J. King Saud Univ., Vol. 11, *Admin. Sci.* (2), pp. 59-77 (A.H. 1419/1999)

Two Simultaneous-equations Models of Employment and Age-specific Migration

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(Received 26/12/1417H; accepted for publication 6/11/1418H)

Abstract. This paper compares and tests two different model specifications of employment and age-specific migration. One specification deals with out- and-in migration as the dependent variables, while the other deals with the net migration as the dependent variables. The migration variable in both models is disaggregated into two-age-specific groups, young and old. The sample employed in this study consists of 62 SMSAs in 32 states distributed in the four main regions of the U.S.A. The two models have been estimated in double-logarithmic form using the three-stage least squares (3LS) method. The empirical results indicate that the use of in-and-out-migration variable is more appropriate than the use of a variable relating to net-migration. Moreover, the results support the hypothesis of the causal relationship between migration of each age group and employment growth rates and the hypothesis of the opposite direction movement between the out-and-in-migration variables. Finally, the major finding of this study, which has not been shown before, is that the total employment increased by the same amount as the young migrant's contribution to it and by less than the old migrant's contribution to it.

Introduction

A major contribution to the literature of labor migration and regional growth was provided by Richard Muth [1]. He attempts to reconcile the demand and supply-oriented approaches of employment growth and migration in the context of a simultaneous-equations systems. He tests the hypothesis of mutual causation between net migration and employment growth.

Among the most important studies beyond Muth's work are Greenwood [2,3], and Greenwood and Hunt [4]. They test the hypothesis of mutual causation between two types of migration variables (out-and in-migration) and employment growth in a more general framework. Greenwood [2] disaggregates each of the out- and in-migration equations to migration to other Standard Metropolitan Statistical Areas (SMSAs) and migration to non- metropolitan areas. He disaggregates the employment growth variable to manufacturing employment, government employment, and other non-manufacturing employment. Moreover, Greenwood [3] disaggregates both the migration and employment growth variables to whites and non-whites. Finally, Graves and Regulska [5] disaggregate the net migration variable by race and 5-year age cohorts. They show the importance of amenities in the migration decision, and conclude that the size and significance of some of the main variables could be improved by including more amenities.

This paper compares and tests two different model specifications of employment and age-specific migration. Its main objective is to know the appropriateness of each specification in migration studies. One specification deals with out-and in-migration as the dependent variables, while the other deals with net migration as the dependent variable. The migration variable in both models is disaggregated into two age-specific groups, young and old. In addition to the mutual causality test for the two different age groups, this study will test the attractiveness of some non-economic variables for both age groups and show the importance of the income and employment variables for the same group. Thus, this study will be mainly common to the ideas of three important studies: Muth [1], Greenwood [2], and Graves and Regulska [5].

The first section of the paper discusses some issues related to the sample data used in the study. The second section specifies the structure of the two models and discusses the theoretical arguments of the equations and the different hypotheses that will be tested. The estimation method and the empirical results are shown in section three. Finally, summary and conclusion are provided in section four.

The Sample Data

The spatial unit employed in this study is the Standard Metropolitan Statistical Area (SMSA). As in the U.S. 1980 census of population, the general concept of an SMSA is that of a large population nucleus, together with adjacent communities that have a high degree of economic and social integration with that nucleus. Each SMSA contains one or more central counties with an urbanized area of at least 50,000 inhabitants, and it could include outlying counties that have close economic and social relationships with the central counties. The sample employed in this study consists of 62 SMSAs in 32 states distributed in the four main regions of the U.S. Northeast, North Central (now called Midwest), South and West and each region is well represented in the sample. All of the sample SMSAs are in published data form for 1970 and 1980 and have population of at least one-half million, except for two SMSAs (Paterson- Clifton -Passaic, Trenton).

The data present some problems. One problem is that the geographic definition of some SMSAs at the end of the period is different than at the beginning of it. And this results from the fact that some new counties were added to those SMSAs definitions or, in a few cases, counties were deleted. In this study, all of the beginning-of-period data have been adjusted to match the end-of-period definition. Another data problem is the inconsistency of the migration data with the other data used in the model. All the endogenous and exogenous variables refer to their levels in 1970 and 1980, or to the changes during 1970-1980 period, while the census migration data refer to the young and old people movements during a five-year period (1975-80). Greenwood [6, p.155] offers an option to solve this problem by making the migration variables compatible with other variables by defining the migration variables over a ten-year period. This requires the assumption that the migration movements that occurred between the first five years and the last five years were identical. Therefore, all migration data have to be multiplied by 2. This multiplication has no effect on the estimates of the coefficients of the explanatory variables (except that they are twice as high as otherwise).

The descriptive statistics of all variables are displayed in Table 1. In this table, the migration rate variables are calculated using the population measure. It shows that relevant to the number of the young and old people who are living in the SMSA at the beginning of 1970, about 21 young and 10 old people per hundred had left within the period 1970-75, and for the same period about, 21 young and 9 old people per hundred had come into that SMSA. This means there are about zero net young and old migrants coming to the SMSA for each 100 young and old people for the period which simply reflects the fact that net migration within a closed system must sum to zero. Technically, the system is not closed, but the SMSAs used in this study represent such a high fraction of total US population that the system behaves as if it were closed. The same table shows that the average employment and income growth rates are 31.38% and 95.9%, respectively. Moreover, the average of the unemployment rate is 4%, which means that on average, four people out of one hundred labor force members residing in the various SMSAs are unemployed.

Table 2 shows the regional average employment and income growth rates for that period. The Northeastern region had the lowest employment and income growth rates, whereas the West had the highest employment growth rate and the South had the highest income growth rates.

Specification of the Models

Both models are intended to be age-specific. Therefore, out- and in-migration variables are disaggregated to the young and the old. Young migrants are defined to be those people who are between the ages of 20 and 64, and old migrants are defined to be those people who are at the age 65 and above (65+).

Table 1. Sample descriptive statistics

Variable	Mean	Minimum	Maximum
OMRY	20.97%	6.74%	37.58%
OMRO	9.73%	3.62%	22.13%
IMRY	21.25%	3.82%	58.60%
IMRO	9.36%	9.52%	49.63%
NMY	0.28%	-16.8%	23.93%
NMO	-0.37%	-10.85%	31.82%
REMPG	31.38%	-5.9%	90.7%
INC	$10496	$7883	$12930
RINCG	95.9%	63.6%	139.7%
TEMPV	32.3	16.4	44
CRRT	0.033%	0.012%	0.067%
AGE	28.19	23.3	37.7
EDU	12.07	10.2	12.6
SIZE	1629200 persons	304000 persons	9974000 persons
AWDS	4.071	2.8	5.65
HDD	2550	139	4388
CDD	822.21	41	2396
REDUG	1.043%	1%	1.18%
RARFG	0.783%	0.075%	1.8%
RNATINC	1.33%	1.12%	1.8%
PMANEMP	0.607%	1.066%	21.2%
RUNEMP	0.044%	0.022%	0.14%

Table 2. Regional average growth rates

Region	North east	North central	South	West
Growth rate				
Income growth rate	91.6	96.6	99.2	93.7
Employment growth rate	15.8	18.2	41.9	55.0

The first model

The first model consists of five equations, five endogenous variables, and 15 exogenous variables. The endogenous variables include out-migration rate of young (OMRY), out-migration rate of old (OMRO), in-migration rate of young (IMRY) in-migration rate of old (IMRO), and rate of employment growth (REMPG). Specifically, the model is of the following form:

(1) OMRY = f_1 [IMRY, REMPG, INC, RINCG, TEMPV, CRRT, AGE, EDU, SIZE, AWDS, HDD, CDD, RUNEMP, e_1]

(2) OMRO = f_2 [IMRO, REMPG, TEMPV, CRRT, AGE, EDU, SIZE, AWDS, HDD, CDD, RUNEMP, e_2]

(3) IMRY = f_3 [OMRY, REMPG, INC, RINCG, TEMPV, CRRT, SIZE, AWDS, HDD, CDD, RUNEMP, e_3]
(4) IMRO = f_4 [OMRO, REMPG, TEMPV, CRRT, SIZE, AWDS, HDD, CDD, RUNEMP, e_4]
(5) REMPG = f_5 [OMRY, OMRO, IMRY, IMRO, INC, RINCG, SIZE, REDUG, RARFG, RNATINC, PMANEMP, e_5]

Where the endogenous and the exogenous variables definitions and data sources are as follow:

ENDOGENOUS VARIABLES

OMRY = Out-migration rate of young people; that is two times the number of young individuals who resided in the SMSA in question on April 1, 1975 but elsewhere on April 1,1980, divided by the 1970 population of young individuals [see 7, Table 7].

OMRO = Out-migration rate of old people; that is two times the number of old individuals who resided in SMSA in question on April 1, 1975 but elsewhere in 1980, divided by the 1970 population of old individuals [see 7, Table 7).

IMRY = In-migration rate of young people; that is two times the number of young individuals who resided in the SMSA in question on April 1, 1980 but elsewhere on April 1, 1975, divided by the 1970 population of young individuals [see 7, Table 10).

IMRO = In-migration rate of old people; that is two times the number of old individuals who resided in the SMSA in question in 1980 but elsewhere in 1975, divided by the 1970 population of old individuals, (see 7, Table 10].

REMPG = Rate of employment growth; that is the ratio of the 1980 to the 1978 level of employment of the SMSA, (see 8, Table 85 and 9, Table 120).

EXOGENOUS VARIABLES

RUNEMP = Rate of unemployment; that is the ratio of the 1970 unemployment level prevailing in the SMSA to the CLF of the SMSA in 1970 [see 8, Table 85 and 9, Table 120].

INC = Median 1970 income of persons residing in the SMSA in 1980 [see 8, Table 89].

RINCG = Rate of income growth; that is the ratio of the 1970 to the 1980 median income of persons residing in the SMSA [see 8, Table 89 and 9, Table 124].

SIZE = Total Population of the SMSA in 1970, [See 8, Table 24].

AGE = Median age of the population of the SMSA in 1970, [see 8 Table 24].

EDU = Median number of years of school completed by persons 25 years of age and over in 1970 [see 7, Table 83].

REDUG	=	Rate of education growth; that is the ratio of the 1970 to the 1980 median number of years of school completed by persons 25 years of age and over [see 7, Table 83 and 8, Table 119].
RARFG	=	Rate of change of armed forces personnel; that is the ratio of the 1970 to the 1980 number of armed forces personnel [see 7, Table 85 and 8, Table 120].
RNATINC	=	Rate of natural population increase; that is the difference between CLF growth rate and net migration rate.
PMANEMP	=	Percentage of the SMSA's 1970 employment in manufacturing [see 7, Table 87].
CRRT	=	Per capita crime rate; that is the ratio of total crimes in 1970 to the SMSA population in 1970 [see 10, Table 5].
TEMPV	=	A historical average annual temperature variance (F°): the difference between July's daily maximum temperature and January's daily minimum temperature, for many different years [11].
AWDS	=	A historical average wind speed: the sum of wind speed rate in January and July divided by two, for many different years [11].
HDD	=	Average heating degree days; a historical measure of cold for many different years [11].
CDD	=	Average number of cooling degree days, a historical measure of warmth for many different years [11].
e_1 to e_5	=	random errors.

The out- and in-migration equations

As shown above both the out-and in-migration equations are disaggregated into two age groups (young and old). Therefore, we have two out-migration equations, one for young (OMRY) and one for old (OMRO) migrants, and also two in-migration equations, one for young (IMRY) and one for old (IMRO). We assume that both young and old out-migration are affected by the same origin and destination characteristics (the same endogenous and exogenous variables), even though the magnitude of the effect might be different for the two age groups. Therefore, we include almost the same variables in each out-migration, by the same assumption, each of the in-migration equations has almost the same variables.

Out-migration and in-migration of both young and old are expected to be positively correlated with each other. Those places that have a lot of in-migration for both young and old are expected to have a lot of out-migration and vice versa. One reason for this phenomenon is that the more in-migrants to the SMSA, the more mobile the population of that SMSA, and therefore the more out-migrants from the SMSA. Greenwood [6] suggests that those people who have moved at least once are more likely to migrate than those who have not moved at all, Renshaw [12] argues that areas that have much in-migration tend to have much out-migration because those in-migrants are "chronic movers".

Generally, the young people are expected to be more sensitive to variables such as rate of employment growth, rates of income growth, unemployment, etc., whereas the old people are expected to be more sensitive to the amenity variables such as crime rates, temperature variance, annual wind speed, etc. This reasoning is based on the assumption that young people are members of CLF and the old people are retired. Therefore, variables like employment and income growth rates will be a major component of the young migrants' decision function of whether to migrate or not, whereas the amenity variables will be the major component of the same decision function for the old migrants. These old migrants have already accumulated their wealth and are looking for a place to spend their wealth and enjoy the rest of their lives in places with more amenities. There are some exceptional cases in which the old people will pay more attention to the employment and income growth variables, when they are planning to work part time or when they are accompanied by someone who is a member of the civilian labor force, such as a wife.

It is generally expected that for young people greater rate of employment growth, which is a measure of job opportunities in an area, will decrease the out-migration rate of young and increase the in-migration rate of young to the area in question, *ceteris paribus*. Moreover, young migrants are expected to move to areas with relatively high income levels and relatively high income growth rates, and move out from areas with relatively low income and relatively low income growth rates, *ceteris paribus*. The higher rate of unemployment is expected to increase the out-migration rate of the young and decrease their in-migration rate, *ceteris paribus*. The same expectations could be made from the effect of the above variables in the out- and in-migration of the old people, but as mentioned before, it will be a lesser effect.

The annual temperature variance is expected to encourage relatively more old in-migrants than young, and discourage relatively more old out-migrants than young, *ceteris paribus*. SMSAs with high cooling degree days, which is a measure of warmth, are expected to be more attractive to old in-migrants than young, and SMSAs with high heating degree days, which is a measure of coldness, are expected to be less attractive for old in-migrants, *ceteris paribus*. Windy places are less desirable for both age groups, but as an amenity variable, windy SMSAs will discourage old people more than young people. It is expected to encourage out-migration of old people more than young and discourage in-migration of old people more than young, *ceteris paribus*.

Young and old migrants are expected to move out from areas with high crime rates and to areas with low crime rates. The size of the area, which is measured by the population, is expected to affect negatively both the young and old decision to migrate, so we expect more young and old in-migration to less populated areas and more young and old out-migration from more populated areas.

Certain personal characteristics such as age and education are very important determinants of the individual's decision to migrate. Older people have a lower tendency to migrate for one or both of the following reasons. First, they have established more family and other ties. Second, the rate of return on migration is lower for them due to their shorter expected life. Therefore, *ceteris paribus,* out-migration rates for both young and old is expected to be lower, the higher the median age of the area in question. Furthermore, more educated people have a higher tendency to migrate because education tends to reduce the importance of tradition and family ties. Therefore, *ceteris paribus,* out-migration rates for both of the age groups is expected to be higher, the higher the level of education of the area in question. Both age and education are meant as characteristics of the places from which the migrants are being drawn, and they are not included in the in-migration equations of young and old, in order to assist in identifying the other equations of the system.

The employment growth equation

In this model, the rate of employment growth equation is assumed to be a function of four endogenous variables (OMRY, OMRO, IMRY, IMRO) and seven exogenous variables. It is generally expected that employment growth is positively related to in-migration and negatively related to out-migration. The young migrants will have a bigger impact on the employment growth than old migrants. The out-migration of young people tends to decrease the rate of employment growth, while the in-migration of young people tends to increase it. With a smaller impact, the out-migration of old people tends to decrease the rate of employment growth and the in-migration of old people tends to increase it. Usually the old in-migrants, who are assumed to be retired, bring capital and assets with them which affect labor demand in those areas and do not contribute to labor supply to meet that demand, which result in shift in the area labor demand curve only. That will attract more young in-migrants to meet the demand that has been created by the old-migrants, and that will cause a shift in both labor supply and demand curves. Therefore, we expect a bigger impact on the employment growth equations from the young than the old.

It is expected that areas with relatively high income levels and relatively high income growth rates have a high rate of employment growth, because high income means high demand for goods and services, and therefore, more production and employment. By the same reasoning, the size of the area, which is measured by population, and the rate of natural increase are expected to be positively related to the rate of employment growth. Education growth is expected to have a positive impact on the employment growth equation. The growth of armed forces personnel is expected to have positive signs, because the more armed forces personnel, the more job opportunities for the CLF members. Lastly, the percentage of the area employment in manufacturing is expected to have a negative sign which means the higher the employment rate in the manufacturing sector, the lower the employment rate in the other sectors. That could be attributed to some reasons such as the reduced share of manufacturing, the reduced levelof manufacturing, and various disamenities.

The second model

The second model consists of five equations (three structural and two identities), three endogenous variables and 15 exogenous variables. Specifically, the model is of the following form:

(1)	NMY	=	f_1 [REMPG, INC, RINCG, TEMPV, CRRT, SIZE, AWDS, HDD, CDD, RUNEMP, e_1]
(2)	NMO	=	f_2 [REMPG, TEMPV, CRRT, AGE, EDU, SIZE, AWDS, HDD, CDD, RUNEMP, e_2]
(3)	REMPG	=	f_3 [NMY, NMO, INC, RINCG, SIZE, REDUG, RARFG, RNATINC, PMANEMP, e_3]
(4)	NMY	=	IMRY - OMRY ;
(5)	NMO	=	IMRO - OMRO ;

Where,

NMY = net migration rate of young people; that is, the in-migration rate minus the out-migration rate of young individuals.

NMO = net migration rate of old people; that is, the in-migration rate minus the out-migration rate of old individuals.

Other than NMY and NMO, each variable has the same definition as before, and the first two equations have the same interpretation as before. Now the third equation, which is the rate of employment growth (REMPG), is assumed to be a function of net migration rate of young and old people. It is expected to be positively related to net migration rate of young and old. That implicitly means REMPG is negatively related to out-migration rate of old and young and positively related to in-migration rate of old and young.

Generally, the above two models differ in the following way: The second model, as in Muth [1] and Greenwood and Hunt [4] uses a net migration variable; whereas the first model, as in Greenwood's [2] model, uses out- and in-migration variables. Greenwood [13] argues that the use of both out- and in-migration variables is preferable to the use of a variable relating to net migration for the following reasons. First, the use of net-migration involves a substantial loss of information about the system, because in- and out-migrants embody different human capital compositions. Second, certain factors that are relevant to explain out-migration are not relevant to explain in-migration. Third, the magnitude of the influence of certain factors on out-migration is likely to be different from the magnitude of the influence of these factors on in-migration. Lastly, the use of OMR and IMR allows account to be taken of differences in the determinants and consequences of each one.

Estimation of the Models

More than one technique is available for estimating simultaneous-equations models. Among those techniques are the two-stage least squares (2SLS) and three-stage least squares (35LS). The last is preferable to the first because 3SLS has greater symptotic efficiency for this study's over-identified models.* The 3SLS estimates of the two models are shown in Tables 3 and 4. The former shows the estimates for the first model, while the later shows those for the second model.

The two models have been estimated in double-logarithmic form where all data have been transformed to logarithms. In this study, the t ratios, which are the ratio of each estimated coefficient to its own standard error, give a rough indication of the statistical significance. When a coefficient has an expected sign, a one-tail test at the 10% level of significance ($t \leq 1.29$) is employed, and when a sign is not specified or when an unexpected sign is obtained, a two-tail test at the 10% level of significance ($t \leq 1.67$) is employed. Therefore, throughout this study, when a coefficient is described as being significant, that means it is significant at the 10% level or better.

Table 5 shows a comparison between the first and the second model summary of empirical results. The number of estimated coefficients in the structural equations was 55 for the first model and 29 for the second. The first model has the greater number of expected signs on the coefficient. Moreover, it dominates the second model in terms of the number of significant coefficients. The first model has 29 anticipated and significant coefficients while the second has 12. This comparison suggest that the first model specification is more appropriate than the second. This support Greenwood's [6] argument that the use of in- and out-migration variables in the model specification, which is the case of the first model, is preferable to the use of a variable relating to net migration, which is the case of the second model.

Empirical results of the first model (Table 3)

The OLS coefficients of determination R_s^2 are presented at the bottom of Table 3. The R_s^2 ranges from 0.94 (OMRY equation) to 0.79 (REMPG equation). Clearly, the out-migration equations had the highest best of fit among other equations.

* Greene [9] argues that in large models that have many predetermined variables, such as the models of the present study, the rank and order conditions are met trivially, and only the order condition should be verified. By examining the different equation in the two models, we find that ech one has excluded exogenous variables greater than the included endogenous variables, which means each equation is over identified. And therefore, the two models are overidentified and consistent estimation of all parameters is possible.

Table 3. 3SLS estimates of the first model

	Equation for				
	IMRY	**IMRO**	**OMRY**	**OMRO**	**REMPG**
OMRY	1.637				-0.440
	(3.37)				(-2.58)
OMRO		0.243			-0.010
		(3.30)			(-1.62)
IMRY			0.215		0.542
			(11.66)		(2.20)
IMRO				0.228	0.112
				(0.742)	(2.74)
REMPG	0.381	0.251	-0.273	-0.012	
	(2.71)	(1.31)	(1.83)	(0.02)	
INC	-0.457*		-0.154		0.123
	(-0.09)		(-1.46)		(1.24)
RINCG	0.560		-0.338		-0.105*
	(2.10)		(-2.02)		(-1.18)
RUNEMP	-0.152	-0.052	-0.117	0.182	
	(-0.90)	(-1.14)	(-1.06)	(0.81)	
EDU			0.270	1.674	
			(2.47)	(1.71)	
AGE			-0.072	-0.530	
			(-.88)	(-1.62)	
SIZE	-0.026	0.134*	0.016	-0.084*	-0.013
	(-0.42)	(1.76)	(0.40)	(-1.29)	(-1.87)
CRRT	0.365*	-0.072	0.243	0.040	
	(1.09)	(-0.37)	(0.23)	(0.25)	
TEMPV	1.301	1.320	-0.789	-0.973	
	(2.41)	(4.64)	(-2.31)	(-1.54)	
AWDS	-0.471	- 0.346	0.301	0.295	
	(-1.39)	(- 0.86)	(1.40)	(0.90)	
HDD	-0.481	-0.942	0.301	0.921	
	(-2.07)	(-3.46)	(2.03)	(1.93)	
CDD	-0.275*	-0.367*	0.174*	0.861*	
	(-1.09)	(-1.05)	(0.97)	(1.26)	
REDUG					-0.631*
					(-2.34)
RARFG					0.010
					(0.75)
RNATINC					1.031
					(3.14)
PMANEMP					-0.001
					(-2.11)
OLS R^2	0.93	0.89	0.94	0.91	0.79

*indicates unexpected sign.

t-values between parantheses

Table 4. 3SLS Estimates of the second model

	Equation for		
	NMY	NMO	REMPG
NMY			1.029
			(6.23)
NMO			0.608
			(3.85)
REMPG	0.561	0.251	
	(3.76)	(2.05)	
INC	0.076		0.003
	(1.41)		(0.93)
RINCG	0.835		-0.033*
	(1.04)		(-0.73)
RUNEMP	0.041*	-1.904	
		(0.74)	(-1.15)
EDU		2.73	
			(1.75)
AGE		-0.571*	
			(1.67)
SIZE	-0.131	0.228*	-0.001
	(0.47)	(1.93)	(-0.34)
CRRT	0.634*	-0.530	
	(1.24)	(-0.38)	
TEMPV	0.731	1.502	
	(1.98)	(4.57)	
AWDS	0.828*	-0.726	
	(1.31)	(-1.02)	
HDD	0.625*	-0.912	
	(1.48)	(-2.62)	
CDD	0.375	0.401	
	(1.66)	(1.56)	
REDUG			-0.173*
			(-1.20)
RARFG			-0.006*
			(-0.95)
RNATINC			1.03
			(11.59)
PMANEMP			-0.001
			(-0.12)
OLS R^2	0.90	0.85	0.72

* indicates unexpected sign.

t-values between parantheses

Table 5. Estimated coefficients statistics

Coefficient / Model	First model	Second model
Estimated coefficient	55	29
Expected sign	45 (82%)	20 (69%)
Expected and significant*	29 (53%)	12 (41%)

*Significantly different from zero at 10 percent level ($t \leq 1.29$ for one-tail test; $t \leq 1.67$ for two-tail test)

Migration equations

The results strongly support the hypothesis about the opposite direction movement of out- and in-migrants relative to each other. More young (old) in-migrants result in more young (old) out-migrants, and the opposite is also true. The coefficients of the OMRY, OMRO, and IMRY in their corresponding equations are positive, as expected, and significant, while the coefficient of the IMRO in the OMRO equation is as expected but not significant. The results show that approximately two young in-migrants will result in one young out-migrant, and the same interpretation could be applied to the other three coefficients.

The young migrants are responsive to employment opportunities in their out- and in-migration decisions. The coefficients of the employment growth variable is positive in the young in-migration equation and negative in the young out-migration equation and that is expected. The greater rates of employment growth significantly encourage young in-migration and significantly discourage young out-migration. Moreover, the old migrants are also responsive to employment growth in their in-migration decision. The greater rates of employment growth significantly encourage old in-migration, which is expected for the reasons given in the previous section of the paper.

Both the income level and income growth rate variables have the anticipated sign in the young out-migration equation. Greater rates of income growth and higher levels of income significantly discourage young out-migration, whereas the higher rates of income growth only encourage young in-migration. The income level variables have an unexpected sign in the young in-migration equation, but it is not significant. Generally, the performance of the income variable in the young migration equations is consistent with several earlier studies that suggest that income is a major determinant of migration and this gives little suport to Greenwood's [15] argument that income neither affects migration, nor is affected by it.

The rate of unemployment variable has the anticipated sign in the in-migration equations for both young and old, but it is not significant for either one. Moreover, it has the expected sign for the old out-migration and unexpected for the young. Greenwood [16] attributes the low performance of the unemployment variable in the migration equations in many labor and migration studies to some of the following reasons. First, the unemployment rates pertain to a small fraction of the labor force. Therefore, studies that aggregate both employment and unemployment rates may not reflect the importance of unemployment. Second, job turnover rates are found to be more relevant than unemployment rates because migrants are more concerned about job turnover rates. Third, migration is a function of asset accumulation, and unemployed people have a lack of such assets; thus, the probability of migration declines with the increased duration of unemployment, which reflects a decreased accumulation of assets.

The education variable in the out-migration of both young and old has a significant and expected positive sign, which supports our hypothesis that as people get more education, they become more mobile, and have a higher probability of leaving than do those with less education. The coefficient of the age variable in the out-migration equation is negative for both age groups but it is only significant for the old. This result supports the hypothesis that as people get older they become less mobile.

The city size variable has the expected sign in the young out- and in-migration equations, even though they are small and insignificant. Moreover, the same variable has an unexpected sign in the old out- and in-migration equations. This result could be explained by one of the following three reasons: First, the older people might be attracted to places that have a lot of old people, which is true for big cities, especially if they are retirement centers; second, it could be that old people are less concerned about the city size because they are not looking for job or education opportunities; third, usually old people are more concerned about amenities, and it could be that the bigger the size of the city, the more amenities they have. The results show that the coefficient of the crime-rate variable is positive in the old out-migration equation and negative for the same age group in-migration equation, but it is not significant for either one.

Temperature variance has a significant and expected sign for both young and old out- and in-migration equations, which is consistent with Graves and Regulska's [5] results. The higher temperature variances encourage in-migration and lower temperature variances discourage out-migration for both age groups. Moreover, the average wind speed variable coefficients have expected signs for both the young and old out- and in-migration equations. This variable is positively correlated with out-migration equations and negatively correlated with in-migration equations. The heating degree days variable has an expected and significant sign in all the four equations. This means young and old people are more attracted to warm places, and the old people are more sensitive than the young people toward that variable. Finally, the cooling degree days variable has unexpected signs for both the young and old equations, but the values of the coefficients are less than the values of the heating degree days coefficients. Thus, the net of those coefficients will support our above argument with respect to the heating degree days.

In general, regarding the amenity variables (TEMPV, AWDS, HDD, CDD), by comparing the size of the coefficients of the young and the old migrants, we find that the size of those coefficients for the old are greater than for the young and that means the results are consistent with our earlier hypothesis that amenities are more important and more attractive to the old migrants than to the young migrants.

Employment growth equation

The empirical results of employment growth rate equation tend to support our earlier expectations about the effect of in- and out-migration of both age groups on employment growth. Greater rates of young and/or old out-migration significantly discouraged employment growth, whereas greater rates of young and/or old in-migration significantly encouraged such growth. These results show the important role of migration variables in causing employment growth in large SMSA. Combining this with the previous result that shows the dependency of migration on employment growth provides strong evidence to Muth [1] mutual causation approach of migration and employment growth.

The income level seems to have a positive effect on the rate of employment growth equation, whereas the rate of income growth has a negative effect on that equation, but it is not significant. The size of the SMSA, which is proxied by the population of the SMSA, has a significant coefficient, which means that there is a low rate of employment growth in larger places, and that could be reconciled with a previous result that the old people tend to move to large places because they are less concerned with economic variables such as employment growth rates. The rate of education growth variable has an unexpected negative sign, which means that a higher rate of education growth tends to decrease the rate of employment growth. This finding could be due to the fact that a lot of those big cities attract educated people who leave directly after completing their education.

The rate of change of armed forces personnel has an expected positive sign. The rate of natural increase is significant and positively related to the employment growth rate, which is expected. Finally, the percentage of manufacturing employment is significant and negatively related to the employment growth rate, which is also expected. This means that the higher the employment rate in the manufacturing sector, the lower the growth of employment.

Empirical results of the second model (Table 4)

As shown in Table 4, the OLS coefficients of determination (R^2) is 0.90 for NMY equation and 0.85 for NMO equation. This indicates that the first migration equation had the highest best of fit. The determination coefficient for the employment growth equation was 0.72 . With the exception of young and old net-migrants variables, all other variables in the second model are common to the first model. Therefore, the interpretation of the estimated coefficients of these variables in the second model is similar to the ones of the first.

The coefficient of the rate of employment growth variable in the young and old net migraion equations is positive and highly significant in both equations and it equals to

0.561 in the first and 0.251 in the second. This result means that each additional job attracts both young and old migrants. More specifically, for each 100 incremental jobs in the area, 56 of them are filled by young migrants and 25 by old migrants. This means young and old migrants replaced the indigenous residents with different effects. And these two age group migrants share the indigenous residents in accommodating local incremental employment.

The coefficients of the young and old net-migration variables in the employment growth equation are positive and highly significant and it equals to 1.029 for the young and 0.608 for the old. This result means that young migrants result in an increase in employment equal to their own contribution to it. This major finding which has not been shown before means that total employment increased by the same amount as the young migrants' contribution to it and increased by less than the old migrants' contribution to it. Generally, the results of the second model give strong support to the mutual causation hypothesis that each age group migration and employment growth are jointly dependent and each affects and is affected by the other.

It is possible to get the same conclusion from the first model by computing the coefficient of the employment growth variable in the net-migration equation. Since the net-migration for each group is defined as the difference between the in-migration and out-migration rate equation for the same age group. The coefficient of employment growth variable in young net-migration equation equals the coefficient of IMRY (0.381) less the coefficient of OMRY (-0.273), or 0.654. According to this model, for each 100 incremental jobs in the area, 65 of them are filled by young migrants. For the coefficient of young net-migration variable in the total employment growth equation, it is calculated by subtracting the OMRY coefficient (-0.440) from the IMRY coefficient (0.542) and it equals (0.982). This means, as before, young migrants result in an increase in employment equal to their own contribution to it. These results are consistent with the second model results discussed before and both lead to the same conclusion.

Finally, Table 6 summarizes the above results and compares them with Muth [1] and Greenwood and Hunt [4] results using the young migrants' coefficient of both models in that comparison, because the old migrants are assumed to be retired, so they neither affect

Table 6. A comparison between the two models and alternative studies

Change / Model	Muth model (1971)	G&H model (1984)	The first model	The second model
$\frac{\partial NM}{\partial REMPG}$	0.67	0.45	0.56	0.65
$\frac{\partial REMPG}{\partial NM}$	1.00	1.29	1.03	0.98

nor are they affected by the employment growth rates.

Summary and Conclusion

This study uses two different model specifications of employment and age specific-migration. One specification deals with out- and in-migration as the dependent variables, and the other deals with net migration as the dependent variable. Also, the migration variable in both specifications has been disaggregated into two age-specific groups, young and old.

With that construction of the two models, more than one hypothesis have been tested. This study gives an evidence to Greenwood's argument that the use of in-and out-migration variables is more appropriate than the use of a variable relating to net-migration. One of the major findings of this study, which has not been shown before, is that total employment increased by the same amount as the young migrant's contribution to it and increased by less than the old migrant's contribution to it. The empirical results of the two models for both old and young support the hypothesis of the causal relationship between migration of each age group and employment growth rates, and the hypothesis of the opposite direction movement or the causal relationship between the out- and in-migration variables. Also, the empirical results support the hypothesis that non-economic variables are more attractive to the old than to the young and economic variables are more attractive to the young than to the old.

In order to push this study forward, the following suggestions are provided. First, some of the main variables could be disaggregated. For example, the out-and in-migration variables, besides or alternative to the age disaggregation, could be disaggregated by gender, color, and skill; the employment growth variable could also be disaggregated by sectors and occupation; the income variable could be disaggregated by earnings income (wages) and non-earnings income, which means we have wages explicitly in the system; and the crime rate variable could be disaggregated to crimes against people and crimes against property. Second, some of the above exogenous variables, such as income and natural increase, could be treated as endogenous variables in the system. Also, some dummy variables could be added to show the attractiveness of different parts of the country to migrants. Third, more amenities could be added in their exogenous and endogenous forms; exogenous amenities like all kinds of weather conditions, which are the ones we have in our models, and endogenous amenities like pollution and crimes. Fourth, in estimating the above two models, different migration measures such as population and civilian labor force (CLF) measures could be used in calculating the out-and in-migration rates. Also the absolute value of the total out- and in-migration could be used directly as an alternative way of using the rates. Finally, a major step in developing the two models could be taken by expanding the data base of the model to include three or four decades, rather than just one decade, to follow the changes in the key variables of the model for those decades, and derive from that some implications that can be implemented in the future.

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نموذجا معادلات آنية للتوظف والهجرة حسب فئات العمر

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ملخص البحث . يقوم هذا البحث بمقارنة واختبار توصيفين مختلفين لنموذج اقتصادي قياسي آني للتوظف والهجرة حسب فئات العمر، التوصيف الأول يقوم على استخدام معدلات الهجرة الكلية للداخل والخارج لمجموعة مدن أمريكية، والثاني يقوم على استخدام معدلات صافي الهجرة لهذه المدن وذلك بالنسبة لفئتي عمر مختلفتين هما الصغار (فئات القوى العاملة) والكبار (المتقاعدين) . تهدف هذه الدراسة بصفة أساسية إلى تحديد النموذج القياسي الأكثر ملاءمة في دراسات الهجرة حسب فئات العمر، وكذلك معرفة التأثير المتبادل بين هجرة كل فئة ومستوى التوظف من جهة ومدى جاذبية بعض المتغيرات الاقتصادية وغير الاقتصادية لكل فئة من جهة أخرى . أوضحت النتائج الإحصائية أن استخدام التوصيف الأول يفضل على الثاني في الدراسات المتعلقة بالهجرة الداخلية وأن هناك علاقة تبادلية بين هجرة كل فئة ومستوى التوظيف . كما تبين من الدراسة أن المتغيرات الاقتصادية ذات تأثير في فئات القوى العاملة أكبر من المتقاعدين والعكس بالنسبة للعوامل غير الاقتصادية .

ينقسم البحث إلى أربعة أجزاء رئيسة، الجزء الأول يناقش طبيعة البيانات المستخدمة في الدراسة، أما الجزء الثاني فيوضح معادلات النموذج المستخدم في كل توصيف والمعنى الاقتصادي لهذه المعادلات وكذلك الافتراضات المستخدمة في الدراسة . كما يتم في الجزء الثالث بيان طريقة التقدير والنتائج الإحصائية، أما الجزء الرابع والأخيرة فيقدم خلاصة هذا البحث وأهم النتائج وبعض الاقتراحات لتطوير البحث .