Testing the Separation Hypothesis in Ayeyarwady Delta Region, Myanmar

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ミャンマー，エラワジ・デルタ管区における分離定理仮説の検証

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ミャンマーでは目覚ましい経済発展の過程で農村から都市への労働移動が増加し，農村の労働力不足が農業生産におよぼす影響が懸念されている．しかし，この影響は，農村労働市場における過剰労働の存在如何によって大きく異なる．本稿は，ミャンマーで最も重要な作物であるコメの最大の産地であり，都市への労働移動が顕著であるエラワジ・デルタ管区における農家個票データを用い，稲作農村における過剰労働の存在を検証することを目的とす

る．そのために，本稿では，先行研究における実証分析の手法を参考に，家族労働と雇用労働の不完全代替性を考慮に入れた実証分析の方法を適用し，競争的な要素市場のもとでは，農家が生産と消費の意思決定を分離して行うという分離定理仮説を検証した．分析の結果，分離定理仮説は棄却され，エラワジ・デルタ管区においては依然として過剰労働が存在し，短期的には農業における労働力不足の問題が生じないことが示唆された．

キーワード：separation hypothesis, surplus labor, Ayeyarwady Delta Region, rural–urban migration

1. Introduction

Myanmar has entered a period of economic transition, which can largely be attributed to the dramatic reopening of its economy and the initiation of wide-ranging political and economic reforms in 2011. Over the past few years, Myanmar's economy has made a slight shift from being a predominantly agricultural economy to one that is based on manufacturing and services. This shift could mark the beginning of structural transformation, which would undoubtedly warrant the large-scale transfer of resources (especially labor) from agriculture to manufacturing and services (LIFT, 2016). Labor is a vital input in almost all economic sectors.

Myanmar's economy has been mainly dependent on

the agricultural sector, which employs a significant proportion of the total labor force (61%). The sector contributes 30% to GDP and 16% to total export earnings. These proportions suggest that the productivity of the agricultural sector is significantly lower than the national average (ADB, 2014). Labor productivity is also found to be as low as one-third of that in the other industries (METI, 2015).

With more than half of the total labor force still engaged in agriculture, it is reasonable to assume that labor force employed in Myanmar's rural economy is abundant (MOALI, 2016).

Recent economic developments, rapid industrial growth, and expansion of the service sector have created significant employment opportunities in Myanmar's urban areas. These opportunities have increased

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the potential for labor migration from the rural-based agricultural sector to the more productive urban-based industrial and service sectors. In the initial phase of the economic transition, migrating the bulk of agricultural labor from rural to urban areas would reduce surplus labor, and thereby increase the marginal product of labor. Remittances by recently migrated labor are expected to affect rural income positively. In other words, this process could catalyze Myanmar's economic transformation and contribute to its economic growth (LIFT, 2016).

However, there is no evidence of surplus labor in the rural economy. This is the result of the scarcity of official labor-related statistics and limited survey records on the labor situation in Myanmar. Labor resource reallocation under Myanmar's structural transformation warrants the smooth expansion of labor supply by labor migration from rural to urban areas (METI, 2015). On the other hand, if there were no surplus labor in rural areas, this migration would cause labor shortages and increase agricultural wages, which, in turn, would further raise the labor cost of farming. The abovementioned factors would negatively affect agricultural income, particularly if technological progress is limited.

Therefore, to understand the impact of rural–urban migration on agricultural production, it is necessary to establish whether surplus labor exists. An effective method to do so is to test the separation hypothesis. Most developing countries, including Indonesia, India, Nepal, China, and Vietnam, have tested the separation hypothesis and, except for Indonesia, all have rejected it (Lopez, 1984; Benjamin, 1992; Jacoby, 1993; Skoufias, 1994; Bhattacharyya and Kumbhakar, 1997; Abdulai and Regmi, 2000; Bowlus and Sicular, 2003; Barrett et al., 2008; Le, 2009, 2010; Muller, 2014).

This study aims to examine the existence of surplus labor in the rural areas of the Ayeyarwady Delta Region, Myanmar, by testing the separation hypothesis. The Ayeyarwady Delta Region is the most densely populated rural area of Myanmar and a key rice-growing region that is predominantly representative of

Myanmar's rice industry and farmers. As rice is the country's staple food and the main export crop, it should become the focus for economic development. Myanmar's rice exports have been increasing as a result of the reopening of its market to the global economy and the sector demonstrates a certain degree of international competitiveness (see Fig. 1).

To test for separability, many scholars have conducted relevance tests to identify the correct model. Most empirical studies employing the separation hypothesis adopt two approaches. The first approach accounts for the relationship between production decisions and preferences by specifying a labor demand function (Lopez, 1984; Benjamin, 1992; Grimard, 2000; Bowlus and Sicular, 2003; Muller, 2014). The second approach considers the relationship between shadow and market wages by using a labor supply function (Jacoby, 1993; Skoufias, 1994; Bhattacharyya and Kumbhakar, 1997; Abdulai and Regmi, 2000; Barrett et al., 2008; Le, 2009).

Benjamin (1992), for instance, tests the hypothesis that the optimal labor demand in farm households is unaffected by household characteristics. On the other

Fig. 1 Myanmar's rice export volume and share of the international rice market.

Source: FAO (2016) and Ministry of Commerce (2017).

hand, Jacoby (1993) examines the hypothesis that the marginal productivity of labor is equal to the market-level wage. However, both models have shortcomings¹. To address these issues, Le (2010) proposes a new analytical framework to test the separation hypothesis using a simultaneous model that combines the approaches of Benjamin (1992) and Jacoby (1993) in a joint estimation. Le's (2010) modification test is not only simpler and less data intensive, but also offers more reliable results.

However, Le's (2010) approach does not consider the variation in labor efficiency when aggregating farm labor for the estimation. Most previous studies argue that the variation in labor efficiency implies that the different types of labor are not perfect substitutes in production (e.g., male/female and family/hired), thereby causing the estimation results to be biased (Lopez, 1984; Deolalikar and Vijverberg, 1987; Benjamin, 1992; Jacoby, 1993; Bowlus and Sicular, 2003).

Therefore, this study attempts to provide evidence of imperfect substitutability of labor and to address the aggregation bias problem in Le's (2010) model. Furthermore, this study makes the following contributions to the literature. This is the first study to empirically assess the existence of surplus labor in Myanmar's rural areas of the Ayeyarwady Delta Region, against the backdrop of the recent economic transition. The data are from a unique cross-sectional dataset that was compiled by the International Rice Research Institute (IRRI) in Myanmar during 2013–2014 and offers rich household-level information. These data have not been previously used. In addition, the present empirical approach extends Le's (2010) model in two aspects. First, it considers the robustness of the aggregation bias by testing the difference in efficiencies of family labor and hired labor. To the best of my knowledge, the empirical model in this study is the first mixed type that considers the differences in efficiency between family and hired labor. Second, Le (2010) considers observed variables while accounting for differences in labor use across households, whereas this study includes additional variables related to the develop-

ment of off-farm labor markets, which can affect labor use, which differs by household. Furthermore, we incorporate additional preference shifter variables to provide a more effective means of identifying the separation test. All these additional variables are used as control variables, which eliminates omitted variable bias.

While Le (2010) considers all economic activities when aggregating the different types of farm labor, this study focuses on the rice industry and aggregates all labor on rice farms using Le's (2010) modification hypothesis test. We also use farm-level wage data to offer a more precise determination and avoid the measurement error when estimating the wage.

2. Analytical Framework

(1) Testing the Separation Hypothesis

This study follows Le's (2010) modified empirical model, which combines two separation hypothesis tests of the Benjamin (1992) type and the Jacoby (1993) type.

Benjamin (1992) derives the optimal labor demand of farm households and estimates the shadow wage using a linear function, $\log(w^*) = \log(w) + \alpha A$, where w^* denotes shadow wage or opportunity cost of time; w is market wage; and A denotes preference shifters, including household characteristics. In Benjamin's (1992) approach, $\alpha = 0$ is for separation and $\alpha \neq 0$ is for non-separation. In addition, he considers the relationship between L and A , where L is the labor demand.

Jacoby (1993) estimates the production function to derive the marginal product of labor (MPL) and defines shadow wage (w^*) as identical to MPL. In addition, he proposes the test $\log(w^*) = \beta \log(w)$ to determine the relationship between w^* and w , where $\beta = 1$ for separation and $\beta \neq 1$ for non-separation.

Le (2010), however, estimates shadow wage in a more flexible manner by identifying w^* as the optimal MPL without estimating the production function. He first uses a semi-parametric production function:

$$\bar{Q} = L^{\lambda} f(z, F, \sigma), \quad (1)$$

where $f(\cdot)$ is a non-parametric function, $\bar{Q}$ is the average of farm product (Q), L is farm labor, z is variable inputs, and F is fixed inputs. Note that Le (2010) assumes hired labor is included in z and there is no substitution between hired labor and family labor. This study assumes that total labor (family plus hired) is a single input and there is imperfect substitution between family labor and hired labor.

Although there is no assumption on the functional form for $f(\cdot)$, labor input must have a Cobb–Douglas form (L^{λ_L}). Here, labor parameter $\lambda_L = e^{\lambda K + \xi}$ is assumed to be an exponential function of observed variables K that affect the value of the labor parameter. This study also uses different regions (R) and other farm products (O). In this case, λ_L becomes

$$\lambda_L = e^{\lambda_0 + \lambda_1 R + \lambda_2 O + \xi}, \quad (2)$$

where ξ is a random unobserved variable.

From the above production function, real output (Q) is assumed to be $Q = \bar{Q}e^\varepsilon$. Here, $\bar{Q}$ is the mean of Q and ε is an error term that follows a normal distribution with $E(e^\varepsilon) = 1$. Farmers' MPL is based on their expected Q and thus,

$$MPL = p \partial E(Q) / \partial L = p \partial \bar{Q} / \partial L = \lambda_L p Q e^{-\varepsilon} / L. \quad (3)$$

Taking logs on both sides and replacing MPL with w^* yields

$$\log(pQ/L) = -\log(\lambda_L) + \log(w^*) + \varepsilon. \quad (4)$$

Equation (4) becomes the basis equation for the separation hypothesis test modified by Le (2010).

Substituting Benjamin's shadow wage $\log(w^*) = \log(w) + \alpha A$ into equation (4) yields

$$\log(pQ/wL) = -\log(\lambda_L) + \alpha A + \varepsilon. \quad (5)$$

Replacing $\log(w^*)$ with Jacoby's $\beta \log(w)$ in equation (4) yields

$$\log(pQ/L) = -\log(\lambda_L) + \beta \log(w) + \varepsilon. \quad (6)$$

Le (2010) combines these two specifications of the shadow wage into one specification, $\log(w^*) = \beta \log(w) + \alpha A$ and then, plugs this into equation (4), yielding

$$\log(pQ/L) = -\log(\lambda_L) + \beta \log(w) + \alpha A + \varepsilon. \quad (7)$$

This study tests the hypotheses that $\beta = 1$ and $\alpha = 0$.

Le (2010) considers variability in labor productivity, where $\log(\lambda_L)$ is a function of different regions (R) and other farm products (O). This study follows Le's (2010) use of a regional dummy, which is based on four selected townships, and a dummy for other farm products (O). In addition, this study accounts for the effect of development in the off-farm labor market on each household's labor use. Therefore, off-farm employment dummies (E) are added to the variability in labor productivity, $\log(\lambda_L)$. Accordingly, the empirical regression model to test the separation hypothesis becomes

$$\begin{aligned} \log(pQ/L) = & -\lambda_0 - \lambda_1 R - \lambda_2 O - \lambda_3 E + \beta \log(w) \\ & + \alpha A + \tau. \end{aligned} \quad (8)$$

This study tests the hypotheses that $\beta = 1$ and $\alpha = 0$, where $\tau = \xi + \varepsilon$.

(2) A Different Efficiency Test

As discussed earlier, aggregation is inappropriate when different types of labor have varying levels of efficiency. Aggregating the heterogeneous types of labor could yield a weaker form of separation, causing the estimation results to be biased. To address the issue of heterogeneous family labor and hired labor in terms of their varying efficiencies and imperfect substitution, this study uses the following test proposed by Benjamin (1992).

$$\log L \cong \beta \log w + \gamma \log V + (1 - \alpha) \frac{L^H}{L} + \varepsilon, \quad (9)$$

where L is farm labor; w is wage; V is harvested land area; L^H/L is the fraction of hired labor; and ε is an error term. The null hypothesis for the efficiency test is $\alpha = 1$, or $(1 - \alpha) = 0$. This implies that the fraction of hired labor does not affect the dependent variable L , suggesting equal efficiency between family labor and hired labor.

3. Data

The data used in this study are taken from a cross-

sectional dataset compiled from the Area-Based Farm Household Survey, which was administered by the IRRI Global Rice Science Partnership (GRiSP) in Myanmar during 2013–2014. Specifically, the survey was conducted in the Ayeyarwady Delta Region, which is mostly a rice-growing area, as a collaborative effort between IRRI and Yezin Agricultural University. The sample covers 2,000 rice farm households, which were randomly drawn from four sample townships located in the higher-yield rice-growing areas of the study region by using computer-assisted personal interviews. This large sample size is representative of the region and can be used to test the separation hypothesis.

The data include demographic characteristics; household income and their economic activities (both on-farm and off-farm); a complete set of labor and wage data on rice production, including detailed time allocation by family labor and hired labor, the recorded wages, and types of payments; other input utilization and commodity prices; marketing and sale of rice; adoption of rice-based technologies; and consumption and expenditure.

This study thoroughly verifies inconsistencies in the data and ensures relatively high-quality data. Households with missing labor information are excluded from the sample, leaving a total sample of 1,998 rice farm households.

4. Estimation Results

(1) Testing for Efficiency Difference between

Family Labor and Hired Labor

To test the difference of efficiency between family labor and hired labor, equation (9) is estimated using Benjamin's (1992) efficiency test. Table 1 presents the basic statistics for the estimation.

The null hypothesis for this test is that the coefficient $(1 - \alpha)$ of mix L^H/L equals 0, where $\alpha = 1$, thereby suggesting equal efficiency.

Table 2 presents the model's estimation results using OLS, 2SLS, and IVGMM. The OLS result indicates that the coefficient on the fraction of hired labor (mix L^H/L) is highly significant; the coefficient $(1 - \alpha)$

is 0.99. In other words, α is 0.01 and $(1 - \alpha)$ does not equal 0. Therefore, the null hypothesis of equal efficiency is rejected in the OLS regression. However, the OLS result is inconclusive, because the main variable, the fraction of hired labor, must be instrumented to avoid simultaneity or division bias. To avoid this outcome, we use household composition variables as natural instruments (IVs) for the fraction of hired labor². However, when performing labor demand regression, wage may suffer from simultaneity or omitted variable bias. This is because wage is determined by labor supply and demand; it can also be generated on the basis of regional variations. To address this bias, we use population density³ as an IV for wage. As mentioned, to ensure the consistency of the estimated coefficients, it is necessary to estimate 2SLS regression using IVs for not only the fraction of hired labor, but also log (wage). The 2SLS regression result shows that the coefficient on the fraction of hired labor is still significant at the 10% level. Coefficient $(1 - \alpha)$ is -0.419 ; thus, α is 1.4, implying that the null hypothesis of equal efficiency is rejected. The negative sign on this coefficient indicates that hired labor is more efficient, which is in line with the findings of Deolalikar and Vijverberg (1987) and Benjamin (1992).

According to the Hausman test, the difference between OLS and 2SLS estimators is highly significant with a critical value of $\chi^2(9) = 48.12$, which suggests that IVs should be used. The test of over-identifying restrictions does not reject the null hypothesis; thus, we can conclude that all IVs are valid and exogenous. Furthermore, when testing the instruments' relevance, the critical value of the F-statistic is 40.9, indicating that the instruments used in this study are not weak.

Finally, the last column in Table 2 shows statistics estimated using IVGMM, which produces consistent and efficient estimates in the presence of non-independently and identically distributed (i.i.d.) errors⁴. The conclusion obtained from the IVGMM estimation is similar to that of 2SLS; however, the main coefficient on the fraction of hired labor $(1 - \alpha)$ is

Table 1. Descriptive Information of Variables used for the Efficiency Test

Variables	Description	Unit	Mean	Std. Dev.
Farm Labor	Total working days on farm before harvesting in both dry and wet seasons	Person days/year	191.6	202.4
Area Harvested	Aggregate of harvest of the largest rice parcel in both dry and wet seasons	Acres	15.4	12.7
Daily Wage	Market wage (cash payment); average of daily hired labor wage reported for select farm activities	MMK/Day	2,581.4	583.3
Fraction Hired	Fraction of working days with hired labor before harvesting in both dry and wet seasons	Person days/year	0.6	0.3
Irrigation	Dummy = 1 if the largest rice parcel is under irrigation or semi-irrigation; 0 otherwise		0.8	0.4
Pesticide Price	Average unit price of various types of pesticides used in farm household	MMK/liter	5,334.9	5,478.6
Fertilizer Price	Average unit price of various types of fertilizers used in farm household	MMK/50 kg	20,565.5	3,973.5
Household Head's Age	Age of household head	Years	53.9	11.9
Household Head's Education	Schooling years of household head	Years	5.3	2.6
Soil Fertility Status	Soil fertility status of the largest rice parcel is an ordinal variable for three classes:		1.8	0.5
	(1) Low fertility	Household		97.0
	(2) Medium fertility	Household		1,480.0
	(3) High fertility	Household		421.0
Definition of Additional Instruments				
Household Composition Variables	No. of prime males between 15 and 64 years	Person	1.8	1.1
	No. of prime females between 15 and 64 years	Person	1.9	1.1
	No. of elderly individuals aged over 64 years	Person	0.3	0.6
	No. of children aged below 15 years	Person	0.6	0.9
Township Population Density ¹⁾	Density of inhabitants per square kilometer of each sample township (Kangyidaunt, Maubin, Myaungmya, Kyaiklat)	Person/km ²	2,55.4	35.9

Source: IRRI GRiSP's Area-Based Farm Households with Focus on Rice Crop in the Ayeyarwady Delta Region using computer-assisted personal interviews (CAPI: Surveybe) (2014)

1) Data are from the 2014 Myanmar Population and Housing Census data.

2) Exchange rate: USD 1 = MMK 1,363 (Central Bank of Myanmar, 2017).

0.44, which is higher than that of 2SLS.

Overall, the findings reject the null hypothesis and show unequal efficiency between family labor and hired labor, which indicates that they are not perfect production substitutes. However, Benjamin's (1992) findings do not reject the perfect substitutability hypothesis in rural Java. The results of our estimation suggest that hired labor is more efficient than family

labor. Therefore, most of the farmers in the Ayeyarwady Delta Region maximize their profit by using more hired labor.

(2) Testing the Separation Hypothesis with Efficiency Labor Units

The results discussed in the previous subsection indicate that the sample data show evidence of inappropriate aggregation of labor units in testing the sepa-

Table 2. Testing for the Effect of Varying Efficiency of Family Labor and Hired Labor on Labor Demand
Dependent Variable: log(L)

Independent Variables	Without Instruments		With Instruments			
	OLS		2SLS		IVGMM	
	Coefficient ²⁾	SE ³⁾	Coefficient ²⁾	SE ³⁾	Coefficient ²⁾	SE
Log_Area_harvested	0.7183***	0.0220	0.9044***	0.0369	0.9073***	0.0367
Log_Wage	-0.4785***	0.0647	-0.6451***	0.1265	-0.6591***	0.1256
Fraction_hired (mix)	0.9982***	0.0670	-0.4190*	0.2258	-0.4402*	0.2247
Irrigation	0.4643***	0.0467	0.4573***	0.0537	0.4535***	0.0536
Log_Pesticide_Price ¹⁾	0.0215***	0.0040	0.0151***	0.0048	0.0148***	0.0047
Log_Fertilizer_Price ¹⁾	0.0171	0.0138	0.0251	0.0182	0.0259	0.0181
Head_Education	-0.0137**	0.0058	0.0092	0.0075	0.0096	0.0075
Head_Age	0.0205***	0.0074	0.0217**	0.0084	0.0212**	0.0084
Head_Age ²	-0.0002***	0.0001	-0.0002**	0.0001	-0.0002**	0.0001
Soil_Fertility_Status	0.0810***	0.0305	0.1108***	0.0364	0.1103***	0.0363
Constant	4.8439***	0.5649	6.2806***	1.0545	6.4084***	1.0468
R-squared	0.61		0.49			
Hausman Test χ^2			48.12			
Overid. Test χ^2			1.17			
F-statistic (Stock-Yogo)			40.90			

1) Log (Pesticide_Price+1), Log (Fertilizer_Price+1)

2) *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

3) OLS and 2SLS estimations with robust standard errors are shown.

ration hypothesis. Therefore, this issue is resolved in this study by disaggregating the efficiencies of family and hired labor.

To account for the variation in efficiency labor units, we use L^* ($= L^F + \alpha L^H$) as aggregate labor input⁵. From the estimation result of the efficiency test, $\alpha = 1.44$ is obtained. Therefore, the total efficiency labor units becomes $L^* = L^F + 1.44 L^H$.

To test the separation hypothesis, equation (8) is estimated on the basis of Le's (2010) modification test using total efficiency labor units. The variables used in this study are described in Table 3. Recalling equation (8), $\text{Log}(pQ/L)$ is a proxy for shadow wage, which is regressed on market wage and preference shifters. The null hypothesis for this test is that the coefficient on $\text{Log}(\text{wage})$, β equals one, and the preference shifters, α , equals zero, thereby suggesting separation and

no surplus labor.

Table 4 presents the results of the separation hypothesis test conducted using OLS and least absolute deviation (LAD) as the estimation methods⁶. In column 1, the OLS estimation shows that the coefficient on $\text{Log}(\text{wage})$ is significantly smaller than 1 and those on children and total assets as preference shifters are significant. Denoting the difference of labor productivity across households as λ_L , it is found that the coefficients on other farm products (cash crops) and region dummies are significant, while those on off-farm employment⁷ are not.

Columns 2 and 3 of Table 4 report the results of LAD estimation using the default and bootstrap methods, respectively. In both methods, the coefficient on $\text{Log}(\text{wage})$ is significantly smaller than 1. As for the coefficients on preference shifters, only the coefficient

Table 3. Descriptive Information of Variables

Variables	Description	Unit	Mean	Std. Dev.
Farm Labor	Total working days on farm before harvesting in both dry and wet seasons	Person days/year	191.6	202.4
Crop Value	Total value of paddy	'000 MMK	4,395.2	4,010.2
Daily Wage	Market wage (cash payment); average of daily hired labor wage reported in some farm activities.	MMK/day	2,581.4	583.3
Preference Shifters				
Household Size	Total number of household members who live together	Person	4.7	1.7
Prime Male	Male household members in the 15–64-year age group	Person	1.8	1.1
Prime Female	Female household members in the 15–64-year age group	Person	1.9	1.1
Elderly	Household members older than 64 years	Person	0.3	0.6
Children	Household members younger than 15 years	Person	0.6	0.9
Assets				
Total Assets	Household assets, including immovable and movable assets	Million MMK	10.6	65.2
Immovable Assets	Assets, including immovable items (e.g., house, compound, and farmland)	Million MMK	9.4	64.8
Movable Assets	Assets, including movable items (e.g., TV, motor cycle, and farming tools)	Million MMK	1.3	4.8
Regions (Four Townships)				
Kangyidaunt	Dummy = 1 if living in Kangyidaunt Township		0.2	0.4
Maubin	Dummy = 1 if living in Maubin Township		0.2	0.4
Myaungmya	Dummy = 1 if living in Myaungmya Township		0.3	0.4
Kyaiklat	Dummy = 1 if living in Kyaiklat Township		0.3	0.4
Other Farm Products				
Cash Crops	Dummy = 1 if household grows crops (e.g., betel nut, betel leaves, and dry land with pulses)		0.2	0.4
Livestock	Dummy = 1 if household raises any type of livestock for sale (e.g., pigs or chickens)		0.4	0.5
Off-farm Employment				
Public	Dummy = 1 if a household member is a government employee (e.g., teacher, nurse, and village officer)		0.08	0.27
Private	Dummy = 1 if a household member is a private employee (e.g., company staff)		0.03	0.17
Manufacturing	Dummy = 1 if household has a factory worker		0.05	0.21
Overseas	Dummy = 1 if household has an overseas worker		0.04	0.19

Source: IRRI GRiSP's Area-Based Farm Households with Focus on Rice Crop in the Ayeyarwady Delta Region using computer-assisted personal interviews (CAPI: Surveybe) (2014)

1) Total number of sample households is 1998.

2) Exchange rate: USD 1 = MMK 1,363 (Central Bank of Myanmar, 2017)

on total assets is found to be significant. Other remaining variables are significant and show that the results

are similar to those of the OLS estimation. However, one difference is that the absolute value of the estima-

Table 4. Results of the Separation Hypothesis Test: Le's New Analytical Test Using OLS and LAD
Dependent Variable: log (pQ/L*)

Independent Variables	OLS		LAD QR-50		LAD BSQR-50	
	Coefficient ¹⁾	SE ²⁾	Coefficient ¹⁾	SE ³⁾	Coefficient ¹⁾	SE ⁴⁾
Log (wage)	0.3744***	0.1031	0.2635***	0.0960	0.2635***	0.0880
Preference Shifters						
Prime Male	0.0149	0.0167	0.0051	0.0158	0.0051	0.0149
Prime Female	-0.0141	0.0167	-0.0068	0.0157	-0.0068	0.0131
Elderly	0.0043	0.0243	0.0069	0.0255	0.0069	0.0286
Children	0.0369*	0.0205	0.0111	0.0194	0.0111	0.0237
Total Assets	0.0005***	0.0001	0.0005***	0.0002	0.0005**	0.0002
Other Farm Products						
Cash Crop	-0.1161***	0.0396	-0.0860**	0.0435	-0.0860***	0.0324
Livestock	0.0493	0.0347	0.0457	0.0341	0.0457	0.0406
Regions (Four Townships)						
Kangyidaunt	0.4911***	0.0422	-0.2160***	0.0594	-0.2160***	0.0566
Maubin	0.7077***	0.0522	0.0099	0.0511	0.0099	0.0505
Myaungmya			-0.6059***	0.0527	-0.6059***	0.0422
Kyaiklat	0.6462***	0.0462				
Off-farm Employment						
Private	-0.0370	0.1122	0.0443	0.0955	0.0443	0.1096
Public	0.0529	0.0585	0.0618	0.0605	0.0618	0.0442
Manufacturing	0.0696	0.0727	-0.0141	0.0778	-0.0141	0.0799
Overseas	-0.0334	0.0930	0.0381	0.0852	0.0381	0.0884
Constant	-0.3826	0.8066	1.1211	0.7756	1.1211	0.7197
R-squared	0.16		0.096		0.096	
Coefficient on Log(wage) = 1 and coefficients on preference shifters = 0	F(6, 1982) = 11.47		F(6, 1982) = 11.96		F(6, 1982) = 14.00	

1) *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

2) OLS estimation with robust standard errors is shown.

3) QR-50 is a median regression (also called LAD) with reported standard errors (basic QR command).

4) BSQR-50 is used to identify bootstrap standard errors with a robust option and does not require identical distribution.

ted coefficients on these significant variables is lower in the LAD than the OLS estimation, and the coefficient on children is insignificant in the LAD estimation. Notably, the positive sign of the coefficient on children implies the presence of a large number of children in the household, which, in turn, increases the availability of farm labor. The positive effect of total assets indicates that wealthier households can afford a

larger production effect by using more labor. Finally, the F-test results for the joint significance of wage and preference shifters are confirmed.

In the last row of Table 4, the test statistics (F-value) show that the expected value of the coefficient on Log (wage) is 1 and all the expected coefficients on the preference shifters are 0 and jointly significant at the 1% level in all regressions. Therefore, the overall

F-test results strongly reject the null hypothesis of the separation hypothesis. This finding indicates that surplus labor still exists in the rural areas of the study region, which has recently undergone an economic transition.

Online appendix Table A1 presents the detailed OLS and LAD regression results for the separation hypothesis by testing the inclusion of additional preference shifters. These results also reject the null hypothesis of the separation hypothesis. In addition, we test the separation hypothesis by assuming that family labor and hired labor are perfect substitutes in production, and find that the non-separation holds when using the aggregation of family labor and hired labor. The aggregation results are not presented in the paper but are available upon request.

5. Conclusions

This study examines the separation hypothesis to determine the existence of surplus labor by focusing on rice-growing farmers in the rural areas of the Ayeyarwady Delta Region. The presence of surplus labor in the agricultural sector influences the impact of rural–urban migration on agricultural production. All empirical findings reject the separation hypothesis, thereby suggesting the existence of surplus labor in the study region. The robustness of rejection of the results for the separation hypothesis owing to aggregation bias is greater in this study than in Le (2010). Furthermore, in contrast to Benjamin (1992), the results in this study show evidence of imperfect substitutability of family labor and hired labor in the Ayeyarwady Delta Region when using Benjamin's (1992) labor demand function. Furthermore, incorporating additional variables produces more reliable results for the separation hypothesis test of this study. Thus, it can be concluded that the principal rice-growing areas in rural Ayeyarwady Delta Region are characterized by surplus labor.

The findings suggest that the labor migration from the Ayeyarwady Delta Region has two possible effects on the development of the rice industry. First, it posi-

tively affects farmers' well-being, because labor productivity and income in the rice industry increase as a result of surplus labor absorption. Second, increased productivity enhances the global competitiveness of the rice industry, which has considerable potential for export expansion. Therefore, if these findings are valid, the current rural–urban migration in the study area will have a positive impact on not only Myanmar's poverty-alleviation effort, but also its economic development through the promotion of rice exports.

Notes

- ¹ Benjamin's (1992) approach faces the simultaneity bias problem when estimating the labor demand function and Jacoby's (1993) approach faces the endogeneity problem when estimating the production function.
- ² Benjamin (1992) also employs household composition variables to address the problems of simultaneity or division bias.
- ³ Similar to Benjamin (1992), who considers population density in surrounding areas as an instrument to address simultaneity bias or omitted variables bias, this study considers township population density as an instrument for wage.
- ⁴ The definition of the simple IV and 2SLS estimators in this study assumes the presence of i.i.d. errors. While these estimators allow for consistency, they are inefficient estimates whose large sample VCE must be calculated using a robust econometric method, such as those available in STATA (Baum, 2006).
- ⁵ Here, we consider that family labor and hired labor are used only in pre-harvest activities; thus, plowing and harvesting are excluded. This assumption is because traditionally plowing requires labor, draft animals, or tractor services, which result in a high wage. Harvest laborers earn on a share basis (not a fixed wage) and some farmers employ harvesters.
- ⁶ Unlike OLS, LAD estimation is less sensitive to the presence of outliers in the dependent variable. If the error term has non-normal distribution, LAD might be more efficient than OLS (Deaton, 1997; Buchinsky, 1998; Le, 2010).
- ⁷ Le (2010) considers a modifier labor productivity, λ_{it} , for crop-based and regional variation. In the present study, off-farm employment dummies are added to account for the different labor utilization across households.

References

- Abdulai, A. and P. P. Regmi (2000) Estimating Labor Supply of Farm Households under Non Separability: Empirical Evidence from Nepal, *Agricultural Economics* 22(3): 309–320.

- Asian Development Bank (ADB) (2014) *Myanmar: Unlocking the Potential, Country Diagnostic Study*, Manila: Asian Development Bank.
- Barrett, C., S. Sherlund, and A. Adesina (2008) Shadow Wages, Allocative Inefficiency, and Labor Supply in Smallholder Agriculture, *Agricultural Economics* 38(1): 21–34.
- Baum, C. F. (2006) *An Introduction to Modern Econometrics using Stata*, College Station, Texas: Stata Press.
- Benjamin, D. (1992) Household Composition, Labor Markets and Labor Demand: Testing for Separation in Agricultural Household Models, *Econometrica* 60(2): 287–322.
- Bhattacharyya, A. and S. Kumbhakar (1997) Market Imperfections and Output Loss in the Presence of Expenditure Constraint: A Generalized Shadow Price Approach, *American Journal of Agricultural Economics* 79(3): 860–871.
- Bowlus, A. and T. Sicular (2003) Moving Toward Markets? Labor Allocation in Rural China, *Journal of Development Economics* 71(2): 561–583.
- Buchinsky, M. (1998) Recent Advances in Quantile Regression Models, *Journal of Human Resources* 33(1): 88–126.
- Central Bank of Myanmar (2017) Exchange Rate. (<http://forex.cbm.gov.mm/index.php/fxrate>) [Accessed 21 September, 2017].
- Deaton, A. (1997) *The Analysis of Household Surveys: A Microeconomic Approach to Development Policy*, Baltimore: Johns Hopkins University Press.
- Deolalikar, A. B. and P. M. Vijverberg (1987) A Test of Heterogeneity of Family and Hired Labor in Asian Agriculture, *Oxford Bulletin of Economics and Statistics* 49(3): 291–305.
- Food and Agriculture Organization of the United Nations (FAO) (2016) FAOSTAT. (http://www.fao.org/fao_stat/en/#data/FBS) [Accessed 24 July, 2018].
- Grimard, F. (2000) Rural Labor Markets, Household Composition, and Rainfall in Côte d'Ivoire, *Review of Development Economics* 4(1): 70–86.
- Jacoby, H. G. (1993) Shadow Wages and Peasant Family Labour Supply: An Econometric Application to the Peruvian Sierra, *The Review of Economic Studies* 60(4): 903–921.
- Le, K. T. (2009) Shadow Wages and Shadow Income in Farmers' Labor Supply Function, *American Journal of Agricultural Economics* 91(3): 685–696.
- Le, K. T. (2010) Separation Hypothesis Tests in the Agricultural Household Model, *American Journal of Agricultural Economics* 92(5): 1420–1431.
- Livelihoods and Food Security Trust Fund (LIFT) (2016) A Country on the Move: Domestic Migration in Two Regions of Myanmar. A Qualitative Social and Economic Monitoring (QSEM) Thematic Study. Myanmar: Livelihoods and Food Security Trust Fund. (<https://www.lift-fund.org/country-move-english-version>) [Accessed 11 April, 2017].
- Lopez, R. (1984) Estimating Labour Supply and Production Decisions of Self-Employed Farm Producers, *European Economic Review* 24(1): 61–82.
- Ministry of Agriculture, Livestock and Irrigation (MOALI) (2016) *Myanmar Agriculture at a Glance*, Nay Pyi Taw: Department of Planning, MOALI.
- Ministry of Commerce (2017) *Various Rice Reports*, Nay Pyi Taw: Department of Commerce and Consumer Affairs.
- Ministry of Economy, Trade and Industry (METI) (2015) *Myanmar Industrial Development Vision; Next Frontier in Asia: Factory, Farm, and Fashion*, Tokyo, Japan: Ministry of Economy, Trade and Industry.
- Muller, C. (2014) *A Test of Separability of Consumption and Production Decisions of Farm Households in Ethiopia (AMSE Working Papers No. 1418)*, Marseille, France: Aix-Marseille School of Economics.
- Skoufias, E. (1994) Using Shadow Wages to Estimate Labor Supply of Agriculture Households, *American Journal of Agricultural Economics* 76(2): 215–227.