to other sectors. We demonstrate that the evidence is mixed and not readily generalised, thus motivating the empirical analysis for Thailand that follows.² Section 3 develops our empirical regression models and section 4 describes the Thai data sources, covering the three and a half decades following the mid-1980s. Section 5 summarises the statistical findings. In section 6 these results are used to estimate the contribution that agricultural productivity growth has made to rural poverty reduction and in Section 7 they are used to estimate the poverty-reducing impact of two long-term drivers of productivity growth – agricultural research and rural infrastructure investment. Section 8 concludes.

2. Literature review

In their seminal paper on the role of agriculture in economic development, Johnston and Mellor (1961) made the important distinction between the developmental effects of expanding agricultural output through (1) increased application of conventional (on-farm) inputs of land, labour and capital, and (2) through non-conventional (off-farm) inputs including research, education, marketing and transport infrastructure, and rural education. Channel (2) increases the measured productivity of the on-farm inputs, as captured in farm-level total factor productivity growth studies. Johnston and Mellor focused on the impact that productivity growth has on average per capita incomes, rather than the incomes of particular sub-groups, such as those with incomes (or expenditures) below the poverty line. Subsequent literature has emphasised these distributional issues more strongly. Nevertheless, in much of this empirical literature the distinction between components (1) and (2) above has often been overlooked.

² More comprehensive literature surveys, focusing on the poverty-reducing power of agricultural growth, are provided in Thirtle *et al.* (2001), Dercon and Gollin (2014) and Fuglie *et al.* (2020).

It should not be assumed that the poverty-reducing effects of sectoral output growth and productivity growth are the same, or even similar. Suppose (Scenario I) that there is no change in farm-level agricultural productivity. Any agricultural output (value-added) growth would then be due to the expanded use of conventional on-farm primary factor inputs. Under constant returns to scale, the cost of these additional inputs would be equal to the value of the additional output they produced. The net impact on farm incomes might be small or even zero. But non-farm rural incomes might be affected, particularly through the wage effects of expanded on-farm employment, and food prices might also be affected, depending on the tradability of these commodities.

Alternatively, suppose (Scenario II) that factor input growth was zero and that productivity increased. In this case – since the additional output has no opportunity cost, for the farmer at least – farm incomes would presumably rise, though not necessarily capturing all or even most of the benefits. If the expanded output entailed increased on-farm employment, rural wages might be affected, but not otherwise. Food prices might again decline. It is indeed possible (Scenario III) that measured total factor productivity growth (TFPG) would take the form of reduced primary factor inputs into agriculture, with no increase in output. Agriculture's total contribution to GDP would not rise at all and food prices would not necessarily be affected, but the resources released from agriculture might raise GDP elsewhere. Agriculture's proportional contribution to measured GDP growth would fall. In short, agricultural output growth and agricultural productivity growth have different economic consequences and may affect poverty incidence differently as a consequence.

Agricultural output growth and poverty reduction

Empirical studies include those that compare agriculture with an aggregate called ‘non-agriculture’ and those that disaggregate the latter – at least into industry and services. Studies in the first category have often, but not always, found that income growth from agriculture reduces poverty significantly, and more than ‘non-agriculture’. Studies in the second category have generally, but not always, also found that agricultural growth generates statistically significant poverty reduction, but that the effects of non-agricultural growth vary greatly among sectors, some of which may be more poverty-reducing than agriculture, others much less so.

Cross-country studies include Hasan and Quibria (2004), presenting evidence that the most poverty-reducing form of sectoral growth can be agriculture (as in Sub-Saharan Africa), industry (East Asia) or services (Latin America). Christiaensen *et al.* (2011) used a cross-country data set that distinguished agricultural and non-agricultural growth. At a \$1-day poverty line, agricultural growth was significantly more poverty-reducing than non-agricultural growth, provided the country was ‘not too unequal’. But at a \$2-day poverty line, the reverse applied (including Sub-Saharan Africa), especially in countries where extractive non-agricultural industries were less important. Since ‘non-agriculture’ is a diverse aggregate, these results imply that growth of at least some non-agricultural sectors (not including extractive industries) was more poverty-reducing at a \$2-day poverty line than agriculture. It is unclear whether this was true at \$1-day.

These findings were reinforced by Ligon and Sadoulet (2018), using a pooled time-series and cross-country dataset, which also distinguished agriculture and non-agriculture, again without disaggregating the latter. The authors’ conclusions emphasised the heterogeneity of the results among countries, but among the poorest people in the poorest countries the estimated income effect of growth in agriculture exceeded that for non-

agriculture by a factor of 3, while this difference steadily vanished at higher levels of average income, both within and across countries. Ligon and Sadoulet's important findings show that the greater poverty-reducing effect of growth arising from agriculture than from other sectors is a feature of the poorest countries, but this differential effect diminishes as average incomes increase from the least developed countries to middle income countries and beyond.

Moreover, within countries the differential poverty-reducing contribution of growth from agriculture diminishes when poverty is measured at higher poverty lines.

Country or region-specific studies of Asia have generally found that agricultural output growth does contribute significantly to poverty reduction. Ravallion and Chen (2007) found that in China agricultural growth was significantly more poverty-reducing than either industry or services. Studies for other countries have found that the contribution of services growth, especially rural services, has been even larger than agriculture, while the poverty-reducing effect of industrial growth was small.³ Examples are Ravallion and Datt (1996) for India, Warr (2006, 2014) for Southeast Asia, and Suryahadi *et al.* (2009) for Indonesia.⁴ For Latin America, de Janvry and Sadoulet (2000) found services growth to be highly poverty-reducing within both rural and urban areas while agricultural and industrial growth each had no significant impact on either, implying that "differential growth of the services sector has been key in reducing the growth of both urban and rural poverty." (p. 285).

In the many studies of this issue in India the findings are vigorously contested, even including whether agricultural productivity growth reduces poverty at all. Ahluwalia (1978, p. 320) states that "there is evidence of some trickle down associated with agricultural growth", but Saith (1981, p. 205) concludes the opposite, regarding agricultural growth and rural poverty: "there can be little doubt that current growth processes have served as

³ Consistent with the later East Asia findings of Hasan and Quibria, Warr and Wang (1999) found that in the case of Taiwan growth of industry was more poverty-reducing than either agriculture or services.

⁴ Loayza and Raddatz (2010) attribute these diverse sectoral outcomes to differences in the labour-intensity of production, drawing particular attention to the poverty-reducing power of the construction sector.

generators of poverty.” Datt and Ravallion (1998, p. 62) observed that studies of Indian household survey data, using the same sources and covering roughly the same time periods, have sometimes produced directly opposing conclusions. For example, Singh (1990) states that “rapid agricultural growth has benefitted all classes of the poor”, whereas Gaiha (1995, p. 285) concludes from similar data that “acceleration in agricultural growth by itself is unlikely to make a dent in rural poverty.”

In a recent study on five African countries, Dorosh and Thurlow (2018) report simulations of the poverty-reducing power of economic growth using a CGE approach based on social accounting matrices. The elasticity of poverty with respect to growth was found to be higher for agriculture than the average for ‘non-agriculture’. The heterogeneity of ‘non-agriculture’ is emphasised, however, and for some industries, such as manufacturing, trade and transport, the above conclusion is reversed.

Clearly, the composition of ‘non-agriculture’ in a particular country at a particular time is crucial for any overall agriculture / non-agriculture comparison. But, as de Janvry and Sadoulet (2010) point out, ‘agriculture’ is also a heterogeneous aggregate. Its composition varies greatly and within it the poverty reduction / agricultural growth relationship is also likely to vary.

Agricultural productivity growth and poverty reduction

Studies on the effects of agricultural productivity growth are less numerous than those on output growth. In many studies, the quantitative analysis concentrates on testing the null hypothesis that productivity growth has zero effect on the welfare of the poor. Most such studies, but not all, reject that hypothesis. Too often, however, this is the end of the analysis. ‘Statistically significant’ does not mean ‘large’. We wish to know the *size* of the resulting

poverty-reducing contribution and how it compares with other possible sources of poverty reduction.

Thirtle *et al.* (2001) surveyed the cross-country and country-specific empirical literature and concluded that productivity growth in agriculture is generally the most poverty-reducing, conditional on equitable land distribution. In an extensive cross-country analysis, Irz *et al.* (2001) study the effects of agricultural productivity growth on poverty alleviation and find positive effects overall. In wording similar to that later used, less cautiously, by Bill Gates, Irz *et al.* speculate that: “It is unlikely that there are many other developmental interventions capable of reducing the numbers in poverty so effectively.” (p. 451) and “... it is a fair guess that rather few alternatives will show a better return.” (p. 462). In his spoken testimony, Gates was understandably using the word “proven” in a rhetorical, non-scientific way. He meant that there was strong evidence supporting his statement, which is somewhat different from “a fair guess”.

An empirical attempt to compare the poverty-reducing power of productivity growth in agriculture with that arising from other sources was contained in a famous survey article by Timmer (2002). Based on a multi-country data set, Timmer concluded that agricultural productivity growth does benefit the poorest groups, but that in countries where agricultural and non-agricultural incomes differ widely (which means most poor countries) “growth in agricultural productivity is no more successful in alleviating poverty than growth in the non-agricultural economy.” (p. 1534).

Very different conclusions were reached by Thirtle, Lin and Piesse (2003), in a further cross-country regression-based study of the impact of research-led growth of labour and land productivity in agriculture in Africa, Asia and Latin America. Their study, focusing on the percentage of the population living on less than \$1-day, concluded that growth of labour productivity in agriculture is poverty-reducing, except in Latin America, where

inequality of land holdings prevents the poor from benefiting. In contrast, labour productivity growth in industry and services did not reduce poverty significantly.

Similarly, an important recent World Bank review of agricultural productivity states that “productivity growth in agriculture has the largest impact of any sector on poverty reduction.” (Fuglie *et al.* 2020, p. xxi) This conclusion draws heavily on an earlier World Bank study (Ivanic and Martin 2018), which applies a global general equilibrium model (the GTAP model) to simulate the effects that hypothetical factor-neutral improvements in agricultural productivity, rather than empirically observed productivity growth, might have on poverty incidence in developing countries, compared with similar hypothetical productivity gains in other sectors. The imposed assumption of factor-neutral productivity growth is important because it implies that productivity growth uniformly increases the demand for all factors of production in all locations.⁵

Ivanic and Martin conclude from these simulations that when the assumed rate of productivity growth is the same in all sectors “in the majority of developing countries, poverty reductions through improvements in agriculture are frequently on par with the gains from equally sized productivity gains in all other sectors.” (p. 438) When the assumed rates of productivity growth are rescaled to reflect the magnitude of sectoral contributions to GDP, the simulations indicate that “productivity gains in agriculture are generally, but not always, more effective in reducing global poverty than equivalent-sized productivity gains in industry or services.” (p. 437). These findings, carefully qualified by the authors, are interesting and important but they are less conclusive than the generalisations that Fuglie *et al.* draw from them.

⁵ Factor-biased productivity growth can have very different distributional implications from this, depending on the characteristics of factor ownership in the country concerned (Nguyen and Warr 2020).

Country-specific studies on the poverty-reducing effects of productivity growth are numerous. An analytical problem is that many studies rely on cross-sectional farm-level analysis, comparing adopters of new, productivity-raising technologies with non-adopters. Adoption is endogenous. Adopters and non-adopters were presumably different to begin with, raising the possibility that these unobserved *ex ante* differences contributed to *ex post* differences in rates of poverty reduction.

In Africa, Adekambi *et al.* (2009) use panel data econometric analysis to argue that productivity growth through adoption of newly developed varieties of rice in Benin has positive and statistically significant effects on poverty reduction. Alene and Coulibaly (2009) present data for 27 Sub-Saharan African countries, indicating that agricultural research has statistically significant impacts on productivity and per capita incomes, and infer from this that it contributes to poverty reduction. Similarly, Abro *et al.* (2014) provide evidence that productivity growth produces statistically significant poverty reduction effects in Ethiopia. On the other hand, Cunguara and Darnhofer (2011) use household survey data from Mozambique to study the effect that increased productivity through adoption of improved technologies had on household incomes. They are unable to reject the hypothesis of zero impact.

Notwithstanding the diversity of findings, the balance of the empirical evidence suggests that for the poorest people in the poorest countries, Gates was largely right – provided the distribution of land is ‘not too unequal’. For all other poor people, the evidence is mixed and generalisation is surely dangerous. ‘Agriculture’ is so heterogeneous that, to a large extent, the true underlying relationship between agricultural productivity growth and poverty reduction seems to be case-specific, reflecting differences in local circumstances.

3. Regression framework

Our objective is to use Thai data to quantify the impact, if any, that productivity growth in agriculture has on rural poverty incidence within Thailand, holding other relevant variables constant. The following section on data explains the focus on rural poverty and the regions covered. Four regression models are developed sequentially below, using a conceptual framework that is original to this paper, reflecting hypotheses about the determinants of rural poverty reduction. This discussion culminates in the fourth and preferred model (Regression 2B).

Conceptual Model 1

We begin with the hypothesis that the level of rural poverty incidence depends on the level of real agricultural income and the level of real non-agricultural income, with the two measured separately as agricultural and non-agricultural components of regional real GDP, and the consumer price of food relative to other consumer prices. ‘Real income’ here means region-level mean agricultural and non-agricultural GDP (value-added) per capita deflated by the region-level consumer price index (CPI). ‘Rural’ is not the same as ‘agricultural’. Rural people earn incomes from both agricultural and non-agricultural activities.

We should not expect these ‘real’ income variables to explain poverty incidence adequately, partly because of the deflator. The regional CPI reflects average budget shares for consumer goods within the region. These may differ from the budget shares of poor rural people, especially because the latter consume a higher proportion of food than the ‘average’ bundle used to measure the regional CPI. The level of poverty incidence may therefore be sensitive to the price of food relative to other CPI components in addition to the level of ‘real’ (CPI-deflated) income.

The hypothesis is that changes in rural poverty incidence – the first difference in the level of poverty incidence – depend on changes in these independent variables. The analysis is cast in terms of absolute changes of the dependent variable and hence the independent variables – rather than proportional changes. Proportional changes in poverty incidence would not be the appropriate dependent variable because, as levels of poverty incidence become low (as they do in the later years of our data set) even large proportional changes in poverty incidence may correspond to small changes in the number of poor people, compared with the same proportional change when levels of poverty incidence are high, as in the early years of the data.

A key assumption is that rural poverty reduction in region r depends on income growth and relative prices in region r and not those other regions. That is, the assumed relationship between the drivers of poverty reduction – the independent variables – and resulting levels of poverty incidence, does not involve cross-regional spillover effects. A further key assumption is that agricultural and non-agricultural GDP are independently determined. Neither drives the other.⁶

Two regression models are presented: Models 1A and 1B, which differ by whether the relative price of food is excluded (1A) or included (1B).

Model 1A:

$$\Delta H_{t,\tau}^r = \alpha_0 + \beta_A \Delta Y_{(t,\tau-1)}^{Ar} + \beta_N^r \Delta Y_{(t,\tau-1)}^{Nr} + \sum_{r=1}^3 \delta^r D^r + \varepsilon D_{1998} + \epsilon_{t,\tau}^r \quad (1)$$

The variables are defined as follows. $\Delta H_{t,\tau}^r = (H_t^r - H_{t-\tau}^r) / \tau$ is the average annual change in the headcount measure of poverty incidence between year $t - \tau$ and year t , where H_t^r denotes the headcount measure of poverty incidence in region r in year t . As explained in the data

⁶ See Gollin, Parente and Rogerson (2002) for an analytical discussion of this point.

section below, poverty incidence data are not available for every calendar year and τ denotes the number of years between observations. $\Delta Y_{(t,\tau)-1}^{Ar} = (Y_{t-1}^{Ar} - Y_{t-\tau-1}^{Ar}) / \tau$ denotes the average annual change in real agricultural GDP over the same period as the poverty incidence observations but lagged one calendar year. Similarly, $\Delta Y_{(t,\tau)-1}^{Nr} = (Y_{t-1}^{Nr} - Y_{t-\tau-1}^{Nr}) / \tau$ is the corresponding lagged variable for real non-agricultural GDP. D^r is a regional dummy (0, 1) variable. Because there are four regions there are three dummy variables. D_{1998} is a dummy (0, 1) variable for the 1998 Asian Financial Crisis, taking a value of 1 for that year. The terms $\alpha_0, \beta_A, \beta_N^r, \delta^r$ and ε are coefficients to be estimated. Finally, $\varepsilon_{t,\tau}^r$ is a stochastic error term. The usual OLS properties are assumed.

Model 1B:

$$\Delta H_{t,\tau}^r = \alpha_0 + \beta_A \Delta Y_{(t,\tau)-1}^{Ar} + \beta_N^r \Delta Y_{(t,\tau)-1}^{Nr} + \gamma \Delta P_{t,\tau}^r + \sum_{r=1}^3 \delta^r D^r + \varepsilon D_{1998} + \varepsilon_{t,\tau}^r \quad (2)$$

Model 1B is the same as Model 1A except that it adds a term for the change in the relative price of food, $\gamma \Delta P_{t,\tau}^r$, where $\Delta P_{t,\tau}^r = (P_t^r - P_{t-\tau}^r) / \tau$ and P_t^r denotes the index of food prices relative to the index of non-food prices within the CPI for region r in year t and γ is a parameter to be estimated.

Conceptual Model 2

We now amend Conceptual Model 1 by decomposing the change in agricultural GDP into two components: a change in total factor productivity (TFP) and a change in factor inputs. By definition, the level of total value-added in agriculture in region r at time t (total regional agricultural GDP), Y_t^{Ar} , is the product of the level of factor inputs used in agriculture, F_t^{Ar} , and the level of TFP in agriculture, T_t^{Ar} . The change in the level of regional agricultural GDP

between years $t-1$ and t is the weighted sum of the change in the level of factor inputs used in agriculture and the change in TFP

$$dY_t^{Ar} = T_t^{Ar} dF_t^{Ar} + F_t^{Ar} dT_t^{Ar}. \quad (3)$$

Models 2A and 2B utilise this decomposition by substituting these two variables for the change in agricultural income appearing in Models 1A and 1B, respectively, thus allowing for possible differences in the poverty-reducing effects of these two variables. As with the difference between Models 1A and 1B, Model 2A does not control for the relative price of food, whereas Model 2B does. The comparison between the coefficients on productivity growth and factor income growth obtained in Models 2A and 2B make it possible to test whether these two sources of income growth operate on poverty through food prices or not.

The estimated equations for Conceptual Model 2 are thus

Model 2A:

$$\Delta H_{t,\tau}^r = \alpha_0 + \beta_A^T \Delta T_{(t,\tau-1)}^{Ar} + \beta_A^F \Delta F_{(t,\tau-1)}^{Ar} + \beta_N^r \Delta Y_{(t,\tau-1)}^{Nr} + \sum_{r=1}^3 \delta^r D^r + \varepsilon D_{1998} + \epsilon_{t,\tau}^r \quad (4)$$

Model 2B:

$$\Delta H_{t,\tau}^r = \alpha_0 + \beta_A^T \Delta T_{(t,\tau-1)}^{Ar} + \beta_A^F \Delta F_{(t,\tau-1)}^{Ar} + \beta_N^r \Delta Y_{(t,\tau-1)}^{Nr} + \gamma \Delta P_{t,\tau}^r + \sum_{r=1}^3 \delta^r D^r + \varepsilon D_{1998} + \epsilon_{t,\tau}^r \quad (5)$$

where $\Delta T_{(t,\tau-1)}^{Ar} = (T_{t-1}^{Ar} - T_{t-\tau-1}^{Ar}) / \tau$ is the average annual change in the level of agricultural TFP between years $t-1$ and $t-\tau-1$, again corresponding to the same years as those in which

poverty incidence is measured, but lagged one calendar year, and $\Delta F_{(t,\tau)-1}^{Ar}$ denotes the corresponding lagged variable for the change in the level of factor inputs.

4. Data

Rural poverty incidence

Data on poverty incidence in Thailand have been assembled by the government's National Economic and Social Development Board (NESDB) since 1969, using data derived from the Socio-economic Survey, a large household income and expenditure survey conducted periodically by the government's National Statistical Office. The poverty estimates indicate the proportion of the population, or specific population sub-groups, whose incomes fall below the official poverty line. Until 1986 estimates of poverty incidence were available only in hard-copy summaries, and only for the years in which the Socio-economic Survey was conducted, initially 1969, 1975, 1981 and 1984. From 1986 onward estimates were produced every two years up to 2006, with some irregularity since then. From 1986 onward the Socio-economic Survey data have been available in unit record digital format.⁷

The real value of the official poverty line has been revised upwards several times. To obtain a consistent long-term series of poverty incidence based on a poverty line with constant purchasing power, it is necessary to adjust for these changes in the poverty line to obtain a series based on a poverty line with constant purchasing power. The results are summarised at the national level in Figure 1, covering the 40 years from 1969 to 2009. The data show dramatic declines in both rural and urban poverty incidence, with the partial exceptions of a recession in the early 1980s and the Asian Financial Crisis of the late 1990s. For the years prior to 1986, the estimates in Figure 1 are approximate, based on splicing

⁷ Income-based poverty incidence estimates, based on the Socio-economic Survey, are available for 2007 and 2009, but not for 2008.

together overlapping published series based on poverty lines with different purchasing power. Poverty estimates are more reliable for the years 1986 onwards, when the underlying unit record data have been available in digital form, so we use these poverty incidence data in our empirical analysis.

As the figure shows, poverty incidence has been consistently higher in rural than in urban areas, but massive reductions in poverty incidence have occurred over time within both. Rural areas represented around 75 per cent of the Thai population in 1969, declining to just over 50 per cent by 2009. This, combined with the much higher level of poverty incidence in rural than in urban areas, implies that between 1969 and 2009 rural areas contained around 70% of all poor people in Thailand. Moreover, between 1969 and 2009, poverty reduction within rural areas accounted for 81% of the reduction in the total number of poor people in the country.⁸ To understand the drivers of poverty reduction in Thailand, and presumably most other developing countries with large rural populations, the determinants of changes in rural poverty must be the primary focus, as it is in this paper.

The regional rural poverty incidence data used in our econometric analysis were 13 observations relating to the years: 1986 to 2006 at two-yearly intervals, plus 2007 and 2009, by which time rural poverty incidence had reached low levels. These data were assembled for the four agricultural regions of Thailand where significant rural populations are located, including many millions of poor people: central, northeast, north and south. The excluded fifth region is Bangkok Metropolitan Region, where agriculture is relatively unimportant and rural poverty is almost non-existent. These data are shown in Figure 2, Panel A.1. These data

⁸ Using 2009 real poverty lines, in 1969 71.5 % of the Thai population of 35.8 million, was officially poor, meaning 25.6 million people. Out of the then rural population of 26.9 million, 73.7 %, or 19.8 million, were poor, representing 77 % of all poor people in the country. In 2009 8.2 per cent of the Thai population of 66.9 million were poor, meaning 5.5 million people. Within rural areas poverty incidence was 10.4 % out of a rural population of 33.5 million, meaning 3.5 million people, representing 64 % of all poor people. Over these four decades the total number of poor people declined by $25.6 - 5.5 = 20.1$ million people. The number of rural poor declined by $19.8 - 3.5 = 16.3$ million, or 81% of the total reduction in poverty.

were then converted to annual changes in poverty incidence over the 12 intervals between these years by dividing the first difference by the number of years included in the interval (two in each case except 2006-2007). Given the four regions this means 48 observations. These data, shown in Figure 2, Panel A.2, form the dependent variable ‘Annual change of rural poverty incidence’ used in our regression analysis.

Total factor productivity in agriculture and factor input levels in agriculture

We begin with estimation of regional total factor productivity growth (TFPG) in the agricultural sector of Thailand. The growth accounting method was used, as was done at the national level for the years 1970 to 2006 in Suphannachart and Warr (2011). The present study disaggregates the underlying data from the earlier study, beginning in 1985 and extended to 2008, for the four agricultural regions described above.

The method accounts for the sources of output growth by identifying the contribution of major factor inputs weighted by their respective factor income shares. TFPG is then measured as the Solow-type residual of output growth that cannot be explained by the combined growth of the factor inputs. Output is measured as value-added, where the values of intermediate inputs such as fertilizer, fuel and other chemical inputs used to produce agricultural output have been subtracted from the gross value of output.

From equation (3) the growth rate of real regional agricultural GDP in region r between times $t-1$ and t , \hat{Y}_t^{Ar} , is approximated by the sum of TFP growth, \hat{T}_t^{Ar} , and \hat{F}_t^{Ar} , the value-added share-weighted sum of the growth rates of the factor inputs used in agriculture – labour (L), capital (K) and land (D), \hat{L}_t^{Ar} , \hat{K}_t^{Ar} and \hat{D}_t^{Ar} , respectively:

$$\hat{Y}_t^{Ar} = \hat{T}_t^{Ar} + \hat{F}_t^{Ar} = \hat{T}_t^{Ar} + S_{Lt}^{Ar} \hat{L}_t^{Ar} + S_{Kt}^{Ar} \hat{K}_t^{Ar} + S_{Dt}^{Ar} \hat{D}_t^{Ar} \quad (6)$$

The assumption of constant returns to scale in the production of value-added is imposed, implying that the value-added shares sum to one. TFPG is then calculated as a residual from equation (6).

The output and input data used for this exercise are available at the annual regional level. The definitions and data sources are summarised in Table 1. The output data are derived from the National Economic and Social Development Board (NESDB), which defines seven regions – North, Northeast, Central, South, East, West and Greater Bangkok. The input data are available for five aggregated regions – North, Northeast, Central, South and Greater Bangkok. Within these input data the Central region incorporates the East and West regions identified in the output data. To make the regional format of the output and input data consistent, the output of East and West regions were therefore included in the Central region, as is consistent with NESDB practice. Greater Bangkok was excluded because it contains virtually no rural poverty, leaving four regions.

The TFPG estimates were converted to estimates of the level of TFP for the 13 years corresponding to the years for which poverty incidence data are available, but lagged one calendar year: 1985 to 2005 at two-yearly intervals, plus 2006 and 2008, with 1985 as the base (1985 = 1), for each of the four regions. These estimates are shown in Figure 2, Panel B.1. To obtain the data required for the regression analysis, these TFP level data were then used to calculate annual rates of change in region-level agricultural TFP for the 12 intervals between these years, again dividing the first difference by the number of years in the interval concerned, for each of the four regions, giving 48 observations. These data become the variable ‘Lagged annual change in agricultural TFP’ at the regional level used in the statistical analysis that follows and are shown in Figure 2, Panel B.2.

Relative price of food

Data on the components of the regional consumer price index are available from the National Economic and Social Development Board. Data were assembled on the food component of the regional CPI relative to the overall regional CPI for the same years as the poverty data described above. These data (Figure 2, Panel C.1) were then converted to annual rates of change in this ratio by again dividing the first difference by the number of years in the interval concerned, for each of the four regions, again giving 48 observations. These data become the variable ‘Annual change in food price / CPI’ shown in Figure 2, Panel C.2. Table 2 provides a summary of the data used in our regressions.

5. Results

Table 3 summarises the results obtained from Models 1A and 1B. Recalling that the dependent variable is the *change* in poverty incidence, a positive sign on an estimated coefficient indicates a poverty-increasing effect and a negative sign indicates a poverty-reducing effect. From Model 1A, growth of agricultural income significantly reduces rural poverty, as indicated by the negative sign of the estimated coefficient, significant at the 1% significance level. Non-agricultural income growth produces the expected negative coefficient, slightly larger in absolute magnitude than the coefficient on agricultural income, but this coefficient is not significantly different from zero at the 10% level. An *F*-test on the null hypothesis that the true values of the coefficients on agricultural and non-agricultural incomes are the same fails to reject the hypothesis at any acceptable level of significance.

Model 1B controls for the relative price of food and this inclusion improves the performance of the regression. Increases in the price of food increase rural poverty, as indicated by the positive sign, significant at the 10% level. Controlling for the price of food reduces the size of the estimated coefficient for agricultural income growth, implying that

the effect that agricultural output growth has on poverty reduction, as captured in Model 1A, operates partly through reductions in the price of food. Agricultural income growth is associated with increased supply of food, inducing some price reduction. Controlling for the price of food in Model 1B removes this channel of impact, reducing the size of the estimated impact (by about one fifth) but not eliminating it. Again the estimated coefficient on non-agricultural income is slightly larger than the coefficient on agricultural income, but is marginally insignificant at the 10% level. An *F*-test on the null hypothesis that the true values of the coefficients on agricultural and non-agricultural incomes are the same again fails to reject the hypothesis at any acceptable level of significance.

Models 2A and 2B, summarised in Table 4, decompose the agricultural income growth variable of Model 1 into a productivity growth and a factor input growth component, as in equation (3). The decomposition improves the statistical performance of the model considerably. In Model 2A agricultural TFP growth and non-agricultural income growth both have a poverty-reducing impact, significant at the 10% level. On the other hand, the estimated coefficient on factor income growth has an unexpected (positive) sign, but is not significantly different from zero. The implication is that expanded agricultural output derived solely from factor input growth does not reduce rural poverty.

When the price of food is included as an explanatory variable (Model 2B), the performance of the regression is again improved. The price of food has a positive and highly significant impact, implying that increases in the price of food raise poverty incidence.⁹ In addition, the size and significance of both the agricultural productivity growth and non-agricultural income growth variables increase. Agricultural factor income growth again has an unexpected (positive) sign, but again is insignificant.

⁹ For a recent argument to the contrary, see Headey (2018).

Controlling for the price of food, as in Model 2B, does not reduce the size of the estimated coefficient on agricultural productivity growth. This finding implies that agricultural growth derived from productivity improvement does not reduce poverty to a significant extent through an induced reduction in the price of food, but primarily through the only remaining channel, its direct income-enhancing effect.

In all four regression models the dummy variable for the Asian Financial Crisis (1998) is significantly positive, confirming its poverty-increasing impact. A less obvious finding is that the dummy variables representing the richest two regions, South and Central,¹⁰ are both negative. The regional dummy variable represents the unexplained component of rural poverty reduction and this unexplained component was larger in the richest two regions, Central and South, than in the poorest two regions, North and Northeast.

In summary, the results confirm that increases in agricultural incomes have been strongly associated with reductions in poverty. This effect operated through increases in agricultural productivity but not increases in the level of agricultural factor inputs. Reductions in food prices have also reduced poverty, but increases in agricultural productivity have reduced rural poverty primarily by raising incomes rather than by inducing a reduction in food prices.¹¹ Increases in non-agricultural incomes have also been significantly associated with reduced poverty, and their effect has not been different from the effect of increases in agricultural incomes derived from agricultural productivity growth.

¹⁰ There are four regions. Central is the omitted region in the three regional dummy variables. Its impact is captured in the constant term.

¹¹ Thai agriculture is strongly export-oriented. The agricultural sector thereby faces highly elastic demand for most of its major products.

6. Sensitivity of poverty reduction to productivity growth

The fact that agricultural productivity growth has a statistically significant effect on the reduction of rural poverty does not necessarily mean that its poverty-reducing contribution is large. The preferred estimates, from Model 2B, can be used to simulate the implications of hypothetical alternative values of the independent variables. The simplest way to do this is to calculate the contribution of the independent variables to the mean change in the dependent variable. As is well known, the estimated OLS equation must pass through the means of the data, meaning that the right hand side of the estimated equation, with all independent variables evaluated at their mean values and multiplied by their estimated coefficients, including the constant term, must sum to the mean value of the dependent variable. We use Model 2B, summarised in Table 4, for this purpose. The means of the variables are reported in Table 2.

The mean annual change in rural poverty incidence was -2.07 per cent. The contribution of agricultural TFPG to this annual change in poverty incidence is its estimated coefficient multiplied by its mean value ($-0.01 \times 10.65 = -0.11$). That is, TFPG accounts for an annual reduction of rural poverty incidence of 0.11 per cent of the rural population, or 5.24 per cent ($100 \times 0.1086 / 2.071$) of the observed annual rate of poverty reduction. That is, productivity growth explains barely one twentieth of the observed reduction in rural poverty. Alternatively, if TFPG in agriculture had been zero, the annual reduction in poverty would have been 0.11 per cent lower than its observed value of 2.07 per cent, or 1.96 per cent. The effect seems small, but it is not negligible. The mean value of the rural population over the period of our data was just over 40 million. An annual poverty reduction of 0.11 per cent is equivalent to 44 thousand people. Extended over 23 years, this implies just under one million people who were non-poor in 2009 but who would have remained poor if agricultural productivity had not improved.

Why was the poverty-reducing contribution of Thailand's agricultural TFP growth since 1985 so small? A possible explanation is that TFP growth was slow. According to Suphannachart and Warr (2011), between 1970 and 2006 Thailand's average rate of aggregate agricultural TFP growth was 0.68 per cent, but in the sub-periods 1970 to 1985 and 1985 to 2006 it was 1.61 and 0.27 per cent, respectively. In the latter period (roughly the period of our data) the rate was only one sixth of the earlier period. Suppose, hypothetically, that it had not slowed, but had continued to grow constantly, from 1985 to 2008, at the earlier annual rate of 1.61 per cent. What would have happened to rural poverty?

Applying the above methods, including the estimated coefficients of Model 2B, to simulate this hypothetical scenario, if TFP grew at 1.61 per cent between 1985 and 2008 the estimated annual reduction in poverty due to TFP growth would have been 0.67 per cent of the rural population. Holding other variables at their observed levels, the annual rate of rural poverty reduction at the mean of the data would have been 2.63 per cent, equivalent to 1.05 million people. The proportional contribution of TFP growth to this outcome would have been 25.5 per cent ($100 \times 0.67 / 2.63$). At the mean of the data, the difference between TFP growth of 0.21 per cent and 1.61 per cent is equivalent to an *annual* difference in rural poverty reduction of 220 thousand people (0.83 and 1.05 million respectively).¹²

7. Poverty reduction and the drivers of productivity

TFP growth is not an 'intervention'. It is the measured outcome of many factors rather than a direct instrument of policy. An earlier study (Suphannachart and Warr, 2011) used time-series error-correction statistical methods to analyse the long-term determinants of

¹² Extrapolating this difference to the end of our data period, poverty reduction would again have been eliminated by 2009. But this calculation is indicative only. At very low levels of poverty incidence, well outside the range of our data, productivity-based mechanisms for reducing poverty presumably become less effective as the remaining poor people become increasingly those least able to benefit from productivity improvements.

productivity growth in Thai agriculture.¹³ The statistically significant explanators were (1) international public investment in agricultural research, through the CGIAR system, (2) Thailand's public investment in agricultural research, and (3) Thailand's public investment in rural road infrastructure.¹⁴ These variables may be considered policy interventions. Drawing on these quantitative results and combining them with the findings of the present study, it is possible to estimate the sensitivity of rural poverty reduction to changes in these variables. For the purposes of this analysis, the key finding of Suphannachart and Warr (2011, p. 47) was that the elasticities of TFPG to each of the above three determinants were: $E^1 = 1.05$, $E^2 = 0.67$ and $E^3 = 0.038$, respectively.

Suppose, hypothetically, that over the period 1982 to 2006 each of these long-term TFP drivers had grown 10 percent faster than its observed value. TFP growth would have been higher and the consequent rate of poverty reduction would also have been higher. How much higher? To make the calculations as transparent as possible it is convenient to estimate these two components – TFP effects and resulting poverty effects – separately.

TFP effects. According to the elasticity estimates cited above, 10 per cent increases in the growth of these three variables would have produced long-term annual increases in TFP growth as follows. The annual change in TFP would be $\Delta TFP^j = \frac{\Delta TFP^j}{TFP} \overline{TFP}$, where $\frac{\Delta TFP^j}{TFP} = \frac{10 \cdot E^j}{100}$, $j = (1,2,3)$, and $\overline{TFP} = 1.137$ denotes the mean value of the level of TFP in the data used in estimation. Thus $\Delta TFP^1 = 0.1194$, $\Delta TFP^2 = 0.0762$ and $\Delta TFP^3 = 0.0043$.

Poverty effects. The implied annual changes in poverty incidence are $\Delta P^j = \Delta TFP^j * \beta_A^T$, where $\beta_A^T = -10.649$ is the coefficient on ΔTFP estimated in Model 2B. Thus $\Delta P^1 = -1.2715$, $\Delta P^2 = -0.8115$ and $\Delta P^3 = -0.0458$.

¹³ For earlier analyses along these lines, see Fan, Hazell and Thorat (1999) for India and Fan and Zhang (2008) for Africa.

¹⁴ Public expenditure on agricultural extension was also included among the explanatory variables, but its estimated impact was clearly insignificant.

These estimated impacts on poverty reduction are surprisingly large.¹⁵ A sustained 10 per cent increase in each of these long-term drivers of TFPG would have increased the annual rate of rural poverty reduction, relative to the rate observed, by 61.7 per cent (international agricultural research expenditure), 39.2 per cent (domestic agricultural research expenditure within Thailand), and 2.2 per cent (domestic investment on roads within Thailand). These impacts are large because Suphannachart and Warr found agricultural TFPG to be highly sensitive to these long-term drivers.

8. Conclusions

In developing countries rural poverty reduction has been by far the most important component of overall poverty reduction (World Bank 2000, 2008).¹⁶ Attempts to relate rural poverty reduction to productivity growth within agriculture relative to other sectors have produced diverse and sometimes contradictory results, limiting the possibility of generalisation. The explanation depends partly on the meanings of ‘poverty’, ‘agriculture’ and ‘productivity growth’. Regarding ‘poverty’, available empirical findings indicate that agricultural growth may be most beneficial for the poorest of the poor (as captured by the lowest poverty lines, as used in the poorest countries) but less so for the better-off poor (not captured by the lowest poverty lines, but still captured by the somewhat higher real poverty lines used in middle income countries like Thailand).

‘Agriculture’ is a heterogeneous category containing wide differences in the distribution of factor ownership between poor and non-poor households, among other relevant differences, and this undoubtedly contributes to diversity of findings.¹⁷ Finally,

¹⁵ See also Thirtle, Lin and Piesse (2003) for comparable analyses for Africa, Asia and Latin America.

¹⁶ Warr (2014) demonstrates this point for the countries of Southeast Asia, including Thailand.

¹⁷ Johnston and Mellor (1961, p. 590) concluded similarly that “diversity among nations and the variety that is so characteristic of agriculture inevitably limits the validity of a condensed, general treatment”.

measures of ‘productivity growth’, such as total factor productivity growth (TFPG), are noisy and approximate measures of technical progress in agriculture because they also capture the effects of other determinants of output growth relative to growth of measured on-farm inputs, such as idiosyncratic weather shocks, plant and animal diseases, pest infestations and improved (or worsened) resource reallocation. Measures of TFPG also overlook the different impacts on poverty incidence arising from different forms of technical change. The same rate of TFPG can result from a wide range of combinations of labour-augmenting and land-augmenting technical progress but their effects on poverty incidence may be quite different.

The findings of this study provide empirical support for the view that, in Thailand at least, measured agricultural productivity growth (TFPG) has indeed contributed to reduction of rural poverty, but that one unit of aggregate income derived from this source has been similarly poverty-reducing to a unit of aggregate income derived from non-agricultural sources. The agricultural sector’s most important contribution to poverty reduction has not been to expand output, *per se*. Output can be expanded either through raising productivity, shifting the supply function to the right, or through increasing factor inputs, moving along the supply function. The evidence presented in this paper indicates that in Thailand the former was a significant contributor to reductions in rural poverty but the latter was not.

Suppose the government’s policy is to expand agricultural output by intervening to raise agricultural output prices. The findings of this study imply that the output expansion induced in this way will not reduce rural poverty directly; to achieve that, it is necessary to do something else that raises productivity. Moreover, the price increase, if it translates into an increase in food prices – as it will unless the intervention takes the form of a subsidy – will raise poverty incidence because it harms poor net purchasers of food in both rural and urban areas. On the other hand, policies that raise productivity do reduce rural poverty, in

the Thai experience at least, because they raise farmers' incomes by lowering their costs. But they do that without raising the food prices faced by poor rural consumers.

An illustration of this phenomenon is the contribution of agricultural research. The scientific performance of Thailand's agricultural research effort has been unimpressive. It has been massively underfunded, as shown by the very high marginal economic rates of return demonstrated in earlier studies, and the real level of funding has declined radically since the mid-1990s. But the activity of taking research results obtained abroad and adapting them to local conditions is apparently so productive that even Thailand's low-level commitment to agricultural research and development has contributed significantly to productivity growth. This has in turn contributed to reduction in rural poverty, but that contribution could have been much greater. If this research effort had been better funded rural poverty could have been reduced far more rapidly.

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Table 1. Data sources used

Variables	Definitions (unit)	Sources
Poverty incidence	Headcount measure by region, per cent of region population, using constant poverty line in real purchasing power, regional CPI deflator	National Economic and Social Development Board (NESDB)
Agricultural income	Agricultural component of regional GDP (value added) at 1988 prices (million baht)	National Income of Thailand, National Economic and Social Development Board (NESDB)
Non-agricultural income	Non-agricultural component of regional GDP (value added) at 1988 prices (million baht)	National Income of Thailand, National Economic and Social Development Board (NESDB)
Agricultural labour	Number of employed persons age 15 and above (person) by region	Labour Force Survey, National Statistical Office
Agricultural land	Stock of agricultural land area (rai) by region	Office of Agricultural Economics
Agricultural capital	Stock of agricultural credit (million baht) by region	Authors' calculation based on agricultural credit data from Bank for Agriculture and Agricultural Co-operatives
Agricultural wage	Imputed wage of all workers, measured as private workers' wage adjusted by 1995 Social Accounting Matrix (SAM) wage to account for self-employed and unpaid family labour, by region	Labour Force Survey, National Statistical Office
Land rent	Actual and imputed rent by region (baht per rai)	National Statistical Office
Regional CPI and food price component	Food price component of regional CPI and overall CPI (1986 = 100)	National Economic and Social Development Board

Source: Authors' investigations.

Note: The baht is the unit of Thai currency. The rai is the unit of land area used in Thailand. One rai = 1,600 square meters (0.16 hectares) or roughly 0.4 acres.

Table 2. Data summary

Variable	Observations	Mean	Standard deviation	Minimum	Maximum	Units
Annual change of rural poverty incidence	48	-2.071	2.551	-9.480	2.906	% per year
Lagged annual change of real agricultural income per capita	48	0.542	0.968	-0.103	2.474	Million baht per person per year (1988 prices)
Lagged annual change of real non-agricultural income per capita	48	0.437	0.539	-0.827	1.547	Million baht per person per year (1988 prices)
Lagged change in agricultural total factor productivity	48	0.0102	0.0759	-0.121	0.365	Change in index (1985=1) per year
Lagged annual change in agricultural factor input per capita	48	0.561	0.996	-3.274	2.651	Million baht per person per year (1988 prices)
Lagged annual change in real non-agricultural income per capita	48	0.437	0.539	-0.827	1.547	Million baht per person per year (1988 prices)
Annual change in food price / CPI	48	1.635	2.538	-2.630	8.500	Change in index (1986=1) per year

Note: All variables are defined for 4 regions and 12 time series observations.

Source: Authors' calculations, using data from the National Economic and Social Development Board and the additional sources summarised in Table 1.

Table 3. Determinants of rural poverty: Regression Model 1

Dependent variable: Annual change of rural poverty incidence				
	Regression Model 1A		Regression Model 1B	
	Estimated coefficient	Standard error	Estimated coefficient	Standard error
Lagged annual change of real agricultural income per capita	-1.028***	0.383	-0.815**	0.395
Lagged annual change of real non-agricultural income per capita	-1.170	0.915	-1.292	0.898
Annual change in food price / CPI			0.290*	0.171
North region dummy	1.508	1.418	1.134	1.404
Northeast region dummy	2.234	1.663	1.470	1.687
South region dummy	-5.662**	2.592	-4.286	2.661
Year dummy (1998)	6.363***	2.055	7.502***	2.118
Constant	-8.733***	2.603	-7.823***	2.602
R^2		0.344		0.388
$adj. R^2$		0.281		0.302
Number of observations		48		48

Note: All variables except the constant term are defined at the regional level. *** denotes $p < 0.01$, ** denotes $p < 0.05$, and * denotes $p < 0.1$. *Source:* Authors' calculations.

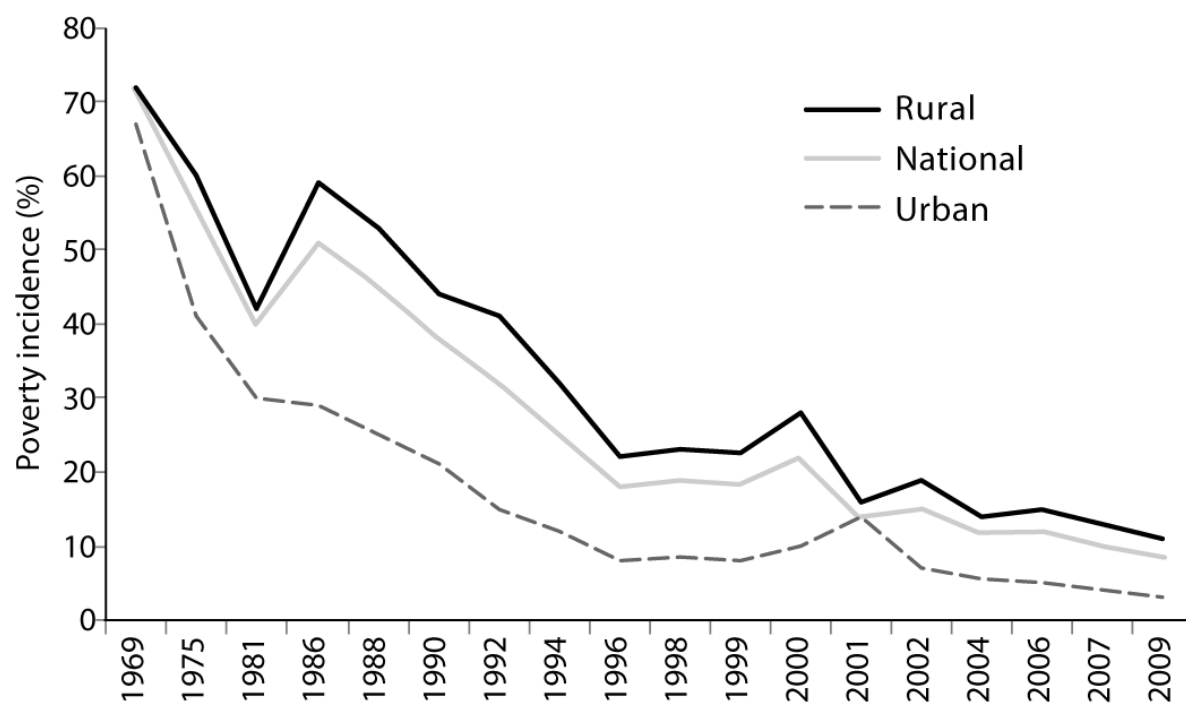
Table 4. Determinants of rural poverty: Regression Model 2

Dependent variable: Annual change of rural poverty incidence				
	Regression Model 2A		Regression Model 2B	
	Estimated coefficient	Standard error	Estimated coefficient	Standard error
Lagged annual change in agricultural TFP	-9.869*	5.723	-10.649**	5.132
Lagged annual change in agricultural factor input per capita	0.7496	0.557	0.778	0.499
Lagged annual change in real non-agricultural income per capita	-1.236*	0.695	-1.330**	0.623
Annual change in food price / CPI			0.374***	0.114
North region dummy	1.205	1.090	1.1442	0.977
Northeast region dummy	0.510	1.037	0.411	0.930
South region dummy	-0.029	1.020	0.120	0.915
Year dummy (1998)	3.818**	1.585	5.366***	1.495
Constant	-7.823***	2.602	-8.733***	2.603
R^2		0.447		0.567
$adj. R^2$		0.350		0.479
Number of observations		48		48

Note: See Table 3.

Source: Authors' calculations.

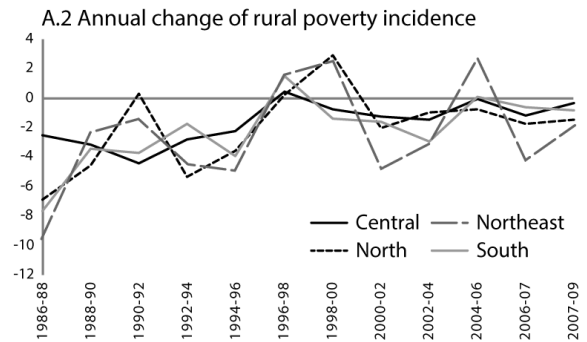
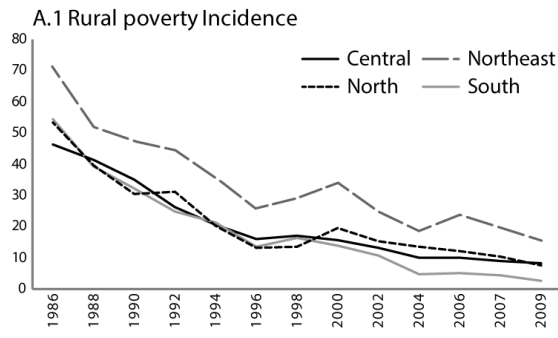
Figure 1. Thailand: Poverty incidence, 1969 to 2009



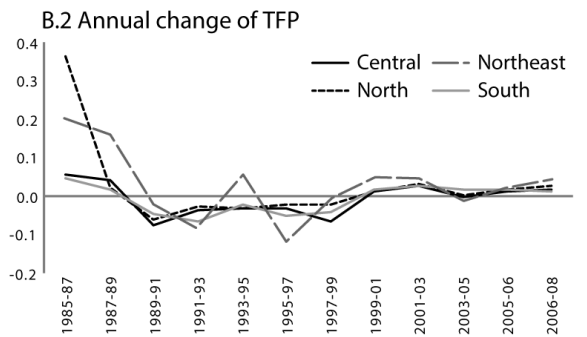
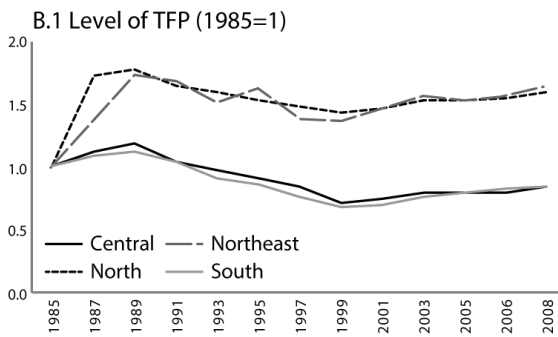
Source: Authors' calculations using data from National Economic and Social Development Board, Bangkok.
Note: National poverty incidence is by definition a population-share weighted average of poverty incidence within rural and urban areas. It therefore necessarily lies between the other two.

Figure 2 Key data

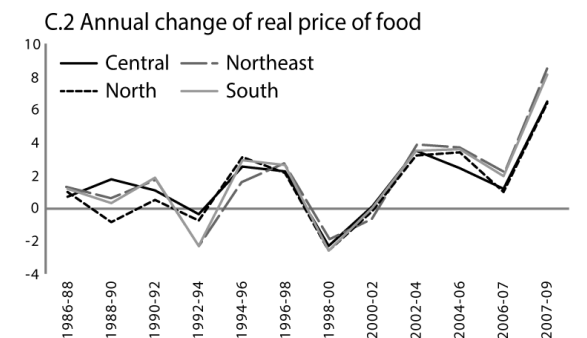
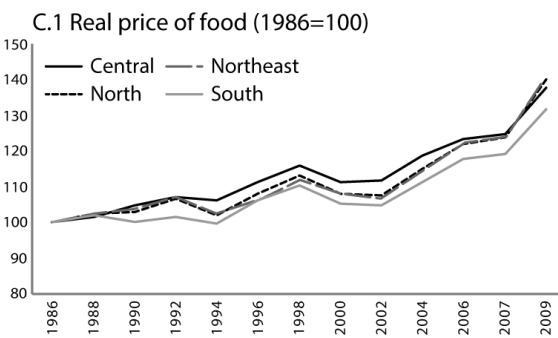
Panel A. Rural poverty incidence



Panel B. Total factor productivity in agriculture



Panel C. Real price of food



Source: Authors' calculations using data from National Economic and Social Development Board, Bangkok.