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## Migration In A Core-Periphery Model: Analysis Of Agglomeration In Regional Growth Centres

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**MIGRATION IN A CORE - PERIPHERY MODEL: ANALYSIS OF  
AGGLOMERATION IN REGIONAL GROWTH CENTRES**

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**Abstract**

The “new economic geography” has generated enormous interest in modelling the spatial aspects of an economy. Empirical analyses concerning these models, however, are still very rare. The present study, therefore, suggests a way in which migration patterns can be analysed to find microeconomic evidence for the core-periphery model. A simple framework is developed for the analysis of regional core-periphery tendencies. This method is applied to a study of the recent migratory trend in Finland in which most migrants are heading towards a few urban growth centres. The human capital of the in-migrants further enhances the growth prospects of those central regions, while the rest of Finland is faced with a “brain-drain” of young, educated migrants. The present study finds evidence for a slow but steady movement towards a regional core-periphery pattern of migration in Finland.

**KEYWORDS:** *Migration, growth centre, core-periphery model, human capital*

**JEL-classification:** O15, O18, R11, R23

## 1. Introduction

The emergence of the "new economic geography" is certainly the most exciting development to take place in regional economics in the 1990s. It has sparked a growing interest in modelling and analysing the regional aspects of the economy. Moreover, the theoretical discussion on the agglomeration and concentration of economic activities has given a new meaning to many observed patterns such as the European growth triangle, Silicon Valley etc. However, even though such patterns are widely recognised, there has been little empirical work concerning a model that could explain why economic activity tends to concentrate spatially, viz, the core-periphery model.

In regional economics two noticeable strands of investigation have emerged since the 1980s. Firstly, the debate on economic growth and convergence has dominated the empirical literature on regional development for most of the 1990s. Seminal work by Barro and Sala-i-Martin (1991) provided easy instruments for analysing international and regional economic growth, and the general consensus was that economic convergence has been taking place in most countries. Simultaneously, by way of contrast to the convergence literature, the issue of the economics of trade and agglomeration launched by Krugman (1991a) produced just as much enthusiasm, particularly among theorists. The outcome of the agglomeration literature was the revival of the so-called core-periphery model. The model predicts that most economic activity will ultimately take place in the core region of a given economy, whereas the periphery will become even more deserted as labour and firms move to the core.<sup>i</sup>

Regional development in Finland seemed to conform well to the framework provided by the neo-classical growth theory until the 1980s. Growth was relatively fast and regional economic differences were constantly narrowing owing to effective regional policy, the formation of the welfare state, a rising level of education, and labour migration (Kangasharju, 1998; Pekkala, 1999a). In the 1980s, however, this harmonious development abruptly ended, and by the 1990s fears were already being expressed about widening regional disparities. One reason for these worries are regional migration patterns, which have shown considerable concentration since the mid 1990s. Strategies for reducing the

possible negative effects in regions that experience excessive out-migration have been pondered in tandem by economists and politicians. However, the fact remains that migration flows are becoming increasingly concentrated every year. Moreover, if this development continues, the excessive concentration of the population in only a few regions will lead to a very uneven regional structure. Hence, the 1990s development in Finland provides an excellent framework for the setting predicted by Krugman (1991) and used in the present study: regional growth centres vs. the rest of the country.

Similarly, trends in other industrialised countries have followed the path predicted by Krugman's model. An extreme example is the US, even though Europe seems to be following closely behind (Krugman, 1991 and 1993a; Kim, 1995; Haaland et al, 1999). The forces driving this development are based on technological change, which has emerged in the demands for more advanced human capital, decreased transportation costs and better commuting possibilities (Beckman, 1994; Mokyr, 1994). Moreover, increased economic integration together with growing labour mobility has enforced the formation of core-periphery economies (Krugman and Venables, 1990; Baldwin and Forslid, 1997). On the other hand, centrifugal forces, such as land rents and immobile factors of production, tend to keep economic activity dispersed to some extent (Krugman, 1998), meaning that the economic geography in fact displays much less concentration than theoretically predicted.

The present study uses a simple core-periphery model for the empirical analysis of microeconomic data. The core-periphery model does not lend itself very easily to robust empirical testing as it is not analytically solvable (Forslid, 1999), and has therefore stimulated little empirical work. Further empirical work with micro data has often been called for (Krugman, 1998), and the present study seeks to respond to these demands. Hence, this paper concentrates on certain key assumptions of the model that eventually produce the actual process of agglomeration, and forms a microeconomic model around them. The aim is to study the most recent information (1994-96) provided by the population census in Finland, and divide the 85 subregions into a group of *growth centres* (Helsinki, Tampere, Turku, Oulu and Jyväskylä) and the *rest of the country*. As the mobility of labour is the central characteristic in the core-periphery model of divergent regional growth (Krugman, 1993a), migration is chosen as the centre of attention here.

The results indicate, firstly, that since the 1970s migrants have continued to move towards the core regions, and that those core regions have experienced rapid human capital accumulation. In other words, between 1975-95 the level of education has grown much more rapidly and the share of highly educated inhabitants has continuously been much higher in the core regions than in periphery. The micro-level results, on the other hand, reveal that it is indeed the “human capital component“ of the labour force that is moving to and residing in the core regions. The present study therefore finds empirical support for the core-periphery model, and suggests that, despite the slow rate at which the pattern is evolving, the threat of a core-periphery economy is imminent in Finland.

The rest of the paper is organised into five sections. The following section presents the standard core-periphery model, concentrating mainly on the aspects that are applicable here, i.e. the determination and role of regional migration, and derives an empirical model for the core-periphery migration framework. The subsequent section (section 3) describes the data and empirical methods. Section 4 presents the results concerning individual migratory behaviour considered in a core-periphery setting, and analyses regional development on the basis of both micro- and macro level observations. The last section concludes.

## **2. The model of economic geography**

### **2.1 A simple core-periphery model<sup>ii</sup>**

The model of geographic concentration radically departs from traditional growth models and abandons constant returns to scale. Instead, it assumes a dynamically evolving world with increasing returns, externalities and cumulative processes, which, however, are much more difficult to model<sup>iii</sup>. The simplest form of the core-periphery model contains only two regions, E and W, and uses the following basic assumptions: economies to scale, transportation costs and strong demand linkages. There are two types of labour: agricultural and manufacturing workers, who have a Cobb-Douglas utility function:

$$(1) \quad U = C_M^\pi C_A^{1-\pi}, 0 < \pi < 1;$$

where  $C_M$  and  $C_A$  are the consumption of manufacturing and agricultural goods, respectively, and  $\pi$  is the share of expenditure on the different varieties of M. Hence, there are also two types of production: firstly, agriculture is evenly distributed across the two regions and experiences perfect competition with constant returns. Secondly, manufacturing may take place in either (or both) region(s) and displays Dixit-Stiglitz monopolistic competition with increasing returns (Fujita et al, 1999). The aggregate production function in manufacturing is of the CES type:

$$(2) \quad C_M = [\sum C_i^{(\sigma-1)/\sigma}]^{\sigma/(\sigma-1)}, \sigma > 1.$$

Above,  $\sigma$  is the (constant) elasticity of substitution between the varieties of M. The economies of scale in manufacturing arise in the form

$$(3) \quad L_{Mi} = \alpha + \beta x_{Mi},$$

where  $\alpha$  is the fixed cost of manufacturing, which is incurred regardless of the amount of goods produced and  $x_{Mi}$  is the quantity of manufactures. (Krugman, 1991b)

The basic model produces three possible equilibria<sup>iv</sup>: The production is split fifty-fifty between E and W, all production takes place in E or all production takes place in W. Concentration happens if either region has some kind of historical advantage that starts the process of cumulative concentration, or if the share of manufacturing workers ( $S_M$ ) in E or W equals 0 or 1 for some other reason. This happens if the fixed cost of production is large, transportation costs are small or the share of footloose production is large. Traditionally, the reasons for the localisation of industries are the benefits to both workers and firms from pooled labour markets, better provision of intermediate goods and technology spill-overs.

The locality where agglomerations eventually take place can be determined either by history or expectations (Krugman, 1991d). Even small initial advantages can start the process of cumulative causation and lead to huge disparities over the long-run. Such initial asymmetries may, for example, come in the form of good geographical locations (Krugman, 1993c), the hub (port, airport) of a transportation network (Fujita and Mori, 1996), a long enough distance to the next centre, a large enough original population or the existence of an education facility generating human capital (e.g. a university). On the other

hand, agglomerations may be formed simply because everyone expects it to happen in a given location (Ottaviano and Puga, 1998). For the multi-region case, it is possible that several growth centres emerge. Krugman (1993b) shows that the number and location of cities can be examined according to the dynamics of the location for workers:

$$(4) \quad \Delta\lambda_j = \phi\lambda_j(\omega_j - \bar{\omega}),$$

where  $\lambda_j$  is the share of the manufacturing labour force in region  $j$ ,  $\omega_j$  is their real wage and  $\bar{\omega}$  is the average real wage. In general, the larger the number of regions, the more cities tend to be formed.

## 2.2 Migration in the core-periphery model

It should be obvious from the above that the migration of workers is an essential aspect of the cumulative process that leads to geographical concentration (Krugman, 1991a; Walz, 1996; Baldwin, 1997). Indeed, inter-regional labour mobility is the driving force behind agglomeration, particularly in the single-country context where industrial agglomeration can only take place in a given region if workers can be drawn from elsewhere in the economy (Ottaviano and Puga, 1998; Puga, 1998). Moreover, the mobility of human capital tends to result in agglomeration, regardless of whether physical capital is mobile or not (Forslid, 1999). Therefore, as the present study shows, studying migration patterns across regions reveals how likely the formation of a core-periphery economy actually is. Below, various strands of the core-periphery literature and micro econometric theory are drawn together to derive an empirical core-periphery migration model.

In the standard core-periphery model, migration is assumed to be governed by real wage differences. Workers choose an optimal migration time path in their attempt to maximise their lifetime utility.<sup>v</sup> Static expectations are assumed here for convenience.<sup>vi</sup> The law of motion for the migration of workers (Baldwin and Forslid, 1997) is

$$(5) \quad (dL/dt) / L = VL^*, \quad V = U_\tau - U^*,$$

where  $V$  represents the difference between the present values ( $\tau$ ) of utility. On the aggregate level we observe the flow of labour across regions, which is, clearly, proceeding from the periphery towards the core in most economies. However, the key assumption here



is that human capital, i.e. skilled workers, is moving to the core, whereas unskilled workers may well remain immobile (Forslid, 1999). We must therefore show that a person's skill-level has a positive impact on his net benefit from a move to a core region, which obviously increases the likelihood of such a move.

Note that, in reality, the perceived net benefit (perceived real wage or utility) of the migrant is never directly observed, but is present as a *latent variable* in the migration decision equation. In other words, the objective function (Baldwin, 1999)

$$(6) \quad \max \int_0^{\infty} e^{-\rho t} \{ \omega L + \omega^*(1 - L) - \gamma/2 [m^2/L(1-L)] \}; m = dL/dt$$

is not directly observable, but we do observe, for example,

$$(7) \quad \begin{aligned} M &= 0, \text{ if the individual does not migrate} \\ M &= 1, \text{ if the individual migrates to the core} \\ M &= 2, \text{ if the individual migrates to periphery.} \end{aligned}$$

This means that the individual has three alternatives, respectively  $U_0$ ,  $U_1$  and  $U_2$ , each of which brings him a given net benefit. Each of the alternatives in (7) can then be interpreted to imply the following:

$$(8) \quad \begin{aligned} U_0 &> U_1 \wedge U_0 > U_2, \text{ iff } M=0 \\ U_1 &> U_0 \wedge U_1 > U_2, \text{ iff } M=1 \\ U_2 &> U_0 \wedge U_2 > U_1, \text{ iff } M=2. \end{aligned}$$

The above suggests that we can use the *latent regression approach* (also called the index function approach), which is the basis for most binary or multiple choice models in econometrics (Greene, 1993), to analyse the agglomeration tendency of labour mobility.<sup>vii</sup> At this point we can bring in Fujita et al (1999) to derive *three conditions for the formation and sustainability of agglomeration*. Firstly, the condition for the agglomeration process to begin and for migration towards the core to continue can be written as

$$(9) \quad d\lambda_c/dt = \gamma(\omega - \bar{\omega})\lambda_c > 0,$$

where  $\lambda_c$  denotes the share of manufacturing workers in the core region and the average real wage is  $\bar{\omega} = \Sigma \lambda_r \omega_r$ . In other words, the core region acquires extra labour as long as the (discounted future) real wage exceeds that of the periphery. Moreover, when the core-periphery pattern is not fully complete (i.e.  $\lambda_c < 1$ ), the condition that such a structure is a

stable equilibrium towards which the system is moving is

$$(10) \quad \omega_c \geq \omega_p, \text{ for a small group of workers moving from } p \text{ to } c.$$

The third condition, with a complete core-periphery structure ( $\lambda_c = 1$ ), is simply that the sustainability condition (10) must hold for all workers.

By constructing a suitable definition for the concept of human capital and estimating (7) by multinomial logit, for example, we will find out how strong the core-periphery tendency is. Using (8), the sustainability of the core-periphery pattern can be established according to the latent regression approach: the second alternative  $U_1 > U_0 \hat{U} U_1 > U_2$  corresponds to the sustainability condition  $w_1 \geq w_2$  for migrants. Moreover, the individual's level of human capital should positively affect the probability to migrate to and stay in the core. If both the aggregate and individual patterns of migration follow the path described above, migration can be held as an agglomeration enforcing factor (Forslid, 1999; Puga, 1999). To summarise, the three hypotheses we hope to test are:

*Hypothesis 1:*

*Formation of a core-periphery pattern begins and persists if the perceived lifetime real wage (or utility) in the core exceeds the average. This is observed as  $d\lambda_c/dt > 0$ .*

*Hypothesis 2:*

*The as yet incomplete core-periphery pattern the economy is moving towards is a stable equilibrium if for a small number of workers a move from periphery to core results in higher lifetime real wages than if they remained in the periphery. Then the concentration becomes self-sustaining, and a shift in the level of transport costs will not de-stabilise the equilibrium.*

*Hypothesis 3:*

*A complete core-periphery pattern is sustainable if for all workers the lifetime real wage obtained by staying in the core is higher than if they moved from core to periphery.*

In the following empirical analysis these hypotheses are confirmed if, firstly, we observe continuous mobility from periphery to core at the aggregate level, accompanied by a growing level of human capital in the core. Secondly, for each individual to contribute to the sustainability of the core-periphery structure, we expect their human capital (education, youth) to positively affect their mobility to the core. Finally, to support the long-term

sustainability of the pattern, we expect to find a lower potential for out-migration and higher potential for remaining for those living in the core.

### 2.3 The formation of the core, and agglomeration enhancing forces

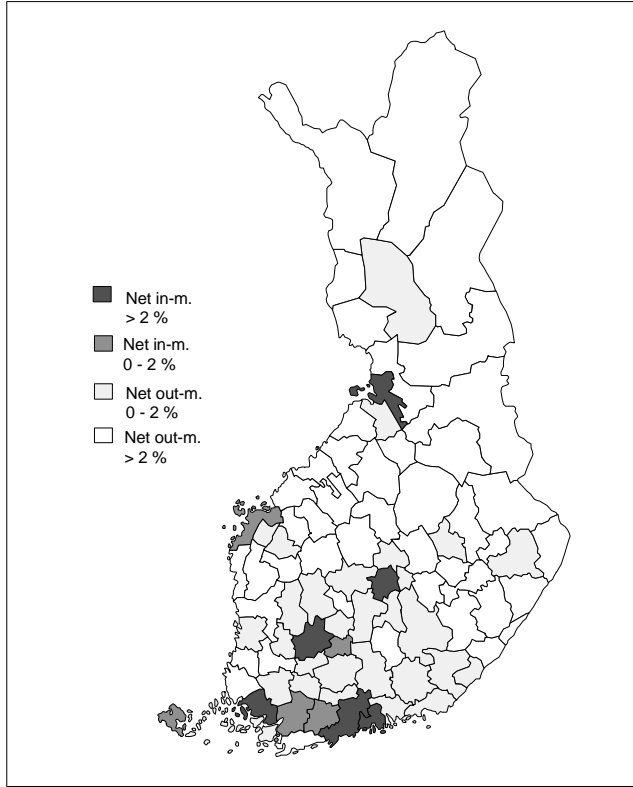
The emergence and formation of a core-periphery economy relies on different forces at different stages of the development of the economy in question. As noted above, major reasons for the start of agglomeration are falling transportation costs and increasing returns to scale. Over the last couple of centuries, especially, transportation has become easier and cheaper, which, together with improved access to telecommunications, has led to the increasing concentration of industry (Krugman, 1991b; Martin and Sunley, 1996). Economic integration has also been shown to reinforce agglomeration (Krugman and Venables, 1990; Baldwin and Forslid, 1997), and easier, more time-efficient commuting further increases the possibility of core formation (Beckman, 1994; Mokyr, 1994). Depending on the shape and size of the economy, the resulting structure may be one with a single central place or with multiple cores (Krugman, 1993b).

Once the formation of a core begins, the process tends to become self-reinforcing (Krugman, 1996). At this stage, the importance of demand linkages explains the crucial role of migration, as firms seek locations that are near their final consumers and where intermediate inputs can readily be acquired (forward and backward linkages). On the other hand, workers like to live in areas where jobs are available in abundance. Persistently high unemployment rates or below average real wages may cause workers to leave a region, and, as in endogenous growth models, labour mobility tends to intensify agglomeration and divergence in long-term development (Grossman and Helpman, 1991; Martin and Sunley, 1996; Fujita et al, 1999). Recent empirical findings show that it is precisely skilled workers who respond to regional employment shocks by relocating in more prosperous regions (Mauro and Spilimbergo, 1999). Hence, the movement of human capital acts as the central force in the process of agglomeration and regional concentration.

### 3. Data and statistical methods

The data set used in the present study consists of a one-percent random sample from the Finnish longitudinal census file and comprises the post-recession years 1994-96. Finland is divided into 85 subregions (NUTS3) that represent the actual commuting and working areas rather well. In the present study, the two subregions of Åland have been excluded, as they cannot be robustly analysed within the same framework as “mainland” Finland. The special character of Åland (self-regulation, isolated geographical position, language) could affect the analysis of core-periphery patterns in the aggregate, and it is likely that the personal migration determinants in Åland differ from those in the rest of the country. In addition to the longitudinal data, macro level data for the 83 subregions have been used to determine the aggregate net migration patterns over a longer time period, i.e. 1975-95.

The core regions can be determined using the methods of previous simulation studies (Krugman, 1993b). Assuming somewhat differentiated products ( $\sigma = 4$ ), average-sized share of manufacturing ( $\pi = 0.27$ ) and moderate transport costs ( $\tau = 0.2$ ), equation (4) can be estimated. The dynamics over 1986-96 are calculated and the system is allowed to evolve until 2006 (appendix 1). In the resulting distribution 5-6 evenly distributed cities emerge. Moreover, there were only five central regions that experienced positive net immigration in 1995-98 (figure 1), i.e. the core regions. In addition, while Helsinki represents a very large labour market area, its neighbouring regions have also been included to control for the typical commuting behaviour in those regions.



**Figure 1: Net in-migration in the Finnish subregions, 1995-1998**

The longitudinal population census data were combined with employment data, and, together, these provide a vast amount of information about the characteristics of 30 000 individuals. For example, 41 % of these individuals were living in one of the five core regions (Helsinki and its neighbouring regions, Oulu, Tampere, Turku or Jyväskylä) in 1996, compared to 38 % in 1987. 8 % of all individuals had moved at some point during the post-recession period examined here (1994-1996). The present study explores the individual decision making process of the movers and the non-movers. If independence of irrelevant alternatives can be assumed, the easiest alternative is to use multinomial logit analysis (MLOGIT) (Greene, 1993), where the dependent variable is given by (7) and can take one of three values, i.e.  $M = 0, 1$  or  $2$ . Estimation is conducted in one stage, i.e. assuming that the migration and destination choices are made simultaneously. An individual with characteristics  $x_i$  has the following migration and destination choice probabilities:

$$(11) \quad \text{Prob}(m_i = j) = \exp(\beta_j' x_i) / (1 + \sum \exp(\beta_k' x_i)),$$

where  $\beta$ 's are vectors of parameters. However, if i.i.a. cannot be assumed, a nested logit model (NLOGIT) is required. Thus, in the first stage the individual decides whether or not

to migrate, and in the second stage he makes the choice between core and periphery. The estimation of the nested logit model provides a set of probabilities for both stages of the decision framework. However, it is somewhat questionable whether migration decisions are made in separate stages, and hence nested logit is used less frequently than multinomial logit analysis.

#### **4. Migration and core-periphery tendencies in Finland**

This section describes how the regional pattern has evolved since the mid 1970s, and how core regions differ from peripheral ones in terms of their income levels, education levels and migration flows. After that a core-periphery migration model is estimated to seek evidence for the hypothesis of agglomeration tendencies in the Finnish economy.

##### **4.1 Aggregate picture**

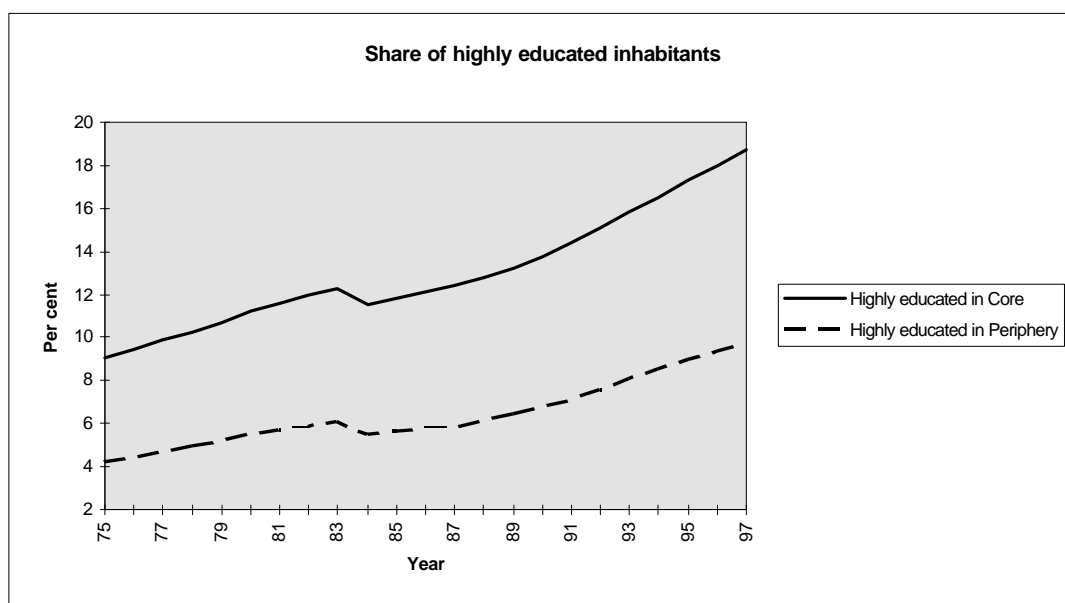
The formation of a core-periphery pattern is generally a long-run phenomenon and full agglomeration is extremely unlikely to be attained in reality. The Finnish economy, as most countries, has displayed a clear trend towards greater concentration of population and economic activity in fewer regions ever since the Second World War. The share of urban population has grown from 32.3 to 65.1 percent between 1950 and 1996, and since the 1960s migration has been directed towards regional growth centres located mainly in southern Finland. The threat of desolation is, in fact, quite substantial in more than 50 out of 85 subregions.<sup>viii</sup> In 1998 only the five core regions received a net inflow of migrants of over 2 percent of their populations, while 74 regions experienced a net loss of migrants.

The growth of human capital is the key factor determining the degree of core formation. Therefore, a comparison is made between the five core regions and 78 peripheral regions in terms of the education level of the population and the share of highly educated inhabitants (table 1).

**Table 1: Comparison of core and periphery**

| Variable                               | Core   |        | Periphery |        |
|--|--------|--------|-----------|--------|
|  | 1975   | 1997   | 1975      | 1997   |
| <b>Level of income (FIM)</b>           | 41 469 | 73 067 | 27 644    | 61 689 |
| <b>Net in-migration (%)</b>            | 0.005  | 0.008  | -0.006    | -0.006 |
| <b>Average age of in-migrants</b>      | 25.1   | 27.2   | 24.5      | 27.8   |
| <b>Level of education<sup>ix</sup></b> | 3.98   | 4.25   | 3.65      | 3.80   |
| <b>Share of higher education (%)</b>   | 9.08   | 18.74  | 4.20      | 9.75   |
| <b>Agricultural employment (%)</b>     | 3.8    | 1.8    | 29.2      | 15.4   |

The level of education has traditionally been much higher in the core regions than in periphery. Moreover, it has grown by 7 percent between 1975 and 1997 in the core, but by only 4 percent in the periphery. The same applies to the share of highly educated inhabitants: twice as many core inhabitants have obtained higher education than in the periphery. The average share of higher education in Finland has grown from 4.5 to 10.1 percent during 1975-97, but has consistently been much above the average in the core regions. Moreover, the growth of higher education has been divergent since the mid 1980s, compared to the previous decade (figure 2). These indicators of regional education support the assumption that human capital tends to accumulate in the core.

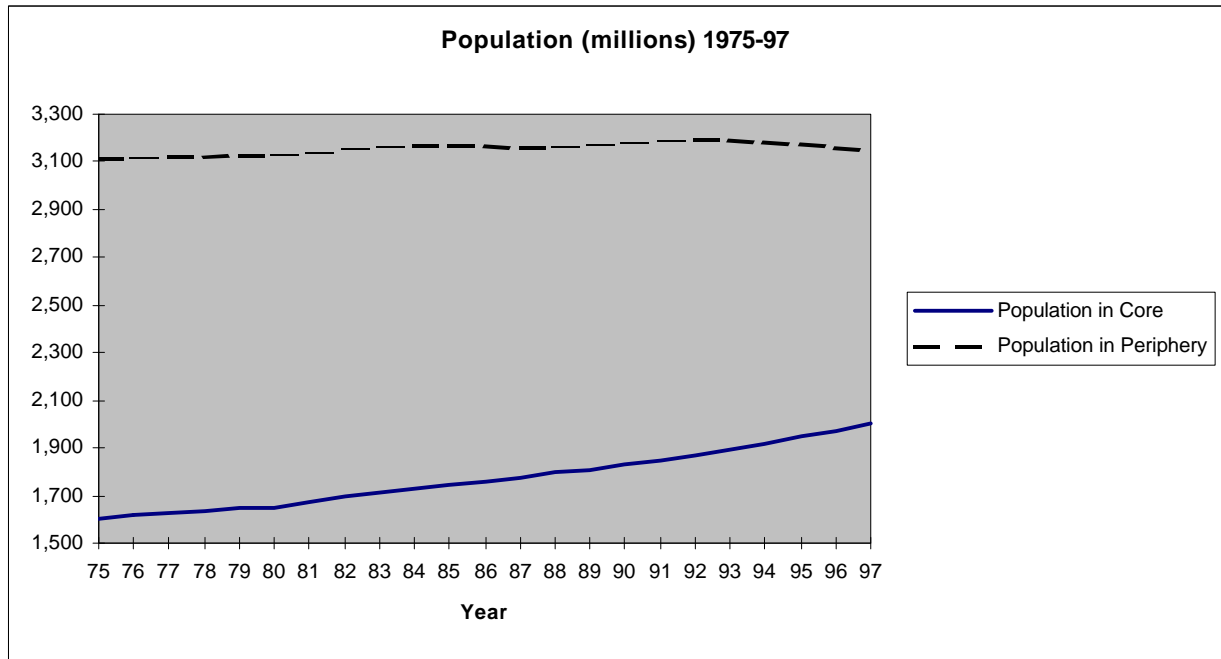


**Figure 2: The share of highly educated inhabitants in the core and in the periphery**

\*Notes: The change of slope around 1984 is due to an update in the education data.

The five core regions have also been richer than the average in terms of their per capita taxable incomes. The income gap has diminished, however, indicating that convergence in per capita incomes can take place simultaneously with a growth in regional disparities as measured by population and economic activity. Indeed, the core regions have continuously been among the biggest winners in terms of net in-migration, and this has probably contributed to their human capital growth. The continuous flow of migrants has certainly contributed to the population growth of the core regions (figure 3), particularly since the mid 1980s. The share of agricultural employment has fallen dramatically, in general, inducing even more mobility from the agricultural periphery to the core. All the above indicators of regional structure seem to support the relatively slow, but clear, formation of a core-periphery pattern. Moreover, the recent expansion of migration flows together with their increasing concentration imply that agglomeration in regional growth centres may have speeded up following the 1990s recession. At the aggregate level migration seems to be an agglomeration enhancing force. The aggregate data do not, however, reveal whether it is in fact the migrants who bring human capital and greater income to the core-regions; to investigate that assumption calls for micro-level data.





**Figure 3: Population in the core and in the periphery**

#### 4.2 Migration as an agglomeration force

As explained above, labour mobility is the most important force behind the formation of agglomeration in a regional context. Hence the aim of the present study is to test implicitly whether there is a tendency for human capital to accumulate in regional growth centres, i.e. the core regions. Moreover, the long-run incentives of workers to move towards core regions can be assessed by analysing the extent to which migrants to the core benefit from the move, and how much their human capital increases this benefit. It is expected that a higher level of human capital will be found positively to affect the probability of moving in general, and, in particular, of moving to the core.

Firstly, the human capital of migrants and stayers can be assessed by comparing their levels of education and higher education (table 2). The individual data also reveals whether human capital is moving from periphery to core or whether it is acquired in the core regions (where universities tend to be established). The results show significant differences across different groups in level of education, and across core and periphery inhabitants in higher

education. Moreover, the propensity of out-migration differs widely between core and periphery. In 1994 the propensity was 3.8% in the peripheral regions and merely 2.1% in the core regions. The respective figures were 3.7% and 2.1% in 1995. Hence, once an individual is living in the core he is less likely to move away than those staying currently in periphery.

**Table 2: Descriptive statistics for various groups**

|                         | <b>Core inhabitants</b> | <b>Periphery inhabitants</b> | <b>Migrants to core</b> | <b>Migrants to periphery</b> |
|-------------------------|-------------------------|------------------------------|-------------------------|------------------------------|
| <b>Education level</b>  | 2.27                    | 1.78                         | 2.40                    | 2.11                         |
| T-test                  | t = 27.98 (0.000)       |                              | t = 3.11 (0.002)        |                              |
| <b>Higher education</b> | 28%                     | 16%                          | 29%                     | 24%                          |
| T-test                  | t = 20.15 (0.000)       |                              | t = 1.41 (0.158)        |                              |
| <b>Out-movers 1994</b>  | 252                     | 683                          | -                       | -                            |
| <b>Out-movers 1995</b>  | 255                     | 655                          | -                       | -                            |
| <b>N</b>                | 11 883                  | 17 980                       | 305                     | 397                          |

To further test our hypotheses concerning migration flows, separate multinomial logit models for core and periphery inhabitants were estimated for individual migration choices during 1994-96. The explanatory variables reflect personal and family characteristics, and the individual's labour market characteristics in 1994. Marginal effects are calculated as percentages and t-ratios are given for each variable (tables 3 and 4). For the first model, the probability at the mean vector tells us that if a person is living in the core, he has a 96 percent likelihood of staying in his current region of residence. On the other hand, he has a three percent likelihood of moving to any of the 5 core and 3 neighbouring regions regions. The remaining 75 subregions have only a one-percent likelihood of in-migration. This indicates that each of the core regions has a noticeably higher probability at the mean vector (0.4%) than their peripheral counterparts (0.04%). On the other hand, a periphery inhabitant has a 94 percent likelihood of staying, a two-percent likelihood of moving to core and a 3.7 percent likelihood of moving to the periphery. Hence, those living in the periphery are less likely to stay, but more likely to remain outside the core.

**Table 3: Results for multinomial logit models: Core inhabitants**

| Variable                        | Staying      |           | Migrating to core |           | Migrating to periphery |           |
|---------------------------------|--------------|-----------|-------------------|-----------|------------------------|-----------|
|                                 | Marg.effect  | (p-value) | Marg.effect       | (p-value) | Marg.effect            | (p-value) |
| <b>Constant</b>                 | 0.154        | 0.000     | -0.100            | 0.000     | -0.054                 | 0.000     |
| <b>Age 18-25</b>                | -0.051       | 0.000     | 0.040             | 0.000     | 0.011                  | 0.050     |
| <b>Age 26-40</b>                | -0.029       | 0.001     | 0.022             | 0.007     | 0.007                  | 0.151     |
| <b>Age 41-55</b>                | -0.003       | 0.771     | 0.001             | 0.951     | 0.002                  | 0.648     |
| <b>Female</b>                   | -0.001       | 0.939     | 0.001             | 0.758     | -0.001                 | 0.786     |
| <b>Married</b>                  | 0.005        | 0.157     | -0.003            | 0.401     | -0.003                 | 0.227     |
| <b>Family size</b>              | 0.002        | 0.075     | -0.002            | 0.036     | -0.001                 | 0.911     |
| <b>Own home</b>                 | 0.027        | 0.000     | -0.022            | 0.000     | -0.005                 | 0.011     |
| <b>Unemployed</b>               | -0.001       | 0.935     | 0.002             | 0.555     | -0.002                 | 0.565     |
| <b>Short-term jobs</b>          | -0.012       | 0.126     | 0.006             | 0.278     | 0.005                  | 0.276     |
| <b>Student</b>                  | -0.002       | 0.778     | 0.002             | 0.573     | -0.001                 | 0.825     |
| <b>Not in labour force</b>      | 0.015        | 0.019     | -0.011            | 0.030     | -0.004                 | 0.329     |
| <b>Entrepreneur</b>             | -0.015       | 0.101     | 0.011             | 0.132     | 0.004                  | 0.498     |
| <b>Commuter</b>                 | -0.033       | 0.000     | 0.022             | 0.000     | 0.011                  | 0.002     |
| <b>Education</b>                | -0.007       | 0.000     | 0.008             | 0.000     | -0.001                 | 0.504     |
| <b>Income</b>                   | 0.001        | 0.000     | -0.001            | 0.001     | -0.001                 | 0.117     |
|                                 | N = 11 117   |           | N = 569           |           | N = 197                |           |
| <b>Prob. at the mean vector</b> | <b>0.959</b> |           | <b>0.028</b>      |           | <b>0.013</b>           |           |

**Table 4: Results for multinomial logit models: periphery inhabitants**

| Variable                   | Staying     |           | Migrating to core |           | Migrating to periphery |           |
|----------------------------|-------------|-----------|-------------------|-----------|------------------------|-----------|
|                            | Marg.effect | (p-value) | Marg.effect       | (p-value) | Marg.effect            | (p-value) |
| <b>Constant</b>            | 0.202       | 0.000     | -0.085            | 0.000     | -1.117                 | 0.000     |
| <b>Age 18-25</b>           | -0.080      | 0.000     | 0.033             | 0.000     | 0.044                  | 0.000     |
| <b>Age 26-40</b>           | -0.046      | 0.000     | 0.021             | 0.001     | 0.025                  | 0.000     |
| <b>Age 41-55</b>           | -0.011      | 0.223     | 0.005             | 0.442     | 0.006                  | 0.363     |
| <b>Female</b>              | -0.001      | 0.948     | -0.001            | 0.719     | 0.001                  | 0.759     |
| <b>Married</b>             | 0.010       | 0.006     | -0.011            | 0.000     | 0.001                  | 0.932     |
| <b>Family size</b>         | 0.003       | 0.009     | -0.001            | 0.682     | -0.003                 | 0.004     |
| <b>Own home</b>            | 0.044       | 0.000     | -0.009            | 0.000     | -0.035                 | 0.000     |
| <b>Unemployed</b>          | 0.001       | 0.717     | -0.005            | 0.014     | 0.004                  | 0.259     |
| <b>Short-term jobs</b>     | -0.017      | 0.069     | 0.013             | 0.002     | 0.004                  | 0.631     |
| <b>Student</b>             | -0.008      | 0.118     | 0.005             | 0.050     | 0.003                  | 0.449     |
| <b>Not in labour force</b> | 0.023       | 0.000     | -0.012            | 0.001     | -0.011                 | 0.021     |
| <b>Entrepreneur</b>        | -0.006      | 0.397     | 0.001             | 0.545     | 0.004                  | 0.546     |
| <b>Commuter</b>            | -0.050      | 0.000     | 0.020             | 0.000     | 0.030                  | 0.000     |
| <b>Education</b>           | -0.016      | 0.000     | 0.007             | 0.000     | 0.009                  | 0.000     |
| <b>Income</b>              | 0.001       | 0.001     | -0.001            | 0.023     | -0.001                 | 0.019     |
|                            | N = 16 198  |           | N = 681           |           | N = 952                |           |
| <b>Prob. at the</b>        |             |           |                   |           |                        |           |

|                    |              |              |              |
|--------------------|--------------|--------------|--------------|
| <b>mean vector</b> | <b>0.943</b> | <b>0.020</b> | <b>0.037</b> |
|--------------------|--------------|--------------|--------------|

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The upper model shows how unlikely a core inhabitant is to move to the periphery. Moreover, it is indeed the human capital of an individual that increases the likelihood of migrating to the core: young, highly educated individual are most likely to move to core regions, whereas older, less educated persons and those not belonging to the labour force tend to stay. Note that the effect of education is negative, yet insignificant, for those migrating to the periphery. The income variable indicates further that migrants to the core tend to be relatively young and just embarking on their professional careers. Conversely, those with higher incomes (older people) are more likely to stay. The lower model shows that family conditions tend to keep persons in the periphery, whereas young age and education motivate them to move. Young, employed and participants in the labour force move to core from peripheral regions. Interestingly, education also has a positive impact on the probability of moving to another peripheral region, i.e. moving in general. All in all, these results lend some support to the hypothesis that human capital migrates to core regions and remains there.

The direct gain from moving to the core is more difficult to analyse. The reason for this is, firstly, that the majority of migrants are rather young and thus have lower incomes anyway, and, secondly, the time period is so short. In other words, potential migrants are assumed to optimise in terms of their *future discounted incomes*, a stream that is obtained through the life-course. However, our data only reveal income growth in the year following the move. The comparison of income levels and growth rates across different population groups shows that even though the level of incomes and wages of the core-migrants is lower than the average, its growth is considerably higher than for those staying in or moving to the periphery (table 5). In other words, the growth of income corresponds to the sustainability condition (10). Note, however, that a much longer period than one year would be more relevant in assessing the cumulative benefits of migrating (Laakso, 1998; Pekkala, 1999).

**Table 5: Income statistics for migrants and stayers**

|                            | <i>Average</i> | <i>Stayers in<br/>core</i> | <i>Stayers in<br/>periphery</i> | <i>Migrants to<br/>periphery</i> | <i>Migrants to<br/>core</i> |
|----------------------------|----------------|----------------------------|---------------------------------|----------------------------------|-----------------------------|
| <b>Taxable income 1995</b> | 934.89         | 1033.70                    | 856.80                          | 657.50                           | 689.50                      |

|                              |        |        |        |        |        |
|------------------------------|--------|--------|--------|--------|--------|
| <b>Wages 1995</b>            | 715.83 | 848.38 | 610.72 | 457.52 | 549.88 |
| <b>Income growth 1994-95</b> | 13.30  | 23.80  | 5.00   | 46.70  | 87.00  |

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To conclude, the results presented above indicate a considerable level of labour mobility. It is also suggested that it is particularly the “human capital component“ of the labour force which migrates and gains considerably from moving. However, the micro data do not reveal the full extent of these gains. In other words, while the theory assumes migrants to optimise in terms of their discounted life-time incomes, these are not observable in reality. Therefore, the latent regression approach yields more accurate results than estimating a simple income model.<sup>x</sup> Both the aggregate and individual data suggest that there is a clear possibility in Finland of a core-periphery pattern, one which particularly seems to be emerging in the aftermath of the recession of the 1990s, i.e. after 1994. However, it should be noted that some workers are moving towards “peripheral“ regions (as defined in the present study), and therefore the speed at which the core-periphery pattern is developing is considerably retarded.

## 5. Discussion and conclusions

The present paper seeks to develop an empirical framework in which the much debated core-periphery model re-introduced by Krugman (1991) can be analysed. There has been a call for micro economic empirical work to confirm the predictions of the model (Krugman, 1998). However, so far there have been few attempts to perform proper empirical testing on the core-periphery model, since it is not analytically solvable as a whole. Therefore the present study concentrated on analysing the key component of the model: mobility of labour. The migration of labour across regions is the factor that leads to the formation of agglomerations in regional growth centres, and, fortunately, is also the easiest component to test empirically. Hence the core-periphery model was manipulated to show how migration leads to the emergence of core-periphery patterns. An empirical framework was derived to explain how the unobservable parts of the model could be tracked with real world data.

The regional pattern in Finland has experienced some degree of concentration ever since the 1950s, and this development has speeded up considerably in the 1990s. The present study analysed those trends at the subregional level during 1975-97, and found clear evidence for the accumulation of population and human capital in five central regions. The aggregate pattern of inter-regional migration seems to conform relatively well to the core-periphery model. However, as the model is based on individual decision making, micro-level data were used to analyse the migration decisions of some 30 000 individuals during 1994-96. The results yielded further evidence for the core-periphery model: human capital is indeed migrating to core and staying there. This indicates greater perceived utility or income for the human capital locating in the regional growth centres, as assumed in the core-periphery model.

It should be noted that even though the Finnish data seem to lend support to the core-periphery model, the pace at which the agglomeration process is occurring is still relatively slow. The reason for this is that some persons are also moving from core to periphery. Krugman (1998) notes that this is a problem in the application of the core-periphery model to actual data: the model suggests a much greater tendency for agglomeration than do most of the empirical data. The most recent figures in Finland show, however, that the speed of agglomeration may actually be accelerating as the decade ends. These findings are in accordance with international studies on similar issues (Krugman 1991, Krugman and Venables, 1995). The threat of a core-periphery economy is therefore imminent in Finland, as in the rest of Europe, and once the cumulative process gets under way it may be difficult to interrupt. One option would be to try and increase the number of growth regions by supporting small-scale regional centres and encouraging the mobility of human capital into smaller towns. On the other hand, to be competitive in the global economy, Finland needs at least one thriving growth pole.

To conclude, the recent development of the core-periphery model promises interesting new ways in which regional patterns can be analysed. However, empirical testing of the core-periphery model is necessary for its future development, so that its caveats can be identified and its empirical validity tested. The present study has suggested one way in which the

model could be used to provide an empirical framework for a migration study. The short time period used here proved to be a problem in some ways, and work is currently being done to extend the analysis to capture long-term effects. Moreover, further empirical applications could easily be envisaged, even if the complete model as such is difficult, if not impossible, to analyse.



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## Notes:

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<sup>i</sup> These two strands in the literature may appear, at the first sight, to contradict each other. The neoclassical growth theory, however, refers to per capita differences that, on the aggregate, may well be declining even if economic activity is concentrating.

<sup>ii</sup> The basic core-periphery model and its varieties have been discussed by Paul Krugman in numerous articles and books. The version presented here is mainly based on Krugman (1991b) and Fujita et al (1999). Basically, those parts of the model that will not be referred to later in the analysis will not be considered in detail, whereas the parts dealing with the migration behaviour of the labour force are presented more thoroughly. Further discussion on similar issues can also be found in Baldwin (1999).

<sup>iii</sup> According to Krugman (1991) these assumptions receive empirical back-up, as regions and nations are diverge in terms of their production structures and population sizes.

<sup>iv</sup> Krugman (1998) shows that, assuming an intermediate range of transport costs, there may be up to 5 equilibria, of which 2, however, are unstable and flanking.

<sup>v</sup> The concepts of the discounted real wage and discounted utility are used interchangeably here, as the custom differs between Fujita et al (1999), Baldwin (1999) and Baldwin and Forslid (1997). Eventually, they both refer to the same thing, i.e. the future stream of benefits discounted by the potential migrant.

<sup>vi</sup> Baldwin (1999) shows that no qualitative difference in the main results of the core-periphery model emerges, even if the expectations are allowed to be forward-looking. Therefore, static expectations can be viewed as a justifiable simplifying assumption.

<sup>vii</sup> A latent regression is specified as  $y^* = \beta'x + \varepsilon$ . However, we only observe  $y = 1$ , iff  $y^* > 0$ . See Greene (1993) for further discussion on latent regression models.

<sup>viii</sup> Source: Statistics Finland Population Statistics, 1995. The threat of desolation is substantial if the share of those square kilometres where the youngest inhabitant is over 50 exceeds 16 percent of all inhabited square kilometres. The threat of desolation covers all of northern Finland and most of eastern Finland. On the west-coast and in the south, where the birth rate and in-migration of youth is much higher, there is no such threat of depopulation (the share of “over 50” square kilometres ranges from 4 to 15,9 percent).

<sup>ix</sup> The level of education is calculated for each region as

$$X = \frac{\sum_{i=1,5}^8 f_{ixi}}{\sum_{i=1,5}^8 f_i}, \text{ where the level of education ranges from secondary education to doctoral degree.}$$

<sup>x</sup> This was also tested, but the income model was highly unsuccessful, probably due to the short time-period used in this analysis. Hence, in order to understand individual decision making we must be able to analyse the unobservable variables, and in this task, the latent regression approach is the only alternative.