The Stock Adjustment Model of

Migration: The Scottish Experience

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Abstract

The many models of migration depict the various reasons why people move. The stock adjustment model of migration assumes the heterogeneity of individuals, while the flow models of migration assume individuals to be homogenous. Using the Scotland data we get different results compared to the previous studies, at least in the effect of house prices on the migration decision.

Keywords: Migration, Stock Adjustment Model, Scotland

1. Introduction

There are many approaches to the study of why people move. The classical approach suggests wage differentials as the main determinant of migration between regions. Migration is taken to be "costless" and without risk in this approach. The human capital approach introduced by Sjaastad (1961) treats migration as an investment in human capital that involves costs and returns. The costs and benefits include both monetary and non-monetary costs.

There are many facets of search theories that have emerged from the basic search strategies initiated by Stigler (1961, 1962). Search theory has also been useful in the study of migration; it shows how migration decisions may involve different stages. The stages include: the decision whether to be involved in the search process; the decision when to stop searching upon receiving an acceptable offer. When the optimal stopping rule is observed, search will stop and an offer accepted when the net present value of the offer received is greater or equal to the reservation NPV.

Gordon and Vickerman (1982) focus, in effect, on contracted migration. They construct a general decision making framework in which the probability of migration taking place is expressed as the product of the probabilities related to migration. The probability of receiving an offer is simplified in the basic search model by assuming a fixed rate at which offers are generated, for example once a day.

As for speculative migration, since it is considered as part of the search process it is quite difficult to differentiate it from the search process *per se*. Once an individual has decided to enter the search process he/she is effectively involved in a speculative form of migration because in the process of searching for opportunities he/she may need to move from one region to another.

Gravity models have been widely used in the study of migration processes. Their early use was highlighted by Ravenstein who argue that in studying migration stream the analyst should consider both the numbers of people in the origin and the destination locations. The basic gravity model of migration emphasises that the migration process between any pair of regions depends on the size of the population in each region and the distance attributes between the two regions.

While the flow model suggests that migration involves the responses of homogenous individuals reacting to changes in the determinants of migration in much the same way, the stock adjustment model has rather different implications. In the stock adjustment model individuals are assumed to be heterogeneous, as reflected in a distribution of expected net present values of migration decisions across individuals. This has fairly radical implications for the appropriate specification of the net migration function.

2. The Stock Adjustment Model

In the stock adjustment model we make several assumptions. The key point here is that we assume that migrants are heterogeneous and may respond quite differently in response to any given change in the variables relevant to the migration decision. People have different psychic transaction costs or may value amenities differently and so the expected net present value from migration varies, possibly significantly, among individuals.

Suppose individuals expected net present values of migration are distributed in accordance with

the solid line as shown in Figure 1.

The origin, O, coincides with a zero expected net present value (NPV) associated with migration. Hence only those who are in the upper tail of the distribution of expected NPVs - above that value of expected NPV - become movers. Those whose expected NPV is below zero are stayers. When the real wage increases in the destination region relative to the region of origin, there will be a shift in the distribution from D1 to D2, with more people being movers than before, but in general there will be more stayers than movers as illustrated by the distribution.

Since people are different, as wages increase in Scotland their expected net present value associated with migrating to Scotland increases. But due to the nature of the distribution across individuals not many households still wish to stay and there is a limited number of new movers as a consequence of the shift in the distribution of expected NPVs. This raises the possibility that the numbers induced to migrate may well be insufficient to restore wage and unemployment differentials, for example. This contrasts with the implications of Harris-Todaro (1970) and Layard *et al* (1991). Notice that we have not actually identified the variables that enter the computation of the expected value of NPV here. The argument is therefore valid with respect to any set of determining variables. For example, if it is wage and unemployment differentials that "matter", the argument implies that net migration flows occur here in response to the *first differences* of wage and unemployment rates, and not their *levels*. As we shall see, this apparently minor alternative specification of the net migration function may have significant consequences for the behaviour of regional economies.

3. Empirical Findings: The Stock Adjustment Model

Here we focus to report on our results using the Stock Adjustment Models of migration. Previous models are all of the flow adjustment variety, which as our analysis in (Baayah, 2007) chapter 3 argues, appear to be based on an implicit assumption of homogeneity among migrants. Allowing for heterogeneity, for example in the form of a distribution of expected psychic migration transactions costs, suggests that a stock-adjustment formulation may be more appropriate. The stock adjustment equation we estimate follow the following form

$$\text{NMGRATE}^{SA} = \beta_0 - \beta_1 \Delta(rw_S - rw_{RUK})_t + \beta_2 \Delta(u_S - u_{RUK})_t + \beta_3 \Delta(p_S - p_{RUK})_t$$

Where Δ is the first difference operator, capturing the stock adjustment specification, and the other variables are as defined.

Data from 1970 to 1994 are used in describing the pattern of migration and the testing of previous net migration models. Although most data are available earlier, the data on wages are only available from 1970.

We estimate the stock adjustment models that we think can be used to explain Scottish-RUK migration data.

We start by regressing the most general form of the stock adjustment model as given by equation 1 of table .1.Only the change in the price variable between Scotland and RUK is significant at the 5 per cent level but has the opposite sign to that predicted by theory. The time trend and the lagged dependent variable are both insignificant at the 5 per cent level. The R^2 value implies the model explains 74% of variation in the dependent variable. There is no evidence of serial correlation or functional form problems. The diagnostic test result does not reject the null hypotheses of normality and homoscedasticity in the residuals. Next we drop the lagged dependent variable from our regression. In equation 2 the result shows that the change in price variable remains significant at the 5 per cent level with a larger t-value than before. However it maintains the sign opposite to that predicted by theory. The time trend now becomes significant at the 5 per cent level. The negative sign indicates that the dependent variable tends to decrease over time. The DW statistic is very close to 2, which implies that there is no evidence of serial correlation in the residuals. This result is confirmed by the other diagnostic test of serial correlation. There is also no evidence of serial correlation or functional form problems. The diagnostic test result does not reject the null hypotheses of normality and homoscedasticity in the residuals. Next, based on the t-values we omit the change in vacancy variable from our regression. The result is given in equation 3. The change in real wage is not significant at the 5 per cent level but has the expected sign. The change in the unemployment rate between Scotland and RUK also remains insignificant at the 5 per cent level and maintains the expected sign. The change in price between Scotland and RUK maintains to be a significant variable but still has the sign opposite to that predicted by theory. The time trend remains significant at the 5 per cent level. The R^2 decreases slightly which implies the model is a worse fit. The DW statistics is greater than 2 which indicate negative autocorrelation of the residuals (e.g. Johnston 1984). This is not corroborated by the other diagnostic test for serial correlation, however. There is also no evidence of a functional form problem in the model. The diagnostic test result does not reject the null hypotheses of normality and homoscedasticity in the residuals.

Next we omit the change in unemployment variable from our regression. We also reintroduce the change in vacancy variable into our model to see whether the change in vacancy will have significant effect on net out migration variable when the change in unemployment is excluded from the regression. The result given in equation 4 indicates that the real wage now becomes significant at the 5 per cent level and has the expected sign. This result supports the theory that people move from low wage to high wage regions. Thus the higher the real wage in Scotland relative to RUK fewer people will migrate from Scotland to RUK. The change in vacancy variable remains insignificant at the 5 per cent level. The price variable remains significant at the 5 per cent level and maintains the negative sign as before. The time trend variable remains significant at the 5 per cent level with a lower standard error. The negative sign implies that the net out migration from Scotland to RUK decreases over time. The R^2 value implies that the model explains 70% of the net out migration flow from Scotland to RUK. The DW statistic of 2 implies there is no autocorrelation in the residuals. The diagnostic test result also implies that there is no evidence of serial correlation and functional form problems. The diagnostic test result does not reject the null hypotheses of normality and homoscedasticity in the residuals.

Finally we omit the change in the vacancy variable from our regression. The result is shown in equation 5. The change in real wage remains significant at the 5 per cent level and maintains the expected sign. The standard error has also reduced. The change in price variable also remains significant at the 5 per cent level and maintains the previous sign. Its standard error has also decreased. The time trend variable also remains significant at the 5 per cent level and the standard error has also decreased. The R^2 value remains unchanged and the corrected R^2 does not change very much, indicating the change imposed on the model is acceptable. The DW statistic of 2 means that there is no evidence that the residuals are not autocorrelated (Johnston 1984). The standard error of the regression has decreased which means equation 5 can be a better model than equation 4. There is no evidence of serial correlation and functional form problems. The diagnostic test result also indicates that the test for normality and homoscedasticity gives affirmative result. We also conduct the parameter stability test for all our models discussed above using the CUSUM and CUSUM-SQ methods. The results provide evidence of parameter stability in all our stock adjustment models. Given the above findings we conclude that equation 4 and equation 5 are among the best statistical models that could be used to describe the net out migration flows between Scotland and RUK, although the unexpected sign on house price variables limits the genuine explanatory power of the model if we follow the old believe that cheaper house prices will encourage the move from the origin to the destination region. Perhaps the present day scenario is different, cheap housing is not an attraction (to the migrants) but comfortable accommodation is. So the fact that the house price variable has a non conventional sign is acceptable and do show a change in the ways variables affects a migration decision.

4. Conclusions

Much had been said about the patterns of migration in the UK and elsewhere. The flow model suggests that migration involves the response of homogenous individuals reacting to changes in the determinants of migration in much the same way, the stock adjustment model has rather different implications. . In the stock adjustment model individuals are assumed to be heterogeneous, as reflected in a distribution of expected net present values of migration decisions across individuals. This has fairly radical implications for the appropriate specification of the net migration function.

References

Adams, D.W. (1980a). Migration From Scotland to the Rest of The United Kingdom. ESU Discussion Paper No. 10. Scottish Economic Planning Department.

Gordon, I and Vickerman, R. (1982). Opportunity, Preference and Constraint: An Approach to the Analysis of Metropolitan Migration. *Urban Studies,* vol. 19, pp. 247-261.

Green, A. E. A Question of Compromise? Case Study Evidence on the Location and Mobility Strategies of Dual Career Households*. Regional Studies,* vol. 31, no.7, pp. 641-658.

Greenwood, M.J. (1985). Human Migration: Theory, Models, and Empirical Studies. *Journal of Regional Science,* vol. 25, pp. 521-44.

Harrigan, F.J, McGregor, P.G. and Swales, J.K. (1996). The System-Wide Impact on the Recipient Region of a Regional Labour Subsidy. *Oxford Economic Papers,* vol. 48, pp. 105-133.

Harris, J.R. and M. Todaro (1970). Migration, Unemployment and Development: A Two-Sector Analysis. *American Economic Review*, vol. 60, no.1, pp. 125-42.

Hart, R.A. (1975a). Interregional Economic Migration: Some Theoretical Considerations (Part I). *Journal of Regional Science,* vol. 15, no.2, pp.127-138.

Johnston, J. (1984). Econometric Methods. Tosho, Japan.

Layard, R., Nickell, S. and Jackman, R. (1991). Unemployment: Macroeconomic performance and the Labour Market. Chaper 6, Oxford.

McGregor, P.G., Swales, J.K. and Yin, Y.P. (1996b). Some Simple Macroeconomics of Increased Accessibility and Spatial Integration: The Case of a Small Open Region. Fraser of Allander Institute and ICMM Department of Economics, University of Strathclyde.

Molho, I. (1986). Theories of Migration: A Review. *Scottish Journal of Political Economy,* pp. 396-417.

Molho, I. (1995). Migrant Inertia, Accessibility and Local Unemployment.   *Economica,* vol. 62, pp. 123-132.

Ravenstein, E. G. (1885). The Laws Of Migration. *Journal of the Royal Statistical Society, 48,* pp. 167-235. (Cited in Plane, D. A. 1984. page 245, ibd.)

Richard Jackman and Savvas Savouri (1992). Regional Migration in Britain: An Analysis of Gross Flows Using NHS Central Register Data. *Economic Journal,* November, pp. 1433-50.

Sjaastad, Larry. A. (1962). The Costs and Returns of Human Migration. *Journal of Political Economy,* Supplement, October, pp. 80-93.

Stewart, Jon. (1991). Econometrics. chapters 1-4, University press, Cambridge.

Stigler, G.J. (1962). Information in the Labour Market.   *Journal of   Political Economy,* vol. 70, pp. 94-104.

Stigler, G.J. (1961). The Economics of Information.   *Journal of Political Economy,* vol. 69, pp. 213-255.

Todaro, M.P. (1969). A Model of Labor Migration and Urban Unemployment in Less Developed Countries.   *American Economic Review,* vol. 59, March , pp. 138-148.

Definition of variables used.

$(p_S-p_{RUK})_t = \log(HPS/HPUK)_t$

$\Delta(p_S-p_{RUK})_t = (p_S-p_{RUK})_t - (p_S-p_{RUK})_{t-1}$

$(rw_S-rw_{RUK})_t = \log(ES/EGB)_t$

$\Delta(rw_S-rw_{RUK})_t = (rw_S-rw_{RUK})_t - (rw_S-rw_{RUK})_{t-1}$

$(u_S-u_{RUK})_t = \log(URATES/URATEUK)_t$

$\Delta(u_S-u_{RUK})_t = (u_S-u_{RUK})_t - (u_S-u_{RUK})_{t-1}$

$(v_S-v_{RUK})_t = \log(VACU/VACS)_t$

$\Delta(v_S-v_{RUK})_t = (v_S-v_{RUK})_t - (v_S-v_{RUK})_{t-1}$

Lower case of the alphabet denotes the natural logarithm of the variables.

Variable	equation1	equation2	equation3	equation4	equation5
intercept	.0036	.0041	.0040	.0044	.0044
	(1.88)	(3.47)	(3.42)	(3.60)	(3.78)
$\Delta(rw_S-rw_{RUK})$	-.0454	-.0561	-.0517	-.0681	-.0676
	(1.05)	(1.97)	(1.86)	(2.37)	(2.59)
$\Delta(u_S-u_{RUK})$	.0029	.0033	.0024	-	-
	(1.19)	(1.67)	(1.43)		
$\Delta(v_S-v_{RUK})$	.0010	.0016	-	.8738E-4	-
	(0.42)	(0.88)		(0.05)	
$\Delta(p_S-p_{RUK})$	-.0123	-.0132	-.0124	-.0134	-.0134
	(2.92)	(3.89)	(3.81)	(3.79)	(4.08)
NMGRATE$_{(t-1)}$	.0944	-	-	-	-
	(0.34)				
T	-.8740E-4	-.9998E-4	.9602E-4	-.1104E-3	-.1099E-3
	(1.67)	(2.79)	(2.72)	(2.99)	(3.16)
R-Squared	0.74	0.74	0.73	0.70	0.70
R-Bar-Squared	0.65	0.67	0.67	0.63	0.65
DW Statistic	-	2.03	2.11	2.00	2.00
Durbin's h-stats	none	-	-	-	-
S.E	.9544E-3	.9291E-3	.9235E-3	.9742E-3	.9483E-3
Diagnostic Tests					
Serial Correlation CHI-SQ(1)	.11395[.736]	.023031[.879]	.15808[.691]	.024225[.876]	.029769[.863]
Functional Form CHI-SQ(1)	.86264[.353]	.98070[.322]	.35074[.554]	1.4319[.231]	1.3230[.250]
Normality CHI-SQ(2)	.13247[.936]	.0092844[.995]	.76732[.681]	.15115[.927]	.15871[.924]
Heteroscedasticity CHI-SQ(1)	.65750[.417]	.79222[.373]	.92204[.337]	1.1224[.289]	1.1278[.288]

D1

D2

movers

O

Expected NPV of migration