Revisiting the Neoclassical Model of Out-farm Migration: Evidence from Nonlinear Panel Time Series Data

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This paper provides an empirical test for the neoclassical model of out-farm migration pioneered by Harris and Todaro against the alternative model based on real options approach. The testing strategy is based on a dynamic panel threshold first-difference general method of moments estimator that allows for endogenous threshold variables. Using state-level US employment data for agricultural and nonagricultural sectors over the period 1990-2016, our findings favor real options framework of the neoclassical model of out-farm migration. In other words, inter-sectoral migration of labor involves large sunk costs and uncertainty. Therefore, a large threshold of the relative nonfarm wages needs to be reached before switching to nonfarm sector becomes worthwhile for hired farm workers.

Key words: out-farm migration, real options, dynamic panel threshold models.

Introduction

Migration of labor away from the agricultural sector is an important element characterizing development of an economy. The neoclassical model of inter-sectoral migration of labor argues that labor migrates between farm and off-farm sectors as a result of investment (in human capital) decisions that are motivated by wage differentials between sectors. In other words, it is assumed that farm workers will move to non-farm jobs if their expected returns outside of agriculture exceed those achieved in the farm sector, net of migration costs. This neoclassical migration framework was developed by Harris and Todaro (1970) and later used by Mundlak (2000) and Barkley (1990), among others, to model the out-farm migration in the United States.

Neoclassical investment approach to migration has two shortcomings: a-) migration, like other investment decisions, is assumed to be completely reversible (i.e., there are no sunk costs to migration); b-) the opportunity to invest (i.e., move to another occupation) presents itself as a now or never proposition; there is no delaying of the decision. However, empirical studies point out that even in the presence of a positive wage differential between the origin and the destination sectors, people do not always migrate to the sector offering the higher rate of return (Mundlak, 1979; Onel, 2014).

We argue that this finding is likely because migration is not completely reversible; it is typically associated with large sunk costs. Furthermore, workers may delay their decision to migrate if there is too much uncertainty in the current period about the opportunities in the destination sector. As a result, the responses of migrants to wage differentials may be characterized by nonlinearities due to the existence of sunk costs and what is called an "option value of waiting." The option value of waiting is the difference between the expected net present value of postponing migration and the expected net present value of migrating immediately, and it represents the opportunity cost of migrating in the current period. This "real options approach" to inter-sectoral migration lays the foundations for a potentially more plausible empirical model of out-farm labor migration.

Labor allocation decisions have been the topic of many studies. Some studies have considered factors determining off-farm work (Goodwin and Mishra 2004; Kimhi and Rapaport 2004; Ahearn, El-Osta, and Dewbre 2006), while others focused on human capital theories and models of out-farm labor migration (Barkley 1990; Goetz and Debertin 2001; D'Antoni, Mishra, and Barkley 2012; Onel and Goodwin, 2014). The neoclassical approach based on the net present value hypothesis assumes that as soon as relative nonfarm wages exceed Marshallian costs of migration, the farm worker will move onto a nonfarm job (Mundlak 2000, Harris and Todaro 1970; Todaro 1969, 1976). However, as Mundlak (1979) has noted, migration may sometimes not realize even if the wage differentials between the origin and the destination sectors exceeds traditional Marshallian costs. This behavior is due to large sunk costs and uncertainty involved in out-migration onto a nonfarm sector, which in return cause larger opportunity cost than traditional Marshallian costs. Onel and Goodwin (2014) is the only study that recognizes the need to account for large opportunity costs involved in out-farm migration decisions. While Onel and Goodwin (2014) utilized aggregate national data, in this paper, we use richer state-level panel time series data to model macroeconomic determinants of out-farm migration.

The objective of this paper is modeling state-level determinants of U.S. out-farm labor movements using an occupational migration model that is consistent with large sunk costs and uncertainty involved in changing occupations. For the empirical application, we develop and use a dynamic panel threshold model that is consistent with potentially large wage thresholds implied by large opportunity costs of inter-sectoral migration. We use our estimates to compute the threshold level of sectoral wage gaps that trigger out-farm migration and the elasticities of

out-farm migration with respect to wage differentials. Results have important implications for policy objectives intended to inhibit the flow of labor and other resources out of the farm sector through the use of price supports or direct payments.

Methodology

The empirical implication of the real options approach is that potential migrants may move out of agriculture only when the wage gaps between farm and non-farm sectors exceed a relatively large threshold point encompassing traditional barriers to the movement as well as the option value of waiting. On the other hand, if migration plays a perfect role in equalizing factor prices (wage rates) across the two sectors, then the relationship between wage differentials and migration rates is expected to be linear in parameters.

Our empirical approach essentially allows us to test these two competing theories of out-farm labor migration. Threshold models (e.g., Hansen 2000) are a naturally good fit for empirically modeling the potentially large thresholds implied by the real options value approach to out-farm migration. We use the dynamic panel threshold model proposed by Seo and Shin (2016), which extends Caner and Hansen's (2004) cross-section setup to allow for endogenous regressors using GMM type estimators. The main challenge with threshold regression models is that they are typically based on the assumption of exogeneity of either regressors, or the transition variable, or both. This strong assumption might hamper the applicability of threshold models to some important economic problems. Seo and Shin (2016) propose a first difference-general moment condition (FD-GMM) allowing both the threshold variable and the regressors to be endogenous.

We consider FD-GMM estimator developed by Seo and Shin (2016) to estimate the two-sector out-farm migration model based on the real options approach. In cases where the threshold variable is strictly exogenous, we argue that a two-step least squares (FD-2SLS) estimator is more efficient. The basic dynamic panel threshold regression model we estimate takes the following form:

$$M_{it} = (1, x_{it-1})\, \Phi_1 I\{z_{it-1} < \gamma\} + (1, x_{it-1})\, \Phi_2 I\{z_{it-1} > \gamma\} + \varepsilon_{it} \qquad (1)$$

where X_t represents matrix of explanatory variables, including the log ratio of nonfarm employment to farm employment, log ratio of weekly nonfarm wages to farm wages, and the unemployment rate in the non-farm sector. Φ_1 and Φ_2 are the coefficients associated with the two regimes and the parameter λ is the unknown threshold parameter to be estimated. I{.} is an indicator function and z is the variable that forces switching between regimes. M is the out-farm migration rate.

In order to estimate the determinants of hired farm workers' out-farm migration, we use both the standard Todaro-type model of out-farm migration and the real options based model with the threshold specification:

Standard Neo-Classical Approach (Based on Harris-Todaro Model):

$$M_{it} = \beta_0 + \beta_1 M_{it-1} + \beta_2 W_{it-1} + \beta_3 L_{it-1} + \beta_4 U_{it-1} + \varepsilon_{t-1} \quad (2)$$

Real Options framework that implies large threshold effects:

$$\begin{aligned} M_{it} = {} & (\varphi_1 M_{it-1} + \theta_{11} W_{it} + \theta_{21} L_{it} + \theta_{31} U_{it})\, I\{Z_{it} \le \gamma\} + \\ & (\varphi_2 M_{it-1} + \theta_{12} W_{it} + \theta_{22} L_{it} + \theta_{32} U_{it})\, I\{Z_{it} > \gamma\} + \alpha_i + v_{it} \end{aligned} \quad (3)$$

where M is the out-migration rate of hired farm workers; W is the log of the ratio of the weekly average nonfarm wages to those earned in the farm sector; L is the log of the ratio of employment in the nonfarm sector to the employment levels in the farm sector; and U is the nonfarm unemployment rate.

Data

Annual State-level panel data for 47 U.S. states was compiled from various sources over the period 1990-2016. We have excluded Alaska, Porto Rico, and Rhode Island due to missing data.

Data on the farm and off-farm employment and income are needed for the empirical application. We use the nonfarm to farm ratio of average weekly wages as the measure of sectoral differences in returns to labor. Weekly state-level wages were obtained from the Quarterly Census of Employment and Wages (QCEW) of the Bureau of Labor Statistics (BLS). As the nonfarm/destination sector, we consider the private nonfarm goods-producing sector.

Farm/origin sector considered in the study is the crop production sector. Employment levels in both sectors were obtained also from the QCEW.

Another important determinant of the out-farm migration of farm labor is the unemployment rates in the destination (nonfarm) sector. We use state-level unemployment data from the Local Area Unemployment Statistics (LAUS) database by the BLS to proxy the probability of obtaining a job in the nonfarm sector. Because there are no sector-specific data on the number people migrating in and out of agriculture, following Mundlak, we approximate net agricultural out-migration (*M*) as the difference between the growth rate of the total labor force and growth rate of the agricultural labor force.

$$M = N - N_f \tag{4}$$

$$M = [(L_{t-1} - L_t)/L_t] - [(L_{f,\,t-1} - L_{f,\,t})/L_{f,\,t}]$$

where N is the growth rate of total labor force, and N_f is the difference in the number of farm sector workers between two years, relative to the agricultural labor force size in the base period. Table 1 presents summary statistics on the data.

Preliminary Results

In order to test the two competing approaches to modeling out-farm migration, we estimate both the standard linear Todaro-type regression (equation 2) and the threshold model (equation 3) that capture the option value of waiting involved in migration decisions.

The linear Neoclassical model predicts a positive relationship between returns to labor (wage rates) and inter-sectoral migration rates. Initially, we visualize this relationship by a plot of out-farm migration rates versus sectoral wage differentials. Figure 1 indicates a non-linear relationship between out-farm migration rates and wage differentials.

We proceed with the formal threshold model estimation. Table 2 presents results of both linear and threshold models of out-farm migration. The results from the linear model indicate that none of the model coefficients are statistically significant, except for the ratio of non-farm to farm employment. This ratio has a positive significant effect on off-farm migration which is consistent with the results by Barkley (1990). This positive sign highlights that farm workers might consider the relative size of the nonfarm employment as nonfarm sector's absorption

capacity, or a signal for potential job opportunities in the off-farm sector. The coefficient on wage differentials is negative but insignificant.

When we extend the model into the dynamic panel threshold framework, the results change dramatically. The estimated threshold is 0.66 and it is statistically significant. The bootstrap p-value for the linearity test is practically zero, providing a strong evidence of threshold effects. The J-statistic indicates the validity of instruments.

Estimated parameters in regime 2 where wage differentials are greater than threshold level, the relative employment in the non-farm sector has a negative effect on off-farm migration; potential migrant's probability of obtaining a nonfarm job may be decreasing as the relative employment in non-farm sector increases, leaving the farm worker discouraged to change sectors. Furthermore, the threshold model yields a significant and positive effect of relative sectoral wages on out-farm migration rates as predicted by the economic theory. The coefficient on past levels of off-farm migration is found to be negative and significant in regime 2. The coefficient on non-farm unemployment rates lacks significance.

Concluding Remarks

Results indicate that there is considerable evidence in favor of threshold effects. The estimated nonlinear labor migration model is generally superior to its linear counterparts. Specification tests that allow a comparison of the model alternatives find important and statistically significant differences in the alternative model specifications. The estimated responsiveness of agricultural employment with respect to inter-sectoral returns seems to be different in two regimes which are identified by the degree of inter-sectoral wage gaps. Overall, our results are in favor of real options framework of the neoclassical model based on net present value approach in modeling state-level out-farm migration equations. More work is needed to consider other important state-level determinants of out-farm migration, as well as alternative destination sectors.

Figure and Tables

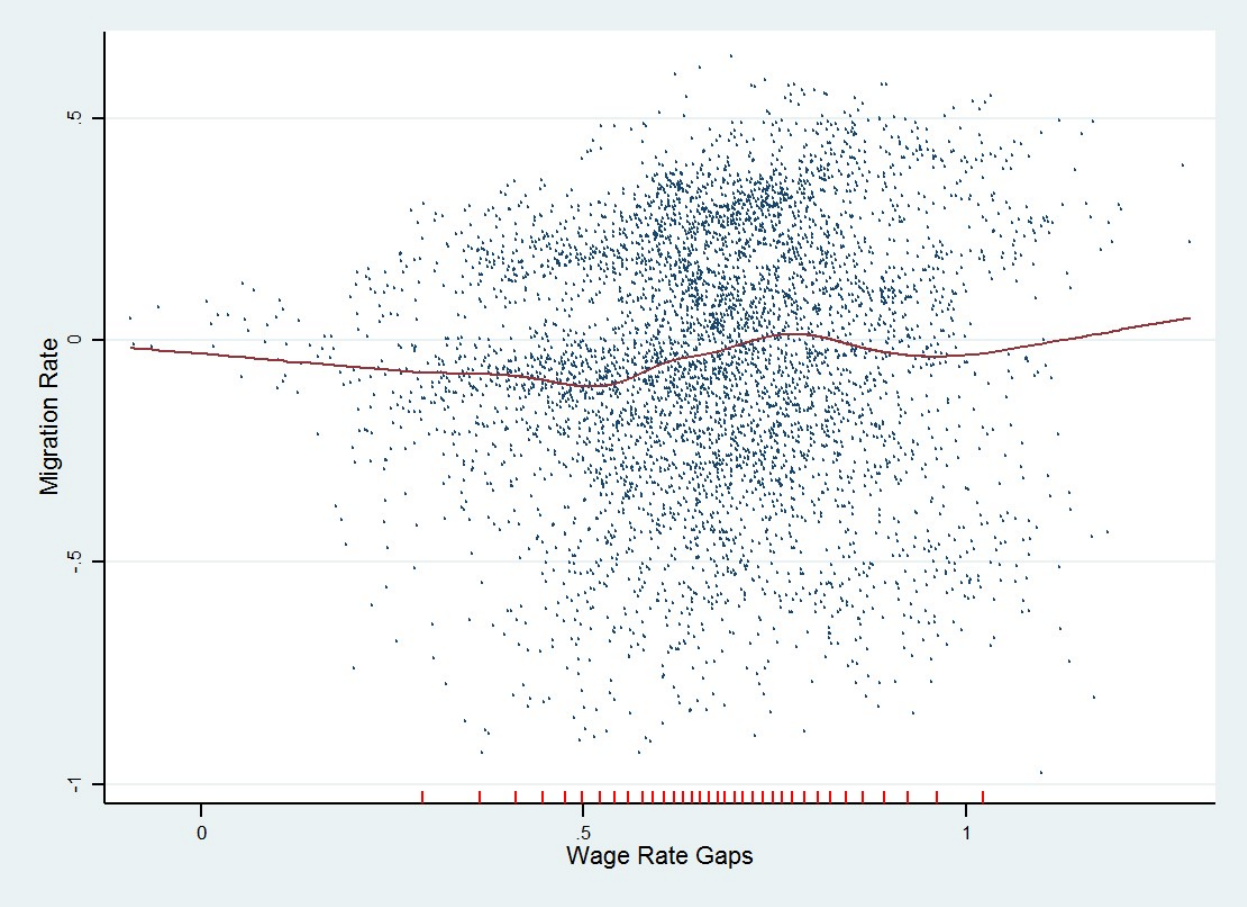

Figure 1: Relationship between out-farm migration rate and sectoral wage differentials

Table 1. Summary Statistics

Variable	Mean	Std. Dev.	Min.	Max
Number of Hired Farm Workers	11642.92	27981.62	272.167	202658.7
Employment in (Private) Non-Farm Sector	478798.8	480772.4	31910.25	3173688
Weekly Average Wage Rate in Non-Farm Sector (Dollars)	810.732	233.873	366.75	1544.75
Weekly Average Wage Rate in Farm Sector (Dollars)	416.295	120.148	168.75	801
Non-Farm Unemployment Rate	5.597	1.825	2.300	13.658
Out-Farm Migration Rates of Hired Farm Workers	0.019	0.061	-1.101	0.521
Log ratio of Weekly Average Wage Rate in Farm to Non-Farm Sector	0.666	0.168	0.133	1.138
Log Ratio of Employment in Farm to Non-Farm Sector	4.257	0.733	2.055	5.754
Growth Rate of Total Labor Force	0.009	0.013	-0.039	0.079
Growth Rate of Farm Labor Force	-0.010	0.059	-0.510	1.119

$$M_{it} = (1, x_{it-1})\,\Phi_1 I\{z_{it-1} < \gamma\} + (1, x_{it-1})\,\Phi_2 I\{z_{it-1} > \gamma\} + \varepsilon_{it}$$

Table 2. Estimation Results for Out-farm Migration of Hired Farm Workers

$X_{it} \backslash Z_{it}$	Estimate	Std. Error
Dynamic Threshold Panel Data Model[1]		
	Lower Regime (Φ_1)	
M_{-1}	-0.218	0.147
W	0.343*	0.150
L	-0.140*	0.036
U	-0.001	0.006
	Upper Regime (Φ_2)	
M_{-1}	-0.418*	0.102
W	0.449*	0.193
L	-0.163*	0.036
U	0.008	0.006
Estimated Threshold	0.666*	0.154
Number of IVs	30	
Linearity Test (p-value)	0.000	
J-test and (p-value)	28.721 (0.120)	
Dynamic Linear Panel Data Model		
M_{-1}	-0.120	0.131
W	-0.108	0.249
L	0.298*	0.096
U	0.010	0.006
Constant	-1.246*	0.304

1.Threshold Variable: M (Log ratio of average weekly wage in non-farm to farm).

* Indicate significant at 5% level.

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