AGRICULTURAL ECONOMICS

Agricultural Economics 44 (2013) 349–364

Cash crop choice and income dynamics in rural areas: evidence for post-crisis Indonesia

Stephan Klasen[a], Jan Priebe[a,*], Robert Rudolf[b]

[a]*Department of Economics, Goettingen University and Courant Research Center "Poverty, equity, and growth in developing and transition countries", Platz der Goettinger Sieben 3, 37073, Goettingen, Germany*

[b]*Division of International Studies, Korea University, 145 Anam-ro, Seongbuk-gu, Seoul, 136-701, Korea*

Received 11 March 2011; received in revised form 25 September 2012; accepted 29 November 2012

Abstract

In this article we investigate the factors affecting levels and growth of incomes in rural Indonesia following the crisis of 1997–1998. In particular, we investigate the relative roles of nonfarm incomes and productivity improvements achieved via changes in crops versus improvements on the same crops on income dynamics. Framing the article in the context of an optimal labor allocation model, relying on unique household panel data from Central Sulawesi, and using advanced panel econometric methods, we find that local innovations related to the adoption and intensification of new cash crop varieties, more specifically the shift from coffee to cocoa production, can explain a substantial part of the observed post-crisis developments. Causal estimates of the effect of growing cocoa suggest that households were on average able to achieve about 14% higher income levels during the post-crisis period compared to the planting of other crops, most notably coffee. Also, our results demonstrate the importance of engagement in nonfarm activities for household income growth. Comparative analyses using a nationally representative survey suggest that similar processes are at play in other parts of Indonesia.

JEL classifications: I31, Q12, Q15, R13

Keywords: Crop choice; Income diversification; Nonfarm sector; Rural development; Indonesia

1. Introduction

In the years 1997–1998 Indonesia experienced a major economic, financial, and political crisis. Within one year real GDP per capita fell by about 15% and real wages in the urban formal sector declined by 40% in 1998 (Frankenberg et al., 2003). Although urban areas were hit hardest during the crisis in economic terms, rural areas, which represent approximately 60% of the population and 80% of the poor in Indonesia, were severely affected too. Moreover, droughts and fires associated with El Niño in 1997–1998 depressed agricultural output in many parts of the country and thereby exacerbated the situation of rural households. Since then the recovery of the Indonesian economy has been comparatively stable with annual GDP growth rates of about 5% between 1999 and 2011. Poverty rates at the national level declined substantially from 24.2% to 12.5% between 1998 and 2011 and in rural Indonesia from 25.7% to 16.6% (BPS, 2011).

However, despite poverty in Indonesia concentrated largely in rural areas, little is known about the underlying factors that determine rural incomes and that have contributed to the observed income growth in the post-crisis period.

Clearly, agricultural output and household incomes in Indonesia are likely to have increased as a result of forest conversion and land use changes related to the planting of rubber or palm oil across the country (Dewi et al., 2005; Sunderlin et al., 2001). However, no empirical study currently exists that investigates to what extent increases in agricultural productivity, in contrast to increases in the area under cultivation, have contributed to the observed growth in agricultural incomes. Improvement in agricultural productivity has been found to be crucial to raise rural incomes in many other parts of the world (Datt and Ravallian, 1998a; Dercon et al., 2009; Fan et al., 2008). However, nearly all of these studies have focused on the analysis of the impact of large public interventions such

*Corresponding author. Tel.: +49(0)551-397304; fax: +49(0)551-397302. *E-mail address*: jpriebe@uni-goettingen.de (J. Priebe).

Data Appendix Available Online

A data appendix to replicate main results is available in the online version of this article.

 DOI: 10.1111/agec.12015

as cash transfer programs, provision of infrastructure, land titling policies or the provision of improved seeds on improvements in agricultural productivity, and the resulting growth in incomes.

In contrast to these studies, and given the absence of large public interventions in rural areas in the post-crisis period, we focus our analysis on the impact of local innovation, more precisely the shift of cropping patterns among cash crops, as an explanatory factor for the observed income growth in rural Indonesia. For our analysis we analyze the large restructuring efforts across Indonesian rural households to switch from coffee to cocoa production. Coffee had been Indonesia's major export crop until the mid 1980s. However, due to falling world market prices for coffee during the 1990s it had progressively been replaced by cocoa in many areas of the country. As a consequence, by the early 2000s Indonesia has become the second largest cocoa producer in the world after Côte d' Ivoire (FAOSTAT, 2011).

Furthermore, we investigate whether income growth has been influenced by more longer term trends away from agriculture. Particularly, engagement in high-productivity, nonagricultural activities has been found to be conducive toward income growth, especially in the presence of poor physical infrastructure and human capital constraints (Datt and Ravallion, 1998b; Lanjouw and Lanjouw, 2001; Micevska and Rahut, 2008; Ravallion and Datt, 2002).

This article's principal objective is to therefore examine the sources of income growth in rural Indonesia. Notably, the following research questions are of paramount interest to us: (a) What have been the main sources of observed income growth in the post-crisis period in rural Indonesia? (b) What has been the relative importance of productivity improvements of the same crops versus shifts to more lucrative crops in explaining agricultural productivity improvements? (c) How has income diversification, in particular into the nonagricultural sector, helped households to increase incomes?

Several contributions set this article apart from others in the literature. First, we use a unique data set based on a household panel survey (STORMA) collected at three different points in time (2001, 2004, 2006). To the best of our knowledge these are the most detailed surveys conducted to investigate the livelihoods of rural households in Indonesia. Second, this article is the first to investigate panel-based household income dynamics related to cropping patterns and the role of income diversification for Indonesia. In particular, the panel structure allows us to address endogeneity issues so that we are able to derive causal estimates for our key variables of interest.

Controlling for endogeneity issues and using a large set of control variables, our analysis reveals that household incomes increased substantially in the post-crisis period. We show that the growth in household incomes can be primarily attributed to increases in the value of agricultural production (both in terms of output and yields), which is caused largely by shifts in cropping patterns related to cash crop production, namely the switch from coffee to cocoa, and much less to an increase in the efficiency of agricultural production for a particular crop; poorer households have particularly benefited from these increases in agricultural self-employment incomes. In addition, in the context of the nationwide economic recovery, the growth in agricultural incomes was complemented by steady increases in nonagricultural incomes, which have become the principal source of income for a rising number of households, with richer households benefiting particularly from these opportunities. These results seem to be robust to different econometric specifications. Furthermore, when comparing our results to SUSENAS we obtain very similar findings when extending our analysis to all of rural Indonesia.

2. Background

Most rural households in Indonesia are engaged in small-scale farming activities deriving a substantial share of their income from the cultivation of subsistence crops such as rice and cash crops. However, the cropping pattern has changed significantly over time due to government interventions, trade patterns, and world market prices (Rosegrant et al., 1998).

In the 1960s and 1970s, Indonesia's primary focus was to become self-sufficient on rice, which was finally achieved in the mid 1980s. To accomplish this objective the government provided farmers with new rice varieties and substantial subsidies on agricultural input factors that aimed at increasing the production of rice. In addition, the producer price of rice was controlled to ensure attractive conditions to producers and stable prices for consumers (Timmer, 2007). Since the end of the 1970s Indonesia has complemented its rice policy by promoting the adoption and intensification of cash crops such as rubber, sugar, coffee, tea, and particularly palm oil in order to increase earnings from nonoil exports (Barbier, 1989).

Since the mid 1980s Indonesia experienced strong growth in the production of its major cash crops. Similarly, the area under cultivation has significantly increased over this period mostly due to deforestation (Sunderlin et al., 2001). One of the most important cash crops over the last three decades has been coffee. In the mid 1980s coffee was the main export crop from Indonesia. Only in the late 1980s coffee was gradually replaced by palm oil and rubber as major export crop of the country. In the wake of the economic crisis in 1997/1998, which coincided with a substantial decline in world coffee prices, farmers started to either plant cocoa on new plots or to gradually switch from coffee production into the production of cocoa (Sunderlin et al., 2001). While the ratio of cocoa to coffee exports, in volume (tons), value (US$), and area under cultivation was about 1/10 in 1986 and 2/5 in 1996, cocoa has replaced coffee as the third major export crop by the early 2000s (FAOSTAT, 2011). At the same time Indonesia has become the world's second largest producer of cocoa after Côte d'Ivoire.

Therefore, in contrast to experience from other main coffee exporting countries such as Uganda (Bussolo et al., 2007; Hill, 2010), rural households in Indonesia did not only respond to the coffee price shock of the late 1990s by replacing old coffee trees with new coffee trees, as observed in Uganda, but as well by starting to produce and intensifying the production of cocoa. One reason for the ready adoption of cocoa was the already prevailing knowledge on cocoa production and its distribution channels in some areas of the countries so that the widely documented risk of adopting new crop varieties (Ashraf et al., 2009; Coxhead et al., 2002; Dercon, 1996; Fafchamps, 1992) was mitigated by already existing experience in other parts of the country.

Interestingly, despite the importance of income from agriculture (including wage or self-employment related to the production of subsistence and cash crops) for the majority of rural households, no study currently exists that evaluates the importance of agricultural income and its different sources on the observed income growth in rural areas over recent years. In contrast, several descriptive studies recently emerged that analyze the role of the nonagricultural sector on incomes of rural Indonesian households (Dewi et al., 2005; Gibson and Olivia, 2010; Suryahadi et al., 2009; World Bank, 2006). Consistent with findings from Latin American (Lanjouw and Lanjouw, 2001) and various Southeast Asian countries (Cherdchuchai and Otsuka, 2006; Estudillo et al., 2006; Nargis and Hossain, 2006) these studies confirm the growing importance of nonagricultural activities as an income source for rural households. Moreover, most of these studies point to a common set of obstacles for the development of nonagricultural activities related to poor infrastructure such as poor roads or unstable power supply. However, all of these studies only present descriptive evidence on the importance of nonfarm activities and therefore need to be interpreted with caution.

In this article we will examine the respective roles of crop switching, productivity improvements on existing crops, and nonfarm incomes on rural income growth in Indonesia. By using panel data and explicitly controlling for endogeneity, we are able to move beyond the existing more descriptive analyses. Before presenting our econometric strategy, we will briefly present our theoretical framework that guides the empirical analysis.

3. Theoretical model

3.1. The farm household's decision problem

In this section we provide a theoretical framework that describes the farm household's optimal labor and land allocation to various income generating activities. To do so, we extend the approach used by Jolliffe (2004) and define the household's resource allocation problem as:[1]

$$\max_{L_{a,t},Z_{a,t},F_{k,t}} U_t\{L(X_{h,t}) - (\Sigma L_{a,t}),\ \Sigma_a Y_a(L_{a,t}, F_{k,t}(P_{k,t-1}), X_t, \varepsilon_{a,t})\},$$

$$a = as, aw, ns, nw \quad k = \bar{r}, f, c,$$

$$\text{subject to: } L(X_h) \geq \sum L_a, \quad L_a \geq 0,$$

$$F = \sum F_k = \bar{F}, \tag{1}$$

where the farm household maximizes utility U in period t as a sum of leisure $(L(X_{h,t}) - (\Sigma L_{a,t}))$ and restricted profit (income less expenditures on variable inputs Z, i.e., $\Sigma_a Y_a$) in the same period. Profits are derived via engagement in any of the four activities: agricultural self-employment (*as*), agricultural wage employment (*aw*), nonfarm self-employment (*ns*), and nonfarm wage employment (*nw*). Corresponding profit functions are assumed to have positive and nonincreasing marginal returns to labor. Profits in each activity are a function of household labor supply, L_a, allocated to activity a, household demographic and endowment variables such as education, household assets, access to infrastructure or markets, X, relative output prices, P. The farmer's choice of the crop to be planted enters the model through the land use variable F, which is a function of lagged crop prices. In our setting, total land is constrained at the farm level, so farmers cannot increase production via the extensive margins; an assumption that is confirmed below empirically.[2] The household allocates a fixed part of its land to annual crops ($\bar{r}$) for food security reasons, and can allocate the remaining land to either coffee (*f*) or cocoa (*c*) production. Cash crop prices are assumed to be exogenous (de Janvry et al., 1991). Total household labor supply is determined by demographic characteristics, X_h, of the household and can be used partly or fully for economic production. ε_{at} are random shocks to production such as extreme weather events or crop diseases.

In the case of perfectly functioning labor markets, Eq. (1) would result in an allocation of household farm labor that equates the marginal product of all four activities to the exogenously determined market wage. As has been shown in many studies (e.g., Benjamin, 1992; Jolliffe, 2004; Udry, 1996), such well-functioning labor markets are rarely found in developing countries.

When facing incomplete labor markets, de Janvry et al. (1991) show that household labor supply is allocated such that the marginal products of labor are equated to an endogenously determined shadow wage, w_t^s:

$$\frac{\partial Y_{a,t}(L_{a,t}, F_{k,t}(P_{k,t-1}), X_t, \varepsilon_{a,t})}{\partial L_{a,t}} = w_t^s. \tag{2a}$$

[1] Jolliffe (2004) uses a similar model to distinguish between direct and indirect effects of education on farm household profitability. In his cross-sectional Ghanaian data set he examines farm households' allocation of labor into two sectors (farm vs. nonfarm).

[2] See Coxhead et al. (2002) for a model where land area to be planted is a key choice variable.

Similarly, land markets also are not functioning well, which is due to uncertainties about tenure and incomplete sales and rental markets.[3] Thus, analogously to the allocation of labor in Eq. (2a), we posit that land is allocated among the cash crops such that the marginal product of land equals an endogenously determined shadow rental value, r_t^s:

$$\frac{\partial Y_{a,t}(L_{a,t}, F_{k,t}(P_{k,t-1}), X_t, \varepsilon_{a,t})}{\partial F_{k,t}} = r_t^s. \tag{2b}$$

The optimal allocation of household labor and farm land is then given by:[4]

$$L^*_{a,t} = L_a(X_t, P_{k,t-1}, \bar{F}, \varepsilon_{La,t}), \tag{3a}$$

$$F^*_{k,t} = F_k(X_t, P_{k,t-1}, \bar{F}, \varepsilon_{Fk,t}). \tag{3b}$$

Thus, both sector choice and farm land allocation depend on expected prices for the current period, for which lagged output prices are likely to be the best prediction.[5] They can therefore serve as potential identifying instruments for dynamic labor allocation and land use decisions. In addition, access to markets (contained in the Xs) may also serve as instruments identifying the labor allocation equation. Substituting Eqs. (3a) and (3b) into the respective profit functions, we obtain:

$$Y_{a,t} = Y\big(L^*_a(X_t, P_{k,t-1}, \bar{F}, \varepsilon_{La,t}), F^*_{k,t}(X_t, P_{k,t-1}, \bar{F}, \varepsilon_{Fk,t}), X_t, \varepsilon_{a,t}\big). \tag{4}$$

Adding up individual profit functions for each activity into a single household profit function gives:

$$Y_t = Y\big(L^*_a(X_t, P_{k,t-1}, \bar{F}, \varepsilon_{La,t}), F^*_k(X_t, P_{k,t-1}, \bar{F}, \varepsilon_{Fk,t}), X_t, \varepsilon_t\big). \tag{5}$$

Thus the optimal labor and land allocation to the four sectors and different types of cash crop production, which itself is endogenously driven, will determine incomes in a given period. This equation will therefore guide our econometric specification below where we will use IV estimation to estimate this model.

4. Data and setting

The data come from three household surveys generated as part of the so-called STORMA (STabilityOf Rainforest MArgins) research project and conducted in the second half of 2001, 2004, and 2006 in the rural areas of the province of Central Sulawesi (CS). Compared to most other provinces in Indonesia, CS has a relatively low GDP per capita, which is partly attributable to its low level of urbanization and industrialization. During the economic crisis of 1998 the province was hit hard but was not as seriously affected as most other provinces (Ravallion and Lokshin, 2007). CS itself is largely agrarian, based on traditional farming methods and terraced slopes. Most production comes from owner-cultivation on small farms with an average size of two hectares. The main staple crop in the area is rice while the main cash crop in the 1990s was coffee. At the end of the 1990s, due to the decline of world coffee prices, the majority of rural households began switching to the production of cocoa.

The study area comprises about 110 villages in four subdistricts (kecamatan). Out of these 110 villages 12 were chosen randomly for the inclusion into the household surveys. The sample size in each village was determined with respect to the share of the village population in the overall population.[6] In 2001, 294 households in 12 villages were interviewed. Of those, 258 households were interviewed in the 2004 round. In the 2006 round, 271 of the original 294 households could be reinterviewed. Since we are primarily interested in income dynamics, we restrict the analysis to those households that were interviewed in all three rounds, which gives a total number of 257 households per round.[7] The surveys themselves provide detailed information on agricultural and nonagricultural activities, demographic status, asset and land holdings, and further socio-economic household and individual characteristics.

An important geographic feature of the study area is its close proximity to the rain forest area of the Lore Lindu National Park. Although enforcement of the borders of the park is occasionally difficult in practice, little deforestation of rain forest areas was observed in the study area during that time period (Schwarze et al., 2009). This circumstance provides us with the empirical advantage that our causal estimates will not be confounded by income effects that result from economies of scale in the production process due to the increase in the land area used for agricultural production.

4.1. Variables of interest

As already discussed in the theoretical framework, we distinguish between four types of income sources following Barrett and Aboud (2001) who classify income sources according to sectors (agriculture and nonagriculture) and employment status (wage and self-employment). Concerning the construction of a measure of agricultural self-employment income, we add the implicit income from subsistence production imputed at local

[3] See Grimm and Klasen (2009) for a discussion of land tenure systems and markets in the study area in Indonesia.

[4] Note that X_t includes X_h, the composition of the household. If household composition has an impact on sector choice, then this provides evidence for incomplete labor markets, as the separability condition between consumption and production decisions of the rural household does no longer hold (Benjamin, 1992).

[5] See, for example, Arnberg and Hansen (2012) on the relevance of past prices for land allocation decisions.

[6] A detailed description of the sampling procedure is provided in Zeller et al. (2002).

[7] The comparison of characteristics between households that could not be interviewed again and those that remained in the sample between the first and third round showed that no statistically significant differences exist.

prices to the value of crops and animal products marketed in the last year. From the total value of agricultural production, we subtract the costs of seed, fertilizer, livestock, repairs of machinery, hired labor, and the like. Agricultural and nonagricultural wage incomes include payments in kind, while nonagricultural self-employed income is net of business costs, such as expenditures on raw materials, energy, hired labor, and equipment maintenance. Based on the proposed sector classification we subsequently utilize four dummy indicator variables, agricultural self-employment (AS), agricultural wage employment (AW), nonfarm self-employment (NS), and nonfarm wage employment (NW), which take the value 1 if a household is engaged in the particular sector.

The level of education of a household can be measured and incorporated in different ways. Since cultural factors in Indonesia often lead to the situation that the oldest person in the household will be considered the head, we follow Basu et al. (2001) to take the highest educational level of an adult in working age as the educational information most relevant for a household.

In most studies, the area of land a household owns is included in the analysis. Instead we use the area of arable land a household uses for agricultural production since this is the relevant measure for land being an input into the household's production process. Moreover, the arable land variable excludes the area dedicated to the housing plot of the household since this land cannot be used for agricultural production. Consistent with the theoretical model and the empirics below, a fixed amount of land is set aside for food production consisting mainly of rice. The remaining area of agricultural land is used for cash crop production. A portion of that is devoted to the production of cocoa with the remainder of the cash crop land being used for coffee production. Both, the total agricultural area and the cocoa variables are meant to capture the ability of households to diversify into more economically rewarding agricultural activities compared to subsistence agriculture.[8]

Clearly, the wealth of households determines their ability to invest, to obtain access to the formal credit market, and to participate in high-productivity nonagricultural activities. We include the value of assets a household owns as a proxy for household wealth. The variable comprises productive, consumer, and financial assets. Taking sample size limitations into account we decided to focus on this aggregate measure instead of incorporating asset variables for each of the three components.

In our empirical analysis we further control for locational characteristics. Ease of access to infrastructure and proximity to markets is proxied by travel time of households to the next paved road. Given the hilly terrain of the region and the sometimes poor condition of roads, mileage is not an appropriate measure. Instead we rely on time measured in minutes. In line with a recent study from Dercon et al. (2009) who find a positive causal effect of improvements in access to roads and agricultural extension services on consumption growth in rural Ethiopia we include a control variable that indicates whether a household was visited by an extension officer during the year preceding the survey. However, in contrast to Dercon et al. (2009) we do not observe any major expansion in road networks, changes in the quality of roads, or an expansion in agricultural extension services. Since travel time to the next paved road and access to extension services remains rather constant over time we do not expect these variables to be responsible for the observed growth in incomes over time. Furthermore, we control for whether a household has access to electricity or not. Interregional disparities are captured by grouping villages into the four subdistricts (kecamatan) they belong to and using kecamatan-fixed effects.[9]

4.2. Descriptive analysis

In 2001, the first year of our panel data, recovery from the crisis of 1997–1998 was already under way in rural Sulawesi. Furthermore, income growth continued substantially between 2001 and 2006 as depicted in Table 1. While in 2001 monthly per capita household income was at 94,303 Rupiah, it increased about 25% to 118,786 Rupiah in real terms in 2006. Nonetheless, income growth was not continuous during this period. From 2001 to 2004 households' per capita income stagnated, mainly attributable to a fall in both agricultural self-employed and agricultural wage incomes due to a restructuring of farm activities. In the context of the economic crisis and strong declines in world coffee prices in the late 1990s, households in the STORMA region gradually switched their main cash crop production from coffee to cocoa. In 2004 households were still in the middle of this transformation process.

In particular, cocoa trees had not reached full maturity for production in most cases. Consequently, income from agricultural self-employment and agricultural wage labor fell from 2001 to 2004. After 2004 agricultural production increased significantly and in 2006 both agricultural self-employment and agricultural wage incomes show peak values for the whole study period.

By 2006, the shift to cocoa appears to have been highly rewarding for rural households. As Table 2 shows, households harvest more physical output per area (kg/*are*)[10] with cocoa compared to coffee, while at the same time mean farm gate prices per kg of cocoa are clearly above those for coffee. These two things together lead to cocoa yields (in value terms) that are on average about 90% above those from coffee.[11] Moreover, Table 2 demonstrates that increases in real incomes from cocoa between 2001 and 2006 are both due to increases in area under cultivation and output per *are*. In 2001,

[8] In the multivariate analysis the inclusion of the area of agriculturally suitable land has in this context the additional role to control for mere size effects in the cocoa and coffee variables.

[9] A detailed overview on the definition and coding of variables is provided in Table A1 in the Appendix.

[10] An *are* comprises 100 square meters, i.e., 100 ares make up one hectare.

[11] The true difference in terms of outputs is likely to be even larger since only productive coffee plants were still left on the plots, while cocoa plants were sometimes not yet ready for full production.

Table 1
Summary statistics (Means) on STORMA households

	STORMA '01	STORMA '04	STORMA '06
Household size	5.41	5.19	4.56
	(1.99)	(1.95)	(1.93)
Age of HH head	43.8	46.5	48.1
	(14.0)	(14.1)	(13.5)
Sex of HH head	0.95	0.93	0.91
	(0.21)	(0.26)	(0.29)
Dependency ratio	0.70	0.75	0.74
	(0.58)	(0.60)	(0.70)
Number of men	1.51	1.44	1.37
	(1.10)	(1.13)	(0.87)
Years of schooling of HH head	6.77	6.79	6.78
	(3.36)	(3.37)	(3.36)
Max. years of schooling of an HH member	8.67	8.66	8.44
	(2.87)	(2.89)	(2.87)
Total per-capita income	94,303	92,428	118,786
	(105,645)	(130,487)	(122,930)
Agricultural self-employed income, per capita	59,804	52,280	67,611
	(68,448)	(77,219)	(80,681)
Agricultural wage income, p.c.	8,318	4,949	8,308
	(16,924)	(11,309)	(18,467)
Nonagricultural self-employed income, p.c.	10,779	11,823	19,488
	(64,004)	(39,854)	(67,931)
Nonagricultural wage income, p.c.	15,401	23,376	22,395
	(46,222)	(101,487)	(63,563)
Gini Index (income, p.c.)	0.49	0.54	0.48
Area owned (*are*)	202.00	195.22	208.38
	(213.94)	(204.07)	(203.05)
Area cocoa (*are*)	50.57	77.21	81.50
	(77.01)	(113.58)	(102.21)
Area coffee (*are*)	42.30	19.55	13.88
	(75.94)	(50.22)	(37.40)
Access to electricity	0.65	0.65	0.71
	(0.48)	(0.48)	(0.45)
Distance to paved road (hours)	0.94	0.85	0.73
	(2.76)	(2.65)	(2.46)
Access to agricultural extension service	0.34	0.39	0.25
	(0.48)	(0.49)	(0.25)
Expenditures on fertilizer/pesticides	12,288	12,542	9,998
	(24,072)	(36,434)	(19,474)
Share of rice fields without irrigation	0.57	0.57	0.57
	(0.63)	(0.63)	(0.63)
Share of rice fields with simple or semitechnical irrigation	0.32	0.32	0.32
	(0.46)	(0.46)	(0.46)
Share of rice fields with technical irrigation	0.11	0.11	0.11
	(0.32)	(0.32)	(0.32)
Value of assets	2,540,766	2,711,764	4,014,757
	(6,793,056)	(10,000,000)	(8,533,662)
Value of livestock	1,375,301	1,331,491	1,259,397
	(2,571,215)	(5,738,906)	(2,491,986)
N	257	257	257

Note: All monetary values are real in Indonesian Rupiahs with base year 2001 and use regional CPIs provided by BPS. Incomes are monthly. Standard deviations in parentheses. Local land units are measured in *are*. One *are* is equal to 100 m^2.

116 out of the 257 households were engaged in cocoa cultivation while in 2006 already 175 households derived agricultural self-employed income from cocoa. Accordingly, the average area of agricultural land devoted to cocoa cultivation increased by about 60%. In addition, it is important to note that the growth in the area of cocoa mirrors the reduction in the area devoted to coffee production. Hence, we do not observe much change in the average area devoted to the production of cash crops or in the total area of arable land. Accordingly, we observe no difference in the area devoted to rice, which is the main perennial crop in the study area. Furthermore, output of cocoa per *are* increased due to the circumstance that more cocoa trees reached its production stage. While price effects partly explain the increase in income from cocoa in the period 2001–2004, the price difference of cocoa between 2001 and 2006 is rather small and therefore does not explain much of the observed increase in cocoa income, an issue we investigate in more detail later.

The analysis mentioned above considers a very heterogeneous population of farmers. In order to be able to better assess to what extent productivity (output per *are*) and price effects in combination with the shift of cropping patterns has actually the potential of increasing incomes of farmers we re-investigate some of the points mentioned above by focusing exclusively on the sample of coffee farmers in 2001 ($N = 97$). Although coffee farmers are a relatively rich group, this approach yields the advantage that we compare the same households over time in order to avoid sample selection effects coming from new household with potentially very different characteristic entering the analyzed production process. Out of these 97 households 38 grew coffee in 2001 and 2006 while 58 households were engaged in cocoa cultivation in both periods. Results from Table 3 (see bottom panel) largely confirm our statements made. Increases in the productivity in coffee (14.3%) have outweighed negative price effects by about 7 percentage points. In contrast to coffee, growing cocoa was even more beneficial, both in terms of productivity (increase of 125%) and prices (increase of 6%). In comparison to coffee, cocoa yields about 168% higher income per *are* in 2006 of which about 70% is due to productivity differences (output per *are*). In addition, from Table 3 one can see that coffee farmers have on average converted approximately 15% of their cash crop area (only considering coffee and cocoa) to cocoa production. In the hypothetical case of a pure coffee farmer (only grows coffee as a cash crop) this average conversion of 15% of the area from coffee to cocoa would have increased his cash crop income by 25% (15% of 168%).

However, one has to bear in mind that the analysis from Tables 2 and 3 is likely to greatly overestimate the impact of improved agricultural productivity between the two years in the two crops. In the case of cocoa, much of the increase in yields is, as discussed, due to the fact that households planted these cocoa trees in the early 2000s and they only started to yield the returns by the third round in 2006. Similarly, it is likely that the much reduced acreage in coffee was now concentrated on the most productive plots so that the increase in yields is actually not primarily due to increases in agricultural productivity. Moreover, this development seems not to be caused by improvements in the agricultural production technology. As shown in Table 1 the values of all three of our proxies (share of rice fields with technical irrigation systems, expenditures on

Table 2
Cocoa and coffee production

	STORMA '01	# Of obs.	STORMA '04	# Of obs.	STORMA '06	# Of obs.
Cocoa						
Output (kg/*are*)	2.30	116	2.33	133	3.65	175
Price (per kg)	5,000	116	6,254	133	5,307	175
Yield (IDR/*are*)	9,777	116	14,454	133	18,978	175
Area cocoa (*are*)	50.57	257	77.21	257	81.50	257
Coffee						
Output (kg/*are*)	1.68	97	1.33	61	2.40	46
Price (per kg)	4,500	97	2,779	61	4,189	46
Yield (IDR/*are*)	6,500	97	3,475	61	9,553	46
Area coffee (*are*)	42.30	257	19.55	257	13.88	257

Note: Monetary values are real Indonesian Rupiahs (IDR) with base year 2001 and use the provincial CPI for Palu provided by BPS. Output, price, and yields are median values per year based on all farmers active in the particular crop. Local land units are measured in *are*. One *are* is equal to 100 m^2.

Table 3
Decomposition of output, price, and shift effects among coffee farmers (N = 97; period 2001–2006)

	Income (IDR)	Area (*are*)	Output (kg/*are*)	Price (kg)	# Of obs.
Coffee '01	71,563	111,7	0.14	4,500	38
Coffee '06	43,063	72,8	0.16 (P1)	4,190 (p1)	38
Cocoa '01	42,292	91.0	0.16	5,000	58
Cocoa '06	132,100	129.9	0.35 (P2)	5,307 (p2)	58

	Predicted income gain (%)	# Of obs.
Output effect in coffee ('01–'06)	14.3	38
Output effect in cocoa ('01-'06)	125.0	58
Output differential (cocoa/coffee) in '06	110.7	-
Price effect in coffee ('01-'06)	−6.9	38
Price effect in cocoa ('01-'06)	6.0	58
Price differential (cocoa/coffee) in '06	26.7	-
Shift effect (from coffee to cocoa,'06) = [(p2 × P2)/(p1 × P1)] − 1	167.9	-

Note: Reported statistics are median values except area variables. All statistics are calculated conditional of being a coffee farmer in 2001. Statistics related to coffee (cocoa) are calculated for those households that were engaged in 2001 and 2006 in coffee (cocoa) production. Output and income values are monthly. The shift effect represents the average monetary production differential of cocoa over coffee per unit of land for the year 2006. It consists of the productivity differential between cocoa and coffee in terms of physical output per unit of land and the price differential per kg between cocoa and coffee. Positive (negative) values in the shift effect indicate that cocoa is more (less) beneficial in monetary terms than coffee per unit of land. The shifting effect shows the average expected benefit a farmer can achieve by converting one unit of land from coffee to cocoa.

Table 4
Agricultural diversification: mean incomes of self-employment

Sector	STORMA '01	STORMA '04	STORMA '06
Livestock	4,321	3,658	4,980
Gathering	10,599	4,200	2,919
Cropping	44,272	46,145	59,712
Annual crops	21,641	18,459	25,948
Perennial Crops	22,631	27,685	33,764
Cocoa	13,126	24,031	28,186
Coffee	5,384	1,748	2,877
N	257	257	257

All values are monthly in per-capita terms and real Indonesian Rupiahs with base year 2001. Provincial CPIs for Palu were provided by BPS.

fertilizer/pesticides, and access to agricultural extension services) remain largely unchanged over the entire period. Thus this descriptive evidence suggests that the primary driver of income growth for farmers with perennial crops was due to the shift to cocoa.

A closer look at the composition of incomes from agricultural self-employment reveals that rural households derive incomes mainly from crops with a minor part coming from other sources like livestock and gathering.[12] Moreover, households derive incomes from perennial and annual crops rather equally. While the income from annual crops, like rice and maize, reflects household preferences for food security, it becomes clear from Table 4 that particularly the growth in incomes from perennial crops helps in explaining the growth of agricultural self-employment income with cocoa constituting about 85% of perennial crop income in 2004 and 2006 (2001: 58%).

In contrast to agricultural incomes, nonagricultural incomes do not seem to have been affected much by the shift from coffee to cocoa and grew steadily in accordance with the growing national economy of the post-crisis period. As shown in Table 1 nonagricultural self-employed income nearly doubled between 2001 and 2006 and nonagricultural wage income increased by about 50% in the same period. In this context, nonagricultural income has become the principal income source for several households in the region. The income source transition matrix in Table 5 shows that the number of households who receive more than half of their income from nonagricultural activities rose from 41 to 54 between 2001 and 2006. Meanwhile, the

[12] The decline in incomes from gathering follows from the improvement in economic conditions. Gathering forest products like rattan is time-intensive and dangerous. It is only done by households in times of greatest needs.

Table 5
Income sector transition matrix

STORMA 2001	Starting income	# Of obs.	STORMA 2006: Agric. Self-employed	# Of obs.	Agricultural Wage Income	# Of obs.	Nonfarm Self-employed Income	# Of obs.	Nonfarm Wage Income	# Of obs.	Mixed Income	# Of obs.
Agricultural self-employed	86,993	180	104,845	135	65,992	14	198,022	12	180,752	12	87,955	7
Agricultural wage	51,554	30	76,603	17	60,450	5	423,417	1	81,924	4	72,583	3
Nonfarm self-employed	178,477	15	153,616	6		0	243,471	4	142,350	5		0
Nonfarm wage	129,681	26	72,397	8	35,164	1	224,819	2	239,930	13	87,608	2
Mixed	163,616	6	120,554	4		0	195,338	1		0	72,661	1
		257	102,585	170	63,065	20	220,927	20	186,104	34	83,178	13

Note: Incomes are monthly, real Indonesian Rupiahs with base year 2001 and provincial CPI for Palu. Households are grouped into sectors according to its principal activity (more than 50% of income from this sector). Households who do not earn income of more than 50% in of the four sectors are grouped into the mixed category.

number of households that generate most of their income from agriculture decreased from 210 to 190.[13]

Engagement in nonagricultural activities is associated with higher incomes. Table 5 shows that already in 2001 households with mainly nonagricultural self-employed incomes were best off, followed by nonagricultural wage, agricultural self-employed and agricultural wage households. Moreover, the income gap between nonagricultural and agricultural households widened in the post-crisis period, when nonagricultural self-employment incomes of households rose by 23.8%, nonagricultural wage incomes by 43.5%, agricultural self-employment incomes by 18.1%, and agricultural wage incomes by 16.6%.

Although engagement in nonagricultural activities seems to be highly rewarding as it is associated with rising incomes of rural households, gaining access to high-productivity nonagricultural income sources strongly depends on a household's income and wealth situation. Dividing the households into quintiles based on their 2001 per capita incomes, Table 6 shows that particularly households situated in the upper two quintiles receive incomes from nonagricultural sources. While the number of households engaged in some sort of nonagricultural activity increased across quintiles from 2001 to 2006, the share of income derived from these sources is much higher for richer households and only increased for households in the richest three quintiles. In contrast, among poorer households the share of nonagricultural incomes fell, and most of their income growth is based on agricultural self-employment. Thus, the principal source of income growth observed between 2001 and 2006 differs between initially poorer and richer households. Income growth among poor households can be primarily attributed to increases in agricultural self-employed income due to increases in crop output, shifting cultivation patterns, and favorable price developments. Richer households in addition seem to have benefited from strong increases in nonagricultural incomes.

Table 6
Income quintile statistics

	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
2001					
Av. total per-capita income 01	13,136	39,449	66,681	107,536	246,845
Share agricultural wage (AW) 01	0.21	0.20	0.16	0.11	0.05
Share agricultural self (AS) 01	0.69	0.61	0.73	0.70	0.62
Share nonfarm wage (NW) 01	0.04	0.11	0.08	0.16	0.21
Share nonfarm self (NS) 01	0.06	0.09	0.03	0.03	0.12
# Households in AW 01	24	26	27	22	13
# Households in AS 01	48	47	51	49	47
# Households in NW 01	5	7	8	14	20
# Households in NS 01	3	7	5	5	15
2006					
Av. total per-capita income 06	23,750	50,892	75,457	128,978	317,569
Share AW 06	0.14	0.15	0.17	0.11	0.02
Share AS 06	0.77	0.69	0.64	0.65	0.50
Share NW 06	0.08	0.08	0.11	0.13	0.27
Share NS 06	0.04	0.04	0.07	0.11	0.21
# Households in AW 06	21	23	28	18	5
# Households in AS 06	50	49	46	51	49
# Households in NW 06	9	9	15	13	22
# Households in NS 06	3	6	9	12	20
N	52	52	51	51	51

Note: Incomes are monthly, real Indonesian Rupiahs with base year 2001 and provincial CPI for Palu. Quintile 1 refers to the poorest quintile.

[13] Nonagricultural self-employment in the STORMA region consists mainly of small trading shops, restaurants (warung), and small-scale handicrafts. Wage employment in the nonagricultural sector is available in terms of work in the construction and public sector.

5. Econometric specification and results

5.1. Determinants of labor allocation and cash crop choice

From the above-mentioned theoretical model we can derive our empirical estimations. In a first step we will analyze the determinants of households' labor allocation and cash crop choice by estimating Eqs. (3a) and (3b) where we argued that lagged prices and specific household characteristics such as distance to markets will affect labor allocation and crop choice. In the case of nonfarm self-employment we make use of an important geographical feature of our study area. All study villages are situated in one of the two valleys (Palolo and Kulawi valley) which extend up to 200 km south of the provincial capital Palu. Both valleys are connected with paved roads to Palu and for each of the villages Palu is by far the nearest city in the area. Palu itself comprises roughly 250,000 inhabitants and contains the main port in CS, which is used to import commodities (durables) and to export cocoa and coffee primarily to the United States. The distance to Palu matters for rural households mainly in that Palu offers a variety of nonagricultural employment opportunities. Therefore, households residing closer to the provincial capital are more likely to find or start nonagricultural activities. Thus, distance to Palu proxies the strength of spill-over effects from urban to rural areas. As found in Suryahadi et al. (2009) such spill-over effects are most likely to occur in the rural service sector, which in our case is part of the nonagricultural sector.

We therefore suggest that this variable is an important driver of nonfarm self-employment. Once we control for asset possession, education, demographic, and location characteristics, as well as sector choice in our income regressions later, we do not expect that distance to Palu (measured in travel time) exercises any direct influence on household incomes so that it should indeed be suitable as an instrument for the endogenously determined sector choice decision.[14]

With respect to our cash crop variables, following Eqs. (3a) and (3b), we use the lagged village level prices of cocoa and coffee as drivers of cash crop choice. Obviously, the decision to grow cocoa depends on the price of cocoa as well as on the price differential between cocoa and coffee. We also believe that the prices of these two crops can reasonably be assumed to be exogenous to the households in our study region since production of these crops in Central Sulawesi is too small to have an effect on the world market price of these products; thus they would also be suitable instruments (see later). Although we have household level data on farm gate prices for cocoa and coffee we instrument by the village level price in order to reduce the presence of measurement error in the price data.

Columns (1) to (4) of Table 7 show the determinants of participation in any of the four sectors. Nonfarm self-employment is higher when past cocoa prices were low and when a household lives closer to the metropolitan area of Palu. Both nonfarm self- and wage-employment are positively related to the household's access to electricity. More educated households are more likely to engage in a well-paying nonfarm wage job and less likely to work for agricultural wage. Thus, as to be expected, a mix of constraints (low cash crop prices) and opportunities (short distance to Palu, electricity access, education) promote nonfarm self-employment and wage employment. Households are more likely to be active in agricultural self-employment if the household is headed by a man and if it has access to extension services. Households that are employed in agricultural wage jobs tend to be younger, less educated, own less farm land and other assets, and reside closer to Palu.

Columns (5) and (6) of Table 7 show the determinants of the area allocated to cocoa and coffee, the two principal cash crop options for STORMA households. Households tend to cultivate cocoa if the household head is relatively young and male, if fewer dependents live in the household, and if the household is well-endowed with land. The decision to opt for a certain crop is, as expected, strongly dependent on lagged prices of the crop. Interestingly, both lagged cocoa and coffee prices have a very similar absolute marginal effect on their respective area planted. Yet, the much higher coefficient for lagged area owned in the case of cocoa suggests that this is the more lucrative cash crop.

5.2. Determinants of income levels and income growth

Having investigated the household's decision problem, we can turn to the primary focus of this article, which is to investigate the impact of agricultural production, in particular the decision to opt for a certain cash crop, and of the engagement in nonagricultural activities, on income levels and the income growth in the post-crisis period. To achieve this we adopt a regression framework derived from Eq. (5) in the theoretical model, in which we control for other factors that might determine incomes in the region and consider sector and crop choice to be endogenous. In the empirical specification, we proceed, however, in two steps and first consider a model where the endogeneity of sector and crop choice is not controlled for, before explicitly considering this endogeneity that was expressed in Eq. (5). This also allows us to see to what extent endogeneity affects our results.

Starting with the first step, in order to understand the determinants of incomes across households i ($i = 1, \ldots, N$) and time t ($t = 1, \ldots, T$) we adopt an econometric framework that links household per-capita income (y_{it}) to a constant (δ), a set of household-specific variables (X_{it}) such as demographic characteristics, access to infrastructure, wealth level of households, cropping patterns, or the economic sector of employment. The main focus of our analysis is on the effect of nonfarm self-employment (*NS*) and the planting of cocoa (*Cocoa*). Since the cash crop area is effectively fixed (see Tables 1 and 2), using this strategy and controlling for total area, we are

[14] Furthermore, it is noteworthy that in our case distance to Palu varies on the household level since households usually first need to reach the nearest paved road (which varies from household to household even within a village) in order to get to the main road to Palu.

Table 7
Allocation of household labor and cash crop choice

Controls	NS (1)	NW (2)	AS (3)	AW (4)	Area cocoa (5)	Area coffee (6)
Age	0.0004	0.001	0.005	−0.017*	−5.192**	0.996
Age^2	−0.00002	−0.000009	−0.00003	0.0002	0.046**	−0.008
Female head	−0.009	0.077	−0.106**	0.058	−34.037***	12.604
Max education	0.003	0.040***	0.006	−0.019**	−0.791	0.702
HH size	0.008	0.019*	0.008	−0.011	3.260	−0.560
Number of men	0.0001	−0.017	−0.010	0.031	−7.938	2.418
Dependency ratio	−0.029	−0.006	−0.031	−0.094***	−12.765***	−0.228
Lagged area owned	0.00003	−0.0001	0.00003	−0.0004***	0.294***	0.029**
Lagged cocoa price	−0.00002***	−0.000008	0.000007	−0.000006	0.007***	−0.001
Lagged coffee price	−0.000005	0.000004	0.000003	0.00004	−0.002	0.006**
Distance to Palu	−0.002*	−0.002	−0.001	−0.038***	−5.906***	1.224
Ln (value of assets)	0.015***	0.001	0.002	−0.012***	2.526***	−0.051
Access to electricity	0.106***	0.072*	−0.026	−0.169***	−6.462	2.050
Distance to road	0.002	0.002	0.001	0.039***	5.935***	−1.228
Visits from extension officer	−0.041	−0.082**	0.034***	0.032	1.976	3.021
N	257	257	257	257	257	257
Adj. *R*-squared	0.08	0.14	0.10	0.17	0.48	0.16

Note: Linear probability estimation in columns (1) to (4) and OLS in columns (5) and (6). Further controls include subdistrict and time dummies. A common intercept is included ***/**/* denote 0.01, 0.05, and 0.1. Robust standard errors are used. NS, NW, AS, and AW stand for nonfarm self-employment, nonfarm wage employment, agricultural self-employment, and agricultural wage employment, respectively.

implicitly comparing the effects of cocoa versus coffee.[15] Although our data set collects very detailed information of a variety of household characteristics there might be additional factors that influence incomes that are specific to each household but that are largely unobservable to the researcher such as ability or motivation (θ_i). The econometric specification of this model is represented in Eq. (6) in which we assume an error term that is household-specific and time-varying.

$$\ln(y_{it}) = \delta + X'_{it}\beta + \gamma_1 NS_{it} + \gamma_2 NW_{it} + \gamma_3 AS_{it} + \gamma_4 AW_{it} + \gamma_5 Cocoa_{it} + \theta_i + u_{it}. \quad (6)$$

Since we cannot completely rule out that the unobserved characteristics θ_i are correlated with at least some of our control characteristics X_i and more importantly with our main variables of interest, NS_{it}, and $Cocoa_{it}$ the coefficients γ_1, and γ_5 might be biased. In order to address this endogeneity problem we make use of our panel structure and implement a Fixed-Effects specification (FE) that helps to eliminate the effect of θ_i on the other coefficients so that γ_1, and γ_5 can be estimated consistently (Baltagi, 2008). However, the implementation of the FE is not uncontroversial. First of all, the FE eliminates all of the between-household variation that is an important element of our analysis. In addition, given that we only have three time periods, the within-household variation over time is rather limited for several of our key variables of interest, which might lead to biased estimates. Second, focusing entirely on the within-household variation, might lead to efficiency problems since the STORMA data set is rather small. In order to mitigate these problems we also rely on the random effects estimator which might be the better estimator in our context because it makes use of both, within- and between-household variation.

Furthermore, we want to assess the impact of *NS*, *Cocoa* (and *Coffee*) on per-capita income growth for the post-crisis period. A natural way of doing so is an empirical growth model that allows for transitional dynamics (Mankiw et al., 1992). In this model growth rates for household i $[\ln(y_{it}) - \ln(y_{it-1})]$ are related to initial levels of income $\ln(y_{it-1})$. Similar to the static model above we assume that there is source of growth common to all households which we again denote byδ. Other sources of growth from t – 1 to t are exogenous levels of our socio-economic control variables X and our main variables *NS* and *Cocoa*, each observed at t – 1. As in model (6) we allow the household-specific unobserved effect θ_i to be correlated with the other regressors.

Mindful of the numerous reasons why one should be careful in applying this framework given the theoretical and empirical assumptions implied by this model (Temple, 1999) our basic model is

$$\ln(y_{it}) - \ln(y_{it-1}) = \alpha \ln(y_{it-1}) + \delta + X'_{it}\beta + \gamma_1 NS_{it} + \gamma_2 \times NW_{it} + \gamma_3 AS_{it} + \gamma_4 AW_{it} + \gamma_5 Cocoa_{it} + \theta_i + u_{it}. \quad (7)$$

In contrast to our model in Eq. (6) using a Random or Fixed Effects approach will provide an inconsistent estimate of γ_1 and γ_5 from Eq. (7) due to the inclusion of $\ln(y_{it-1})$ as regressor. To address the discussed econometric problems we use a Generalized Methods of Moments (GMM) estimator with a two-step

[15] We also tried other specifications that, for example, use the share of cocoa as control variable (with the share coffee being the left-out category); the results are very similar and available on request.

Windmeijer (2005) correction so that our estimates of γ_1 and γ_5 are both consistent and efficient (Blundell and Bond, 1998).

Before estimating Eqs. (6) and (7) there are further empirical issues that require consideration.

While we addressed endogeneity issues arising from our explanatory variables being potentially correlated with the household-specific time-invariant unobserved effect θ_i, there might be further endogeneity problems arising from the labor and land allocation problem discussed earlier in the theoretical framework.[16] As a result, our main variables of interest, *NS* and *Cocoa* might be correlated with the household-specific and time-varying error component u_{it}, which might lead to biased estimates of γ_1 and γ_5.

To address this problem of endogeneity, we adopt an Instrumental Variable (IV) approach based on the theoretical considerations in Eq. (5) to estimate Eqs. (6) and (7). To instrument the four economic sectors (*NS, NW, AS, AW*), and *Cocoa*, we use the determinants of sector allocation and cash crop choice from Eqs. (3a) and (3b) that were empirically found to be relevant in Table 7, i.e., lagged coffee and cocoa prices and distance to Palu.[17] In addition, we make use of the panel dimension of our data to strengthen our instrumentation strategy by using lagged values of sector and crop choice as instruments. Estimation of Eq. (6) is done by two-stage least squares. In the GMM framework we include in addition the lagged differences of these values as recommended in Blundell and Bond (1998). Since the lagged values of the endogenous variables are only providing moderate variation over time, we include, based on our theoretical framework, the additional instruments discussed that we believe are exogenous to the income generating process.

Table 8 presents the results of our panel regressions, the determinants of per capita income levels (6), and the determinants of per-capita income changes (7). The first, second, and fifth columns provide results for the case that the sectors (*NS, NW, AS, AW*), and *Cocoa* are assumed to be exogenous determinants of the dependent variable while the third, fourth, and sixth columns show the IV estimates when the sectors and *Cocoa* are instrumented as outlined earlier. All regressions include a common set of control variables *X* that are related to demographic characteristics (age and age[2] of the household head, gender of the head, household size, number of men in the household, and dependency ratio), household wealth variables (wealth in durable consumption and production assets, area of arable land), and infrastructure variables (access to electricity, distance to the next paved road, visits from an extension officer over the last year). Moreover, time and subdistrict dummies were included.[18]

The results show that a household's engagement in nonfarm self-employment has a strong positive impact on income levels (columns 1 and 2). Likewise, nonfarm self-employment seems to lead to substantially higher income growth (column 5). All three coefficients are statistically significant at a 1% level. When controlling for the potential endogeneity of *NS* using an IV approach we find that the results do change slightly. After instrumenting the effect of *NS* on per-capita income levels increases slightly in the RE specification while it declines and renders statistically insignificant in the FE specification at conventional levels. Considering the random effects results and the strong and significant effect of *NS* on income growth in the GMM models (columns 5 and 6), this suggests overall that engagement in the nonfarm sector boosts incomes and income growth.

With respect to the effect of cropping patterns on household incomes we find that growing cocoa boosts incomes by 0.2% per *are* (columns 1 and 2). Given that households had on average about 70 *are* under cocoa cultivation across 2001 and 2006 this effect implies that on average households were able to achieve approximately14% higher incomes due to the cultivation of cocoa, holding everything else constant. Moreover, *ceteris paribus*, an average household having planted *all* its two hectares with cocoa in 2006 would have had an about 40% higher income level. Similarly, households growing cocoa were experiencing higher income growth throughout the period 2001–2006 of a similar magnitude (column 5). The results in columns 3, 5, and 6 are nearly identical to those in columns 1, 2, and 4. Therefore, even in the IV set up we still find a substantial economic and statistically significant effect of cocoa on household incomes. Given that the area devoted to cash crop is essentially fixed and thus cocoa implicitly compares

[16] Apart from the endogeneity issue identified in our theoretical framework, there are other potential sources of endogeneity that can stem from issues of reversed causality between the dependent variable and the NS and Cocoa variable. For instance, in our context it is possible that those households that achieve a high level of or growth in per-capita incomes are more likely to have the financial resources to be able to diversify into lucrative nonfarm self-employment opportunities. Likewise, richer households might be better able to cope with periods of lower agricultural incomes and higher income risks when transiting from the production of coffee to cocoa. This discussion can be seen as well as a discussion of selection problems in which richer or more capable households self-select into certain economic activities. Our IV strategy therefore seeks to address these issues as well.

[17] To reduce the number of instruments for efficiency reasons, we use in Table 8 the difference in lagged cocoa and coffee prices for the area used for cocoa production (given the fixed amount of land for cash crop production, this implicitly determines the allocation of land for coffee). Using the lagged cocoa and coffee prices as separate instruments leads to nearly indistinguishable results (results available on request).

[18] In the discussion of our results we focus on the role of NS, cocoa (and coffee) on the levels, and growth of household per-capita income. The direction, magnitude, and significance levels of the control variables, *X*, are in line with what would be expected from economic theory or what is known from other empirical studies. In particular, the effects of the demographic variables, and the lagged dependent variable are similar to those found in other studies (e.g., Fields et al., 2003; Woolard and Klasen, 2005). The insignificant education coefficient is also not unusual. In fact, the sign of the education coefficient on rural incomes have even been found to be negative in some cases, e.g., Adams (1995) on the value of wheat, sugarcane, and rice production in Pakistan or Rosegrant and Evenson (1992) on total factor productivity in India. In our case, the correlation of the education variable with nonagricultural activities and the value of assets, is likely to cause the coefficient to be statistically insignificant.

Table 8
Determinants of income and income growth

	Income	Income	Income	Income	Income Growth	Income Growth
Controls	RE (1)	FE (2)	RE-IV (3)	FE-IV (4)	GMM (5)	GMM+ (6)
Age	0.028***	0.031	0.037	0.081	0.024	0.019
Age^2	−0.0003***	−0.0003	−0.0004*	−0.001	−0.0003	−0.0002
Female Head	0.174	0.913*	0.058	0.752	0.222	0.218
Max Education	0.0006	0.007	−0.022	−0.041	0.017	0.020
HH size	−0.148***	−0.156**	−0.162***	−0.184***	−0.174***	−0.172***
Number of Men	−0.018	−0.065	0.014	0.006	0.027	0.022
Dependency ratio	−0.137**	−0.128*	−0.144	−0.068	−0.099	−0.097
Nonfarm self-emp	0.600***	0.541***	0.741**	−0.252	0.513***	0.600***
Nonfarm wage emp.	0.523***	0.511**	0.923*	0.898*	0.407**	0.398**
Ag. Self-employment	0.639***	1.075**	−0.307	−1.295	0.309	0.172
Ag. Wage employment	−0.060	0.041	−0.220	0.132	0.048	0.055
Area owned	0.0004***	0.0002	0.0003	0.0002	0.001	0.001
Area cocoa	0.002***	0.002***	0.003***	0.005	0.002**	0.002**
Ln (value of assets)	0.019***	0.001	0.050**	0.018	0.041*	0.041*
Access to electricity	0.250***	0.194	0.129	0.142	0.173	0.163
Distance to road	−0.001***	−0.001**	−0.001	−0.00009	−0.0003	−0.0003
Visits from extension officer	0.036	−0.093	0.184	0.071	0.045	0.062
Lagged dependent variable	-		-	-	−1.001***	−0.948***
N	771	771	514	514	257	257
F-statistic			8.5	1.8	13.0	11.6
Hansen test (*p*-value)			0.09	0.07	0.18	0.10

Notes: Income refers to log per-capita monthly household income. All monetary values were included in real terms with base year 2001. Further controls include subdistrict and time dummies. A common intercept is included. Significance levels: ***/**/* denote 0.01, 0.05, and 0.1. Standard errors are clustered at the subdistrict level. The "GMM" specification instruments the lagged depended variable with a "system" of lagged values (lagged levels and lagged differences of the lagged depended variable) while the "GMM+" specification instruments in addition the potentially endogenous variables (four economic sectors, area cocoa, and area coffee) with their respective "system" and the "system" of the previously discussed external instruments (difference of the lagged price of cocoa and coffee and the distance to Palu).

with growing coffee, the results imply a substantial advantage to growing cocoa over growing coffee.[19]

5.3. Robustness checks

Table 9 shows the results of a series of robustness checks designed to assess whether changes in model specification, estimation, or sample affect the core results. Row (0) repeats the results from our preferred specification (Table 8, columns 3 and 6). Row (1) explores how sensitive results are to the influence of outliers. In particular, the GMM estimates might be vulnerable to the influence of outliers because the optimal weighting matrix that underpins them is a function of fourth moments (Baum et al., 2003). We address this concern by trimming our sample such that we drop the top and bottom 1% of observations of income growth in the period 2001–2006. Doing so does not have a large effect on our estimates.

In row (2) we test whether our results are robust to the inclusion of additional covariates. More specifically, we include the share of irrigated rice fields, the usage of pesticides, and taking part in formal or informal credit groups. Again the obtained results are very similar. Similarly, results do not change much when we use village fixed effects instead of subdistrict fixed effects (row 3).

Row (4) reports results when we run a sort of reduced form regression by excluding the value of assets from the regressions. As before, the main results seem to be robust to a change in the specification.

In row (5) we adopt again a reduced form regression framework by excluding all three variables compared to the basic specification. The results seem not be very sensitive to the potential endogeneity of these control variables.[20]

[19] Using the share of cash crop area devoted to cocoa yields quantitatively and qualitatively similar results.

[20] An exception is the value on cocoa which renders with a *p*-value of 0.14 slightly insignificant. However, given that the specification with instrumenting eight variables at the same time is "overspecified" given the number of observations and the assumptions involved in IV methods that this result is not worrisome it terms of significance levels. It is more over important to note that the coefficient itself remains very stable. As further robustness check we run the regressions when using adult equivalent incomes instead of per capita incomes. We used adult equivalents scales as provided in Deaton and Zaidi (2002). Again our results on NS and cocoa did not change much compared to the presented specifications. Given that we include a variety of demographic controls in our main specification the results should in general not be affected very strongly by using per-capita income instead of some sort of adult equivalence scale.

Table 9
Selected robustness checks on basic results

	Specification	Income: Nonfarm self. emp. (1)	Income: Area of Cocoa (2)	Income Growth: Nonfarm self. emp. (3)	Income Growth: Area of cocoa (4)
(0)	Basic results	0.741**	0.003***	0.600***	0.002**
(1)	1% trim of dependent variables	0.658**	0.003***	0.598***	0.002***
(2)	Additional controls	0.888***	0.003*	0.436*	0.002*
(3)	Village fixed effects	0.533*	0.003***	0.536***	0.002**
(4)	Excluding value of assets	0.876***	0.003***	0.570***	0.002***
(5)	Excluding infrastructure	0.767**	0.003***	0.608***	0.002**

The basic results specification (0) repeats the results from columns (3) and (6) from Table 8. Specifications (1)–(5) are reported against specification (0). This means that each row reports results applying exactly only one change compared to the basic specification. Significance levels: ***/**/* denote 0.01, 0.05, and 0.1.

6. Extension

In a last step we explore to what extent the findings obtained from our study region can be generalized to a larger geographical setting covering substantial parts of rural Indonesia. To do this we compare our results to those obtained from large national household surveys called SUSENAS. SUSENAS is conducted by the Indonesian National Statistical Office (BPS) and covers more than 100,000 households annually. Moreover, SUSENAS is Indonesia's principal source for official poverty, consumption, income, and education statistics. For our analysis we make use of the 2002 and 2005 rounds of SUSENAS, which are the two rounds during the STORMA survey period for which a detailed income and consumption module is available.

Unfortunately, SUSENAS does not capture information on several of the covariates that we used in the previous analysis, e.g., infrastructure variables, value of household assets, and detailed income data from agricultural sources. In particular, SUSENAS does not contain data on type of crops planted, quantity harvested, and respective output prices, but simply asks households about their income from agriculture in the respective year. Likewise, the SUSENAS 2002 and 2005 rounds are cross-sectional data so that we cannot apply any of the previous panel techniques. Given this restriction our analysis rests on comparing descriptive estimates between our study region and rural Indonesia as a whole. More specifically, we rely on simple cross-sectional OLS regressions using the same set of explanatory variables on our and the SUSENAS data.[21]

Bearing in mind the limitations of the final SUSENAS data set we estimate OLS regressions with household per capita income in logs as dependent variable. The regression coefficients can be interpreted as similar to those in a simple Mincerian earnings regression. Table 10 shows the respective results for the 2001, 2004, and 2006 round of our data set and the 2002 and 2005 rounds of SUSENAS for rural Indonesia. First note that the coefficients on sectoral choice using the simple OLS model for the STORMA data in Table 10 are quite similar to the more complex causal models shown in Table 8; we might infer from this that the OLS estimates for the national SUSENAS data can give a relatively good impression of causal estimates.

Second, comparing OLS estimates of SUSENAS with STORMA shows that the coefficients on most covariates are very similar. Key determinants of the income generating process are in both data sets a subset of the household characteristics in particular household size and composition as well as the education levels all of which are statistically

Table 10
Regional OLS regressions: comparison

	LN(INCOME PER CAPITA)				
	STORMA 2001	STORMA 2004	STORMA 2006	SUSENAS 2002	SUSENAS 2005
Age	0.023	−0.026	0.059***	0.018***	0.012***
Age^2	−0.0002	0.0004	−0.001*	−0.016***	−0.013***
Female head	−0.225	−0.232	0.372	−0.116***	−0.185***
Max education	0.025	0.081*	−0.026	0.036***	0.054***
HH size	−0.117**	−0.165**	−0.152**	−0.132***	−0.144***
Number of men	−0.051	0.162	0.147	0.011	0.032***
Dependency ratio	−0.200***	−0.022	−0.287	−0.080***	−0.092***
NS	0.721**	0.564**	0.776**	0.228***	0.341***
NW	0.652*	0.540**	0.386**	0.284***	
AS	0.795*	−0.186	0.921**	−0.099***	−0.082***
AW	−0.106	−0.287	−0.442*	−0.016	
W					0.317***
Constant	10.329***	11.478***	9.934***	11.542	10.812***
N	257	257	257	26,460	31,655

Note: Further controls include subdistrict dummies. Significance levels: ***/**/* denote 0.01, 0.05, and 0.1. Standard errors are clustered at the kecamatan level. W refers to wage employment in general, which cannot be disaggregated in SUSENAS 2005.

[21] In order to compare households we need to guarantee that variables are measured in the same or similar way. The main difference between variables that are available in STORMA and SUSENAS is found to be in the total household income data. Total household income in SUSENAS contains imputations for rent and housing. Since the exact imputation procedure has not been published by BPS and moreover such an imputation can easily lead to merely adding additional noise to the income variable we subtract this imputed income from the total household income variable in SUSENAS.

significant and take signs as expected from economic theory.[22] Most importantly, we observe that in rural Indonesia as a whole, households that are predominantly engaged in the nonfarm sector (wage or self-employment) seem to do much better than households who derive most of their incomes from farm employment. This observation is in line with our previous findings. At the same time, agricultural wage employment is relatively more lucrative elsewhere in Indonesia than in Sulawesi (compare STORMA 2001 and SUSENAS 2002). Thus it seems that agricultural wage labor is better paid for in other parts of rural Indonesia. Particularly on the islands of Kalimantan and Sumatra, which have large rubber and palm oil plantations, it is likely that higher agricultural wages can be earned compared to Sulawesi, which is rather dominated by small-scale farm structures.

7. Conclusion

In this article we investigate to what extent diversification to nonfarm activities, productivity improvements for identical crops, and crop switching are driving income dynamics in rural Indonesia. Drawing on a new household panel data set for Central Sulawesi collected in the years 2001, 2004, and 2006 we find that both, the growth in and the level of rural incomes in the post-crisis period, can be explained by a common set of factors.

First, in the wake of the general recovery of the Indonesian economy, nonagricultural household incomes increased constantly over the considered period of time. While we observe that more and more households derive part of their incomes from this sector, significant entrance barriers for poorer households to become engaged in profitable nonagricultural activities remain. Here we largely confirm the existing international literature on the importance of nonfarm employment for rural income dynamics for the Indonesian case.

Second, we find that incomes from agriculture still constitute the financial backbone of rural households across the entire income distribution. Moreover, in contrast to the majority of the existing literature on rural Indonesia, we observe even strongly growing incomes from agricultural production that contributed to the observed increases in total household incomes. Consequently, the principal source of income growth between 2001 and 2006 differs between initially poor and rich households. Income growth among poor households can be primarily attributed to increases in agricultural self-employed income while richer households in addition benefited from strong increases in nonagricultural incomes.

Investigating the reasons behind the unexpected high growth rate in agricultural incomes, we show that incomes from agriculture increased due to a shift in cropping patterns, particularly cash crops, in our case from coffee to cocoa. Higher output volumes and more favorable commodity prices for cocoa than coffee help to explain most of the increase in agricultural incomes. The change from coffee to cocoa instructively shows how switching cropping patterns can be a crucial strategy in order to achieve income growth particularly for the poorer section of the rural population. Moreover, it shows that the observed increases in the value of agricultural production at the regional level in Indonesia can partly be explained by local innovations and experimentation in the choice of crops, and not only by forest clearing, increases in world commodity prices, or increases in production efficiency. The results presented are robust to various econometric specifications. They are of interest beyond the Indonesian case as the importance of crop switching is rarely considered in the international literature that often focuses on nonfarm incomes, agricultural productivity improvements on the same crop, and area expansions.

In a further step we examine whether results from STORMA hold lessons for a larger regional context. Extending our previous investigations to the national level by analyzing data from SUSENAS, we find the basic income relationships obtained from STORMA can be found all over rural Indonesia. One important difference, however, between STORMA and SUSENAS concerns the role of the agricultural self-employed sector. While this sector has been an important element toward income growth in the STORMA area, its effect on incomes seems to be smaller in other parts of rural Indonesia.

While we are confident about our main findings, we also need to point to limitations of our assessment. The comparatively small sample size in the STORMA data set affects the standard errors of the estimated regression coefficients which makes the evaluation of significance levels sometimes difficult. Moreover, since the panel data set was collected between 2001 and 2006, only a later part of the transformation process from coffee to cocoa production could be observed. Therefore, the observed effect of switching from coffee to cocoa is likely to represent only a partial effect. For instance, higher incomes from cocoa than coffee could have lifted the capital constraint of households already before 2001, which then enabled them to engage in nonagricultural activities.

Acknowledgments

We would like to thank Emre Eytimur, Matin Qaim, Stefan Schwarze, as well as participants of the 4th Annual International Conference of the German Economic Association's Research Committee on Development Economics and of the CRC-PEG Inaugural Conference for valuable comments. Funding by the German Research Foundation is gratefully acknowledged.

[22] In the regional SUSENAS specifications (not reported here) we observe that the significance level of a variety of covariates improves, when going to higher regional aggregates. This points to the circumstance that sample size issues might be responsible for the observed differences in significance levels between the distinct SUSENAS specifications and STORMA.

Appendix

Table A1
Description of variables

Variable	Characteristic	Database	Level
Individual characteristics			
Age	Age of household head	STORMA, BPS	HH Head
Sex	Sex of household head (1 = male; 0 = female)	STORMA, BPS	HH Head
Years of schooling of HH head	Years of schooling completed by hh head	STORMA, BPS	HH Head
Household characteristics			
Household size	No. of household members	STORMA, BPS	Household
Dependency ratio	No. of economic nonactive hh members (age <15 or >60) divided by # of economic active hh members	STORMA, BPS	Household
Number of men	No. of men in a household	STORMA, BPS	Household
Max education	Maximum years of schooling of a household member	STORMA, BPS	Household
Income variables			
Real per-capita income	HH income divided by hh size and deflated with provincial CPI data in IDR	STORMA, BPS	Household
Agricultural self-employed income	HH income from self-employment in the agricultural sector	STORMA, BPS	Household
Agricultural wage income	HH income from wage-employment in the agricultural sector	STORMA, BPS	Household
Nonagricultural self-employed income	HH income from self-employment in the nonagricultural sector	STORMA, BPS	Household
Nonagricultural wage income	HH income from wage-employment in the nonagricultural sector	STORMA, BPS	Household
Livestock income	HH income from livestock farming	STORMA	Household
Gathering income	HH income from gathering	STORMA	Household
Cropping income	HH income from crop production	STORMA	Household
Annual cropping income	Annual e.g. rice, maize	STORMA	Household
Perennial cropping income	Perennial e.g. cash crops like coffee, cocoa	STORMA	Household
Cocoa income	HH income from cocoa cultivation	STORMA	Household
Coffee income	HH income from coffee cultivation	STORMA	Household
Productivity variables			
Cocoa yield per *are*	Cocoa income divided by area cocoa	STORMA	Household
Coffee yield per *are*	Coffee income divided by area coffee	STORMA	Household
Cocoa output per *are*	Amount of cocoa harvested per month per area of cocoa	STORMA	Household
Coffee output per *are*	Amount of cocoa harvested per month per area of coffee	STORMA	Household
Price variables			
Cocoa price per kilo	Farm gate prices per kilo in IDR	STORMA	Household
Coffee price per kilo	Farm gate prices per kilo in IDR	STORMA	Household
Sector dummies			
Agricultural self-employed	HH receives income from this sector; no (0), yes (1)	STORMA, BPS	Household
Agricultural wage	HH receives income from this sector; no (0), yes (1)	STORMA, BPS	Household
Nonagricultural self-employed	HH receives income from this sector; no (0), yes (1)	STORMA, BPS	Household
Nonagricultural wage	HH receives income from this sector; no (0), yes (1)	STORMA, BPS	Household
Other variables			
Area owned	Agriculturally suitable land in *are*	STORMA	Household
Area cocoa	Agricultural land planted with cocoa in *are*	STORMA	Household
Area coffee	Agricultural land planted with coffee in *are*	STORMA	Household
Value of assets	Estimated value of physical and financial assets in IDR	STORMA	Household
Value of assets at marriage	Estimated value of assets in IDR at time of marriage	STORMA	Household
Value of livestock	Estimated value of livestock in IDR	STORMA	Household
Expenditures on fertilizer/pesticides	HH expenditures on fertilizer and pesticides per month	STORMA	Household
Share of rice fields with irrigation	Share of rice fields with no, semitechnical, or technical irrigation system	STORMA	Household
Distance to road	Distance to the next paved road in hours	STORMA	Household
Access to electricity	Household is connected to electricity: no (0), yes (1)	STORMA, BPS	Household
Access to extension services	Household received agricultural extension service in last year: no (0), yes (1)	STORMA	Household
Distance to Palu	Distance to the provincial capital Palu in hours	STORMA	Household

References

Adams, R. H., 1995. Agricultural income, cash crops, and inequality in rural Pakistan. Econ. Dev. Cultural Change 43(3), 467–491.

Arnberg, S., Hansen, L.G., 2012. Short-run and long-run dynamics of farm land allocation: Panel data evidence from Denmark. Agric. Econ., 43, 179–190.

Ashraf, N., Giné, X., Karlan, D., 2009. Finding missing markets (and a disturbing epilogue): Evidence from an export crop adoption and marketing intervention in Kenya. Am. J. Agric. Econ. 91(4), 973–990.

Baltagi, B.H., 2008. Econometric Analysis of Panel Data, Fourth Edition. Wiley, Chichester.

Barbier, E., 1989. Cash crops, food crops, and sustainability: The case of Indonesia. World Dev. 17(6), 879–895.

Barrett, C., Aboud, M., 2001. Income diversification, poverty traps and policy shocks in Côte d'Ivoire and Kenya. Food Pol. 26(4), 367–384.

Basu, K., Narayan, A., Ravallion, M., 2001. Is literacy shared within households? Theory and evidence for Bangladesh. Labour Econ. 8(6), 649–665.

Baum, C., Shaffer, M., Stillman, S., 2003. Instrumental variables and GMM: Estimation and testing. Department of Economics, Boston College Working Papers (545).

Benjamin, D., 1992. Household composition, labor markets, and labor demand: Testing for separation in agricultural household models. Econometrica 60(2), 287–322.

Blundell, R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. J. Econom. 87(1), 115–143.

BPS, 2011. Poverty rate in Indonesia 2011. Technical report, Badan Pusat Statistik (Central Bureau of Statistics), Jakarta, Indonesia.

Bussolo, M., Godart, O., Lay, J., Thiele, R., 2007. The impact of coffee price changes on rural households in Uganda. Agric. Econ. 37(2–3), 293–303.

Cherdchuchai, S., Otsuka, K., 2006. Rural income dynamics and poverty reduction in Thai villages from 1987 to 2004. Agric. Econ. 35(s3), 409–423.

Coxhead, I., Shively, G., Shuai, X., 2002. Development policies, resource constraints, and agricultural expansion on the Philippine land frontier. Environ. Dev. Econ. 7, 341–363.

Datt, G., Ravallion, M., 1998a. Farm productivity and rural poverty in India. J. Dev. Studies 34(4), 62–85.

Datt, G., Ravallion, M., 1998b. Why have some Indian states done better than others at reducing rural poverty? Economica 65(2), 17–38.

Deaton, A., Zaidi, S., 2002. Guidelines for constructing consumption aggregates for welfare analysis. World Bank Policy Research Working Paper 135.

De Janvry, A., Fafchamps, M., Sadoulet, E., 1991. Peasant household behavior with missing markets: Some paradoxes explained. Econ. J. 101(409), 1400–1417.

Dercon, S., 1996. Risk, crop choice, and savings: Evidence from Tanzania. Econ. Dev. Cultural Change 44(3), 485–513.

Dercon, S., Gilligan, D., Hoddinott, J., Woldehanna, T., 2009. The impact of agricultural extension and roads on poverty and consumption in fifteen Ethiopian villages. Am. J. Agric. Econ. 91(4), 1007–1021.

Dewi, S., Belcher, B., Puntodewo, A., 2005. Village economic opportunities, forest dependence, and rural livelihoods in East Kalimantan, Indonesia. World Dev. 33(9), 1419–1434.

Estudillo, J., Sawada, Y., Otsuka, K., 2006. The green revolution, development of labor markets and poverty reduction in the rural Philippines. Agric. Econ. 35(s3), 399–407.

Fafchamps, M., 1992. Cash crop production, food price volatility, and rural market integration in the third world. Am. J. Agric. Econ. 74(1), 90–99.

Fan, S., Gulati, A., Thorat, S., 2008. Investments, subsidies and pro-poor growth in rural India. Agric. Econ. 39(2), 163–170.

FAOSTAT, Food and Agriculture Organization of the United Nations—Statistics Division. 2011. Retrieved on 15 January 2011, Available at: http://www.faostat.org/.

Fields, G., Cichello, P., Freije, S., Menéndez, M., Newhouse, D., 2003. For richer or for poorer? Evidence from Indonesia, South Africa, Spain and Venezuela. J. Econ. Inequality 1(1), 67–99.

Frankenberg, E., Smith, J., Thomas, D., 2003. Economic shocks, wealth and welfare. J. Human Res. 38(2), 280–321.

Gibson, J., Olivia, S., 2010. The effect of infrastructure access and quality on non-farm enterprises in rural Indonesia. World Dev. 38(5), 717–726.

Grimm, M., Klasen, S., 2009. Geography vs. Institutions at the Village Level, CESifo Working Paper Series 2259, CESifo Group Munich.

Hill, R. V., 2010. Investment and abandonment behavior of rural households: An empirical investigation. Am. J. Agric. Econ. 92(4), 1065–1086.

Jolliffe, D., 2004. The impact of education in rural Ghana: Examining household labor allocation and returns on and off the farm. J. Dev. Econ. 73(1), 287–314.

Lanjouw, J., Lanjouw, P., 2001. The rural non-agricultural sector: Issues and evidence from developing countries. Agric. Econ. 26(1), 1–23.

Mankiw, G., Romer, P., Weil, D., 1992. A contribution to the empirics of economic growth. Quart. J. Econ. 107(2), 407–437.

Micevska, M., Rahut, D., 2008. Rural nonfarm employment and incomes inthe Himalayas. Econ. Dev. Cultural Change 57(1), 163–193.

Nargis, N., Hossain, M., 2006. Income dynamics and pathways out of rural poverty in Bangladesh. Agric. Econ. 35(s3), 425–435.

Ravallion, M., Datt, G., 2002. Why has economic growth been more pro-poor in some states of India than in others? J. Dev. Econ. 68(2), 381–400.

Ravallion, M., Lokshin, M., 2007. Lasting impacts of Indonesia's financial crisis. Econ. Dev. Cultural Change 56(1), 27–56.

Rosegrant, M., Evenson, R., 1992. Agricultural productivity and sources of growth in south Asia. Am. J. Agric. Econ. 74(3), 757–761.

Rosegrant, M., Kasryno, F., Perez, N., 1998. Output response to prices and public investment in agriculture: Indonesian food crops. J. Dev. Econ. 55(2), 333–352.

Schwarze, S., Erasmi, S., Priess, J., Zeller, M., 2009. Do national parksreduce deforestation? The effectiveness of the Lore Lindu National Park in Indonesia. STORMA Discussion Paper No. 30.

Sunderlin, W., Angelsen, A., Derwawan, D., 2001. Economic crisis, small farmer well-being, and forest cover change in Indonesia. World Dev. 29(5), 767–782.

Suryahadi, A., Suryadarma, D., Sumarto, S., 2009. The effects of location and sectoral components of economic growth on poverty: Evidence from Indonesia. J. Dev. Econ. 89, 109–117.

Temple, J., 1999. The new growth evidence. J. Econ. Lit. 37(1), 112–156.

Timmer, C., 2007. A historical perspective on pro-poor growth in Indonesia. In: Grimm, M., Klasen, S., McKay, A. (Eds.), The Determinants of Pro-Poor Growth. Palgrave, Hampshire.

Udry, C., 1996. Efficiency and market structure: Testing for profit maximization in African Agriculture. Mimeo, Northwestern University.

WB, 2006. 2: Indonesia: Revitalizing the rural economy. The World Bank, Washington, D.C.

Windmeijer, F., 2005. A finite sample correction for the variance of linear efficient two-step GMM estimators. J. Econ. 126(1), 25–51.

Woolard, I., Klasen, S., 2005. Determinants of income mobility and household poverty dynamics in South Africa. J. Dev. Stud. 41(5), 865–897.

Zeller, M., Schwarze, S., van Rheenen, T., 2002. Statistical samplingframe and methods used for the selection of villages and households in thescope of the research program on stability of rainforest margins in Indonesia. STORMA Discussion Paper Series 1, STORMA, University of Goettingen.