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HOUSEHOLD COMPOSITION, LABOR MARKETS, AND LABOR DEMAND: TESTING FOR SEPARATION IN AGRICULTURAL HOUSEHOLD MODELS

BY DWAYNE BENJAMIN[1]

Complete and competitive markets imply a separation of the consumption (labor supply) and production (labor demand) decisions of the farm household. This paper tests for separation using the observation that in the absence of labor markets, household composition is an important determinant of farm labor use. The test has power when off-farm employment or hiring constraints, or differing efficiencies of family and hired labor lead to demographic variables affecting farm labor demand. An empirical model is developed to test the proposition that household labor demand (farm employment) is independent of family composition. The model is estimated on a household-farm data set from rural Java. Measurement error and endogeneity issues are addressed with instrumental variables techniques. I cannot reject the null hypothesis that farm labor allocation decisions are independent of household structure. The results are robust to different specifications of the labor demand function.

KEYWORDS: Agricultural household models, rural labor markets, labor demand.

1. INTRODUCTION

A CENTRAL QUESTION in development economics is whether agricultural households are price-taking participants in a clearing labor market. Though recent research has emphasized the role of market wages and prices in determining labor supply and demand, there remains a heritage of characterizing rural labor markets by underemployment in the presence of rigid wages.[2] Agricultural household models (AHM) incorporate a farmer's interaction with outside markets and are a source of testable implications regarding these interactions. The most important implication is that when markets are complete and efficient, market prices support a separation of household consumption and production decisions. This paper proposes a test of the labor market implications of the separation property. Following Card (1987), I will argue that the power of the neoclassical model lies in its distinction between supply and demand. Controlling for the wage, supply side variables should not influence labor demand and vice versa. Such exclusion restrictions contain economic content and provide a

[1] I am indebted to David Card and Angus Deaton for valuable suggestions and encouragement. Many useful discussions with Joshua Angrist, Paul Beaudry, John Capeci, Mark Gersovitz, and Thomas Lemieux are greatly appreciated. The paper has been substantially improved by comments from Michael Baker, Angelo Melino, an editor, and three anonymous referees, though remaining shortcomings and any errors are my responsibility. I also thank the Biro Pusat Statistik in Jakarta for use of the data. Financial support from the Industrial Relations Section, Princeton University, The Alfred P. Sloan Foundation, and the Institute for Policy Analysis, University of Toronto is gratefully acknowledged.

[2] Lewis (1958) represents the classic discussion of surplus labor and imperfect rural labor markets. For more recent discussions of the non-market-clearing view, see Stiglitz (1982), Bardhan (1984), Lluch (1985), Hart (1986), and Fields (1987). Bertrand and Squire (1980) and Binswanger and Rosenzweig (1984) present a variety of evidence in favor of the market clearing framework.

foundation for testing the validity of the supply and demand framework. My strategy is to derive plausible exclusion restrictions implied by the separation hypothesis, and then determine empirically whether these restrictions are satisfied for a sample of farm households from rural Java.

I test for evidence of nonmarket allocations of labor. In the extreme, when there is no labor market, a farm's labor input should depend on family composition. Chayanov (1926) observes:

> Since the labor family's basic stimulus to economic activity is the necessity to satisfy the demands of its consumers, and its work hands are the chief means for this, we ought first of all to expect the family's *volume of economic activity* to quantitatively correspond more or less to these basic elements in family composition (Chayanov (1926, p. 60, italics in original)).

Chayanov's research predates Sen's (1962) observation that with limited outside opportunities, large families apply more labor to a farm of given size than small families. Thus, imperfect labor markets and other violations of the separation assumptions imply that demographic variables will affect farm labor allocation. However, as "supply side" variables, measures of household composition should not influence labor demand: with separation, the number of workers in Baron Rothschild's vineyards should not depend on the number of daughters he has.

The development and refinement of this test, a discussion of its limitations, and its empirical implementation form the core of this paper. Section 2 begins with a review of the agricultural household model and demonstrates the separation result. While nonseparation can occur for many reasons, I focus on the nonseparation of labor supply and demand decisions. Market imperfections leading to hiring-in or off-farm employment constraints, or differing efficiencies of family and hired labor are commonly suggested sources of nonseparation. While other studies of nonseparation are rare (see Lopez (1986) and Pitt and Rosenzweig (1986), for example), the main contribution of this paper is its direct focus on the labor market as a source of nonseparation. The proposed test has power against several alternative hypotheses, and is particularly aimed at the hypothesis that farm households face off-farm employment constraints.

Section 3 evaluates the power of the test to detect violations of separation. The null hypothesis of the paper is that farm employment is determined according to the neoclassical labor demand model, while the alternative is that it is not, and that deviations from the usual first order condition are correlated with household composition. I develop the conditions under which unobservable labor market constraints and differing efficiencies of family and hired labor are reflected in observed farm labor allocations. Section 4 subjects the stylized model to the constraints of the data set. The sample of rice farmers is drawn from the 1980 Indonesian National Socioeconomic Survey (SUSENAS), restricted to the island of Java. While the farm employment data are unusually rich, I still have to make compromises in the transition from theoretical to measured variables. I detail these compromises, and clarify the interpretation of coefficients in the empirical model of farm employment. I also address the most contentious assumption of the paper: the exogeneity of household structure.

Endogeneity affects the interpretation of my results unless household structure is recursive to the labor demand function. However, I argue that the main concern with household composition is not economic, but statistical endogeneity. Omitted variables may be correlated both with measures of household structure and labor demand. Consequently, this source of misspecification draws further attention during estimation.

Section 5 catalogs the estimation results. With a few minor exceptions, the separation hypothesis is not rejected. The specification of the labor demand function is subjected to extensive testing. Concerns of functional form, aggregation, measurement error, and simultaneity are addressed with no substantive effects on the conclusions. Finally, to address the issue of differing efficiency of family and hired labor more directly, in Section 6 I devise and implement a different test of separation. This test reinforces my conclusions in Section 5: household structure may affect the composition of farm employment (family versus hired), but farm employment is determined according to neoclassical labor demand theory. Section 7 offers some conclusions.

2. AGRICULTURAL HOUSEHOLD MODELS

2.1. *The Separation Result*

Rather than present a general version of the model, I focus on the more stylized model which underlies the empirical work.[3] The first component is a twice differentiable, quasi-concave household utility function defined over consumption c, and leisure l: $u_h = u(c, l; a)$. The vector a parameterizes the utility function and summarizes household characteristics, such as the number of people in each age and sex category. In this paper, a is treated as exogenous. I address the implications of this assumption for the test later in the paper.[4] The second component is a twice differentiable, convex production function: $q = F(L; A)$, where labor L is the sum of family and hired labor, $L^F + L^H$, and land A is assumed fixed and exogenous. Other variable inputs are subsumed in the analysis.

The market is a critical part of the model. The prices of hired labor L^H and off-farm labor L^O are equal to w. The household has a time endowment $T(a)$ and exogenous income y. All prices are normalized by the output price. The farmer allocates his family's time between leisure, work on the farm, and work off the farm. He can also purchase labor to produce output that he sells in a

[3] See Lau, Lin, and Yotopolous (1978) for a more formal presentation of the AHM. Further early examples of agricultural household models can be found in Barnum and Squire (1979), Rosenzweig (1980), Strauss (1982). The volume by Singh, Squire, and Strauss (1986) provides several excellent examples of the diversity of problems that can be tackled in this framework.

[4] See Pollak and Wales (1979) and (1981) and Deaton and Muellbauer (1980) and (1986) for discussions of the issues involved in analyzing utility functions conditional on household structure. The operative word here is "conditional": there is no presumption of comparing utility levels of households with different demographic profiles except as regards their observable consumption behavior.

competitive market. The farmer's problem is:

$$\max u(c,l;a) \quad \text{w.r.t.} \quad c,l,L^O,L^H,L^F \quad \text{s.t.}$$
$$c=F(L;A)-wL^H+wL^O+y, \quad \text{and}$$
$$l+L^F+L^O=T(a), \quad \text{and} \quad L^F+L^H=L.$$

Rearranging the budget constraint yields:

$$c+wl=y+\rho(w;A)+wT(a)\equiv M. \tag{1}$$

Consumption of goods and leisure equals full income M that is composed of exogenous income, value of time endowment, and nonmaximized farm profits $\rho(w;A)=F(L;A)-wL^H-wL^F$. Treating M as fixed, the solution to this problem yields an indirect utility function, $u=\psi(M,w;a)$. By in turn maximizing M we obtain a new indirect utility function: $u=\psi(y+\pi(w;A)+wT(a),w;a)$, where π is the profit function. This illustrates the separation or recursion property: for utility maximization, profits are maximized independent of the utility function. The separation property provides a convenient representation of the dual nature of the farm household as both capitalist and worker. Household equilibrium is depicted in Figure 1. In this figure, $L^S>L^*$, so the farmer works off the farm and $L^O>0$. The crucial implication of separation for this paper is that the optimal amount of farm labor L^* depends only on the production technology and the wage. Household preferences do not influence L^*. The farmer is a land manager who has the option of hiring himself, his family, or outsiders to work his farm. Separation places no restriction on the mix of family and hired labor. The separation property has been exploited to allow separate estimation of consumer and producer sides of the model. Results, however, are sensitive to the violation of any of the above assumptions. Among leading candidates as violations are: (1) farmers have preferences for working on their farms, (2) family and hired labor are not perfect substitutes in production, and (3) some markets are incomplete. For example, if off-farm employment opportunities are limited, the farmer's on and off-farm labor decisions will not be separable.

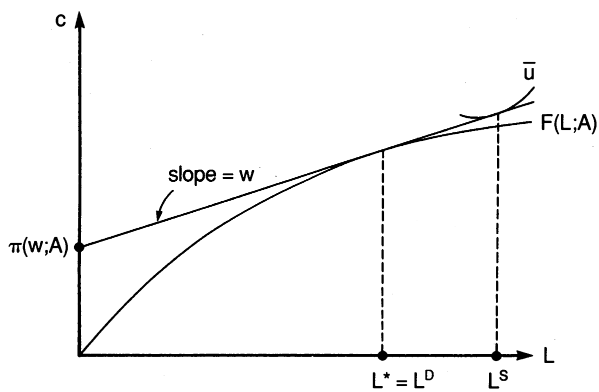

FIGURE 1.—Separation.

2.2. *Previous Studies of Nonseparation*

While commonly employed in the study of farmer behavior, it is rare that the separation hypothesis is tested. Yet, the role of demographic variables in nonseparating models has been recognized since the model was first developed. Chayanov emphasized the role of demographic composition as a determinant of the "subjective equilibrium" for peasant households where there was no labor market. For these households, the level of farm labor and farm output depends on family size. Nakajima (1968) introduced Chayanov's ideas to modern economics and formalized his ideas further. Sen (1966) outlines a similar model, and shows that certain preferences and technology can lead to a perverse situation where household labor supply and farm production are independent of household size, even in the absence of labor markets.

A recent empirical paper that examines household behavior in the absence of labor markets is Jacoby (1988). He estimates labor supply functions for Peruvian farm households. Estimated marginal products of labor on the farm (shadow wages) are the relevant decision variables for farm labor supply. Because the shadow wages are endogenous to the household's supply and demand for labor system, Jacoby employs such variables as village characteristics and household composition to instrument the marginal products. His paper shows that demographic variables play a vital role in the determination of household labor supply and farm output where labor markets are almost nonexistent.

Lopez (1984, 1986) provides the first explicit test of nonseparation. His test is motivated by commuting costs that drive a wedge between the returns to on and off-farm employment. Lopez uses standard nonnested hypothesis techniques to compare separating and nonseparating models. Essentially, he tests whether on-farm labor returns are significant determinants of consumption behavior. Since the model is estimated with Canadian census division level farm data, it is not clear how his results would generalize. More importantly, the testing procedure is sensitive to misspecification, whether statistical or of functional form, and it is difficult to interpret a rejection of separation. Though cast in a more restrictive framework, Arayama (1986) implements a separation test akin to that developed in this paper. Since individuals usually work 40 hours per week, Arayama suggests this is evidence of constraints on off-farm labor supply. Farmers could turn to their farms for extra work. Using district level Japanese data he tests for the effect of family size on the hours of family labor supplied to the farm. In a situation where hired labor is important to production, this is not a very revealing test. Those who own farms tend to work on their farms. This cannot be interpreted as a violation of separation, since the mix of family and hired labor is theoretically indeterminate. A more informative test is whether total labor use is influenced by household structure, not just family labor.

The study by Pitt and Rosenzweig (1986) is closely related to this study. In addition, the data employed in their paper are drawn from an earlier SUSENAS 1978 survey. Their paper explores the relationship between farmer health and farm profits. An important input in their framework is a test of separation: if labor can be hired as a substitute for family labor, then farm profits should be unaffected by farmer illness. In principle, this can be tested by determining whether farmer health affects farm profits. The authors find that while illness adversely affects farmer labor supply, farm profits remain unaffected. This test provides indirect evidence that the separation hypothesis is valid.

My paper extends and magnifies these previous studies through its explicit focus on farm labor allocation. Since I have data on actual labor used on the farm, both family and hired, I can implement a more direct test of separation. In addition, with farm level wage data, the role of prices can be more accurately determined than in the other studies. I will argue that the demographic variables provide an especially powerful means of identifying nonseparation. The test has power against an assortment of alternative hypotheses. For example, the Pitt and Rosenzweig test has power against the imperfect substitutability of family and hired labor. They were primarily looking for evidence that family labor could not be replaced by hired labor. The test in this paper has power against this alternative, as well as the opposite hypothesis that farmers are constrained in their off-farm opportunities.

3. HOUSEHOLD COMPOSITION AND LABOR DEMAND

In this paper, identification of nonseparation relies on the observation of a correlation between demographic composition and observed farm employment. The economic mechanism underlying this correlation is the convolution of household labor supply and demand. While nonseparation can result from any violation of the above assumptions, imperfect labor markets and differing efficiencies of family and hired labor have most often been suggested as alternative hypotheses. To evaluate evidence regarding separation, I must assess the power of the test in detecting these violations, especially with "real world" data. I consider three simple models. First, the "surplus labor" model is examined, where constraints on off-farm employment opportunities affect on-farm employment decisions. Second, a case where there are constraints on hiring-in is examined. Finally, I consider a more general model where the off-farm wage w_O differs from the hiring-in wage w_I. This model offers a means of interpreting differing efficiencies of family and hired labor.[5]

Case 1: *A Binding Constraint on Off-farm Employment*

Hart (1986) illustrates a common view of rural labor markets in her study of labor allocation in a Central Javanese rice village. Here, she argues that economic theory must explain why "despite some sensitivity to demand conditions, rural wages fail to adjust downward in the face of considerable involun-

[5] These alternative models are not mutually exclusive. For example, constraints could exist in the labor market while family and hired labor have differing efficiencies. Farmers might experience shortages during the peak season, and underemployment in a slack season. I have worked out the tedious details of combining these models in Benjamin (1989).

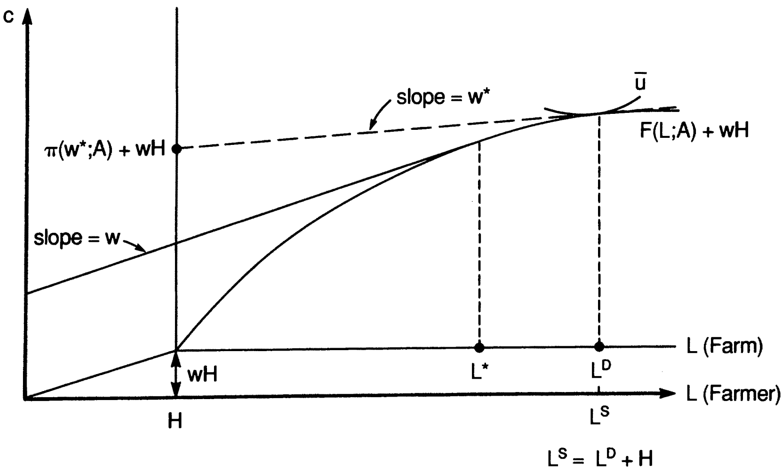

FIGURE 2.—Case 1 constraint H on off-farm labor supply.

tary unemployment."[6] Different reasons have been suggested for the failure of the labor market to clear, ranging from old-fashioned cultural norms to more modern efficiency wage stories. Yet it is rarely clear what rationing means, or what the rationing mechanism might be. In Hart's study, family or village ties, and land-holding status are suggested as possible rationing criteria. Instead of dismissing these possibilities as theoretically implausible, the purpose of my paper is to determine whether the separation property can be exploited to test for evidence of responses to these market constraints.

Consider the ration as represented by a maximum amount of hours H that a household may work off its own farm.[7] Denote household labor supply as $L^S(w, M; a) = T(a) - l(w, y + \pi + wT(a); a)$, where l is leisure demand. $L^* = L^*(w; A)$ is farm labor demand at the market wage. The ration binds when desired labor supply exceeds available off-farm opportunities plus on-farm labor demand *at the market wage*:

$$(2) \qquad L^S(w, M; a) > L^*(w; A) + H.$$

If so rationed, the family can turn to its own farm for further employment until it achieves household equilibrium. Figure 2 illustrates this equilibrium. If the ration does not bind, even with constraints in the external labor market, observed labor demand, L^D, will correspond to L^*. While we would expect less hired labor in this situation, we would not *observe* nonseparation. Under these circumstances, my test lacks power to detect the constraint.

When the ration binds, the amount of labor used depends on both preferences and technology. It is now optimal for the farmer to choose from labor L^D past the point where $F_1(L; A) = w$. The wage that would have induced the

[6] Gillian Hart (1986, page 170).
[7] More generally, H could be drawn from a distribution of labor market constraints, and these constraints could depend on household composition and other factors.

farmer to choose L^D is defined as the shadow wage w^*. Through analysis of the shadow wage and its relationship to L^S, L^*, and L^D we can determine how demographic variables influence the equilibrium choice of labor.

The farmer's budget constraint with the shadow wage is:

$$(3) \qquad c + w^* l = wH + y + \pi(w^*; A) + w^*(T(a) - H).$$

Household expenditure equals the sum of "conditional fixed income": $wH + y$, shadow profits: $\pi(w^*; A)$, and the value of the remaining time endowment: $T(a) - H$, all evaluated at w^*. M^* is full income evaluated at w^*. Neary and Roberts (1981) and Strauss (1986) present a general development of the comparative statics of the shadow wage. My discussion focuses on the particular effects of demographic variables on observed labor demand. The derivative of interest is dL^D/da:

$$(4) \qquad L^D = L^*(w^*; A) = -\frac{d\pi(w^*; A)}{dw^*} \Rightarrow \frac{dL^D}{da} = -\pi_{11}\frac{dw^*}{da}.$$

In a separating model, $w^* = w$, so $dw^*/da = 0$ and therefore $dL^D/da = 0$.[8] But here, labor demand responds to a change in the shadow wage, which in turn depends on demographic characteristics. Since $\pi(w^*; A)$ is convex, i.e., labor demand is nonincreasing in the wage, we have $-\pi_{11} < 0$. The remainder of dL^D/da depends on the term dw^*/da.

The shadow wage is implicitly defined by the household employment equilibrium:

$$(5) \qquad L^S(w^*, M^*; a) = L^*(w^*; A) + H.$$

Labor supply equals farm labor demand plus off-farm employment. In addition, the first order condition for profit maximization defines the shadow wage:

$$(6) \qquad F_1(L^S(w^*, M^*, a) - H; A) = w^*.$$

Implicit differentiation of this equilibrium condition, with occasional substitution, yields:

$$(7) \qquad \frac{dw^*}{da} = \frac{\dfrac{-dL^S}{da}}{\dfrac{dL^{SC}}{dw} - \dfrac{dL^*}{dw}}.$$

Since the compensated labor supply elasticity dL^{SC}/dw is positive, and the labor demand elasticity is negative, the denominator is unambiguously positive. The sign of the numerator depends on the *total* effect of a change of family structure on labor supply. This includes a change in M. The shadow wage falls if there is a net increase in available labor supply with a change in family

[8] The assumption of exogenous, fixed farm size implies $dA/da = 0$, which simplifies the comparative statics. This is appropriate for the empirical work since I condition on farm size. Later, I assess some of the consequences of this assumption.

structure. This will depend on how the demographic variables enter the utility function and time endowment.[9] For example, if an increase in family size increases labor power more than it raises demands on leisure time, the shadow wage will fall.

The preceding analysis expresses the observed effect of demographic variables on labor demand in terms of the underlying preferences and technology. While the total effect is indeterminate in general, we can say the following. Changes in demographic structure will influence labor demand unless: (i) the labor demand schedule is "flat," $-\pi_{11}=0$, or (ii) labor supply does not respond to demographic structure. It is also worth noting that both the available labor time and the "conditional fixed income" depend on H. Households with higher H *ceteris paribus* will have higher income and lower available time, so if leisure is normal we expect less "excess labor" to be applied to the farm. Clearly, the power of the test diminishes as H is higher.

In the above discussion I have ignored an additional source of correlation between demographic variables and labor demand. The ration H, and whether it binds, is treated as exogenous. However, differentiating the rationing condition with respect to a yields the condition that if $dL^S/da>0$, rationing is increasing in a. For example, larger households might be rationed more often. The model could be extended to allow the ration to depend on the age or gender composition of the household, with perhaps younger, more female households being rationed more often. The above analysis provides the basic apparatus by which the equilibrium of the farm household can be examined to determine how it responds to changes in demographic variables.

Case 2: *Rationing on the Labor Demand Side*

Although Case 1 may describe the slack season, most agriculture is also characterized by a peak season. During the peak season, wages may not rise sufficiently to clear the market, resulting in labor shortages. The farmer may have to depend on his family to meet demand. This alternative to separation implicitly underlies the test used by Pitt and Rosenzweig (1986). This notion of rationing can be formalized in a similar way to Case 1: a farmer is constrained on the demand side if at the prevailing market wage:

$$(8) \qquad L^*(w;A)>\bar{L}+L^S(w,M,a).$$

Labor demand exceeds available hired labor $\bar{L}$ plus family labor supply. Figure 3 illustrates this condition. Because the marginal product of labor exceeds the market wage, it will be optimal for the family to apply labor to its own farm until the shadow wage equilibrium is achieved:

$$(9) \qquad L^D=L^*(w^*;A)=L^S(w^*,M^*,a)+\bar{L}.$$

[9] See Pollak and Wales (1981) and Gorman (1976) for a discussion of models of demographic variables in demand analysis.

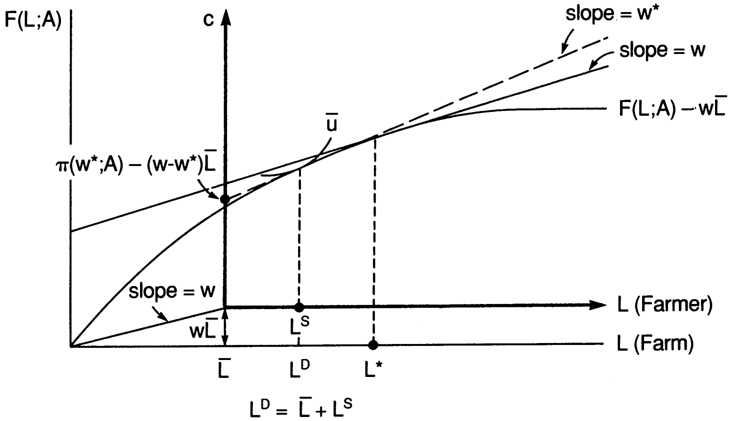

FIGURE 3.—Case 2 constraint $\bar{L}$ on hired labor.

Farmers will apply their labor to the farm until

$$(10) \qquad F_1\left(L^S(w^*, y + \pi(w^*; A) - (w - w^*)\bar{L} + w^* T(a), a) + \bar{L}; A\right) = w^*.$$

Similar differentiation to Case 1 will yield an identical expression for dw^*/da, and thus dL^D/da. Of course, the derivatives are evaluated at different points. However, the same conditions apply in determining whether an increase in family size leads to an increase in observed farm employment. In addition, the ration condition itself implies that large households may be less likely to be constrained as defined by (8).

Case 3: *Differing Returns to On and Off-farm Employment*

A more general approach to nonseparation is to consider hired and family labor as having different prices. Let w_O be the off-farm wage for family labor and w_I be the cost of hiring labor. While w_I and w_O might be market determined prices, they could represent the implicit wage of using labor of differing efficiencies. Let one hour of hired labor be perfectly substitutable but equal to α hours of family labor. Measured in family-labor equivalent efficiency hours: $L_f^e = L_F + \alpha L^H$. To hire one hour of family labor, $1/\alpha$ hours of outside labor must be hired. Therefore, one hour of hired "family labor" costs $w/\alpha \equiv w^h (\equiv w_I)$. Unless $\alpha = 1$, the two types of labor have different effective wage rates. If $\alpha > 1$, hired labor is more efficient and $w^h < w$ (or $w_I < w_O$). If $\alpha < 1$ the situation is reversed. Two subcases need to be examined, depending on the relative prices of the two types of labor.

Subcase 1: $w_O > w_I$. This yields a weaker form of separation. The budget constraint is

$$(11) \qquad c = w_O L^O + w_I L^F + F(L; A) - w_I L + y.$$

Holding labor supply constant, consumption and indirect utility are maximized by working off the farm at w_O, maximizing labor income. Profits are maximized

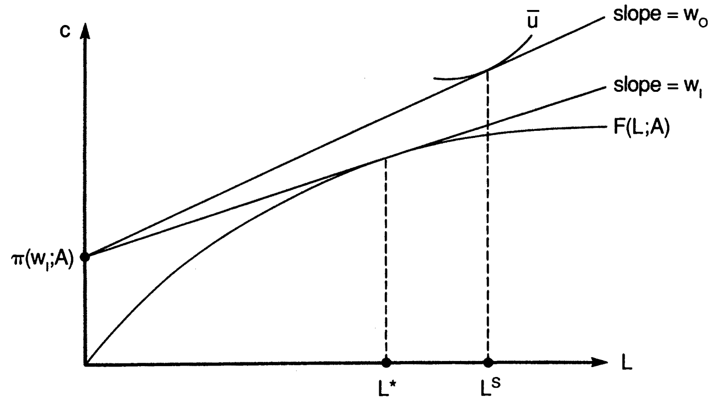

FIGURE 4.—Case 3 $w_O > w_I$.

by hiring labor until $F_1(L; A) = w_I$. Labor supply is given by $L^S(w_O, \pi(w_I; A) + y + w_O T(a); a)$, while labor demand is $L^D = L^*(w_I; A)$. Although there is no single hyperplane supporting the equilibrium, we do have independence of the production and consumption decisions. This case, shown in Figure 4, corresponds to a situation where the farmer has uniformly better off-farm opportunities. He does not provide any of the farm labor. Note that w_O need not refer explicitly to off-farm wage employment, but also may refer to other self-employment activities, including other farm activities. In Java, for example, it has been suggested that farmers have more lucrative activities than performing the tedious tasks that comprise rice labor. According to the efficiency interpretation, hired labor is more efficient (cheaper) so the farmer uses only hired labor.

Subcase 2: $w_I > w_O$. Hired labor may cost more than the farmer's own return to off-farm employment. If hired and family labor are perfect substitutes and the farmer does not dislike working on his farm, he will work on his farm, "saving himself some money." Figure 5 depicts this case, with the three potential equilibria. (a) With $w_O < w_I$, labor income (for given labor supply) is

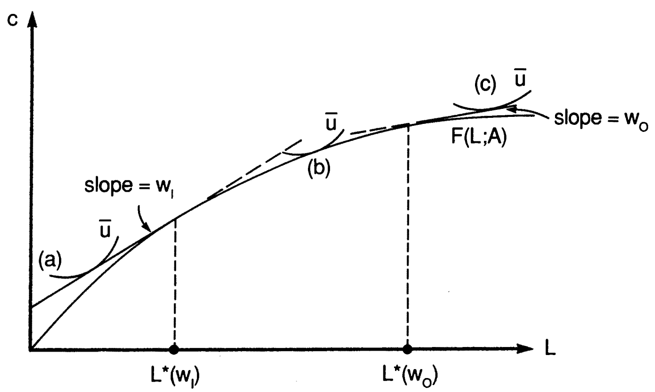

FIGURE 5.—Case 3 $w_I > w_O$.

maximized by working on the farm and supplanting the relatively expensive hired labor. Labor will never be hired beyond the point where $F_1(L; A) = w_I$. Alternatively, if family labor is more efficient, then the mix of hired and family labor (but not the total efficiency units) depends on household preferences. Total efficiency units of labor, L_f^e, are determined by the first order condition of the production decision: $F_1(L; A) = w^h$. In this case we might see a *negative* correlation between family size and observed labor. We can express L^D in terms of L_f^e and L^F:

$$\alpha L^D = L_f^e + (\alpha - 1) L^F,$$

$$L^D = (1/\alpha) L_f^e + \left(\frac{\alpha - 1}{\alpha}\right) L^F. \tag{13}$$

Hence,

$$\frac{dL^D}{da} = \frac{dL^D}{dL^F}\frac{dL^F}{da} = \left(\frac{\alpha - 1}{\alpha}\right)\frac{dL^S(w, M; a)}{da},$$

since L_f^e does not depend on a. If a represents household size, and if family labor supply is increasing in a, we would expect observed labor use to decline with family size. This occurs because there is a larger endowment of the more efficient labor. With family labor more efficient, the differing efficiency hypothesis yields the opposite prediction to the rationing alternative. (b) As long as $F_1(L; A) > w_O$, the farmer enjoys a higher return on his farm until the point where $F_1(L; A) = w_O$, where it is worth working off the farm as well. This regime depicts a common view of "underemployment" or surplus labor. Transport, transaction costs, or a lack of market opportunities embodied in low alternative wages, force farmers to work on their farms beyond the point where the marginal product of labor equals the hired labor wage rate. The comparative statics of this regime with respect to demographic variables mimic those of Case 1, with $H = 0$ at the wage rate w_I. Only here is there a clear lack of separation. (c) At high levels of family labor supply, the extra effort is directed off the farm instead of on the farm. In (c), the marginal product of labor is set equal to the farmer's alternative wage instead of the hired labor wage rate.

4. EMPIRICAL IMPLEMENTATION

4.1. *Description of Data*

The data set used in this study is a sample of 4117 households from rural Java drawn from the 1980 SUSENAS household survey. The data appendix describes details of data set construction. Clusters form the sampling frame and can loosely be interpreted as villages. The 858 clusters are drawn from 85 *kabupatens* (counties) of Java. Where possible, I exploit the spatial nature of the data. Table I outlines the economic activities of the households in my sample. The most important thing to note is that 62% of households have land, and 44% grow wet rice. So while rice farmers are a large fraction of the sample, the

TABLE I

HOUSEHOLD ECONOMIC ACTIVITIES

	Landed	Landless
1. Percentage of sample	62	38
2. Percentage of households that engage in: (based on previous year)		
Agriculture	100	0
Grow Rice	70.9	
Animal Husbandry	63	29
Fishing	5	4
Manufacturing	9	8
Transport	2	3
Services	2	3
Trade	14	22
Other	1	2
Wage Earnings	48	73
3. Percentage of households with: (based on previous week)		
Male member earning wage off-farm	24.4	57.1
Female member earning wage off-farm	13.1	39.6
Male member in off-farm agricultural employment	13.4	32.3
Female member in off-farm agricultural employment	9.5	31.3
Male member in off-farm nonagricultural employment	18.4	46.7
Female member in off-farm nonagricultural employment	15.9	26.4
Male member working on own "farm"	70.6	6.7
Female member working on own "farm"	48.3	3.4
Unemployed member	4.6	3.2
Underemployed (self-reported) member	11.0	16.9
4. Percentage of individuals: (based on previous week)		
Male Labor Force Participation Rate[a]	70.7	70.4
Female Labor Force Participation Rate	33.3	39.8
Percentage of Male Labor Force Earning Wage	23.7	69.4
Percentage of Female Labor Force Earning Wage	27.4	78.1
Unemployment Rate	3.2	2.5
"Underemployment Rate"	8.7	16.9

[a] Labor force rate is defined as the fraction of household members over 10 years of age in the labor force. The definition of the labor force follows Bertrand and Squire (1980): all adults over 10 years of age excluding those who worked less than 20 hours a week who do not want to work more, and those working without compensation for nonrelatives or members of other households.

power of my test to detect wider labor market imperfections will be restricted to observable effects on rice farmers. Table I emphasizes the diversity of household economic activity for both landless and landed households. 75% of landless households and 50% of landed households engage in wage labor at some point in the year. Small scale enterprises, as well as the rice farms, round out the economic portfolio of these households. Tables II and III, which describe details of labor input for rice farms, further show an active labor market. 95% of rice farmers hire some labor, though not for all tasks. The average level of labor input, at 221 person days per hectare, compares well with other sources.[10] Farmers engage in several activities, such as maintaining large vegetable gar-

[10] See *Women in Rice Farming* (1985) for several studies of farm labor allocation in Java. Barker et al. (1986) and Booth and Sundrum (1985) also provide corroborating evidence that compares favorably with the labor and land use data in the SUSENAS.

TABLE II

LABOR USE ON RICE FARMS

	Percent Use[a]	Person Days[b]	Percent Hire[c]	Average Hired Person Days[d]	Average Family Person Days	Labor Days per Hectare[e]	Average Daily Wage[f]
Labor Type:							
Plowing	49	4.1	37	3.1	1.0	8.5	900
Hoeing	99	20.6	73	13.6	7.0	46.6	475
Planting	99	20.9	86	18.1	2.9	43.0	270
Weeding	96	23.7	68	17.3	6.4	45.0	293
Harvesting	100	29.4	79	23.5	6.0	64.8	625
Other Labor	52	5.7	27	2.5	3.2	13.7	622
Total Labor	100	104.5	95	78.2	26.3	221.7	

[a] Percent Use is the percentage of farmers who report employing that type of labor.
[b] Person Days is the average annual person days of labor per farm for that task.
[c] Percent Hire is the percentage of farmers who hire some of their labor for that task.
[d] Average Hired/Family Person Days are average annual person days of each type of labor used.
[e] Labor per Hectare is the annual average person days of labor per hectare of rice land harvested.
[f] Average Wage is the average daily wage for that task (in Rp.).

TABLE III

CROSS TABULATION OF HIRING-IN AND "HIRING-OUT" FOR RICE FARMERS[a]

		Hired Labor[b]	No Hired Labor
Use family labor?	Yes	94.5	5.5
Wage employment last year?[c]	Yes	46.0	2.0
	No	48.5	3.5
Nonagricultural employment last year?[d]	Yes	82.3	4.9
	No	12.2	0.6
Work off-farm last week?[e]	Yes	39.8	1.9
	No	54.7	3.6

[a] Hiring out refers to participating in any identifiable nonfarm economic activities.
[b] Hired labor refers to whether any labor was hired for employment on the rice farm.
[c] Wage employment last year refers to whether the household received any wage income in the previous year (corresponds to Table I).
[d] Nonagricultural employment refers to whether the household received any income besides agricultural income (through activities in any of the other categories outlined in Table I).
[e] From the labor supply side of the survey, whether or not any member of the household engaged in off-farm employment activities in the previous week.

dens, fish ponds, livestock, and other agricultural and nonagricultural enterprises. Therefore, I am not testing for separation of the household from its entire economic activities, only the rice enterprise. Again, the test has power if it is this type of labor that provides the source of additional employment for constrained farmers.

These simple tables of means provide no *prima facie* case against separation: there is an active labor market where households engage in both the hiring and selling of labor. Nor is this evidence in favor of separation. Abey, Booth, et al. (1981), Lluch and Mazumdar (1985), and Hart (1986) assert that slack season conditions and underemployment are the predominant features of rural labor markets. We cannot yet discern whether farmers turn to their farms for extra employment, or whether separation is violated more subtly by differing efficiencies of hired and family labor.

4.2. *Empirical Specification of Labor Demand*

The theory outlined above suggests the following empirical strategy. Under the null hypothesis of separation, farmers choose L to set $F_1(L; A) = w$. The alternative hypothesis is that they deviate from this rule, and that this deviation is correlated with family structure. In other words, they use another rule to determine L, acting as if they set $F_1(L; A) = w^*$, where w^* is a function of household composition. The simple theory and the more complicated data must now be brought together. First, I develop a stylized empirical model that closely matches the theoretical model above. This model adequately describes labor allocation decisions. Subsequently, I relax some of the simplifying assumptions to determine the robustness of the results.

L^D, total farm employment, is the variable to be explained. This would ideally correspond to total person-days of labor used on each farm. However, two types of labor are excluded from this aggregate. First, harvest labor is excluded since it is rarely traded on a spot market at a fixed wage.[11] Second, I exclude plowing labor because it is a convolution of labor and draft-animal or tractor services (notice the high wage rate). The SUSENAS data regarding draft animals and tractor services are poor, so the simplest solution to modelling this small category of labor is to exclude it.[12] What remains is an aggregate of planting and weeding labor, predominantly performed by females, hoeing labor primarily performed by males, and "other" labor. Aggregation raises the question of the appropriate price or wage. While it is not fully appropriate to use one wage as the price of this aggregate, I chose the planting wage as the measure of the cost of labor. This choice yields the largest sample of wage observations and represents the actual wage of a large fraction of the labor employed. To assess the biases induced by this choice, I separately model the allocation of male and female labor in a subsequent section. Note also that an incomplete sample arises from the choice of any wage.[13] While it is impossible to estimate a wage elasticity for those farmers with incomplete wage observations, the independence of labor allocation from household structure remains testable.

My measure of L^D masks another type of employment variation. Agriculture is characterized by peak and off-peak seasons, both within and between growing

[11] The allocation and compensation of harvest labor, often performed on a share basis, is itself an interesting question. See Case (1988) for a discussion of some of the issues involved.

[12] It should be noted that the exclusion of harvest labor and/or plowing labor does not affect the results or conclusions of this study, but rather makes the empirical model more closely resemble the stylized theoretical model. See Benjamin (1989) for results including plowing labor, for example.

[13] Indeed, I cannot estimate a labor demand regression for farmers who do not report either a wage or labor use. Of the 1681 farmers in the sample, 6 do not report any nonharvest labor use. A further 92 do not report using hired labor: these may be the rationed farmers. In addition, 146 farmers did not hire planting labor, leaving a total of 1443 farmers with a complete set of labor and wage observations.

periods. It may be the case that farmers experience different regimes over the year. Any regime that predicts no hired labor can be ruled out as holding year round since most farmers hire some labor. Unfortunately, we only observe total labor use over the growing period, not by peak and off-peak seasons. Labor demand over the year will be the sum of labor demand during "separating" days S, and "nonseparating" days S':

$$L^D(w_I, w_O, A, a) = \sum_{j \in S} L_j^*(w_I; A) + \sum_{j \in S'} L_j^D(w_I, w_O, A, a). \tag{14}$$

Days in S' correspond to any form of nonseparation described in the previous sections. The relative size of S and S' will affect whether I detect nonseparation. Hart (1986) and Lluch and Mazumdar (1985) suggest that the peak season in Java may last as little as an hour, the rest of the growing season being characterized by underemployment. Of course, even the peak season could be characterized by labor shortages if the wage does not adjust. To some degree, each type of labor reflects a different level of peakedness. The subsequent male-female disaggregation should capture some elements of the peakedness of labor demand. In addition, one peak activity is harvesting, and this is excluded from my study.

Another component of seasonality is hidden by my aggregation. Depending on factors such as the availability of irrigation, the fortunes of location, or the variety of rice grown, some farmers can grow in either or both of the rainy or dry season. This raises questions, not so much related to peak versus off-peak, but whether there are systematic differences in the labor markets where seasonal cropping patterns differ. The implications of multiple cropping for the test of separation are examined in a later section.

With nonseparation, total labor demand will depend on w_I, w_O, household structure, and land. Lacking measures of w_O, the farmer's off-farm alternative wage, I rely on the demographic variables to identify nonseparation. The effect of demographic variables on observed labor demand is

$$\frac{\partial L^D}{\partial a} = 0 + \sum_{j \in S'} \frac{\partial L_j^D}{\partial a} \tag{15}$$

conditional on S'. The power of the test depends on the size of S' and on the determinants of $\partial L_j^D / \partial a$ as discussed in Section 4. It must be reiterated that I am testing whether the farm can be analyzed without reference to the household variables, as opposed to the stricter definition of separation that requires that a single hyperplane (the market wage) support the preferences and technology equilibrium. I think this is a more realistic and interesting test since it is less vulnerable to slight empirical misspecification and robust to other less precise forms of nonseparation. For the labor demand function, I employ a log-linear restricted demand function:

$$\log L = \alpha + \beta \log w^* + \gamma \log A. \tag{16}$$

The land input is treated as fixed in the short run, though I allow for limited endogeneity of the land input in a subsequent section.[14] β is the short run wage elasticity, while γ is the scale elasticity. Although this is a restrictive functional form, corresponding to a Cobb-Douglas production function, it has the merit of being simple to estimate. Rather than employ this limited interpretation, I view this as estimating the average elasticity of labor demand with respect to different variables. As will be seen when I use a more flexible functional form, this interpretation is appropriate. In a subsequent section I augment this specification to allow for other input prices or factors that may shift the labor demand function.

For the shadow wage, let $w^* = m(a) \cdot w$.[15] This allows a flexible response of the shadow wage to demographic structure, and resembles the scaling model discussed in Pollak and Wales (1981). I would like to choose a functional form for $m(a)$ such that $m(a) = 1$ if there are no demographic effects. Let

$$(17) \qquad m(a) = 1 + \sum_{i=1}^{G} \delta_i a_i = 1 + \delta(a)$$

where the a_i are measures of demographic composition and G is the number of demographic variables. Combining w with the log L^* specification yields

$$(18) \qquad \log L = \alpha + \beta \log m(a) + \beta \log w + \gamma \log A.$$

As long as $\delta(a)$ is small (which it is under the null), then $\log m(a) = \log(1 + \delta(a)) \approx \delta(a)$. The expression simplifies to

$$(19) \qquad \log L \simeq \alpha + \beta \log w + \gamma \log A + \beta \sum_{i=1}^{G} \delta_i a_i.$$

I wish to test whether $\delta(a) = 0$. This leads to an intuitively appealing regression. Consider the simple function $\delta(a) = \delta N_w$ where N_w is the number of workers in the family. Then $d \log L^D / dN_w = \beta\delta$. With $\delta > 0$ and $\beta < 0$, the derivative is negative. If the shadow wage rises with the number of workers (efficiency effect), then observed labor use declines. Alternatively, if $\delta < 0$, farms with more workers will use more labor. This corresponds to the usual surplus labor view.

Several specifications of $\delta(a)$ were estimated without affecting the conclusions. One representative and appealing functional form for $\delta(a)$ is

$$(20) \qquad \delta(a) = \delta_0 \log n + \sum_{i=1}^{D-1} \delta_i \frac{n_i}{n},$$

[14] This is not unreasonable for the case of Java. As shown in Benjamin (1989) most farms (90% in SUSENAS) are owner operated, as opposed to leased or sharecropped, and land sales are rare. Further, Chapter 2 of Benjamin (1989) explores the consequences of relaxing this assumption.

[15] In order to precisely estimate a shadow wage function, it would be appropriate to include land as an argument in w^*. However, as the object of this paper is to test for separation, rather than estimate w^* per se, it is sufficient to rely on the demographic variables to identify nonseparation subject to the caveats above. As it turns out, allowing for more complicated interactions of demographic variables and land does not affect my empirical conclusions.

where n_i is the number of members in each of D demographic categories: males and females, both prime-age and over 55. The coefficient on $\log n$ can be directly interpreted as the elasticity of labor demand with respect to family size. For elasticities with respect to specific types of household members, the formula in terms of the underlying parameters is given by

$$(21) \qquad \eta_{L,n_i} = \frac{n_i}{n}\left[\delta_0 + (1-\Delta_i)\delta_i - \sum_{j=1}^{D-1}\delta_j\frac{n_j}{n}\right]\beta,$$

where $\Delta = 1$ if $i = D$ and 0 otherwise. The omitted category D is household members less than 15 years old.

4.3. *Effects of Endogenous Household Structure*

Since this test of separation hinges on the interpretation of the effect of demographic variables on labor demand, it is important to consider the consequences of endogenous household structure on the validity of the test. Endogenous household structure, whereby family composition is modeled as a choice variable, diminishes the validity of the comparative statics presented in the theoretical section. However, the basic intuition of the separation result remains: household size and composition should not affect farm level activities such as labor allocation, unless there is a violation of the assumptions underlying the separation hypothesis. Furthermore, the power of the test still depends on whether the labor demand schedule slopes downward, and whether household labor supply increases with family size. For my purposes, I am more concerned with the statistical than the theoretical consequences of endogenous household structure.

Consider the following simple statistical model:

$$(22) \qquad \begin{aligned} \log L &= \alpha_1 + \gamma_1 \log A + \beta_1 \log w + \delta \log n + \varepsilon_1, \\ \log n &= \alpha_2 + \gamma_2 \log A + \beta_2 \log w + \theta \log L + \varepsilon_2. \end{aligned}$$

I wish to test whether $\delta = 0$ as implied by separation. In this model, household size is "endogenous" since it is determined within the larger system: there is no presumption that household structure is purely randomly allocated across households. Indeed, it is likely that economic variables such as area harvested affect household size. For example, larger farms generate more income to support larger families. However, in this model "endogenous" family size is only a problem for the separation test if (1) $\theta \neq 0$, i.e., labor use determines household size, or (2) $\mathrm{Cov}(\varepsilon_1, \varepsilon_2) \neq 0$. Regarding (1), if households grew larger to meet labor demand in peak periods, or shrank with insufficient labor demand, we would find a relationship between household size and labor demand. This resembles the usual simultaneity bias problem and would bias δ

upwards, leading to a rejection of separation. While rejection would not necessarily be consistent with surplus labor, it would correctly suggest a form of nonseparation: farm production and household formation decisions would not be separable. In addition, this nonseparation could be driven by labor market imperfections.

As a statistical problem, endogeneity refers to more than the potential choice-based nature of household size. It is $\mathrm{Cov}(\varepsilon_1, \varepsilon_2) \neq 0$ that poses the most serious difficulties for the separation test. For example, there are potentially serious measurement issues that could bias the demographic coefficients toward zero. First, the household survey is conducted in February, a slack period in rural Java. Reported household size may have changed since the growing season. If this is the case, or if there is simple measurement error of family composition, these coefficients would be biased toward zero. Second, family labor input may be measured with a different error than hired labor. This could bias the demographic effects through the correlation between family labor and household structure. Finally, there might be omitted variable bias. The test relies on the correlation of demographic variables with the unobserved shadow wage. Household size may be correlated with other unobserved and omitted variables, such as land quality, that affect labor demand. If true, there is no guarantee that rejection or acceptance of the null hypotheses can be interpreted as I would like. The impurity of the error term is a hazard of doing *any* empirical work, since nature rarely conducts controlled experiments. Unfortunately, there does not exist a convincing set of instruments with which to control for the potential endogeneity of household structure. However, several steps are taken to minimize the possibility that my conclusions are the result of endogenous family size. Cluster fixed-effects regressions, as well as direct measures of kabupaten soil quality, help eliminate some heterogeneity that might lead to correlation between demographic structure and labor demand. I also employ different measures of family size to establish the robustness of my empirical results. Finally, I control for aspects of the farm household, like age and education of the household head, that legitimately may belong in the labor demand equation. Ultimately, for the purposes of this paper, I maintain that the demographic variables are relatively exogenous to the labor demand equation, and that conditional on production side variables, household structure should not influence total farm labor demand if the separation hypothesis is valid.

5. RESULTS

Table IV presents the estimation results for various specifications. The results are generally encouraging for the separation hypothesis.[16]

[16] The standard errors presented have not been corrected for arbitrary conditional heteroskedasticity. Estimates of the White corrected standard errors are presented in the working paper version of the paper and are virtually identical to the OLS estimates.

TABLE IV

DEMAND FOR PRE-HARVEST LABOR
Dependent Variable: Log person days employed[a]
(Standard Errors in Parentheses)
(p values for F tests)

	Parsimonious OLS	Full OLS	Excluding Children[b] OLS	Within Cluster[c]	2SLS[d] (meas. error)	2SLS[e] (simultaneity)	2SLS[f] (simultaneity and log h)	Means
Intercept	4.780	2.085	2.255		2.343	2.657	2.623	
	(0.119)	(0.533)	(0.532)		(0.543)	(0.682)	(0.663)	
Log area harvested	0.680	0.680	0.682	0.696	0.686	0.757	0.742	−0.823
	(0.018)	(0.017)	(0.017)	(0.018)	(0.018)	(0.036)	(0.038)	
Log wage	−0.296	−0.274	−0.274		−0.315	−0.939	−0.894	0.912
	(0.027)	(0.026)	(0.026)		(0.040)	(0.252)	(0.231)	
Log pesticide price		0.139	0.139	−0.058	0.149	0.157	0.155	2.663
		(0.042)	(0.042)	(0.062)	(0.043)	(0.051)	(0.050)	
Log fertilizer price		0.407	0.409	0.401	0.367	0.409	0.405	4.301
		(0.111)	(0.111)	(0.107)	(0.117)	(0.135)	(0.132)	
Not irrigated		−0.147	−0.147	0.070	−0.172	−0.156	−0.157	0.385
		(0.034)	(0.034)	(0.053)	(0.035)	(0.042)	(0.041)	
Log household size	0.043	0.078	0.068	0.052	0.097	0.032	0.039	1.471
	(0.045)	(0.046)	(0.044)	(0.045)	(0.049)	(0.059)	(0.057)	
Prime male fraction	−0.058	0.079	−0.075	0.127	0.094	0.015	0.023	0.256
	(0.108)	(0.105)	(0.127)	(0.100)	(0.109)	(0.130)	(0.127)	
Prime female fraction	−0.163	0.019	−0.133	0.106	0.067	0.004	0.004	0.272
	(0.128)	(0.128)	(0.109)	(0.116)	(0.131)	(0.156)	(0.152)	
Eld. male fraction	0.043	0.279	0.129	0.194	0.280	0.208	0.220	0.055
	(0.145)	(0.187)	(0.167)	(0.171)	(0.198)	(0.230)	(0.224)	
Eld. female fraction	−0.076	0.166		0.085	0.129	0.051	0.053	0.051
	(0.151)	(0.163)		(0.150)	(0.173)	(0.203)	(0.198)	
Age of head		0.013	0.014	0.009	0.010	0.012	0.012	45.588
		(0.007)	(0.007)	(0.006)	(0.007)	(0.009)	(0.009)	
Age squared		−0.00015	−0.00010	−0.0001	−0.0001	−0.0001	−0.0001	2241.534
		(0.00008)	(0.00007)	(0.00007)	(0.00008)	(0.00009)	(0.00009)	
F Education[g] of head		2.91	3.06	1.83	2.95	1.38	1.45	
		(0.008)	(0.006)	(0.089)	(0.007)	(0.22)	(0.189)	
F Kabupaten soil[h]		7.92	7.95		8.69	6.76	7.06	
		(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)	
F Kabupaten climate[i]		13.05	13.34		7.23	3.56	3.86	
		(0.0001)	(0.0001)		(0.0001)	(0.014)	(0.009)	
Sugar regency[j]		0.135	.135		0.115	0.110	0.111	0.447
		(0.033)	(0.033)		(0.035)	(0.041)	(0.040)	
F Dems[k]	1.19	1.03	1.55	0.53	1.03	0.237	0.279	
	(0.311)	(0.399)	(0.18)	(0.756)	(0.396)	(0.948)	(0.924)	
R-Squared	0.525	0.591	.591	0.872	0.6017	0.473	0.408	
Wu-Hausman[l]					3.67	7.05	7.75	
Overid.[m]						0.722	0.865	
Sample size	1443	1443	1443	1675	1271	1443	1443	1443

[a] Dependent variable is log of preharvest labor, mean = 3.95 (0.02).
[b] Children under 15 years old excluded from measure of household size. Elderly females fraction is the excluded category.
[c] Deviations from cluster means estimates.
[d] 2SLS estimates: average of other observations of cluster wage as instrument for wage.
[e] 2SLS estimates: Kabupaten rural population density and City in Kabupaten as instruments for wage (overidentified by 1).
[f] 2SLS estimates: same as above, only additionally instrument (logs) area harvested by land operated and sawah operated (overidentified by 2).
[g] F test for joint significance of education indicator variables: $F(6, n)$.
[h] F test for joint significance of Kabupaten soil classification variables: $F(5, n)$.
[i] F test for joint significance of Kabupaten climate classification variables: $F(3, n)$.
[j] Indicator for whether Kabupaten was a sugar regency.
[k] F test for joint significance of demographic variables: $F(5, n)$.
[l] Wu-Hausman test for bias of the OLS specification, given consistency of the 2SLS specification. $\chi^2(1)$ for first two specs., $\chi^2(2)$ for the third.
[m] Overidentification test for the exclusion of the instruments. Distributed $\chi^2(d)$ under the null, where d is the order of overidentification.

TABLE V
IMPLIED DEMOGRAPHIC ELASTICITIES FROM TABLE IV
(Standard Errors in Parentheses)

Specification:	Elasticity of Labor Demand with respect to additional Household Members: (1)	(2)	(3)	(4)	(5)	(6)	(7)
Type of member:							
Prime age male	0.012	0.028	0.010	0.027	0.032	0.007	0.010
	(0.024)	(0.025)	(0.018)	(0.024)	(0.026)	(0.031)	(0.030)
Prime age female	−0.016	0.013	−0.004	0.022	0.027	0.005	0.006
	(0.025)	(0.027)	(0.019)	(0.025)	(0.028)	(0.003)	(0.032)
Elderly male	0.008	0.017	0.013	0.010	0.017	0.012	0.013
	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)	(0.006)	(0.007)
Elderly female	0.001	0.010	0.006	0.003	0.008	0.003	0.004
	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.006)	(0.006)
Child (< 15 yrs)	0.038	0.011		−0.007	0.012	0.005	0.006
	(0.018)	(0.017)		(0.016)	(0.018)	(0.020)	(0.021)

Specifications: (1) Parsimonious OLS. (2) OLS with full set of control variables. (3) OLS with full set of control variables, but children under 15 yrs. excluded from household size. (4) Within cluster estimation. (5) 2SLS for correction of measurement error of wage. (6) 2SLS for correction for potential simultaneity of wage. (7) 2SLS for correction for potential simultaneity of wage and adjustment of area harvested.

Parsimonious OLS

Column 1 shows the simple OLS specification that corresponds to equation 19. There is a well determined negative wage elasticity of -0.3. Each demographic coefficient is insignificant and the joint F test for the inclusion of the demographic variables shows that they can be excluded from the regression. The implied elasticities of labor demand with respect to particular types of household members are presented in Table V. These elasticities are small and generally statistically insignificant. For prime age males or females, an elasticity of 0.01 implies that adding such a person to the household increases annual labor demand by 0.8%, or about half a day at the mean. Given that prime age males and females supply nearly 275 person days of labor per year to all activities, this is a small effect. Alternatively, using the wage elasticity of -0.3, adding a prime age male is equivalent to reducing the wage by 2.5%.[17]

With a t statistic of 2.5 (insignificant using the Schwarz criterion),[18] the most significant effect on labor demand is the presence of children under 15. Adding a child to a household increases labor use by 1.5 days. This is also a small effect. Still, it is not unreasonable to suppose that the child labor market might be less developed than the adult market. The separation hypotheses would not hold then. However, given the small size of these effects, I do not think there is sufficient evidence to abandon the separation hypothesis. It would be an

[17] This is small magnitude (2.5%), especially given that the standard deviation of $\log w$ is 0.61 and the mean 0.91.

[18] In an attempt to control for sample size in choosing a critical value, I commonly employ the Schwarz criterion (Schwarz (1978)). In this case, the critical value for a $\chi^2(q)$ test is q times log(sample size). With a sample size of 1443, log(sample size) = 7.27 and the implied critical t statistic is 2.7. The reader may choose his/her own critical value if he/she prefers.

overstatement to claim that labor demand schedules were misspecified lacking controls for family size.

Full Specification OLS

Even with a limited data set, accounting for all the factors that influence farm labor allocation would fill many pages. However, a richer specification of labor demand has the benefit of controlling for additional heterogeneity that could bias my conclusions, besides providing intrinsic insight into farm labor demand. Column 2 shows the results for the base regression for the specifications that follow.[19] The inclusion of the extra variables does not alter conclusions regarding the demographic and wage effects. The new regression includes controls for whether the farm is *not* irrigated (as opposed to partial or full irrigation). Nonirrigated farms use significantly less labor, even controlling for area harvested. Fertilizer and pesticide prices also have a significant effect on labor demand, suggesting that labor is a substitute for these inputs.[20]

Even with separation, not all household characteristics should be excluded from the labor demand function. Measures of farmer human capital probably affect farm management. These measures may be correlated with family structure, their omission biasing my conclusions. I therefore include controls for the age and education of the household head. I only report the F statistic for the joint test of significance of the education effects, but the underlying coefficients suggest that labor use increases with the level of education. The coefficients are jointly significant. Without further theory and more directed empirical study, interpretation of this effect is pure conjecture. It is important to note that the strongest effects apply only to the 4% of rice farmers with more than elementary school. Only one coefficient is individually significant. The age profile shows rising labor use with age, but neither of the age coefficients is significant.

Finally, as a crude control for unobserved land quality, particularly for the 2SLS specifications that follow, I include indicators of kabupaten soil and climate type. I also include an indicator of whether the kabupaten was a sugar regency, an indirect indicator of the level of agricultural infrastructure according to Geertz (1963). While the variables themselves are significant, their inclusion does not affect the demographic coefficients.

Regarding the demographic variables themselves, the F test shows they are jointly insignificant and none of the individual coefficients is significant. The only change from the simpler specification is that instead of children having the most significant elasticity, it is elderly males that have the largest elasticity. The elasticity for elderly males (over 55 years old) corresponds to an additional 3.5 days per year for an additional person. Again, this is not a large effect, but it is conceivable that markets for the older laborers may be less efficient.

[19] Regressions with simple controls for whether the farmer used high yielding varieties of rice were also estimated with no effect on the conclusions.

[20] Farmers that do not report the use of fertilizer or pesticide are imputed the geographically nearest price for the input.

OLS Excluding Children

Unobserved characteristics of the farm, such as land quality, that are correlated with farm income and labor demand, may lead to a spurious correlation between family composition and labor demand. One simple way to allow for this possibility is to exclude children from the definition of the household and include only potential workers. Column 3 of Table IV shows results of this specification. The conclusions are almost identical, but the implied demographic elasticities are slightly smaller, suggesting that there may have been a small amount of heterogeneity. Since it makes little difference, all members will be included in measures of household composition for the remainder of the paper. This increases the power of the test.

Within-Cluster

Column 4 presents results of within-cluster estimation that removes cluster fixed-effects. This meets two objectives. First, it allows estimation over all farms, including those who hired no labor and lack a wage variable.[21] Second, it removes cluster level heterogeneity that may be correlated with household size. With the more inclusive sample, the demographic variables still do not influence farm labor allocation. Further, the demographic elasticities change little from the previous specifications.

Interaction of Demographic Variables with Farm Size

Pooling results for large and small farms might bias the results toward separation. Smaller farmers may be more affected by off-farm employment constraints. I estimated the model (results not shown) with interaction terms between log area harvested and the demographic variables. The original demographic variables remain statistically insignificant ($F(5,1443) = 1.06$), the interaction terms are jointly insignificant ($F(5,1443) = 1.06$), and together they are insignificant ($F(10,1443) = 1.04$). While none of the individual coefficients are significant at even the 5% level, the interaction effects are positive, suggesting that it is the larger farms where larger households use more labor. This would be consistent with the hypothesis that farmers are constrained on the demand side, possibly depending on family labor during the peak season.

Assessing the Wage Elasticity

At -0.3 the OLS estimate of the wage elasticity resembles other estimates of labor demand elasticities.[22] If we interpret the regression literally as a Cobb-Douglas demand function, the elasticity should be greater than -1.0. The low

[21] The sample size rises from 1443 to 1681 when the farms that lack a wage measure, or who hired no labor, are included.

[22] See Binswanger and Rosenzweig (1984) for other estimates of labor demand elasticities.

elasticity could be consistent with a different technology, such as CES with an elasticity of substitution less than one. Alternatively, there may be statistical problems that bias the coefficient toward zero.

Functional Form:

To determine whether the low elasticity is an artifact of my simple functional form, I estimated the demand function using a translog functional form. This meant including interaction and squared terms for the wage, area harvested, input prices, and irrigation variables. The results (not shown) support the simpler specification. The only second-order effect that is significant is the interaction term between irrigation and the pesticide price. The second order wage and land terms are jointly insignificant ($F(5,1443)=2.01$ and $F(5,1443)=1.74$). The implied wage elasticities, calculated for each farm, had a mean and median equal to -0.27. This is the same as the OLS estimates reported for the log-linear model. The 10th and 90th percentile elasticities were -0.18 and -0.36. Therefore, the log-linear model accurately represents the "average" wage elasticity of the farms in this sample. Finally, to make the shadow wage and demographic variables more flexible, I interacted the wage with the demographic variables. These terms were jointly insignificant ($F(5,1443)=0.57$).

Aggregation of Male and Female Labor:

To determine the potential bias on the wage elasticity treating the planting wage as the "price" of labor, I examined male and female labor separately. This approach also captures some within-growing season variation of labor demand. The tasks that so far have comprised labor are hoeing, weeding, planting, and other labor. The SUSENAS survey does not distinguish between male and female labor, but weeding and planting are generally regarded as female tasks, while hoeing is predominantly male. Since the weeding and planting wages are almost identical, I treat the planting wage as the "female" wage and the hoeing wage as the "male" wage. A system of labor demand equations was estimated for the two types of labor (results not shown).

The most striking features of these equations are the strong own-price elasticities and zero cross-price effects. The cross-price effects were individually and jointly insignificant with $F(2,1146)=0.93$.[23] The elasticities for each type of labor determine the elasticity for aggregate (total) labor. If cross effects are zero, the total effect of increasing each wage is given by summing the elasticities of aggregate (total) labor with respect to each wage: $-0.23 + -0.07 = -0.30$, where -0.23 is the female and -0.07 is the male wage elasticity for aggregate labor. If the log-linear specification is correct and there are no cross-price effects, the same total elasticity can be calculated from the individual equations.

[23] The sample size is reduced to 1146 from 1443 since I have to take the intersection of the sample of farmers who use both male and female labor, and report a wage for both types.

The total effect is $S_M \eta_M + S_F \eta_F$, where S_M, S_F are the quantity shares of male and female labor, and the η_i are the own wage elasticities. The implied total effect from the separate equations is $0.32 \times -0.28 + 0.68 \times -0.36 = -0.33$. This is extremely close to, and statistically insignificantly different from, the estimated effect from the aggregated equation ($F(1,1146) = 2.15$), and provides strong support for aggregating male and female labor.

If the two wages were perfectly correlated, the total effect also could be estimated by regressing labor on the planting wage alone (according to the Composite Commodity Theorem). To the degree they are not, we will get reverse omitted variables bias.[24] Since the wages are highly correlated, we get an estimated effect of -0.28 in the specifications using only the planting wage. The total wage effect is underestimated by 6% (-0.28 vs. -0.30). Because my interest is in the total effect, and other statistical concerns turn out to be greater, I continue using the planting wage alone. Aggregation also hides very little in the way of demographic effects. The demographic variables are individually and jointly insignificant for both male and female labor.

Measurement Error:

Because I calculate the wage by dividing the wage bill by the number of days of labor, there may be measurement error. The measurement error may result in attenuation bias, or alternatively, there may be division bias that imparts a spurious negative correlation between labor demand and the wage.[25] Measurements of w from neighboring farms should have the property that they are correlated with the farmer's wage but not with farm specific measurement error. Accordingly, I estimate the model by instrumental variables where the cluster average of other observations of w are instruments. Estimation is limited to clusters where there are at least two rice farmers reporting planting wages. The fifth column of Table IV shows that there is some evidence of attenuation bias caused by mismeasured wages. The Wu-Hausman test indicates that this bias is not significant at the 5% level. As well, the coefficients on the demographic variables are similar to the OLS specification.

Simultaneity Bias:

A potentially more serious problem may arise from simultaneity or omitted variables bias. Even with perfectly measured wages, we cannot confidently view the data as generated by an experiment by which farmers respond to wages sprinkled randomly from heaven. The data are more likely generated by the shifting of both labor supply and demand curves (not just shifting supply curves). An omitted variable such as local farm productivity might be correlated with the

[24] In this case, we are worse off if the omitted prices are not perfectly correlated with our included price.

[25] See Deaton (1988) for a discussion and proposed solution to the problem of division bias in the context of unit prices.

wage and impart an upward bias on the demand elasticity. A set of possible instruments exists to help assess this hypothesis. The population density of the surrounding countryside should be correlated with the wage through the labor supply side of the supply and demand system. Ideally, population density is uncorrelated with the error term.[26] As a partial check, I perform a test of overidentification restrictions to see whether the instruments meet minimal exogeneity conditions. In addition, the kabupaten soil quality and climate variables, and the sugar Regency indicator, are included to control for the kabupaten level of land quality that may be correlated with the instruments. The chosen measures of population density are population per square kilometres of the kabupaten, and the presence of a large city in the kabupaten.

The IV equation for omitted variable or simultaneity bias is presented in column 6 of Table IV. The results support the view that the labor market is not completely at odds with a simple competitive model. The first stage regression (Column 2 of Table VI) shows that the measures of population pressure have a significant negative effect on wages as one would expect if a supply and demand system generated the wages. The second stage shows that there is an upward bias in the OLS equation, with the new elasticity estimate rising to a well determined -0.94. The Wu-Hausman test suggests that this bias is (marginally) statistically significant. With a value of 0.72, the overidentification test suggests no evidence against the validity of my instruments.[27] Taken together, the evidence suggests this is the preferred specification.

Assessing the Scale Effect

The Inverse Relationship:

With constant returns to scale the land coefficient γ should be equal to 1.0, yet it is less than 1.0 in all specifications. As shown with the translog estimates, this is not an artifact of the functional form. Actually, declining intensity of labor input with farm size has long puzzled development economists.[28] Where tested, diminishing returns to scale is rejected as the explanation.[29] Abey,

[26] Horstmann and Rutz (1980) present demographic evidence in favor of the notion that population density in Java is uncorrelated with soil fertility. Geertz (1963) and Hart (1986) also discuss the issue of whether Javanese settlement patterns are correlated with soil fertility. The general consensus seems to be that at least at the broad (regency or county) level, it is reasonable to assume they are uncorrelated. Of course, no one knows for sure. See Benjamin (1991) for more discussion of this issue.

[27] See Newey (1985) for a discussion of such tests. It is also worth noting that both instruments are statistically significant in the first stage regression. Thus the overidentification test has some power.

[28] See M. Carter (1984) for a thorough discussion of this problem in an Indian context. The work by Berry and Cline (1979) represents the most comprehensive discussion of the inverse relationship.

[29] In Benjamin (1991) I show that diminishing returns to scale is inconsistent with the scale and wage effects in a larger system of equations generated by the profit function.

TABLE VI

First Stage Regressions
(Standard Errors in Parentheses)
(p values for F tests)

Equation:	Measurement Error[a]	Simultaneity Bias[b]	Simultaneity and Area Harvested[c]	
Dependent Variable:	Log Wage	Log Wage	Log Wage	Log Area Harvested
Intercept	0.596	1.316	0.980	−2.720
	(0.407)	(0.0607)	(0.618)	(0.564)
Log area harvested	0.039	0.105		
	(0.014)	(0.018)		
Log other wage	0.744			
	(0.022)			
Log pop. density		−0.106	−0.108	−0.083
		(0.043)	(0.044)	(0.040)
City in Kabupaten		−0.141	−0.139	−0.021
		(0.041)	(0.041)	(0.037)
Log land operated			0.031	0.058
			(0.014)	(0.013)
Log sawah operated			0.059	0.747
			(0.020)	(0.018)
Log household size	0.004	−0.043	−0.046	0.005
	(0.037)	(0.048)	(0.049)	(0.044)
Prime male fraction	−0.056	−0.088	−0.076	0.124
	(0.082)	(0.108)	(0.109)	(0.100)
Prime female fraction	−0.011	0.001	−0.026	−0.126
	(0.098)	(0.132)	(0.132)	(0.121)
Elderly male fraction	0.103	−0.081	−0.082	0.152
	(0.147)	(0.193)	(0.194)	(0.177)
Elderly female fraction	−0.042	−0.124	−0.172	−0.350
	(0.130)	(0.169)	(0.170)	(0.154)
Not irrigated	−0.016	−0.018	−0.057	−0.310
	(0.027)	(0.036)	(0.036)	(0.033)
Log pesticide price	0.001	0.056	0.057	−0.035
	(0.032)	(0.043)	(0.044)	(0.039)
Log fertilizer price	−0.071	0.033	0.019	−0.144
	(0.084)	(0.114)	(0.115)	(0.106)
Age of head	−0.003	−0.0007	−0.0007	0.007
	(0.006)	(0.007)	(0.008)	(0.007)
Age-squared of head	0.00003	0.00002	0.00003	−0.00006
	(0.00006)	(0.00008)	(0.00008)	(0.00007)
F Education of head	1.73	2.32	2.53	2.09
	(0.110)	(0.031)	(0.019)	(0.051)
F Kabupaten soil	1.25	8.71	10.89	9.08
	(0.289)	(0.0001)	(0.0001)	(0.0001)
F Kabupaten climate	1.06	6.72	6.28	3.48
	(0.382)	(0.0002)	(0.0004)	(0.014)
Sugar Regency	−0.019	0.016	0.015	0.019
	(0.026)	(0.036)	(0.037)	(0.033)
F Demographic variables	0.343	0.376	0.382	2.38
	(0.887)	(0.866)	(0.863)	(0.036)
R-squared	0.5217	0.1117	0.1050	0.683

[a] First stage measurement error/division bias correction with log of other village (cluster) measurements of the planting wage as instrument.
[b] First stage simultaneity/omitted variable bias correction regression with log of population density and presence of large city (designated Kotamadya) in Kabupaten.
[c] First stage simultaneity/omitted variable bias correction regression with log of population density and presence of large city (designated Kotamadya) in Kabupaten, and instrument area harvested by log land operated and log sawah operated.

Booth, et al. (1981) outline four other hypotheses pertaining to the Indonesian case:

(1) Labor input is often measured as employees or family members per hectare. These "indivisibilities" in units of measurement may lead to the inverse relationship.

(2) Indivisibility of capital or other complements to labor may force small farms to choose more labor intense combinations of inputs.

(3) The quality of farm land may not be uniform. If smaller farms are of a higher quality soil, they would have higher labor input per acre.

(4) Surplus labor or rationing in the outside labor market leads to extra family labor input on the farm. This overworking will be particularly acute on small farms (Sen (1962)).

The preceding results help address these hypotheses. (1) Since I employ data on actual labor input, the inverse relationship cannot result from mismeasurement of labor. Furthermore, family size is unrelated to total labor use. (2) Since plowing labor is not included in my labor measure, there is no obvious capital that small rice farms could substitute for the tasks that I model. (3) The omitted variable bias argument is the focus of Benjamin (1991) and Bhalla and Roy (1988). If land quality is negatively correlated with farm size, we would expect a downward bias on the land coefficient. Bhalla and Roy eliminate the inverse relationship between output per acre and farm size with controls for land quality. I use instrumental variables and a structural model of omitted land quality to show that omitted land quality is a plausible suspect in biasing the land coefficient from 1.0. Hypothesis (4) is the focus of this paper. The data show that there is no evidence of a correlation between family composition and labor demand that would result if the surplus labor hypothesis were true.

Heterogeneity across Growing Seasons:

The dependent variable is annual pre-harvest farm employment. Previously I examined the consequences of aggregating different types of labor (male and female). I now investigate the consequences of aggregating crop cycles, i.e., pooling farmers who grow only in the dry season (7%), only in the rainy season (53%), and those who can plant more than one crop (multiple-cropping) (40%). A richer specification of labor demand might account for the sequential nature of the different tasks or crops, especially focusing on preharvest and harvest labor. A useful framework for that type of approach is outlined in Antle (1983) and implemented by Antle and Hatchett (1986). My concern in this paper is more limited.[30] I am concerned with the possible heterogeneity that is masked by pooling the different types of farms, and the implications for the separation test. Specifically, while the area harvested variable accounts for the *scale* of the rice operation, including multiple crops, we might observe different labor

[30] All farmers in my sample grow wet rice, so I avoid pooling wet and dry rice farmers which itself could introduce nuisance heterogeneity.

markets and different interactions with those labor markets in areas where multiple cropping is prevalent.

I estimated several specifications with controls for type of growing season and interactions between the demographic variables and the seasonal structure of the crops (results not shown). Farmers who multiple crop use significantly more labor, even controlling for area harvested and irrigation. It is possible that there is some type of heterogeneity that is related to multiple-cropping. Estimated demographic effects were stronger for the multiple-cropping farms. While the demographic variables were only marginally significant at the 5% level ($F(5,1443) = 2.93$) in the OLS specification, the coefficient on log household size rose to 0.25 with a standard error of 0.07. This result was not robust to other specifications, such as cluster fixed-effects, or the 2SLS correction for wage endogeneity. In the 2SLS specification, the coefficient was 0.16 with a standard error of 0.09, and the F test for the joint significance of the demographic variables was also insignificant ($F(5,1443) = 1.17$). In both the OLS and 2SLS specifications, the hypothesis that the demographic effects were equal for the 3 types of farms was accepted ($F(10,1443) = 1.10$ for OLS and $F(10,1443) = 0.62$ for 2SLS). However, the OLS household size effect is the largest in all the specifications I estimated. While not robust enough to overturn the separation hypothesis, it warrants discussion. Given that the share of hired labor is higher on the farms in which there are more harvests, the size effect seems to suggest that to meet high labor demand in a "tight" market, family members pitch in with the farm work. This would be *consistent* with an external labor market in which the wage did not adjust upward.

Adjustment of Area Harvested:

So far I have cast the separation question as: *conditional* on area harvested, are adjustments in farm employment correlated with household composition? If we limit the question of separation to whether labor demand is independent of labor supply variables, given the area harvested, this is legitimate. To the degree that area harvested is itself adjusted in response to labor market conditions, we may miss evidence of nonseparation. For example, labor market imperfections may limit the number of crops that can be grown by a household, or with surplus labor, farmers may cultivate their land more extensively in response to insufficient off-farm opportunities. To adjust for this possible endogeneity, I instrument area harvested with measures of the amount of *sawah* (rice-specific land) and total land operated by the household. Note, land operated (hectares owned, rented, or sharecropped) *is* correlated with household composition. This could occur because of income effects on the determination of household size, or, because of imperfections in the market for farm management, limits on the size of operation may be determined by family structure. In Java, Hardjono (1987) emphasizes the "life-cycle" features of farm size. Parents often lease or sharecrop land to their heirs for current use. These particular subtleties of land ownership are not distinguished in the SUSENAS survey. The more limited question I address is whether farmers adjust their area harvested, given the size of their plot. The margins for adjustment are increasing the area planted or increasing the number of harvests.

The first stage equation in column 4 of Table VI isolates this possible effect. Here we see that the number of elderly females is marginally significant at the 5% level, with a t statistic of -2.3. This suggests that households with a lower fraction of elderly women cultivate more intensively, though the effect is small. As a group, the demographic variables are jointly insignificant. In the second stage, we see no change in the coefficients of interest. The demographic variables remain insignificant and the wage and land elasticities are approximately the same as the previous 2SLS specification. Indeed, the Wu-Hausman test rises only slightly with the additional endogenous variable. Therefore, neither from the perspective of biasing the land coefficient, nor in hiding demographic effects on area harvested, does using area harvested as the scale variable seem misleading.

6. TESTING FOR DIFFERING EFFICIENCIES

My suspicion is that the imperfect labor markets alternative most readily leads to a correlation between demographic variables and labor demand. The following test focuses on the differing efficiency issue. Recall the previous depiction of the efficiency relationship: $L^* = L^F + \alpha L^H$. Perfect substitutability, despite differing efficiency, is an implicit assumption. Deolalikar and Vijverberg (1986) show that this assumption is not necessarily true. Since I am looking at specific tasks like weeding, instead of a broader measure of labor that includes family supervision and farm management, the assumption of perfect substitutability is in principle more reasonable. However, in testing for equal efficiency, perfect substitutability is a maintained and (jointly) refutable assumption. The objective is to test whether $\alpha = 1$. We observe $L = L^F + L^H$ and so

$$\frac{L}{L^*} = 1 + (1-\alpha)\frac{L^H}{L^F + \alpha L^H}. \tag{22}$$

Under the null hypothesis, $L = L^*$. Therefore, for small deviations from the null

$$\begin{aligned} \log L &\approx \log L^* + (1-\alpha)\frac{L^H}{L^F + \alpha L^H} \\ &= \beta \log w + \gamma \log A + (1-\alpha)\frac{L^H}{L^F + \alpha L^H} \end{aligned} \tag{23}$$

using the previous specification for L^*. One method of testing whether $\alpha = 1$ is to employ a modified Lagrange multiplier framework, estimating the restricted model. This is equivalent to the following derivation of the test. Expand the function

$$f(\alpha, L^H, L^F) = (1-\alpha)\frac{L^H}{L^F + \alpha L^H}$$

around the point $\alpha = 1$. This first order expansion yields

$$f(\alpha, L^H, L^F) = (1-\alpha)\frac{L^H}{L^H + L^F} = (1-\alpha)\frac{L^H}{L}. \tag{24}$$

The following regression can then be run:

$$\log L \approx \beta \log w^* + \gamma \log A + (1-\alpha)\frac{L^H}{L} + \varepsilon. \tag{25}$$

The test of $\alpha = 1$ is the test that $(1-\alpha) = 0$. Intuitively, this tests whether, given the optimal amount of labor, L^*, the mix of family and hired labor affects total observed labor use. If family labor were more efficient, we would expect a higher percentage of family labor to be associated with lower observed labor.

The mix L^H/L may need to be instrumented to avoid simultaneity or division bias. Natural instruments for the fraction of hired labor are family composition variables. This does not violate our assumption of separation, since separation places no restrictions on the determinants of the mix of family and hired labor. The results of estimation of this model, both by OLS and 2SLS are presented in Table VII. The OLS estimate of $(1-\alpha)$ is 0.009 with a standard error of 0.07, implying that we cannot reject the null hypothesis of equal efficiency. The two stage least squares regression leads to the same conclusion of equal efficiency, though both the coefficient and standard errors change. The negative sign is in the direction of more efficient hired labor, as was found in Deolalikar and Vijverberg. The Wu-Hausman test indicates, however, that the difference between OLS and 2SLS is not statistically significant. The first stage regression shows households with smaller farms, and those with more family members (particularly working age males) have a higher percentage of family labor. However, as has been shown here, this does not lead to an increase in total labor use. Finally, the test of the overidentifying restrictions reiterates the validity of the demographic variables as instruments: controlling for the fraction hired, they do not belong in the regression. The statistically preferred version of the regression is also presented in Table VII, where besides instrumenting the fraction hired, I instrument the wage. The results are essentially similar.

7. CONCLUSIONS

Gathering together the above results, consider Chayanov's summary of the separation issue:

> The whole key to the problem is in the confrontation of these two hypotheses. We ought to accept either the concept of the fictive twofold nature of the peasant, uniting in his person both worker and entrepreneur, or the concept of the family farm, with work motivation analogous to that of the piece rate system (Chayanov (1926 p. 42)).

As Chayanov emphasizes, only in a capitalist system, that is a system with fully functioning labor markets (for family and hired labor), is the first characterization correct. The theoretical results showed that we should expect nonseparation to lead to correlation between household composition and farm labor allocation subject to two conditions: demographic effects on household labor supply, and a downward sloping labor demand function. The first condition is established in Benjamin (1989). The focus of this paper has been the specification and estimation of the labor demand function and testing whether farm employment is uncorrelated with household composition. Accounting for possible biases that can result from imperfectly measured or nonexperimentally allocated regressors, most results point to the validity of the separation hypothesis. Where separation is less certain, auxiliary evidence suggests that farmers might be constrained on the demand side. Together, the evidence is not consistent with surplus labor or constraints on farm labor supply, though a few qualifications must be made. The power of the test is limited by the degree that farmers turn to their farms for extra work. More importantly, 40% of households are landless and I will not observe whether they are constrained. Never-

TABLE VII

EFFECT OF DIFFERING MIXES OF FAMILY AND HIRED LABOR ON LABOR DEMAND
(Standard Errors in Parentheses)
(p-values for F tests)

	OLS for Wage			Instrument Wage		
Specification: Dependent var:	OLS Log L	2SLS[a] Log L	OLS Mix (1st stage)	2SLS Log L	2SLS[b] Log L	OLS Mix (1st stage)
Intercept	2.215	2.519	0.528	2.778	2.856	0.828
	(0.526)	(0.581)	(0.215)	(0.670)	(0.656)	(0.237)
Log area	0.684	0.735	0.089	0.767	0.781	0.084
harvested	(0.018)	(0.039)	(0.007)	(0.035)	(0.039)	(0.007)
Log wage	−0.276	−0.288	−0.022	−0.948	−0.873	
	(0.026)	(0.027)	(0.010)	(0.235)	(0.283)	
Fraction hired	0.009	−0.607		−0.078	−0.363	
("mix")[c]	(0.065)	(0.428)		(0.085)	(0.528)	
Not irrigated	−0.151	−0.152	−0.007	−0.157	−0.157	−0.013
	(0.034)	(0.035)	(0.014)	(0.042)	(0.040)	(0.014)
Log pesticide	0.137	0.154	0.025	0.159	0.164	0.032
price	(0.042)	(0.044)	(0.017)	(0.051)	(0.050)	(0.017)
Log fertilizer	0.406	0.450	0.077	0.413	0.433	0.080
price	(0.111)	(0.119)	(0.045)	(0.135)	(0.136)	(0.045)
F Education[d]	3.25	3.19	2.82	1.48	1.62	3.34
	(0.004)	(0.004)	(0.010)	(0.180)	(0.136)	(0.003)
Age of head	0.013	0.012	0.003	0.011	0.010	0.003
Age-squared of	−0.00013	−0.00012	−0.00003	−0.00011	−0.00011	−0.00003
head	(0.00007)	(0.00007)	(0.00003)	(0.00008)	(0.00008)	(0.00003)
F Kabupaten soil[e]	7.32	6.92	4.93	6.59	6.00	5.23
	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0001)
F Kabupaten	13.37	10.46	27.73	3.60	3.86	22.75
climate[f]	(0.0001)	(0.0001)	(0.0001)	(0.010)	(0.009)	(0.0001)
Sugar Regency	0.134	0.135	0.0004	0.110	0.113	0.021
	(0.033)	(0.034)	(0.013)	(0.041)	(0.051)	(0.014)

TABLE VII—Continued.

	OLS for Wage			Instrument Wage		
Specification: Dependent var:	OLS Log L	2SLS[a] Log L	OLS Mix (1st stage)	2SLS Log L	2SLS[b] Log L	OLS Mix (1st stage)
	(0.007)	(0.007)	(0.003)	(0.008)	(0.008)	(0.003)
Log household size			−0.082			−0.071
			(0.018)			(0.019)
Prime male fraction			−0.105			−0.098
			(0.042)			(0.042)
Prime female fraction			−0.010			−0.0004
			(0.051)			(0.051)
Elderly male fraction			−0.083			−0.066
			(0.076)			(0.075)
Elderly female fraction			0.010			0.031
			(0.066)			(0.066)
Log population density						−0.058
						(0.017)
City in Kabupaten						−0.007
						(0.015)
F Demographic variables[g]			7.14			5.88
			(0.0001)			(0.0001)
R-squared	0.5890	0.5744	0.1772	0.4796	0.4950	0.1819
Wu-Hausman[h] test			2.12	8.26	10.62	
Overid. test[i]		2.89		0.72	1.59	

[a] This specification instruments the fraction hired with demographic variables.
[b] This specification is the same as above, except the wage is also instrumented.
[c] Fraction hired (mix) is the fraction of labor used that is hired (mean = 0.70).
[d] F test for exclusion of the education of household head indicator variables, $F(6, n)$.
[e] F test for the exclusion of the Kabupaten soil classification variables, $F(5, n)$.
[f] F test for the exclusion of the Kabupaten climate type variables, $F(3, n)$.
[g] F test for the exclusion of the demographic variables in the first stage equation, $F(5, n)$.
[h] Wu-Hausman test for (i) endogeneity/division bias of mix, (ii) bias of wage elasticity, and (iii) bias in both the mix and wage coefficients, $\chi^2(1)$, $\chi^2(1)$, and $\chi^2(2)$ respectively.
[i] Overidentification test for validity of instruments: $\chi^2(4)$ for the specification with only demographic variables as instruments, $\chi^2(1)$ for wage instruments, and $\chi^2(5)$ for the specification with all instruments.

theless, since household composition has no effect on labor demand I conclude we do no obvious wrong in treating the farm and the farmer's household separately in rural Java.

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APPENDIX A

Data Description

Subsample Selection

The sample was drawn from the 1980 SUSENAS survey in the following manner:

(1) I drew the 16456 individual level (one per household) records corresponding to rural Java, as well as the 14765 agricultural (one per household) records. Households which were repeated or not perfectly matched in the matching information were "discarded' leaving a total sample of 13760

"good" households. Most of the nonmatches were a result of the fact that the version of the data set I am using is missing some data (agricultural records corresponding to East Java). The data are otherwise clean, and were essentially used "as is."

(2) From this set of households I selected a 30% random subsample of clusters, yielding 858 clusters with 4117 households. The smaller subsample was chosen to reduce subsequent computing expenses.

Variables in the Labor Demand Regressions

(1) The dependent variable, log L, is the natural logarithm of preharvest labor. Preharvest labor includes total person days (family and hired) of weeding, planting, hoeing, and "other" labor. The only excluded category is plowing labor, because of its convolution with draft animal services. There are a total of 1675 rice farms after removing those farms with '999' values for the labor demand data. This forms the full sample.

(2) Area harvested is total hectares of rice harvested in the previous year.

(3) Wages are calculated by dividing the wage bill by the number of days of hired labor of the given type. Wages are divided by the producer price of a kilogram of rice. This makes no difference in the regressions since there is virtually no variation in the producer price. The planting wage is the wage used in the regressions. There are a total of 1443 farms with observations of the planting wage.

(4) Pesticide and fertilizer prices are calculated as unit prices for those farmers who use the inputs. I then impute the geographically nearest price to those farmers without observations. The nearest price is taken as the cluster, kabupaten, or province average, the narrowest geographic unit available.

(5) Not irrigated refers to farms who report neither year round nor part of the year irrigation.

(6) Log household size is the log of the total number of household members. Prime males/females are males/females between 16 and 55 years of age, while elderly males/females are those individuals over 55 years old.

(7) Age of household head is the age of the reported household head.

(8) The education variables are 7 indicator variables corresponding to different levels of education.

(9) The soil variables are indicators for the presence of each of 5 soil types in a kabupaten: (1) andosols (young soils from volcanic ashes), (2) mountain soils of humid and subhumid tropics, (3) dark, heavy soils of the temporary humid tropics and subtropics, (4) lateritic soils, partly bleached, (5) mineral hydromorphic soils and alluvial soils. The classifications are gleaned from a soil map in Donner (1987, page 96).

(10) The climate variables are indicators for the presence of each of 3 climatic zones in a kabupaten: (i) tropical climate, rainforest climate despite a short dry season; (ii) tropical climate, tropical savanna climate with a pronounced dry season; (iii) temperate rainy climate, wet in all seasons. The classifications are gleaned from maps in Donner (1987, page 88).

(11) The sugar variable is an indicator variable of whether the kabupaten was a sugar Regency, as classified in Geertz (1963).

(12) The measurement error regression uses the log of the average wage of other farmers in the cluster (excluding the observation being instrumented). This specification is restricted to observations with at least 2 farms with planting wages in the cluster. The sample size is reduced to 1271.

(13) The simultaneity/omitted variables regression has the following excluded instruments. (i) Log of the ratio of population to kabupaten area. This measure is calculated not from the SUSENAS but from the 1980 population census. The population is the population of the Kabupaten that does not live in a Kotamadya (principal city), a close approximation to the rural population. The kabupaten area is the actual surface area (in square kilometres) accounted for by the kabupaten. The data was gleaned from *Penduk Indonesia*: *Hasil Penduluk 1980* (Population of Indonesia: Results of the 1980 Population Census), Jakarta, Indonesia, Biro Pusat Statistik, 1983. (ii) The city variable is an indicator of whether the kabupaten contains a principal city (Kotamadya).

(14) The additional instruments in the final regressions are (i) the log of total land operated, and (ii) the log of total sawah (rice land) operated.

(15) Fraction hired, or "mix" is the fraction of farm employment (in person days) that is accounted for by hired labor.

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