The University of Manchester

Economics Discussion Paper

EDP-0621

Agricultural growth, employment and wage rates in developing countries

Raghav Gaiha and Katsushi Imai

August 2006

Correspondence email: Katsushi.Imai@manchester.ac.uk

School of Social Sciences,
The University of Manchester
Oxford Road
Manchester M13 9PL
United Kingdom

Revised on 29 August, 2006

Agricultural Growth, Employment and Wage Rates in Developing Countries [1]

Raghav Gaiha† and Katsushi Imai ‡ [2]

†Faculty of Management Studies, University of Delhi, India

‡Economics, School of Social Sciences, University of Manchester, UK

Abstract

Drawing upon different specifications and methods of panel data estimation designed to make efficient use of cross-country samples, we have analysed the relationships among agricultural productivity, employment, technology, openness of the economy, and inequality in land distribution. Agricultural productivity varies with technology and employment, but more so with employment. The effect of openness on agricultural productivity is ambiguous -it is positive, negative or not significant, depending on the definition of openness, specification and estimation procedure used. Agricultural employment and diversification of agriculture are inversely related. A somewhat surprising result is the positive effect of inequality in land distribution on agricultural productivity. Arguably, when credit markets are incomplete, greater inequality in land distribution may imply a more significant role for large landowners in agricultural investment through easier access to credit. In another specification, the determinants of growth rates of agricultural and non-agricultural employment, and their linkages are examined using both dynamic and static models. There is a strong (lagged) positive effect of growth rate of agricultural employment on that of non-agricultural employment. Even though the share of agriculture has declined in developing countries, its contribution to overall economic growth and generation of employment is substantial. While a case for acceleration of agricultural growth through modernisation of its technology, crop diversification and exploitation of high value export opportunities rests on more complete credit and insurance markets, and infrastructural support, some negative effects of crop-diversification on employment are likely.

JEL Code: C33, J43, O13, Q16, Q17
Key Words: Agriculture, Growth, Employment, Wages, Prices, Inequality

---

[1] This study was carried out under the overall supervision and support of T. Elhaut, Director, and G. Thapa, Regional Economist, Asia and the Pacific Division, IFAD, Rome. We have also benefited from discussions with P. Scandizzo, R. Jha, and Anil Deolalikar. This is one of a series of background studies undertaken to update the Regional Rural Poverty Reduction Strategy for Asia and the Pacific region. The views expressed are those of the authors and they bear full responsibility for any deficiencies that remain.

[2] Contact: Katsushi Imai, Economics, School of Social Sciences, University of Manchester, Oxford Road, Manchester M13 9PL, UK; Email: Katsushi.Imai@manchester.ac.uk, Phone: +44-(0)161-275-4827, Fax: +44-(0)161-275-4928.

Agricultural Growth, Employment and Wage Rates in Developing Countries

1. Introduction

The purpose of this paper is to carry out a systematic assessment of the relationships among agricultural production, employment, and wage rates, based on a detailed econometric analysis of cross-country panel data. Although agricultural growth is central to economic growth and poverty reduction in developing countries, there have been relatively few attempts to analyse the determinants of agricultural growth *per se* and to link the latter to growth of employment in agriculture and elsewhere.[3] Much of the recent literature on agricultural growth consists of country case studies. This is partly because growth of agricultural production or productivity is specific to each country's endowments of physical and human capital. Besides, agricultural growth is affected by development of new labour-intensive technologies (Lipton, 1977; Thirtle, Lin and Piesse, 2003). More importantly, greater openness to international markets and crop-diversification are transforming agriculture and livelihoods in many ways. Accordingly, the main objectives of this paper are: to assess (i) the determinants of agricultural growth; (ii) the determinants of agricultural employment; and (iii) to examine the role of agricultural employment in stimulating non-farm employment through backward and forward linkages with the rest of the economy (Mellor and Lele, 1972, and Mellor, 1976)[4].

[3] A notable exception is Thirtle, Lin and Piesse (2003).

[4] The linkages between farm and non-farm activities have been emphasised in the development literature. There are production linkages- backward and forward. Backward linkages relate to the demand of farmers for inputs e.g. ploughs, engines and tools, while forward linkages are linked to the need for processing of agricultural commodities e.g. spinning, canning and milling. Moreover, there

The rest of the paper is organised as follows. The next section describes the data sources. Section 3 is devoted to a discussion of changes in agricultural productivity, employment and crop-diversification, first for selected regions and then for a few countries. Section 4 is about specification and estimation of econometric models. Section 5 concentrates on the econometric results. Simulations based on the regression results for China and India are discussed in Section 6. Section 7 offers some concluding remarks.

2. Data

We construct panel data from various sources viz. World Development Indicators or WDI (World Bank, 2005), FAOSTAT (FAO, 2005), and LABORSTA (ILO, 2006).[5] The data on R&D are obtained from Thirtle, Lin and Piesse (2003). A major constraint is that agricultural wage series and R&D data are available only for a limited number of developing countries. A related difficulty is that the overlap between different sources is limited. So for these two reasons the best we could do was to construct small panel data sets and analyse them.

---

are consumption linkages. As agricultural income rises, it feeds into higher demand for non-farm goods produced locally or in neighbouring villages / towns. Finally, there are linkages through the supply of labour and capital. As agricultural productivity rises, either labour is released or wages go up. Also, agricultural surpluses could finance expansion of the non-farm sector. And the latter in turn could stimulate agricultural production via lower input costs, technological change and ploughing back of profits into farming.

[5] FAOSTAT is available on http://faostat.fao.org/site/291/default.aspx. LABORSTA is available on http://laborsta.ilo.org/.

3. Diversification, Productivity and Employment

Table 1 focuses on changes in averages of the share of non-cereal crops, agricultural employment, productivity, and wages by region[6]. The first three sets of averages are compared between 1980s and 1990s, and the last between 1990-96 and 1997-2004, as wage data are only available after 1990.

In East Asia and the Pacific, the share of non-cereal crop area increased during 1980s to 1990s. Agricultural employment per hectare decreased, while agricultural value added increased. East Europe and Central Asia also saw an increase in the non-cereal crop share, while agricultural employment per hectare increased. Agricultural value added decreased, however. Real wages did not change much. In South Asia, the non-cereal crop share *decreased* while both employment and agricultural value added increased[7,8]

The share of non-cereal crops, agricultural employment and productivity were more or less stable between 1980s and 1990s in Latin America and the Caribbean. Real wages, however, doubled between 1990-96 and 1997-2004.

In Middle East and North Africa, the non-cereal crop share rose slightly, while agricultural employment dropped and agricultural value added increased. In Sub-Sahara Africa, the crop diversification index slightly decreased, while agricultural value added

---

[6] Measurement of agricultural diversification in terms of share of area devoted to non-cereal crops is limiting in two respects: (i) one is neglect of livestock, and (ii) the other is the ambiguity of enlargement of non-cereal crop share. The non-cereal crop share could be larger either because of greater diversity of non-cereal crops or because of greater specialisation in fruits or vegetables. For an elaboration, see Joshi et al. (2004).

[7] As (real) wage data were unavailable for South Asia, no comment is made.

[8] Joshi et al.(2004), however, report a slow rise in the Simpson Index of Crop Diversity for South Asia, from 0.59 in triennium ending (TE) 1981-82 to 0.64 TE 1999-2000. Bangladesh, Bhutan and Nepal show less diversity as compared to other countries in this region.

increased. Employment did not change much. Real wages-lowest among all regions in both periods- rose markedly during 1990-96 to 1997-2004.

Appendix 1 contains graphs of changes in the crop diversification index (i.e. share of non-cereal crop area in total arable land), agricultural employment per hectare of arable land, and agricultural value added per hectare of arable land for selected countries.

Table 1 Changes in Crop Diversification, Agricultural Employment, Production and Wages by Region

Averages of Crop Mix, Agricultural Employment and Agricultural Production	1980s	1990s	Averages of Agricultural Wages and Production [*1]	1990-96	1997-2004
East Asia and the Pacific			*East Asia and the Pacific*		
Crop Mix (the share of area for non-cereal production in the total arable land) (%)	**57.25**	**65.86**	Real Wage (Constant US$ in 2000)	**955.73**	**NA *2**
L (agricultural employment per arable land) (no. of people)	**2.42**	**2.08**	Agricultural Value Added	**12.9**	**14.7**
Agricultural Value Added (Constant US$ in 2000)	**10.70**	**13.30**			
East Europe & Central Asia			*East Europe & Central Asia*		
Crop Mix (the share of area for non-cereal production in the total arable land) (%)	**45.25** `	**54.70**	Real Wage (Constant US$ in 2000)	**330.37**	**203.44**
L (agricultural employment per arable land) (no. of people)	**0.34**	**0.44**	Agricultural Value Added	**3.17**	**2.95**
Agricultural Value Added (Constant billion US$ in 2000)	**4.34**	**3.08**			
Latin America and Caribbean			*Latin America and Caribbean*		
Crop Mix (the share of area for non-cereal production in the total arable land) (%)	**74.41**	**73.10**	Real Wage (Constant US$ in 2000)	**2286.05**	**2200.92**
L (agricultural employment per arable land) (no. of people)	**0.44**	**0.46**	Agricultural Value Added	**3.24**	**3.79**
Agricultural Value Added (Constant billion US$ in 2000)	**2.74**	**3.31**			
Middle East and North Africa			*Middle East and North Africa*		
Crop Mix (the share of area for non-cereal production in the total arable land) (%)	**68.39**	**69.62**	Real Wage (Constant US$ in 2000)	**NA** [*2]	**NA** [*2]
L (agricultural employment per arable land) (no. of people)	**1.52**	**0.98**	Agricultural Value Added	**4.49**	**5.18**
Agricultural Value Added (Constant billion US$ in 2000)	**4.14**	**4.58**			
South Asia			*South Asia*		
Crop Mix (the share of area for non-cereal production in the total arable land) (%)	**49.44**	**44.32**	Real Wage (Constant US$ in 2000)	**NA** [*2]	**NA** [*2]
L (agricultural employment per arable land) (no. of people)	**1.73**	**2.46**	Agricultural Value Added	**19.2**	**21.5**
Agricultural Value Added (Constant billion US$ in 2000)	**14.10**	**19.80**			
Sub Saharan Africa			*Sub Saharan Africa*		
Crop Mix (the share of area for non-cereal production in the total arable land) (%)	**58.32**	**56.55**	Real Wage (Constant US$ in 2000)	**30.41**	**46.51**
L (agricultural employment per arable land) (no. of people)	**1.27**	**1.22**	Agricultural Value Added	**1.01**	**1.24**
Agricultural Value Added (Constant billion US$ in 2000)	**0.83**	**1.05**			

Notes: 1. Agricultural wage data are unavailable before 1990. 2. Real wages cannot be computed as appropriate exchange rates are unavailable.

Three variables are scaled in the range of 0-100 to facilitate comparison. It is difficult to find a single pattern in these graphs largely because (i) of the complex causality among these variables, and (ii) different conditions faced by these countries depending on, for example, their stage of agricultural and industrial development. The differing patterns are delineated below.

Brazil saw a simultaneous increase in the non-cereal crop share and agricultural productivity, and a decrease in agricultural employment. In Bolivia, a spurt in agricultural employment is observed, while the non-cereal crop share and agricultural productivity remained unchanged.

Sri Lanka's agricultural productivity gradually improved over the years. However, the non-cereal crop share increased from 1990-1996, followed by a decline until 2000. In Thailand, the non-cereal crop share *fell* over time, while agricultural productivity rose. Employment gradually decreased. Indonesia is yet another interesting case where a decline of the non-cereal crop share coincided with higher agricultural productivity until1995-96, after which there was a reversal.

Mongolia experienced a significant increase in the non-cereal crop share and employment but without a noticeable improvement in agricultural productivity. Other countries show no clear pattern among these variables except Iran where both non-cereal crop share and agricultural productivity rose during 1990 to 2004 while agricultural employment decreased from 1990 to 1995- a pattern similar to Brazil's.

Some deeper insights, however, follow from the econometric analysis.

4. Econometric Models-Specification and Estimation

The following two models are estimated. Model 1 aims at analysing the relationship among agricultural production, employment, new technologies, and wage rates. In Model 2, the focus shifts to growth rates of farm and non-farm employment, and the relationship between them.

Model 1

Model 1 is formulated to assess the determinants (e.g. technology, R&D, agricultural employment, inequality in land distribution, openness) of agricultural production per hectare of arable land (hereafter referred to as agricultural productivity). Agricultural wage is included as an additional endogenous variable, determined by food price and agricultural productivity. More specifically, equations (1), (2) and (3), as shown below, are estimated.

$$\log Y_{a,it} = \alpha + \beta_1 \log Am_{it} + \beta_2 \log Irr_{it} + \beta_3 \log Fert_{it} + \beta_4 \log L_{it} + \beta_5 \log R\&D_i + \beta_6 \log GINI(Land)_i + \beta_7 Open_i + \gamma_t + \lambda_i + \varepsilon_{it} \quad (1)$$

where $\log Y_{a,it}$ is log of value added per hectare of arable land (in constant 2000 US dollars, taken from WDI) i denotes country, and t denotes year. $LogY_{a,it}$ measures a country's agricultural productivity. The explanatory variables include technology comprising log of agricultural machinery/ tractors per hectare of arable land ($\log Am_{it}$), log of share of irrigated land in total arable land ($\log Irr_{it}$), and log of fertiliser consumption per hectare of arable land ($\log Fert_{it}$). $LogL_{it}$ refers to log of total employment in agricultural sector per hectare of arable land (based on WDI); $\log R\&D_i$

denotes log of agricultural R&D expenditure per hectare (in 1995 US dollars) available for selected countries in Sub-Saharan Africa, East and South East Asia, and Latin America (Thirtle, Lin and Piesse, 2003, p.1970); $\log \text{GINI(Land)}_i$ is log of GINI coefficient of land distribution (based on FAOSTAT). We also experiment with the log share of small farmers in total farmers as an alternative to $\log \text{GINI(Land)}_i$. Recent growth theory literature emphasizes generally positive effects of reduction in income inequality (which is related to asset inequality) on economic growth, say, due to political economy factors in fiscal policies (e.g. the median voter's preference for redistribution)[9]. Lower inequality in land distribution is likely to be associated with better incentives as well as higher efficiency of small farmers or labourers in agricultural production or activities. This raises total agricultural productivity and production. However, to the extent that ability to invest in agriculture is determined by easy access to credit, large landowners are in an advantageous position in a context of incomplete credit markets. So it is difficult to say *a priori* whether the degree of inequality in land distribution will have a positive or negative effect on agricultural productivity.

Open_i refers to openness of an economy to the rest of the world or to degree of integration with global markets. Different measures have been proposed in recent studies[10]. We have experimented with some. The first is the IV estimate of openness where trade share in GDP is estimated by an institutional quality measure and two other instruments viz. a measure of physical isolation[11] and country size (i.e. surface area)

[9] For a characterization of the median voter's preferences, see Alesina and Rodrik (1994).

[10] These include the Sachs-Warner, and Frankel-Romer indices, among others. For a review and details of construction of our own index of openness, see Gaiha and Imai (2005). Briefly, all these measures are confined to trade liberalisation.

[11] The physical isolation index measures the proportion of a country's population that lives less than 100 km from the coast (McArthur and Sachs, 2002).

(Gaiha and Imai, 2005). Other openness measures used are Frankel-Romer and Sachs-Warner.[12] γ_t is a time effect constant for all countries for a particular year, λ_i is an unobservable individual (country) effect, and ε_{it} is an *i.i.d.* error term.[13] The maximum set of observations for equation (1) covers 33 countries over the period 1980 to 2002 (see Appendix 2).[14]

Equations (2) and (3) specify the determinants of agricultural employment and wage rates, respectively.

$$\log L_{it} = \chi + \delta_1 \log Ya_{it} + \delta_2 \log Wage_{it} + \delta_3 \log Non-Cereal_{it} + \upsilon_t + \mu_i + \omega_{it} \qquad (2)$$

where $\log L_{a,it}$, log of agricultural employment per hectare, is estimated by $\log Y_{a,it}$, log of (lagged) agricultural value added, and log of monthly agricultural wage, $\log Wage_{it}$. Monthly agricultural wages have been taken from LABORSTA, the ILO data set. We use both nominal agricultural wages and real agricultural wages.[15] Log Non-Cereal is log of share of land used for crops other than cereal crops in total arable land. This is a proxy for agricultural diversification towards high value commodities, e.g. fruits and vegetables.[16] χ is a constant, υ_t is a time effect, μ_i is an individual (country) effect, and ω_{it} is an

---

[12] The Frankel-Romer index is the aggregated fitted values of trade share, derived from a bilateral trade equation with geographical variables (e.g., area, population) (Frankel and Romer, 1999). On the other hand, the Sachs and Warner measure is a binary variable based on a series of trade related indicators- tariffs, quotas, black market premium, social organisation and the existence of export marketing boards (Sachs and Warner, 1995).

[13] As STATA does not have a ready-made command for two-error components model to control for both time and individual effects, we use one-error component models (see, e.g. Baltagi 2005) where year dummies are included to control for time effects.

[14] See Appendix 3 for descriptive statistics of the variables.

[15] The former is adjusted by the Consumer Price Index and exchange rates taken from WDI.

[16] For example, diversification towards high value agricultural products is an important feature in recent years in India (Rao, et al. 2006). Log Non-Cereal$_{it}$ is not used as an explanatory variable in equation (1) or (3) as it did not have a significant effect. In principle, the crop diversification index should be treated as an endogenous variable, depending on agro-ecological conditions, access to markets, and changing dietary patterns-especially in urban areas. For some illustrative evidence, see Joshi et al. (2004), and Rao et al. (2006).

error term. As ILO wage data have a limited coverage, the maximum set of observations for equation (2) covers 39 countries over the period 1995 to 2003 for nominal wages and 19 countries for real wages (see Appendix 2). The number of countries for the latter is smaller due to limited availability of exchange rate data in WDI.

Agricultural wages are estimated by equation (3):

$$\log \text{Wage}_{it} = \phi + \varphi_1 \log \text{Food Price}_{it} + \varphi_2 \log \text{Ya}_{it} + \xi_t + \pi_i + \zeta_{it} \quad (3)$$

where $\log \text{Wage}_{it}$ refers to log of nominal or real agricultural wage rate, and $\log \text{Food Price}_{it}$ is log of consumer food price index. ϕ is a constant, ξ_t is a time effect, π_i is an individual (country) effect, and ζ_{it} is an error term. The maximum set of observations for equation (3) covers 38 countries over the period 1996 to 2003 for nominal wages, and 19 countries for real wages (see Appendix 2).

As noted earlier, simultaneous- equations estimation is ruled out because of the small overlap between samples for different variables -in particular, there is a very small overlap among the sets of countries with wage, R&D or openness data. For efficient use of these samples, a compromise is made. First, equations (1)-(3) are estimated separately as fixed-effects or random-effects specifications. While this estimation strategy is somewhat *ad hoc* as the endogeneity of some of the explanatory variables is overlooked, it yields approximations to the coefficient estimates or elasticiticies from larger samples. Second, we estimate real agricultural wages using fixed or random effects specifications of equation (3) to obtain the out-of-sample predictions for the sample with explanatory variables, i.e. log Food Price and logYa. We are thus able to derive predicted wages for a sample larger than the actual. Using the predicted values, we use fixed or random effects IV (instrumental variable) specifications for equations (1) and (2) simultaneously.

Model 2

In an alternative specification, we focus on *growth rates*, rather than levels, of agricultural employment as a function of lagged growth rates of agricultural value added, lagged agricultural wage rates and share of area devoted to non-cereal crops in the total arable area. Growth rates can be expressed as the first differences of logarithmic transformation of a variable. Growth rates of non-agricultural employment are then estimated as a function of the predicted growth rates of agricultural employment, as shown below in equation 5.

$$D\log L_{it} = \beta_1 D\log L_{it-1} + \beta_2 D\log L_{it-2} + \beta_3 D\log Y_{a\,it-1} + \beta_4\, D\log Ya_{\,it-2} + \beta_5\, D\log Wage_{\,it-1} + \\ + \beta_6 D\log Wage_{it-2} + \beta_7 D\log NonCereal_{it-1} + \varepsilon_{it} \qquad (4)$$

$$D\log LN_{it} = \pi_1 D\log L_{it-1} + \theta_i + \omega_t + \varphi_{it} \qquad (5)$$

where LN_{it} denotes non-agricultural employment. LN_{it} is defined as the total number of people employed in sectors other than agriculture. Note that the lagged predicted value of $D\log L_{it-1}$ is used as one of the explanatory variables in (5) to examine the effects of growth of agricultural employment on that of non- agricultural employment over time.

Estimating equation (4) as a static panel data model may cause bias in coefficient estimates. Accordingly, we use the Arellano-Bond estimator (Arellano and Bond, 1991) to estimate equation (4). Ideally, equations (4) and (5) should be estimated as a system of dynamic equations. However, to avoid complication, we use actual values of $D\log L_{it-1}$ in the fixed-effects version of equation (5) when the Arellano-Bond estimator is applied to equation (4). In other specifications, equations (4) and (5) are simultaneously estimated as the static version of fixed-effects IV panel model.

5. Results

Model 1

In this section, we present the econometric results based on Models 1 and 2, respectively. Table 2 shows elasticities of agricultural value added per hectare to technological and other explanatory variables in equation (1), for fixed or random effects specifications. Note that all explanatory variables (including employment per hectare of arable land) are taken as given. These results are contrasted with those in Table 5 where the endogeneity of $\log L_{it}$ is taken into account.

Five cases are presented in Table 2, based on different measures of openness and inequality of land distribution. Case A (in the second and third columns) is that where an IV estimate of trade openness and log of Gini coefficient of land distribution are used as explanatory variables, amongst others.[17] In Case B, the IV estimate of openness is replaced by log of trade share from WDI (log of sum of imports and exports/GDP). Although not endogenised, this measure of openness varies over time. Case C is same as Case B except that log of land Gini is replaced by log of share of small farmers in total farmers. Case D uses the Frankel-Romer index as an openness measure and log of land Gini. In Case E, the Sachs-Warner index replaces the Frankel-Romer index.

[17] The IV measure of openness was constructed by Gaiha and Imai (2005).

Table 2 Elasticity estimates of agricultural value added per hectare (Model1, Single Equation for (1))

Single Equation: Equation (1) (Fixed or Random Effects Model)
Dependent Variable: logYa

	Case A			Case B			Case C			Case D			Case E		
Land inequality:	logGini(Land)			logGini(Land)			log(Smallfarmer's share)			logGini(Land)			logGini(Land)		
Openness:	IV Estimate			Trade Share			Trade Share			Frankel-Romer			Sachs-Warner		
	Coef.	Z		Coef.	Z		Coef.	Z		Coef.	Z		Coef.	Z	
Fixed-effects model															
logAm	0.0709	(3.36)	**	0.0845	(4.04)	**	0.0809	(3.84)	**	0.0702	(3.33)	**	0.0709	(3.36)	**
logIrr	0.6196	(13.29)	**	0.5946	(12.94)	**	0.5756	(12.52)	**	0.6216	(13.33)	**	0.6196	(13.29)	**
logFert	0.0961	(4.31)	**	0.1024	(4.68)	**	0.1087	(4.94)	**	0.0924	(4.10)	**	0.0961	(4.31)	**
logL	**0.0398**	**(2.55)**	*	**0.0427**	**(2.81)**	**	**0.0425**	**(2.76)**	**	**0.0402**	**(2.58)**	*	**0.0398**	**(2.55)**	*
logR&D	-	-		-			-			-			-		
Land inequality	-	-		-			-			-			-		
Openness	**-**	**-**		**-0.1629**	**(-3.90)**	**	**-0.1695**	**(-4.02)**	**	**-**			**-**		
Constant	4.8278	(30.81)		5.5012	(23.83)	**	5.5290	(23.72)	**	4.8373	(30.69)	**	4.8278	(30.81)	**
No. of observations	347			347			349			345			347		
No. of countries	33			33			34			32			33		
Joint Significance	F(26,288)=	35.88**		F(27,287)=	39.54**		F(27,288)=	38.62**		F(26,287)=	38.64**		F(26,288)=	38.59**	
Overall R^2	0.1702			0.1481			0.1593			0.1678			0.1702		
Random-effects model															
logAm	0.0557	(2.34)	*	0.0741	(3.10)	**	0.0820	(3.71)	**	0.0586	(2.54)	*	0.0590	(2.49)	*
logIrr	0.3211	(8.25)	**	0.3017	(7.75)	**	0.4272	(10.39)	**	0.3809	(9.57)	**	0.3270	(8.31)	**
logFert	0.1122	(4.49)	**	0.1243	(5.03)	**	0.1177	(5.15)	**	0.1046	(4.28)	**	0.1155	(4.65)	**
logL	**0.0589**	**(3.39)**	**	**0.0617**	**(3.59)**	**	**0.0517**	**(3.23)**	**	**0.0523**	**(3.09)**	**	**0.0596**	**(3.44)**	**
logR&D	**0.1514**	**(2.33)**	*	**0.1615**	**(2.47)**	*	**0.1748**	**(1.92)**	+	**0.2102**	**(3.27)**	**	**0.1447**	**(2.09)**	*
Land inequality	**0.4671**	**(2.20)**	*	**0.4085**	**(1.91)**	+	**0.1032**	**(1.00)**		**0.2662**	**(1.25)**		**0.3450**	**(1.51)**	
Openness	**0.3348**	**(2.16)**	*	**-0.1484**	**(-3.17)**	**	**-0.1671**	**(-3.82)**	**	**0.0535**	**(4.82)**	**	**0.1989**	**(1.09)**	
Constant	4.8104	(7.29)	**	-	-		6.0046	(14.37)		-	-		-		
No. of observations	347			347			349			345			347		
No. of countries	33			33			34			32			33		
Joint Significance	Wald Chi^2(29)=	769.478**		Wald Chi^2(29)=	792.97**		Wald Chi^2(29)=	934.84**		Wald Chi^2(29)=	8517.33**		Wald Chi^2(29)=	7550.51**	
Overall R^2	0.4588			0.3414			0.2451			0.4612			0.3923		
Hausman Test	Chi^2(25)=	77.73**		Chi^2(27)=	781.45**		Chi^2(26)=	201.15**		Chi^2(26)=	730.30**		Chi^2(26)=	7550.51**	
	In favour of Fixed effects model			In favour of Fixed effects model			In favour of Fixed effects model			In favour of Fixed effects model			In favour of Fixed effects model		
Breusch Pagan Test	Chi^2(1)=	1395.31**		Chi^2(1)=	1435.92**		Chi^2(1)=	1259.73**		Chi^2(1)=	1730.91**		Chi^2(1)=	1698.20**	
	In favour of Random effects mode			In favour of Random effects mode			In favour of Random effects mod			In favour of Random effects mo			In favour of Random effects mode		

Notes 1. ** = significant at 1% level. * = significant at 5 % level. + = significant at 10% level. 2. Results for year dummies are omitted from the table.

2. The missing constant values are not printed by STATA.

Each case in Table 2 has two regression results, one for fixed-effects and another for random effects. As the choice between the two is far from straightforward, we present results based on both fixed and random effects specifications.[18] First, we will comment on the significance of explanatory variables. The magnitude of elasticities will be discussed later in conjunction with the results in Table 5. As expected, all technological variables, synonymous with modernisation of agricultural production, have positive and significant roles in explaining agricultural value added per hectare of arable land, our proxy for agricultural productivity. Machinery/ tractors per hectare of arable land has a positive and significant coefficient at the 1 % level. Irrigation share also has a positive and highly significant coefficient (at the 1 % level), confirming the importance of irrigation in raising agricultural productivity. Fertilise use has a positive and significant coefficient at the 1 % level, as also R&D expenditure per hectare.[19]

The positive and significant coefficient of land Gini suggests that the greater the inequality, the higher is the agricultural productivity. However, the coefficient of the share of small farmers is not significant.

The results on openness are mixed. Positive and significant coefficients are obtained with the IV estimate of openness (Case A) and the Frankel-Romer Index (Case D). However, the coefficient of trade share is *negative* and significant (Cases B and C). The Sachs-Warner Index has a positive but not significant coefficient (Case E). The reason for the negative coefficients of trade share in Cases B and C is far from obvious.[20]

---

[18] See, for example, the discussion in Greene (2002).

[19] A cautious interpretation is, however, necessary, given the relatively high correlations of log Am, log Irr, log Fert and log R&D. The correlation matrix is given in Appendix 4. It may be noted nevertheless that dropping of some variables does not much affect the coefficients and z values of other explanatory variables.

[20] In some recent contributions, Rodrik and his collaborators (e.g. Rodrik, 1999, and Rigobon and Rodrik, 2004) report a negative contribution of trade liberalization to income growth. In a conversation, Rodrik was

So, under certain conditions, a favourable effect of openness on agricultural productivity cannot be ruled out.[21] This is plausible as greater openness implies more competitive markets and easier access to better technology. However, in specific cases of incomplete credit and insurance markets, and weak infrastructure, the *potential* gains from trade liberalisation may not be fully realised and /or accrue to a small subset of large landowners.

The choice of a specification is usually based on a specific test but this is limiting in some ways. With this caveat, it may be noted that while the Hausman test favours fixed-effects specification, the Breusch-Pagan test favours random effects.[22]

Table 3 contains results on determinants of employment per hectare of arable land (i.e. equation (2) of Model 1). Three cases are shown: Case A, where log of nominal monthly wage is used as an explanatory variable in a sample of 39 countries; Case B, where log of real wage replaces log of nominal wages in a sample of 19 countries; and Case C, where log of nominal wages is used in the same sample of 19 countries to facilitate comparison

---

emphatic that in many cases trade liberalization involves exploitation of scarce natural resources that could lower growth over a short period.

[21] In an earlier study (Gaiha and Imai, 2005), openness did not contribute to higher income, controlling for the effects of institutional quality and lagged agricultural output. So the fact that openness has a positive effect on agricultural productivity is not necessarily inconsistent with the earlier result.

[22] The Hausman specification test compares the fixed versus random effects under the null hypothesis that the individual effects are uncorrelated with the other regressors in the model (Hausman, 1978). If correlated or the null is rejected, the random effects specification produces biased estimators and the fixed effects version is preferred. The test statistic is:

$$W = \chi^2[K] = [b_{fixed} - b_{random}]' \hat{\Sigma}^{-1} [b_{fixed} - b_{random}]$$

where $\hat{\Sigma}^{-1} = Var[b_{fixed} - b_{random}] = Var(b_{fixed}) - Var(b_{random})$

and b_{fixed} or b_{random} is a vector of coefficients for fixed or random effects specification. Under the null, W is asymptotically distributed as chi-square with K degree of freedom (Greene, 2002). We present the results of both fixed and random-effects as (1) our test statistics are based on all the coefficients of fixed-effects and a subset of the coefficients of random-effects, as time-invariant variables are dropped from the former in the first-differencing; and (2) testing for orthogonality of the individual effects and the regressors is based on the comparison of only two specific versions and thus a relative one.

with Case B. Since the random-effects version is favoured by *both* Hausman and Breusch-Pagan tests in all the cases, we shall confine our comments to this case.

Table 3 Elasticity estimates of agricultural employment per hectare

Single Equation: Equation (2) (Fixed or Random Effects Model)
Dependent Variable: logL

	Case A		Case B		Case C	
Wage:	**Nominal Wage**		**Real Wage**		**Nominal Wage (sample is same as Case B)**	
	Random-effects model		***Random-effects model***		***Random-effects model***	
	Coef.	Z	Coef.	Z	Coef.	Z
logYa	0.3060	(2.49) *	0.1119	(0.57)	0.1119	(0.57)
logWage	-0.0284	(-1.35)	-0.0216	(-0.73)	-0.0216	(-0.73)
logNonCereal	-0.1829	(-1.66)	-0.3269	(-1.59)	-0.3269	(-1.59)
constant	-2.1451	(-2.02)	-	-	-	-
No. of observations	186		99		99	
No. of countries	39		19		19	
Joint Significance	Wald Chi^2(29)= 18.84*		Wald Chi^2(29)= 44.54**		Wald Chi^2(29)= 44.54**	
Overall R^2	0.2662		0.0532		0.0574	
Hausman Test	Chi^2(9)= 5.60		Chi^2(10)= 3.14		Chi^2(10)= 2.60	
	In favour of Random effects model		In favour of Random effects model		In favour of Random effects mod	
Breusch Pagan Test	Chi^2(1)= 307.36**		Chi^2(1)= 185.77**		Chi^2(1)= 183.81**	
	In favour of Random effects model		In favour of Random effects model		In favour of Random effects mod	

Notes 1. ** = significant at 1% level. * = significant at 5 % level. + = significant at 10% level.
2. Results for year dummies are omitted from the table.

Log Ya_{it}, log of agricultural output per hectare of arable land, has a positive and significant coefficient only in Case A. As expected, this confirms that higher agricultural productivity leads to more agricultural employment. What is important is that the elasticity of agricultural employment to productivity is high. Log of (nominal) wages is negative but not significant. Log of share of land devoted to non-cereal crops in total arable land (our index of crop diversification), is negative and significant at the 10 % level. This is plausible as diversification towards non-cereal or high value crops is likely to be associated with use of labour-saving agricultural technology[23]. Detailed comments on Cases B and C are not necessary, as the results are identical. It is, however, notable that in both cases the coefficient of crop diversification has a negative coefficient. So even though the sample is much too small, this finding is consistent with the result from the larger sample in Case A.

The results on determinants of agricultural wage rates are shown in Table 4. Three cases are shown: Case A- random-effects specification for nominal monthly wages in a sample of 48 countries; Case B- fixed-effects specification for real wages in a sample of 25 countries; and Case C- random-effects specification for nominal wages in the same sample of 25 countries as in Case B.

---

[23] Attention may be drawn to high labour intensity of fruits and vegetables. Joshi et al. (2004), for example, point out on the basis of rough and ready comparisons that 1 ha shift in area from wheat to potato would generate 145 additional person-days of employment; similarly, a shift from coarse cereals (sorghum and pearl millet) to onion would generate 70 person-days of additional employment. While these comparisons are illustrative, two caveats must be borne in mind: (i) these differences are not adjusted for changes in technology and agro-ecological conditions; and (ii) are commodity-specific. Our finding of a negative effect of crop–diversification on employment controlling for other effects on labour-intensity are thus not not necessarily contradicted by the notional differences in employment per hectare for specific cereal and non-cereal crops.

Table 4 Estimates of log Agricultural Wage (Model1, Single Equation for (3)

Single Equation: Equation (3): Static Model (Random Effects Model)

Dependent Variable: log Wage

	Case A			**Case B**			**Case C**		
Dep. Variable:	**Nominal Wage**			**Real Wage**			**Nominal Wage**(same sample as B)		
	Random-effects model			*Random-effects model*			*Random-effects model*		
	Coef.	Z		Coef.	Z		Coef.	Z	
logFoodPrice	-0.0696	(-0.64)		-0.9569	(-4.21)	**	0.1763	(0.80)	
logYa	0.1449	(0.66)		0.0223	(0.06)		0.0050	(0.01)	
Year 1995	-0.7166	(-3.76)	**	8.2291	(3.19)	**	7.6333	(3.00)	**
Year 1996	-0.5055	(-2.86)	**	8.4857	(3.29)	**	7.9331	(3.11)	**
Year 1997	-0.2643	(-1.58)		8.6673	(3.34)	**	8.1411	(3.18)	**
Year 1998	-0.0949	(-0.58)		8.7856	(3.39)	**	8.2568	(3.22)	**
Year 1999	-0.1029	(-0.65)		8.5511	(3.29)	**	8.0340	(3.12)	**
Year 2000	-0.1182	(-0.75)		8.6058	(3.30)	**	8.1111	(3.15)	**
Year 2001	-0.0127	(-0.08)		8.6674	(3.30)	**	8.1814	(3.15)	**
Constant	8.2563	(5.15)		-	-		8.2393	(3.16)	
No. of observations	313			162			162		
No. of countries	48			25			25		
Joint Significance	Wald $Chi^2(9)$= 30.12**			Wald $Chi^2(9)$= 84.41**			Wald $Chi^2(9)$= 250.10**		
Overall R^2	0.0449			0.0338			0.0065		
Hausman Test	$Chi^2(8)$= 0.24			$Chi^2(9)$= 4.63			$Chi^2(8)$= 3.79		
	In favour of Random effects mode			In favour of Random effects mode			In favour of Random effects model		
Breusch Pagan Test	$Chi^2(1)$= 782.37**			$Chi^2(1)$= 454.15**			$Chi^2(1)$= 459.85**		
	In favour of Random effects mode			In favour of Random effects mode			In favour of Random effects model		

Notes 1. ** = significant at 1% level. * = significant at 5 % level. + = significant at 10% level.

As expected, log of Food Price has a negative and significant coefficient but only in Case B. It is interesting to note that all year dummies have positive and significant coefficients, implying a rising real wage rate. Somewhat surprisingly, Log Ya does not have a significant coefficient in any of the three cases in question. The predicted wage from this regression is used in the IV estimation for equations (1) and (2) in Table 5.

The procedure used for estimating the results in Table 5 is summarised first. In the first stage of IV estimation, equation (2) is estimated and, in the second stage, equation (1) is estimated. The results are shown in the same format as in Tables 2 and 3 to facilitate comparisons.

As many of the results in the first panel of Table 5 are similar to those in Table 2, we shall confine our remarks to some differences. In Table 5, log of fertiliser use ceases to be significant, while agricultural machinery/ tractor and irrigation continue to have positive and significant coefficients. Log of R&D expenditure also ceases to have a significant effect on agricultural productivity. Openness indicators are generally not significant except in Case B of fixed and random effects in Table 5. As trade share is not instrumented, we are inclined to be sceptical of the negative effect.

Absolute values of coefficient estimates or elasticity estimates also vary between Table 2 and Table 5. In Table 2, the elasticity of agricultural value added per hectare with respect to employment per hectare ranges from 0.04 to 0.06, implying that a 1% increase in employment leads to an increase of 0.04 to 0.06% in agricultural productivity. But this elasticity is much larger -between 0.68 and 0.87- in Table 5. This implies that a 1% increase in employment is associated with a 0.68- 0.87% increase in agricultural productivity when an allowance is made for the endogeneity of employment.

Table 5 Elasticity estimates for agricultural value added per hectare and agricultural employment per hectare (Model1, IV Model for equations (1) & (2))

IV Estimation- 2nd Stage: Equation (1) (Fixed or Random Effects IV Panel Model)

Dependent Variable: logYa

	Case A			Case B			Case C			Case D			Case E		
Land inequality:	**logGini(Land)**			**logGini(Land)**			**log(Smallfarmer's share)**			**logGini(Land)**			**logGini(Land)**		
Openness:	**IV Estimate**			**Trade Share**			**Trade Share**			**Frankel-Romer**			**Sachs-Warner**		
	Coef.	Z		Coef.	Z		Coef.	Z		Coef.	Z		Coef.	Z	
2nd Stage Fixed-effects IV panel model															
logAm	0.2889	(2.74)	**	0.3316	(2.96)	**	0.2889	(2.74)	**	0.2889	(2.74)	**	0.2889	(2.74)	**
logIrr	0.5289	(3.49)	**	0.4476	(2.71)	**	0.5289	(3.49)	**	0.5289	(3.49)	**	0.5289	(3.49)	**
logFert	-0.1748	(-1.37)		-0.1599	(-1.25)		-0.1748	(-1.37)		-0.1748	(-1.37)		-0.1748	(-1.37)	
logL	**0.6781**	**(3.04)**	**	**0.7246**	**(3.20)**	**	**0.6781**	**(3.04)**	**	**0.6781**	**(3.04)**	**	**0.6781**	**(3.04)**	**
logR&D	-	-		-			-	-		-			-	-	
Land inequality	-	-		-			-	-		-			-	-	
Openness	**-**	**-**		**-0.3391**	**(-2.19)**	*	**-**	**-**		**-**			**-**	**-**	
Constant	7.6631	(7.18)		9.1894	(6.62)	**	7.6631	(7.18)		7.6631	(7.18)	**	7.6631	(7.18)	
No. of observations	297			297			297			297			297		
No. of countries	30			30			30			30			30		
Joint Significance	Wald Chi^2(26)=	156820**		Wald Chi^2(27)=	141324.00		Wald Chi^2(26)	156820**		Wald Chi^2(26)	156820**		Wald Chi2(26	156820**	
Overall R^2	0.1702			0.1032			0.1702			0.1702			0.1702		
2nd Stage Random-effects IV panel model															
logAm	0.3306	(2.63)	*	0.3791	(2.94)	**	0.3371	(2.75)	**	0.2718	(2.55)	*	0.3329	(2.78)	**
logIrr	0.3414	(2.95)	**	0.3267	(2.62)	*	0.4034	(3.32)	**	0.3161	(3.26)	**	0.3941	(3.05)	**
logFert	-0.1701	(-1.22)		-0.1694	(-1.20)		-0.1999	(-1.41)		-0.0949	(-0.83)		-0.2059	(-1.47)	
logL	**0.8355**	**(3.46)**	**	**0.8743**	**(3.63)**	**	**0.8225**	**(3.36)**	**	**0.6975**	**(3.39)**	**	**0.8330**	**(3.55)**	**
logR&D	**0.0033**	**(0.02)**		**0.0068**	**(0.04)**		**0.0948**	**(0.56)**		**0.0419**	**(0.34)**		**-0.0315**	**(-0.15)**	
Land inequality	**0.9517**	**(2.08)**	*	**0.8995**	**(1.68)**	+	**-0.1060**	**(-0.51)**		**0.8576**	**(2.35)**	*	**0.7304**	**(1.10)**	
Openness	**0.0896**	**(0.27)**		**-0.3009**	**(-1.84)**	+	**0.0679**	**(0.16)**		**0.0147**	**(0.75)**		**0.5508**	**(0.96)**	
Constant	-	-		-	-		-	-		-	-		-	-	
No. of observations	297			297			297			297			297		
No. of countries	30			30			30			30			30		
Joint Significance	Wald Chi^2(29)=	1712.98**		Wald Chi^2(29)=	1236.39**		Wald Chi^2(29)=	1145.73**		Wald Chi^2(29)=	3014.31**		Wald Chi^2(29)=	843.48**	
Overall R^2	0.1377			0.1032			0.1028			0.1919			0.1429		
Hausman Test	Chi^2(26)=	280.69**		Chi^2(27)=	43.66*		Chi^2(26)=	54.86*		Chi^2(26)=	24.47		Chi^2(26)=	139.01**	
	In favour of Fixed effects model			In favour of Fixed effects mode			In favour of Fixed effects mode			In favour of Random effects mode			In favour of Fixed effects mode		

Notes 1. ** = significant at 1% level. * = significant at 5 % level. + = significant at 10% level. 2. Results for year dummies are omitted from the table.

Table 5 (Cont.)

IV Estimation 1st Stage: Equation (2) (Fixed or Random Effects IV Panel Model)

Dependent Variable: logL

	1st Stage Fixed-effects model			*1st Stage Random-effects model*		
Wage:	Predicted Real Wage			Predicted Real Wage		
				G2SLS		
	Coef.	Z		Coef.	Z	
logYa	0.2604	(0.98)	*	.23=730	(1.39)	
logNonCereal	-0.3116	(-2.44)	*	-0.3005	(-2.75)	**
Predicted logWage	0.0145	(1.11)		0.0140	(1.05)	
constant	-4.1493	(-2.68)		-	-	
No. of observations	297			297		
No. of countries	30			30		
Joint Significance	F(28,239)= 3.80**			Wald Chi^2(31)= 120**		
Overall R^2	0.1987			NA		

Notes 1. ** = significant at 1% level. * = significant at 5 % level. + = significant at 10% level.

2. Results for year dummies are omitted from the table.

Also, elasticities of agricultural production with respect to factors related to modernisation of agriculture vary. Table 2 shows the elasticities of 0.06-0.08 for machinery/ tractor, 0.32-0.62 for irrigation, 0.09-0.12 for fertiliser use, and 0.15-0.21 for R&D expenditure. In Table 5, however, the elasticities are 0.27-0.34 for machinery/ tractor and 0.33-0.45 for irrigation. As we are inclined to rely more on the results in Table 5, it follows that modernisation of agricultural technology has the potential of raising agricultural productivity in a substantial way.

In the second panel of Table 5, the first stage results of IV estimation for $\log L_{it}$ are given. An interesting result is that our proxy for crop diversification, log of share of area devoted to non-cereal crop in total arable land, has a negative and significant coefficient in both fixed and random-effects versions. That is, if the country diversifies agricultural production towards high-value commodities-that is, non-cereal crops- agricultural employment is likely to decrease, presumably due to the use of labour-saving technology. The elasticity estimates imply that a 1 % increase in 'the share' of non-cereal crops in total arable land (e.g. from 50% to 50.5%) results in a 0.3% decrease in agricultural employment per hectare of arable land. If we accept this result at face value, the adverse effect on agricultural employment is substantial.

Model 2

Table 6 shows two sets of results for Model 2, which focuses on determinants of agricultural and non-agricultural employment-including the link between them. Consider first the case of agricultural employment. The first two cases, Case A where nominal wage is used as an explanatory variable and Case B where real wage replaces nominal wage, show the results based on the Arellano-Bond estimator for equation (4), and fixed-effects specification of equation (5). The next two cases, Case C for nominal wage and Case D for real wage, are based on fixed-effects IV panel data specifications. As the samples are small, the results have to be interpreted with caution.

D log L(-1) or one-period lagged agricultural employment growth has a positive and significant effect only in Case C while D log L(-2) or two-period lagged agricultural growth has a positive and significant coefficient in Cases A and B, in the determination of D log L or growth of agricultural employment (i.e. equation (4)), as shown in the first panel of Table 6. Only the former seems consistent with our intuition, as it is not obvious why the two-period lagged agricultural employment growth matters. Consistent with our earlier results, lagged growth of crop diversification/non-cereal production has a negative effect on growth of agricultural employment (Cases C and D).

Table 6 Estimates for log Agricultural Employment and non-agricultural employment (Model 2; Equations (4) & (5))

Dependent Variable: D log L (Equation (4))

	Case A			Case B				Case C			Case D		
	Nominal Wage			Real Wage				Nominal Wage			Real Wage		
	Dynamic Model			Dynamic Model				Static Panel Model			Static Panel Model		
	Arellano-Bond (2step estimator)			**Arellano-Bond** (2step estimator)				Fixed-effects IV model			Fixed-effects IV model		
	Coef.	Z		Coef.	Z			Coef.	Z		Coef.	Z	
D log L(-1)	0.0658	(0.35)		-1.2616	(-1.17)		***First Stage***	0.3328	(1.66)	+	-0.2828	(-0.86)	
D log L(-2)	0.2077	(2.07)	*	1.1539	(2.78)	**		0.1328	(0.63)		-0.1079	(-0.32)	
D logYa(-1)	-0.1670	(-0.49)		1.2350	(0.81)			0.4625	(1.39)		0.0605	(0.13)	
D logYa(-2)	-0.0542	(-0.26)		-2.4760	(-1.37)			0.1261	(0.41)		0.2152	(0.56)	
D logWage(-1)	-0.0033	(-0.23)		-0.0351	(-0.55)			-0.0817	(-1.64)		-0.0639	(-2.10)	*
D logWage(-2)	-0.0019	(-0.15)		-0.0265	(-0.52)			0.2059	(1.06)		-0.4797	(-1.70)	
Dlog NonCereal(-1)	0.1721	(1.48)		-0.5167	(-0.75)			-0.3840	(-1.68)	+	-0.5603	(-2.19)	*
Constant	-0.0006	(-0.04)		0.0009	(0.02)			-0.7698	(-2.06)		-1.9653	(-2.65)	
No. of observations	79			45				55			33		
No. of countries	26			13				23			12		
Joint Significance	Vald $Chi^2(7)$= 1365**			Wald $Chi^2(7)$= 31.11**				F(7,25)= 2.70*			F(7,14)= 1.21		
m^2 [*2]	0.77	$Pr>m^2$= 0.4410		0.95	$Pr>m^2$= 0.3404			–			–		
Sargan Test [*3]	$Chi^2(93)$= 11.86			$Chi^2(93)$= 3.38				–			–		

Notes 1. ** = significant at 1% level. * = significant at 5 % level. + = significant at 10% level.

2. Arellano-Bond Test for second order serial autocorrelation (H_0: No autocorrelation)

3. Sagarn Test of over identifying restriction (H_0: the overidentifying restrictions do not hold in the precence of autocorrelation)

Dependent Variable: D log LN (Equation (5))

	Case A			Case B				Case C			Case D		
	Fixed-effects model			Fixed-effects model				Fixed-effects IV model			Fixed-effects IV model		
								Second Stage			*Second Stage*		
D logL(-1) [2]	0.1063	(1.88)	+	0.1315	(1.57)		***Second Stage***	0.5190	(2.21)	*	1.1642	(2.61)	*
Constant	0.1237	(2.20)		0.1451	(1.75)			0.7102	(2.29)		1.6604	(2.65)	
No. of observations	140			88				55			33		
Joint Significance	F(1,100)= 3.54			F(1,100)= 2.47				Wald $Chi^2(3)$= 10.24**			Wald $Chi^2(2)$= 9.28**		
Hausman Test	$Chi^2(1)$= 3.16+			$Chi^2(1)$= 2.39			Hausman Test	$Chi^2(1)$= 4.72*			$Chi^2(1)$= 6.64**		
	In favour of Fixed effects model			In favour of Random effects model				In favour of Fixed effects model			In favour of Fixed effects model		
Breusch Pagan Test	$Chi^2(1)$= 0.04			$Chi^2(1)$= 0.15				-			-		
	In favour of Fixed effects model			In favour of Fixed effects model									

Notes 1. ** = significant at 1% level. * = significant at 5 % level. + = significant at 10% level.

2. D logL(-1) takes the actual value in Cases A and B, while predicted values are used in Cases C and D in the IV estimations.

In the second panel of Table 6, the effect of lagged growth rate of agricultural employment on the growth rate of non-agricultural employment is positive and significant in all cases. This implies that higher growth of agricultural employment has some positive effects on the growth of non-agricultural employment, for example, through backward and forward linkages with the rest of the economy. It is important to note that the effect of growth rate of agricultural employment is substantially greater when predicted values of D log L (-1) are used. This further confirms that endogenous treatment of some of the variables used here can lead to marked differences in corresponding elasticities.

An issue of policy significance is whether conditions can be created for smallholders to benefit from the potential benefits of agricultural diversification. Some evidence points to substantially greater profitability of fruits and vegetables. Fruits are 8 times more profitable than cereals and other crops while vegetables are 4.8 times more profitable. But both yields and prices of horticultural commodities tend to be more volatile. So apart from protection against production and price risks (through, for example, technological choices, provision of crop insurance), there is a strong case for ensuring easy access to markets and credit. As perishability of fruits, vegetables, dairy products is also a major concern for smallholders, expansion of storage and refrigeration facilities is an additional priority[24].

6. Simulations for China and India

As China and India are two important developing countries with large populations and high growth rates, simulations based on regression results would be helpful for illustrative purposes.

In the first panel of Table 7, based on Case A in Table 6 (equation (5)), the effects of faster agricultural employment growth rates on non-farm employment growth rates are given. The baseline is the average of predicted values based on actual values of all explanatory variables. Three cases are shown: 5 %, 10%, and 15% higher growth rates of agricultural employment per hectare (or $D L_{it}$). Our simulations suggest that higher farm employment growth would further accelerate the growth of non-farm employment. For example, a 10% higher growth rate of agricultural employment would raise non-farm employment growth by 4.87% in China and 2.79% in India.

The second panel of Table 7 shows the effects of changes in irrigation share, fertilizer use, agricultural employment per hectare, and openness (IV estimate) on agricultural productivity, using Case A in Table 2 (equation (1)). The baseline is the case where all explanatory variables take the actual values. We consider four cases: (1) irrigation share is larger by 5%, 10%, or 15% (with other explanatory variables unchanged); (2) fertilizer use is higher by 5%, 10%, or 15%; (3) agricultural employment per hectare rises by 5%, 10%, or 15%; and (4) openness is greater by 5%, 10%, or 15%.

The results corroborate the importance of modernization of agricultural production and of opening up to global trade in raising agricultural productivity in both China and India. For example, higher irrigation share or fertilizer use has a substantial positive

[24] Some of these concerns are voiced by Joshi et al. (2004).

effect on agricultural productivity. On the other hand, higher employment per hectare has a positive but limited impact on agricultural productivity.

The last panel illustrates the effects of change in share of non-cereal crop areas on agricultural employment per hectare of arable land. Because the share of non-cereal crop area is unavailable for China, the results are presented only for India. It turns out that agricultural employment per hectare is reduced substantially as the share of non-cereal crop area increases.

Table 7: Simulations for China and India

Based on Table 6, Equation (5), Case A	*Change in Average of Growth Rates of Non-Farm Employment* [*1] China	India
Change in Average of Growth Rate of Agricultural Employment per hectare of arable land [*2]		
5% increase	**2.52%**	**1.39%**
10% increase	**4.87%**	**2.79%**
15% increase	**7.31%**	**4.18%**
Average of Actual Growth Rate of Agricultural Employment per hectare of arable land	0.92% (1987-2000)	3.50% (1991-1995)

Note: 1. Time-series average is calculated by the observations in 1987-2000 for China and in 1991-1995 for India.
The periods are determined by the availability of explanatory variables for these countries.
2. The baseline is the predicted value of time-series average growth rates of non-farm employment based on the actual values of explanatory variables. Simulation is carried out by increasing the growth rate of agricultural employment per hectare of arable land by 5%, 10%, or 15% with the values of other explanatory variables unchanged.

Based on Table 2, Equation (1), Case A, Random-effects Model	***Change in Average of Agricultural Value Added per hectare of arable land*** (in constant 2000 US$) [*1 *2] China	India
Irrigation Share		
5% increase	**1.58%**	**1.58%**
10% increase	**3.11%**	**3.11%**
15% increase	**4.59%**	**4.59%**
Fertilizer Use		
5% increase	**0.55%**	**0.55%**
10% increase	**1.07%**	**1.07%**
15% increase	**1.58%**	**1.58%**
Agricultural Employment per hectare of arable land		
5% increase	**0.29%**	**0.29%**
10% increase	**0.56%**	**0.56%**
15% increase	**0.83%**	**0.83%**
Openness (IV estimate)		
5% increase	**1.65%**	**1.65%**
10% increase	**3.24%**	**3.24%**
15% increase	**4.79%**	**4.79%**
Average of Actual Agricultural Value Added per hectare of arable land (in 2000 US$)	538.19 (1980-2000)	333.32 (1990-1995)

Note: 1. Time-series average is calculated by the observations in 1980-2000 for China and in 1991-1995 for India.
The periods are determined by the availability of explanatory variables for these countries.
2. These calculations correspond to elasticity estimates and the results are same for China and India.

Based on Table 5, Equation (2), Random-effects Model	***Change in Average of Agricultural Employment per hectare of arable land*** [*1 *2] China	India
Share of non-cereal crop in total arable land		
5% increase	**NA**	**-2.40%**
10% increase	**NA**	**-4.74%**
15% increase	**NA**	**-7.03%**
Average of Actual Agricultural Employment per hectare of arable land	NA	1.58 (1980-2002)

Note: 1. Time-series average is calculated by the observations in 1980-2002 for India.
China does not have data of non-cereal crop share and thus computation is not feasible.
2. These calculations correspond to elasticity estimates.

7. Concluding Observations

Drawing upon different specifications and methods of panel data estimation designed to make efficient use of cross-country samples, we have analysed the relationships among agricultural productivity, employment, technology, openness of the economy, and inequality in land distribution. Agricultural productivity varies with technology and employment, but more so with employment. The effect of openness on agricultural productivity is ambiguous-it is positive, negative or not significant, depending on the definition of openness, specification and estimation procedure used. Simulations for China and India show that in a *specific* case the positive effects of openness on agricultural productivity for these countries are large.

Agricultural employment and diversification of agriculture are inversely related. A somewhat surprising result is the positive effect of inequality in land distribution on agricultural productivity. Arguably, when credit markets are incomplete, greater inequality in land distribution may imply a more significant role for large landowners in agricultural investment through easier access to credit. In another specification, the determinants of growth rates of agricultural and non-agricultural employment, and their linkages are examined using both dynamic and static models. There is a strong (lagged) positive effect of growth rate of agricultural employment on that of non-agricultural employment, as corroborated by our simulations for China and India. Even though the share of agriculture has declined in developing countries, its contribution to overall economic growth and generation of employment is substantial. While a case for acceleration of agricultural growth through modernisation of its technology, crop diversification and exploitation of high value export opportunities rests on more complete credit and insurance markets, and infrastructural support, some negative effects of crop-diversification on employment are likely.

References

Alesina, A. and D. Rodrik (1994) "Distributive Politics and Economic Growth," *The Quarterly Journal of Economics*, vol. 109(2), pp. 465-90.

Arellano, M. and S. Bond (1991) "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations", *The Review of Economic Studies* Vol. 58, pp. 277-297.

Baltagi, B. H. (2005) *Econometric Analysis of Panel Data*, third edition, John Wiley & Sons.

Frankel, J. A. and D. Romer (1999) "Does Trade Cause Growth?" *The American Economic Review* Vol. 89, pp. 379-399.

Gaiha, R. and K. Imai (2005) "Do Institutions Matter in Poverty Reduction? Prospects of Achieving the MDG of Poverty Reduction in Asia", A paper presented at WIDER Jubilee Conference: Future of Development Economics, Helsinki: WIDER.

Greene, W (2002), *Econometric Analysis*, Fifth Edition, Prentice-Hall, New Jersey.

Hausman, J. A. (1978) 'Specification Tests in Econometrics' *Econometrica,* Vol. 46, No. 6, pp. 1251-1271.

Joshi, P. K., A. Gulati, P. S. Birthal, and L. Tiwari (2004) " Agriculture Diversification in South Asia: Patterns, Determinants and Policy Implications", *Economic and Political Weekly*, June 12.

Lipton, M. (1977) *Why poor people stay poor? Urban bias in world development. London*: Temple Smith.

McArthur, J. and J. Sachs (2002) "A Millennium Development Strategy for Achieving Poverty Alleviation and Economic Growth", Draft.

Mellor, J. W. (1976) *The New Economics of Growth: A Strategy for India and the Developing World,* Cornell University Press: Ithaca, NY.

Mellor, J. W. and U. Lele (1972) "Growth Linkages of the New Food Grain Technologies", *Indian Journal of Agricultural Economics,* vol. 19 no.1, pp.35-55.

Rao, P. P., P.S. Birthal and P. K. Joshi (2006) " Diversification towards High Value Agriculture: Role of Urbanisation and Infrastructure", *Economic and Political Weekly*, June 30.

Rigobon, R. and D. Rodrik (2004) "Rule of Law, Democracy, Openness and Income: Estimating the Interrelationships", Draft.

Rodrik, D. (1999) *The New Global Economy and Developing Countries: Making Openness Work*, Washington DC: Overseas Development Council.

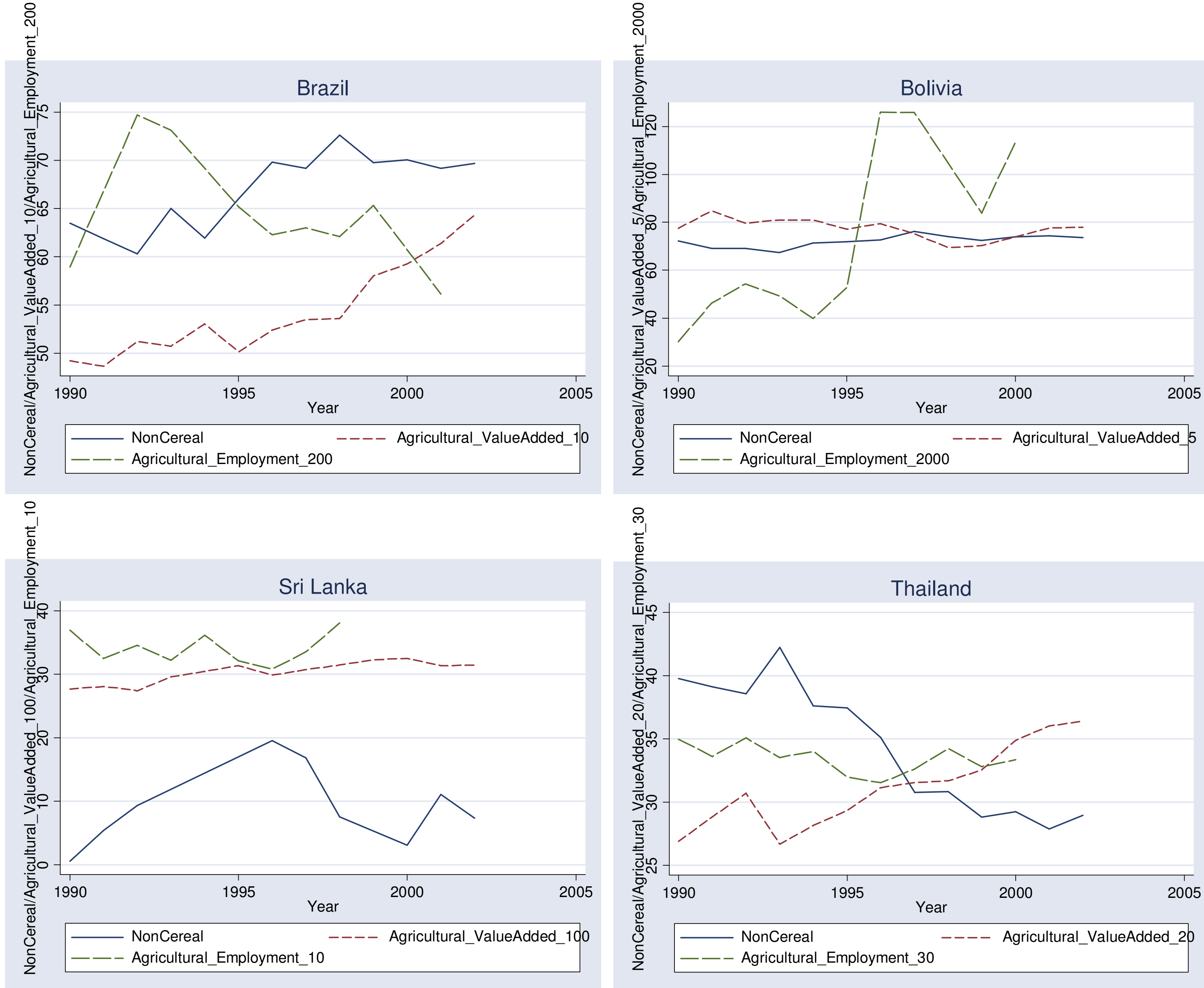
Sachs, J. and W. A. Warner (1995) "Economic Reform and the Process of Global Integration", *Brooking Papers on Economic Activity*, vol.1, pp.1-118.

Rao, P. P., P. S. Birthal and P. K. Joshi (2006) "Diversification towards High Value Agriculture: Role of Urbanisation and Infrastructure" *Economic and Political Weekly* June 30, 2006.

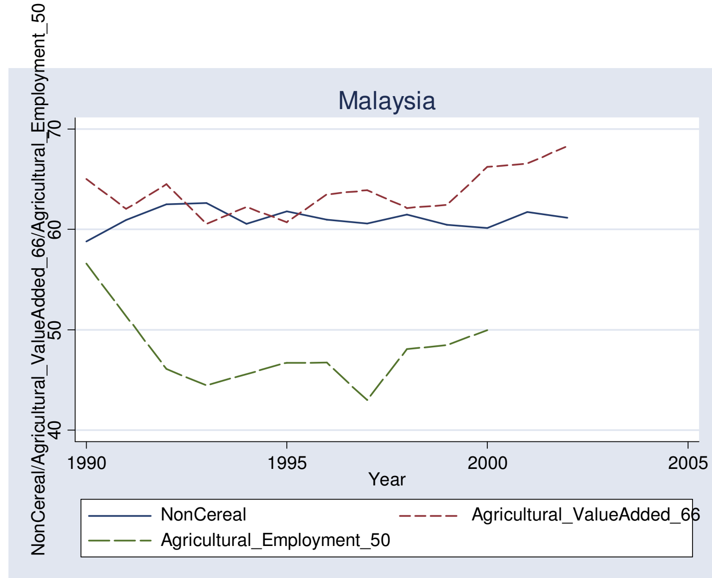
Thirtle, C., L. Lin and J. Piesse (2003) "The Impact of Research-Led Agricultural Productivity Growth on Poverty Reduction in Africa, Asia and Latin America", *World Development*, vol. 31, no. 12, pp.1959-1975.

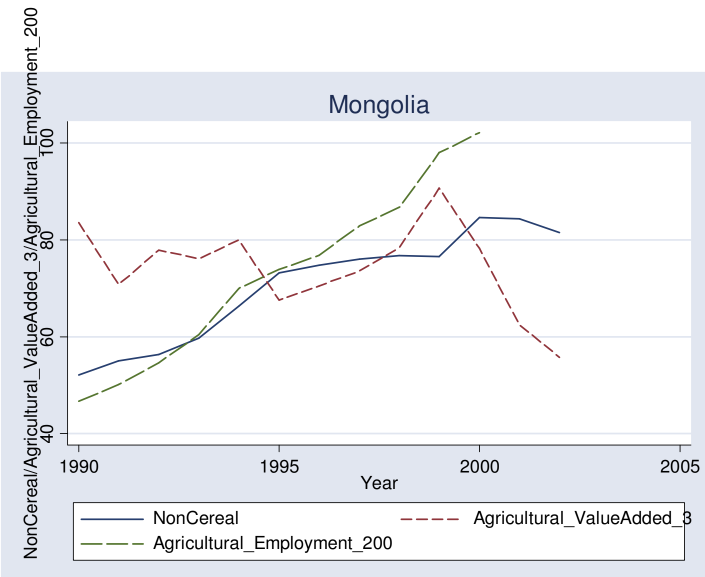
World Bank (2005) *World Development Indicators.* Washington D.C.: Oxford University Press.

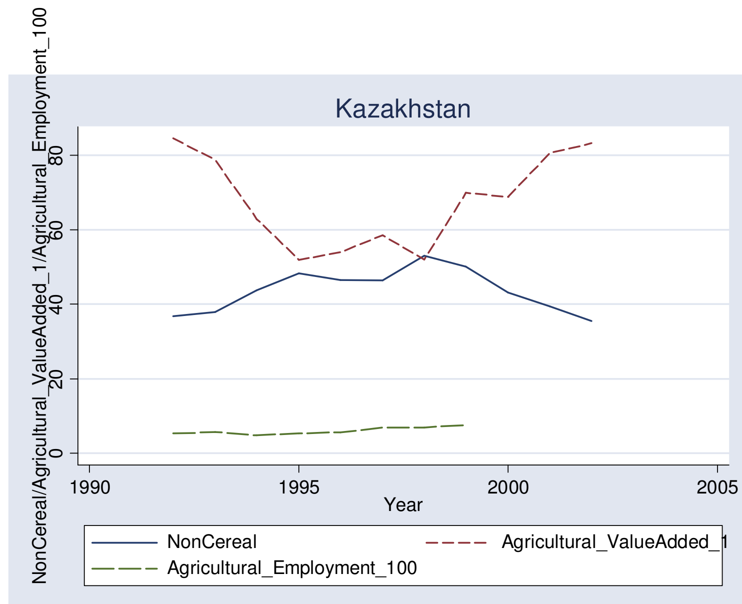
Appendix 1: Graphs on Time Series Changes of Crop Diversification, Agricultural Employment, and Production by Selected Countries

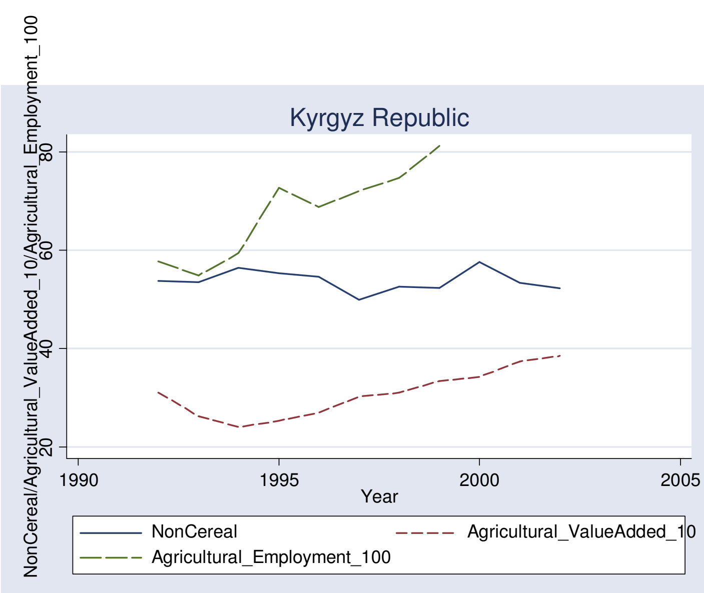


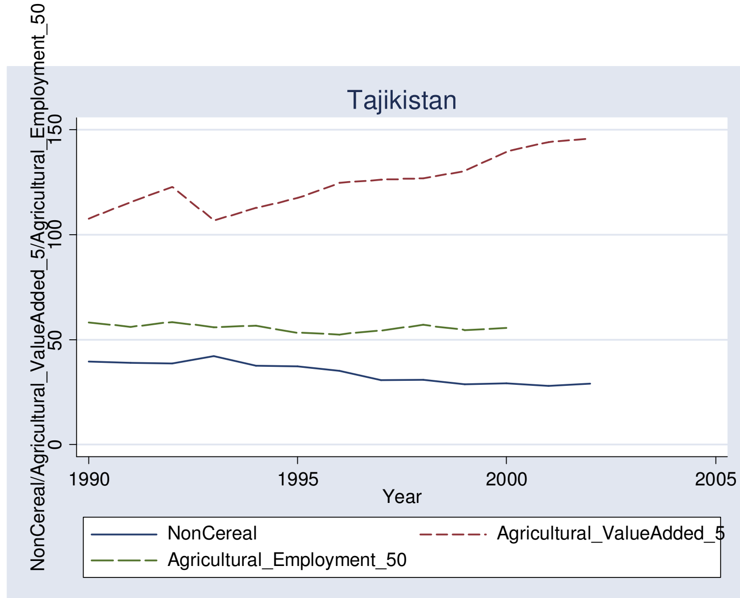

Indonesia
NonCereal/Agricultural_ValueAdded_50/Agricultural_Employment_10
15
20
25
30
35
1990
1995
2000
2005
Year
NonCereal
Agricultural_ValueAdded_50
Agricultural_Employment_10

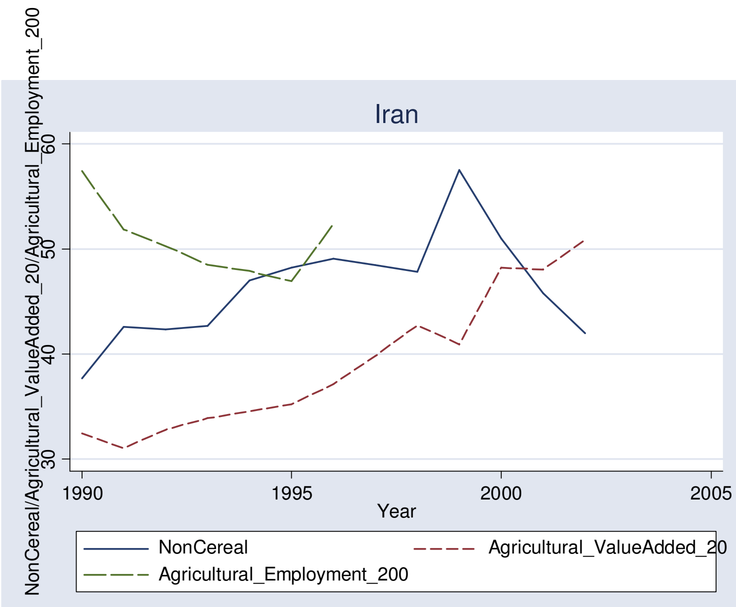

Malaysia
NonCereal/Agricultural_ValueAdded_66/Agricultural_Employment_50
40
50
60
70
1990
1995
2000
2005
Year
NonCereal
Agricultural_ValueAdded_66
Agricultural_Employment_50


Mongolia
NonCereal/Agricultural_ValueAdded_3/Agricultural_Employment_200
40
60
80
100
1990
1995
2000
2005
Year
NonCereal
Agricultural_ValueAdded_3
Agricultural_Employment_200


Kazakhstan
NonCereal/Agricultural_ValueAdded_1/Agricultural_Employment_100
0
20
40
60
80
1990
1995
2000
2005
Year
NonCereal
Agricultural_ValueAdded_1
Agricultural_Employment_100

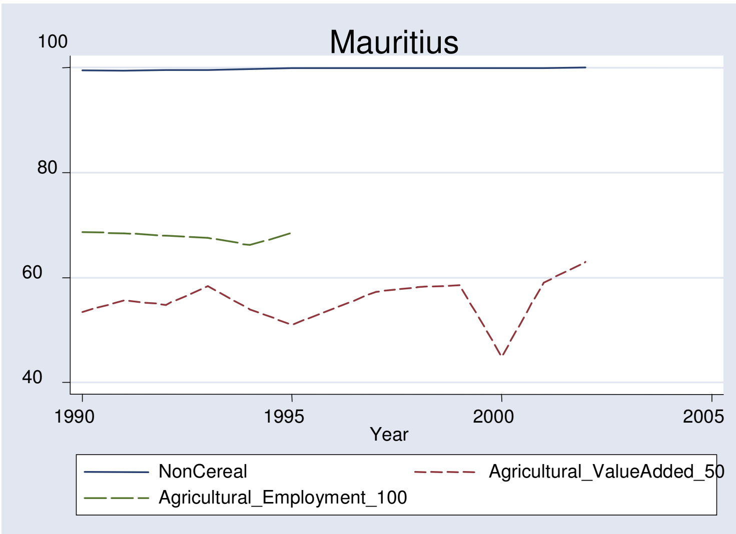

Kyrgyz Republic
NonCereal/Agricultural_ValueAdded_10/Agricultural_Employment_100
20
40
60
80
1990
1995
2000
2005
Year
NonCereal
Agricultural_ValueAdded_10
Agricultural_Employment_100


Tajikistan
NonCereal/Agricultural_ValueAdded_5/Agricultural_Employment_50
0
50
100
150
1990
1995
2000
2005
Year
NonCereal
Agricultural_ValueAdded_5
Agricultural_Employment_50


Iran
NonCereal/Agricultural_ValueAdded_20/Agricultural_Employment_200
30
40
50
60
1990
1995
2000
2005
Year
NonCereal
Agricultural_ValueAdded_20
Agricultural_Employment_200


Kenya
NonCereal/Agricultural_ValueAdded_10/Agricultural_Employment_100
35
40
45
50
55
60
1990
1995
2000
2005
Year
NonCereal
Agricultural_ValueAdded_10
Agricultural_Employment_100

NonCereal/Agricultural_ValueAdded_50/Agricultural_Employment_100



The number after 'Agricultural_ValueAdded_' or 'Agricultural Employment_' is used to rescale 'Agricultural value added per hectare of arable land' or 'Agricultural Employment per hectare of arable land' in the range of 0-100. For example, 'Agricultural_ValueAdded_50' is 'Agricultural value added per hectare of arable land' divided by 50 and Agricultural Employment_100' is 'Agricultural Employment per hectare of arable land' multiplied by 100.

Appendix 2: Availability of Data and Averages of Variables by Country

Note: 'l' denotes log.

Country Name	Code	l_Wage	l_RWage	l_Ya	l_L	l_LN	l_Am	l_Irr	l_Fert	l_RandD	l_giniLand	Open	l_tradeshare	Frankel	SW	l_foodprice	logNoncereal
East Asia and the Paccific																	
American Samoa	ASM	-	-	-	-	-	-0.61	-	-	-	-	-	-	-	-	4.42	-
Brunei	BRN	-	-	-	-0.30	11.67	-0.23	2.52	8.02	-	-0.31	-	-	-	-	4.47	3.88
Cambodia	KHM	-	-	5.82	0.02	14.05	-3.11	1.64	2.30	-	-	-	3.69	-	-	4.53	3.52
China	CHN	6.63	2.00	6.61	1.08	19.19	-1.03		6.88	-0.13	-	3.69	3.02	2.30	0.00	-	-
Fiji	FJI	5.96	1.32	7.46	-3.40	12.52	1.20	-0.38	6.91	-	-0.30	-	4.61	-	-	4.29	4.50
French Polynesia	PYF	8.50	-	-	-	-	1.93	1.46	8.13	-	-	-	3.37	-	-	4.47	-
Guam	GUM	7.40	-	-	-	-	0.40	-	-	-	-	-	-	-	-	4.42	4.60
Hong Kong, China	HKG	9.02	-	-	-	14.90	-	-	-	-	-	-	5.32	-	-	4.21	-
Indonesia	IDN	-	-	6.68	0.76	17.50	-2.47	2.71	6.12	0.73	-0.71	4.22	3.72	4.47	1.00	3.44	3.47
Kiribati	KIR	-	-	8.32	-	-	-0.42	-	-	-	-0.33	-	4.76	-	-	-	-
Korea, Dem. Rep.	PRK	7.43	-	-	0.51	15.50	0.48	3.67	7.41	-	-	-	-	-	-	-	3.48
Lao PDR	LAO	-	-	6.66	0.60	12.87	-2.90	2.07	2.32	-	-	4.43	3.72	27.32	0.00	-	2.37
Macao, China	MAC	8.50	-	-	-	12.23	-	-	-	-	-	-	5.04	-	-	4.35	-
Malaysia	MYS	-	-	8.41	0.21	15.48	-0.17	1.72	8.12	2.70	-0.67	5.26	4.74	16.82	1.00	4.25	3.66
Marshall Islands	MHL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Micronesia, Fed. Sts.	FSM	-	-	-	-	-	-	-	-	-	-	-	4.47	-	-	-	-
Mongolia	MNG	4.30	-	5.45	-1.04	12.74	-0.43	1.76	3.88	-	-	4.88	4.76	13.52	0.00	-	4.02
Myanmar	MMR	-	-	-	0.33	15.53	-2.65	2.33	4.17	-	-0.82	-	2.48	-	-	2.94	3.76
New Caledonia	NCL	12.45	-	-	-	-	2.53	3.07	7.08	-	-	-	3.81	-	-	4.39	4.50
Northern Mariana Islands	MNP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.47	-
Palau	PLW	-	-	-	-	-	-2.08	-	-	-	-	-	4.38	-	-	-	-
Papua New Guinea	PNG	-	-	8.22	2.03	12.68	-0.19	-	5.66	-	-	-	4.38	-	-	3.76	4.59
Philippines	PHL	9.01	4.44	7.35	0.71	16.40	-1.79	2.57	6.39	0.22	-0.73	4.63	3.95	8.84	1.00	3.87	-0.77
Samoa	WSM	10.11	5.54	6.51	-	-	-2.77	-	3.57	-	-1.27	-	4.52	-	-	-	-
Singapore	SGP	7.95	3.31	11.41	1.62	14.25	0.60	-	9.86	-	-	-	-	-	-	4.49	-
Solomon Islands	SLB	6.79	2.72	-	1.00	11.72	-3.11	-	-	-	-	-	4.82	-	-	-	4.52
Thailand	THA	8.73	-	6.07	0.08	16.31	-1.80	2.88	5.38	1.19	-0.89	4.54	4.01	9.45	1.00	4.21	3.57
Timor-Leste	TMP	-	-	7.07	1.44	10.93	-2.28	-	-	-	-	-	-	-	-	-	3.09
Tonga	TON	-	-	7.63	-	-	-0.34	-	4.17	-	-0.82	-	4.46	-	-	4.22	-
Vanuatu	VUT	-	-	7.06	-	-	-1.66	-	-	-	-	-	4.64	-	-	4.34	4.55
Vietnam	VNM	-	-	6.94	1.55	16.17	-1.33	3.33	6.52	-	-	-	4.24	-	-	-	1.91

Regional Average		8.06	3.22	7.27	0.42	14.35	-0.93	2.33	5.94	0.94	-0.69	4.52	4.21	11.82	0.57	4.19	3.51
East Europe & Central Asia																	
Albania	ALB	-	-	7.14	-	-	0.36	3.88	6.39	-	-	3.85	3.84	3.68	0.00	3.80	-
Andorra	ADO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Armenia	ARM	9.87	5.31	6.77	0.22	13.73	1.25	3.92	5.19	-	-	4.34	4.43	3.68	0.00	3.64	-
Azerbaijan	AZE	12.51	-	6.17	-0.33	14.22	0.61	4.31	4.85	-	-	-	4.54	-	-	2.86	-
Belarus	BLR	13.44	-	5.59	-1.68	15.18	0.43	0.74	7.16	-	-	4.75	4.78	-	0.00	0.55	4.09
Bosnia and Herzegovina	BIH	6.51	-	6.25	-	14.17	1.10	-1.50	5.54	-	-	-	4.52	-	-	-	4.20
Bulgaria	BGR	7.38	3.39	5.94	-1.36	15.04	0.20	3.14	7.01	-	-	4.73	4.50	31.12	0.00	0.22	3.81
Channel Islands	CHI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Croatia	HRV	8.41	3.82	6.99	-1.38	14.38	-1.41	-1.67	7.28	-	-	4.52	4.62	21.07	0.00	-1.54	3.90
Cyprus	CYP	6.80	2.15	-	-0.93	12.52	2.32	2.95	7.58	-	-0.60	-	4.65	-	-	4.23	3.76
Czech Republic	CZE	9.47	4.89	6.46	-2.23	15.42	0.98	-0.33	6.97	-	-	4.76	4.72	21.07	0.00	4.39	3.86
Estonia	EST	8.42	-	5.63	-2.59	13.44	1.60	-0.95	5.87	-	-	5.08	5.01	3.68	0.00	4.14	4.21
Faeroe Islands	FRO	-	-	-	-	-	-	-	-	-	-1.39	-	-	-	-	-	-
Georgia	GEO	-	-	6.74	0.54	14.06	0.81	3.76	6.16	-	-	3.98	4.32	-	0.00	4.38	4.11
Greenland	GRL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.37	-
Hungary	HUN	11.31	6.77	6.09	-2.58	15.30	0.29	1.34	7.24	-	-	4.51	4.43	26.92	1.00	3.28	3.69
Isle of Man	IMY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.20	-
Kazakhstan	KAZ	9.55	-	4.20	-2.82	15.57	-0.99	2.14	3.37	-	-	4.24	4.48	3.68	0.00	2.82	3.77
Kyrgyz Republic	KGZ	6.86	-	5.72	-0.40	13.90	0.62	4.33	5.38	-	-	4.49	4.40	3.68	0.00	3.61	3.98
Latvia	LVA	4.88	-	5.16	-2.01	13.93	1.16	0.11	5.73	-	-	4.72	4.63	3.68	0.00	4.24	4.27
Liechtenstein	LIE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lithuania	LTU	6.84	-	5.63	-2.11	14.20	1.14	-1.32	6.10	-	-	4.74	4.60	3.68	0.00	1.82	4.15
Macedonia, FYR	MKD	9.35	4.65	6.36	-	-	2.18	2.24	6.30	-	-	-	4.45	-	-	-	4.13
Moldova	MDA	5.96	1.63	5.37	-0.51	13.89	0.95	2.65	5.06	-	-	4.83	4.79	-	0.00	2.53	3.92
Monaco	MCO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Poland	POL	7.31	2.85	5.93	-1.12	16.48	1.26	-0.05	7.28	-	-	4.02	3.94	13.84	1.00	1.77	3.75
Romania	ROM	14.33	10.42	6.23	-0.99	15.77	0.29	2.69	6.48	-	-	4.12	4.09	18.80	0.00	1.03	-
Russian Federation	RUS	-	-	4.78	-2.48	18.01	-0.33	1.35	4.98	-	-	3.90	3.99	3.68	0.00	2.60	-
San Marino	SMR	10.78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Serbia and Montenegro	YUG	8.31	-	-	-	-	1.13	0.57	6.86	-	-	-	4.10	-	-	4.17	-
Slovak Republic	SVK	9.30	4.81	-	-	14.79	-	-	-	-	-	4.84	4.70	21.07	0.00	3.62	-
Slovenia	SVN	12.11	-	7.97	-0.52	13.71	-	0.04	8.27	-	-	4.74	4.77	3.68	0.00	0.32	3.76
Tajikistan	TJK	7.68	-	5.71	0.25	13.72	1.14	4.25	6.03	-	-	-	4.74	-	-	-	4.13

Turkey	TUR	11.85	-	6.77	-1.19	16.59	0.22	2.28	5.86	-	-0.65	3.95	3.25	11.26	1.00	0.44	3.82
Turkmenistan	TKM	-	-	5.88	-0.67	-	1.14	4.54	6.60	-	-	4.75	4.57	3.68	0.00	-	4.13
Ukraine	UKR	5.39	1.00	5.02	-1.75	16.45	0.25	1.99	5.39	-	-	4.48	4.37	-	0.00	-0.39	4.11
Uzbekistan	UZB	8.11	-	6.77	-0.14	15.49	1.34	4.48	7.29	-	-	4.22	4.04	3.68	0.00	-	4.17
Regional Average		8.95	4.31	6.05	-1.20	14.80	0.74	1.85	6.22		-0.88	4.46	4.42	10.82	0.13	2.58	3.99
Latin America and Caribbean																	
Antigua and Barbuda	ATG	-	-	7.81	-	-	0.98	-	-	-	-	-	5.06	-	-	-	4.60
Argentina	ARG	-	-	5.75	-6.01	16.41	-0.36	1.52	3.82	-	-	-	2.75	-	-	1.21	-
Aruba	ABW	-	-	-	-	-	-	-	-	-	-	-	5.44	-	-	4.36	-
Bahamas, The	BHS	-	-	-	-0.04	11.78	0.07	2.32	6.82	-	-	-	4.86	-	-	4.35	-
Barbados	BRB	-	-	9.15	-0.66	11.66	1.09	1.77	7.86	-	-	-	4.77	-	-	4.32	4.57
Belize	BLZ	-	-	7.08	-1.15	10.69	0.48	1.03	6.19	-	-0.39	-	4.76	-	-	4.52	4.23
Bermuda	BMU	-	-	-	-	-	1.48	-	7.27	-	-	-	-	-	-	-	-
Bolivia	BOL	7.29	2.87	5.91	-3.45	14.86	-1.70	1.66	3.09	-2.21	-0.60	3.93	3.90	8.06	0.00	1.94	4.26
Brazil	BRA	6.58	-	6.11	-1.15	17.68	-0.11	1.09	6.17	0.44	-0.31	2.84	2.83	3.03	1.00	-4.69	4.05
Cayman Islands	CYM	-	-	-	-	-	-	-	-	-	-1.27	-	-	-	-	4.47	-
Chile	CHL	12.32	7.80	6.86	-1.15	15.25	0.19	3.71	6.37	0.31	-0.45	4.07	3.77	7.25	1.00	3.69	4.31
Colombia	COL	13.02	8.52	7.89	-2.66	16.47	-0.28	2.17	6.82	-0.26	-0.36	3.58	3.42	7.54	1.00	3.08	4.11
Costa Rica	CRI	11.44	6.99	7.89	0.09	13.68	0.78	2.35	7.94	-0.54	-0.40	4.48	4.24	23.37	1.00	3.64	4.07
Cuba	CUB	-	-	-	-1.03	15.17	0.71	2.99	7.08	-	-	-	3.48	-	-	-	4.50
Dominica	DMA	-	-	9.07	-	-	0.26	-	8.72	-	-	-	4.74	-	-	-	4.58
Dominican Republic	DOM	8.53	3.94	7.27	-0.64	14.80	-1.53	2.58	6.29	-0.06	-0.36	4.22	4.04	22.37	0.00	3.46	4.46
Ecuador	ECU	-	-	6.85	-1.66	15.15	-1.00	3.15	5.92	-	-0.37	4.04	3.90	11.42	1.00	1.41	4.05
El Salvador	SLV	6.90	-	7.66	-0.43	14.33	-0.59	1.47	7.19	-	-0.56	4.07	4.02	28.91	1.00	3.61	3.28
Grenada	GRD	-	-	9.41	-	-	-0.54	-	-	-	-	-	4.73	-	-	-	4.44
Guatemala	GTM	7.28	-	7.73	0.14	14.74	-1.23	1.57	6.43	0.21	-0.33	3.73	3.65	22.04	1.00	3.90	3.70
Guyana	GUY	-	-	5.71	-1.77	12.14	-0.21	3.34	5.64	-	-0.51	5.34	4.98	25.92	1.00	3.73	4.31
Haiti	HTI	-	-	7.38	0.78	14.32	-4.01	1.74	2.95	-	-0.43	-	3.63	-	-	-	3.81
Honduras	HND	-	-	5.91	-1.28	13.89	-1.74	1.43	5.34	-1.39	-0.45	4.60	4.20	27.58	1.00	3.40	4.26
Jamaica	JAM	-	-	8.06	0.56	13.71	0.59	2.27	7.20	1.46	-0.39	4.58	4.46	22.19	1.00	3.04	4.58
Mexico	MEX	7.81	-	6.56	-1.16	17.04	-0.42	2.94	6.07	0.10	-0.54	4.13	3.33	4.52	1.00	2.45	4.06
Netherlands Antilles	ANT	-	-	-	-2.40	11.42	-1.47	-	-	-	-	-	-	-	-	4.33	-
Nicaragua	NIC	7.74	3.30	6.09	-0.83	13.70	-2.30	1.42	5.53	-	-	4.72	4.09	23.46	1.00	-3.92	4.31
Panama	PAN	5.94	-	7.10	-0.78	13.50	-0.24	1.45	6.22	1.08	-0.30	4.37	5.03	23.56	0.00	4.52	4.10
Paraguay	PRY	13.63	9.15	6.37	-3.52	14.14	-0.55	1.21	3.92	-	-0.26	4.29	3.79	10.43	1.00	3.38	4.35
Peru	PER	-	-	6.85	-2.90	15.93	-1.04	3.51	6.01	-0.15	-0.49	3.46	3.53	7.03	1.00	-1.55	4.28
Puerto Rico	PRI	-	-	-	-0.14	13.93	-	3.31	-	-	-	-	4.88	-	-	3.98	4.59

St. Kitts and Nevis	K-	-	-	7.09	-	-	0.61	-	7.67	-	-0.54	-	4.88	-	-	-	-
St. Lucia	LCA	-	-	9.27	-	-	0.48	2.14	8.64	-	-	4.88	4.93	68.83	0.00	4.34	4.60
St. Vincent and the Grenadines	VCT	8.46	3.91	8.57	-	-	0.20	2.22	8.58	-	-	-	4.89	-	-	4.47	4.55
Suriname	SUR	-	-	7.30	-2.01	11.79	0.91	4.21	6.65	-	-0.51	-	4.50	-	-	0.32	2.07
Trinidad and Tobago	TTO	-	-	7.06	-0.31	13.01	1.18	0.99	6.88	-	-0.49	4.62	4.48	30.33	0.00	3.52	4.53
Uruguay	URY	4.96	0.57	6.60	-3.05	14.12	0.86	1.77	6.21	-	-0.33	3.70	3.56	17.07	1.00	1.66	3.91
Venezuela, RB	VEN	12.07	8.51	7.05	-1.05	15.68	0.12	2.36	6.28	0.54	-	3.91	3.82	8.94	1.00	1.72	4.29
Virgin Islands (U.S.)	VIR	-	-	-	-	-	0.47	-	7.45	-	-	-	-	-	-	-	-
Regional Average		8.93	5.56	7.27	-1.37	14.17	-0.22	2.19	6.40	-0.04	-0.46	4.17	4.21	19.23	0.76	2.66	4.19
Middle East and North Africa																	
Algeria	DZA	-	-	5.75	-1.36	15.21	-0.21	1.47	5.08	-1.14	-	3.94	4.01	13.97	0.00	3.50	-
Bahrain	BHR	5.46	0.87	-	-	-	-0.61	3.57	7.25	-	-	-	5.16	-	-	4.56	-
Djibouti	DJI	-	-	9.74	-	-	-0.59	-	8.37	-	-	-	4.64	-	-	-	4.60
Egypt, Arab Rep.	EGY	10.07	-	8.23	0.99	16.28	0.34	4.61	7.81	-	-1.05	3.80	3.84	11.75	0.00	4.10	2.50
Iran, Islamic Rep.	IRN	-	-	6.36	-1.37	16.41	-0.76	3.61	5.50	-	-	-	3.54	-	-	2.90	3.88
Iraq	IRQ	-	-	-	-1.81	14.96	-0.81	3.64	4.83	-	-1.05	-	-	-	-	-	4.53
Israel	ISR	-	-	-	-1.34	14.44	1.81	3.80	7.70	-	-	-	4.31	-	-	3.04	4.14
Jordan	JOR	7.12	-	6.16	-	-	0.32	2.60	5.76	0.40	-0.56	4.78	4.78	68.18	1.00	4.19	3.83
Kuwait	KWT	-	-	-	1.59	13.39	0.08	4.25	7.45	-	-	4.29	4.57	14.36	1.00	4.42	4.53
Lebanon	LBN	-	-	9.17	-0.67	13.68	0.44	3.27	7.39	-	-	-	4.24	-	-	-	4.28
Libya	LBY	-	-	-	-2.29	13.71	-0.18	2.53	5.25	-	-	-	4.32	-	-	-	4.32
Malta	MLT	6.04	1.37	-	-1.08	11.89	0.92	2.16	6.27	-	-0.80	-	5.08	-	-	4.44	4.35
Morocco	MAR	-	-	6.29	-2.95	16.06	-1.24	2.59	5.41	-0.26	-0.76	4.07	3.92	12.71	1.00	4.27	3.65
Oman	OMN	-	-	-	1.86	12.22	-1.52	4.27	6.69	-	-	-	4.53	-	-	4.58	4.50
Qatar	QAT	7.97	-	-	-0.32	12.00	0.04	4.15	7.03	-	-	-	4.38	-	-	-	4.54
Saudi Arabia	SAU	-	-	7.46	-0.86	14.73	-2.36	3.51	5.43	-	-	-	4.32	-	-	4.54	4.34
Syrian Arab Republic	SYR	-	-	6.08	-	-	-0.65	2.48	5.34	-	-0.53	-	3.92	-	-	3.86	3.76
Tunisia	TUN	-	-	6.06	-1.32	14.11	-0.26	1.56	5.25	0.29	-0.54	4.48	4.17	23.83	1.00	4.16	4.06
United Arab Emirates	ARE	-	-	-	0.71	13.77	0.03	4.06	7.82	-	-	-	4.70	-	-	-	4.59
West Bank and Gaza	WBG	9.38	-	-	-	13.06	-	-	-	-	-	-	4.35	-	-	-	-
Yemen, Rep.	YEM	-	-	6.53	0.41	14.08	-1.48	3.05	3.45	-	-	4.31	4.31	16.83	1.00	-	3.08
East																	
Regional Average		7.68	1.12	7.08	-0.61	14.12	-0.33	3.22	6.25	-0.18	-0.76	4.24	4.35	23.09	0.71	4.04	4.08
South Asia																	
Afghanistan	AFG	-	-	4.85	-0.46	14.50	-4.84	3.41	3.10	-	-	-	3.25	-	-	-	-

Bangladesh	BGD	-	-	6.75	1.31	16.70	-3.31	2.94	5.99	1.11	-0.69	3.42	3.08	10.31	0.00	4.18	-
Bhutan	BTN	-	-	6.94	0.86	9.66	-	3.00	2.26	-	-0.56	-	4.22	-	-	4.15	2.34
India	IND	-	-	5.95	0.46	18.63	-1.52	3.14	5.70	0.01	-0.60	3.24	2.67	3.29	0.00	3.90	3.64
Maldives	MDV	-	-	-	1.60	11.18	-	-	-	-	-	-	4.67	-	-	4.29	4.53
Nepal	NPL	-	-	6.36	1.10	14.46	-2.59	2.82	4.38	-0.13	-0.53	4.09	3.40	13.26	1.00	3.83	1.21
Pakistan	PAK	-	-	6.06	-0.06	16.79	-0.97	4.29	5.94	0.00	-0.69	3.64	3.48	8.04	0.00	3.97	3.84
Sri Lanka	LKA	8.24	-	7.72	1.22	15.14	0.08	3.28	7.48	1.54	-0.54	4.37	4.25	13.94	1.00	3.77	2.08
Regional Average		8.24		6.38	0.75	14.63	-2.19	3.27	4.98	0.51	-0.60	3.75	3.63	9.77	0.40	4.01	2.94
Sub-Saharan Africa																	
Angola	AGO	-	-	5.16	0.02	13.77	-1.34	0.80	3.22	-	-	-	4.62	-	-	-	-
Benin	BEN	-	-	5.54	-0.24	13.38	-4.88	-1.18	3.59	-	-	-	3.65	-	-	4.24	-
Botswana	BWA	7.14	-	5.60	-1.04	13.23	-0.42	-1.13	3.73	-1.31	-0.69	4.37	4.62	24.03	1.00	3.84	4.13
Burkina Faso	BFA	-	-	5.18	0.20	12.66	-4.90	-1.10	2.44	-	-	3.75	3.41	14.10	0.00	4.40	2.83
Burundi	BDI	-	-	5.60	-	-	-5.63	1.32	2.66	-	-	-	3.38	-	-	-	4.37
Cameroon	CMR	-	-	5.87	-0.70	13.98	-5.35	-1.63	3.66	-	-0.87	-	3.87	-	-	4.57	4.43
Cape Verde	CPV	-	-	7.08	-0.08	11.19	-3.73	1.72	3.33	-	-1.27	-	4.27	-	-	-	3.65
Central African Republic	CAF	-	-	5.14	-0.56	12.34	-6.38	-	1.51	-	-	3.73	3.95	15.13	0.00	4.38	4.52
Chad	TCD	-	-	4.74	-0.43	12.75	-5.65	-0.93	2.40	-	-	-	3.73	-	-	4.39	4.12
Comoros	COM	-	-	6.66	0.57	10.49	-	-	3.37	-	-	-	4.02	-	-	-	4.39
Congo, Dem. Rep.	ZAR	-	-	5.81	0.39	15.26	-3.70	-2.24	1.83	-	-	-	3.62	-	-	-	4.37
Congo, Rep.	COG	-	-	6.73	1.18	12.93	-0.88	-0.54	4.81	-	-	-	4.64	-	-	4.12	4.48
Cote d'Ivoire	CIV	-	-	6.54	0.11	14.20	-2.34	-0.30	5.02	0.26	-1.02	4.41	4.23	-	0.00	-	3.96
Equatorial Guinea	GNQ	-	-	6.22	-0.34	10.25	-2.75	-	3.51	-	-	-	4.58	-	-	-	-
Eritrea	ERI	6.08	-	5.51	-	12.98	-2.45	1.55	4.42	-	-	-	4.59	-	-	-	3.29
Ethiopia	ETH	-	-	5.64	0.84	14.37	-3.51	0.58	4.92	-0.84	-1.39	3.67	3.42	8.44	0.00	4.10	3.46
Gabon	GAB	-	-	6.99	-0.20	12.03	-1.02	1.12	2.70	-	-	-	4.52	-	-	4.39	4.56
Gambia, The	GMB	7.59	2.93	6.18	0.67	11.11	-3.60	-0.34	4.08	-	-0.97	4.70	4.61	52.20	1.00	3.91	3.87
Ghana	GHA	-	-	6.30	0.49	14.76	-1.96	-1.72	3.53	-1.11	-0.82	4.37	3.70	18.87	1.00	2.74	4.07
Guinea	GIN	-	-	6.52	1.17	12.54	-4.04	1.58	3.08	-	-	-	3.93	-	-	-	2.66
Guinea-Bissau	GNB	-	-	5.74	0.29	10.98	-5.20	1.57	2.83	-1.14	-	-	3.92	-	-	-	3.99
Kenya	KEN	8.59	-	5.71	-0.74	16.07	-1.59	-0.09	5.09	-0.69	-0.33	4.15	4.09	12.48	0.00	3.55	4.01
Lesotho	LSO	-	-	5.85	-0.24	12.78	-1.22	-1.20	4.23	0.41	-0.76	4.93	4.67	20.66	0.00	3.71	3.36
Liberia	LBR	-	-	-	0.48	12.28	-2.82	-0.92	3.66	-	-	-	-	-	-	-	3.95
Madagascar	MDG	-	-	5.72	0.42	13.81	-2.26	3.07	3.51	-	-	3.89	3.67	9.90	0.00	3.31	3.90
Malawi	MWI	5.24	2.05	5.17	-	-	-2.80	-0.43	5.01	-	-1.02	-	4.10	-	-	2.46	2.79
Mali	MLI	-	-	5.56	0.50	13.08	-3.16	1.52	3.61	-	-	4.08	3.84	12.80	1.00	4.38	2.93
Mauritania	MRT	-	-	5.98	0.60	12.61	-2.90	2.47	3.58	-4.61	-0.65	4.55	4.49	23.44	0.00	4.25	3.39

Mauritius	MUS	9.11	-	7.89	-0.33	12.77	-1.11	2.71	7.90	-	-	-	4.76	-	-	4.12	4.60
Mayotte	MYT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mozambique	MOZ	-	-	5.28	0.63	13.96	-1.86	0.45	3.24	-	-	3.72	3.72	11.11	0.00	-	4.12
Namibia	-M	-	-	5.77	-1.07	12.65	-1.01	-0.40	1.08	-	-	4.66	4.74	21.31	0.00	3.99	4.26
Niger	NER	-	-	5.16	-	-	-6.19	-0.03	1.27	-	-1.20	3.73	3.61	12.37	0.00	4.33	1.19
Nigeria	NGA	-	-	5.59	-3.17	17.57	-3.52	-0.38	3.10	-	-0.99	4.34	3.78	8.68	0.00	2.80	3.98
Rwanda	RWA	-	-	6.44	1.25	12.39	-4.69	-0.82	1.85	0.01	-0.94	3.44	3.37	26.20	0.00	3.81	4.26
Sao Tome and Principe	STP	-	-	7.77	-	-	1.78	3.26	-	-	-	-	4.34	-	-	-	4.06
Senegal	SEN	-	-	5.57	-0.03	13.32	-4.06	1.16	4.43	0.43	-	4.29	4.11	19.87	0.00	4.30	3.90
Seychelles	SYC	8.09	-	9.69	-	-	0.93	-	6.55	-	-	-	4.91	-	-	4.54	-
Sierra Leone	SLE	-	-	6.65	0.70	12.97	-3.31	0.94	3.07	-	-0.82	3.62	3.85	27.81	0.00	-	2.34
Somalia	SOM	-	-	-	0.84	13.46	-1.93	2.63	2.43	-	-	-	3.86	-	-	-	-
South Africa	ZAF	8.39	3.84	5.32	-2.03	16.54	0.06	2.09	6.26	-	-	3.89	3.92	8.90	1.00	3.69	3.90
Sudan	SDN	-	-	5.13	-0.78	14.69	-2.88	2.61	3.62	-	-	-	3.33	-	-	-	4.10
Swaziland	SWZ	-	-	6.66	-	-	0.32	3.51	6.22	-	-	-	4.97	-	-	3.68	3.87
Tanzania	TZA	-	-	6.79	1.16	14.57	-1.01	0.78	4.30	-1.27	-	3.78	3.86	10.97	0.00	2.83	2.75
Togo	TGO	-	-	4.85	-0.88	12.92	-5.63	-1.20	2.85	-	-0.82	-	4.40	-	-	4.29	4.31
Uganda	UGA	-	-	5.71	0.47	13.93	-2.94	-2.31	1.40	-0.20	-0.53	3.50	3.52	12.97	1.00	4.28	4.30
Zambia	ZMB	-	-	4.41	-0.87	13.47	-2.50	-1.13	4.41	-2.30	-2.53	4.21	4.33	13.81	0.00	0.78	4.41
Zimbabwe	ZWE	8.65	-	5.59	-	-	-0.43	0.97	6.16	-0.78	-	4.41	3.95	11.27	0.00	2.45	3.61
Regional Average		7.65	2.94	5.98	-0.02	13.28	-2.75	0.43	3.68	-0.94	-0.98	4.09	4.07	17.27	0.25	3.76	3.80
Grand Average		8.49	4.17	6.55	-0.49	14.07	-0.98	1.80	5.41	-0.17	-0.70	4.23	4.20	15.85	0.41	3.36	3.88

Appendix 3: Descriptive Statistics of Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
log_Wage	505	8.6368	2.4127	4.1320	16.7901
log_RWage	223	4.3252	2.7235	0.5158	10.8494
log_Ya	3904	6.5770	1.2028	3.9506	12.0010
log_L	1033	−0.7443	1.3986	−6.6609	2.1933
log_LN	1127	14.6967	1.7198	9.5460	19.3180
log_Am	6043	−1.1295	2.0114	−8.3798	3.6589
log_Irr	5045	1.7973	1.6613	−3.6243	4.6052
log_Fert	5179	5.4019	2.0742	−2.1671	11.0818
log_RandD	1845	−0.1729	1.2004	−4.6052	2.7014
log_GiniLand	3015	−0.6968	0.3658	−2.5257	−0.2614
OPENNESS	3915	4.2346	0.4716	2.8375	5.3354
log_Tradeshare	4914	4.1160	0.6463	0.4257	5.8009
FRANKEL	3690	15.8535	12.2046	2.3000	68.8300
Sachs & Warner	3915	0.4138	0.4926	0.0000	1.0000
log_FoodPrice	2731	3.3237	2.6900	−19.9189	8.4860
log_NonCereal	4903	3.9815	0.7025	−3.6836	4.6052

Appendix 4: Correlation Matrix of Variables

	log_Wage	log_Rwage	log_Ya	log_L	log_LN	log_Am	log_Irr	log_Fert	log_R&D	log_GiniLand	Openess	log_Tradeshare	FRANKEL	SW	log_FoodPrice	log_NonCereal
log_Wage	1.00															
log_RWage	0.99	1.00														
log_Ya	0.80	0.78	1.00													
log_L	0.14	0.16	0.57	1.00												
log_LN	0.38	0.36	0.01	-0.53	1.00											
log_Am	0.81	0.82	0.71	0.42	-0.17	1.00										
log_Irr	0.73	0.76	0.60	0.45	0.17	0.69	1.00									

log_Fert	0.76	0.76	0.97	0.67	-0.06	0.73	0.68	1.00								
log_RandD	0.63	0.64	0.71	0.55	0.27	0.43	0.87	0.77	1.00							
log_GiniLand	0.49	0.47	0.70	0.21	-0.01	0.28	0.39	0.65	0.55	1.00						
OPENNESS	-0.24	-0.21	0.21	0.88	-0.76	0.21	0.08	0.31	0.14	-0.12	1.00					
log_Tradeshare	-0.29	-0.26	0.22	0.86	-0.66	0.02	0.10	0.32	0.25	0.05	0.92	1.00				
FRANKEL	-0.26	-0.26	0.35	0.67	-0.75	-0.01	-0.16	0.36	0.07	0.43	0.72	0.78	1.00			
SW	0.92	0.92	0.77	0.29	0.24	0.87	0.65	0.75	0.53	0.23	0.01	-0.14	-0.21	1.00		
log_FoodPrice	-0.20	-0.11	-0.28	0.08	-0.04	-0.18	0.11	-0.21	0.04	-0.21	0.13	0.24	-0.06	-0.26	1.00	
log_NonCereal	0.02	0.02	-0.03	-0.21	-0.38	0.13	0.05	-0.04	-0.15	0.52	-0.22	-0.17	0.19	-0.24	0.02	1.00