

# Mobility of Human Resources and Systems of Innovation: A Review of Literature

Thomas E Pogue

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## ABBREVIATIONS AND ACRONYMS

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EU	European Union
FDI	foreign direct investment
HRST	human resources in science and technology
ICT	information and communication technology
LDCs	less economically developed countries
MDCs	more economically developed countries
NSI	national system of innovation
OECD	Organisation for Economic Co-operation and Development
R&D	research and development
SADC	Southern African Development Community
SAMP	Southern African Migration Project
SANSA	South African Network of Skills Abroad
S&T	science and technology
UNESCO	United Nations Educational, Scientific and Cultural Organization

# Introduction

The intensified pace of scientific advancements and technological progress reflected in newspaper headlines around the world today is related to the unprecedented and ever-accelerating speed of knowledge creation, accumulation and depreciation. In this environment, innovation is seen increasingly as the only means to enhance one's competitiveness and avoid falling behind the international productivity frontier (David and Foray 2002). Innovation and associated productivity improvements are therefore fundamental to ensuring economic growth and employment in the competitive global marketplace. These imperatives are central to discussions about the 'knowledge-based economy' and the 'knowledge society'.

Knowledge is a complex and multidimensional object that needs to be defined explicitly if it is going to be analytically useful. Smith (2002) discusses four basic views about the changing significance of knowledge:

- Knowledge inputs are quantitatively and in some sense qualitatively more important than before. This perspective implicitly takes knowledge accumulation as something separable from capital accumulation. However, knowledge cannot be incorporated in production except through investment, and the function of investment is often to implement new knowledge in production technology. The evidence comparing investment in physical capital and knowledge is complicated, even though it does not show any general increase in importance for knowledge in aggregate investment.<sup>1</sup>
- Knowledge has become more important as a product than previously. This is supposedly evidenced by the rise of new forms of activity based on the trading of knowledge products. The growing significance of knowledge-intensive business services is central to support of this view. While a relatively small activity, growth has been strong in this area in Europe and the United States, representing thereby an important recent development in innovation systems.
- Codified knowledge increases in its relative importance within economically relevant knowledge bases. There is broad evidence of this; the only employment categories rising in OECD (Organisation for Economic Co-operation and Development) economies are those of individuals with higher education. Further, the uses of codified results of science are rising as is evidenced by a growth in citations to basic science in patents.
- Because information and communication technology (ICT) changes both the physical constraints and costs in collecting and disseminating information, the knowledge economy rests on technological changes in ICT. As ICT facilitates our ability to handle data and information, knowledge production and distribution is also supported.

As these alternative perspectives reflect, knowledge is becoming increasingly important in the economy in a variety of ways. Nor is it only in high-technology sectors where this transformation is occurring. Knowledge creation is not the sole product of formally undertaken research and development work. In a more nuanced

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<sup>1</sup> See OECD (1999).

view Smith (2002) also describes some important characteristics of knowledge creation:

- Innovation does not occur as a result of discovery, but as a result of learning. Thus, activities such as design and trial production runs can be knowledge-generating activities.
- Knowledge creation also occurs in environments external to the firm. Firms' diverse interactions with each other as well as intermediate purchases of capital goods with embodied knowledge are both important sources of knowledge creation.
- Since innovations are economic implementations of new ideas, exploration and understanding of markets and use of market information to shape creation of new products are central to innovation.

Mobility of human resources is intimately related to the emerging knowledge economy. This literature survey demonstrates the wide variety of ways in which this relationship is manifest. As such it serves as an introductory guide to the role of mobility in systems of innovation. Chapter 2 reviews some underlying definitions and concepts, and then discusses causal conditions for mobility while highlighting linkages between these causes and mobility-related effects on a system of innovation. Effects of mobility on four primary aspects of innovation are then reviewed. In Chapter 3 attention turns to the empirical assessment of mobility, in particular its influence and structure in a system of innovation. Following an overview of methodologies, the focus shifts to a review of African mobility analyses, with particular emphasis on the South African experience and evidence of mobility associated with its system of innovation. Chapter 4 reflects on policies influencing mobility in light of the experiences, causes and effects of mobility on a system of innovation. Finally, Chapter 5 returns to the concept of the knowledge economy and the importance of mobility in terms of South Africa's ability to remain competitive in this new paradigm.

# Human resource mobility in systems of innovation

## Introduction

There are many theoretical perspectives regarding the mobility of individuals, groups and peoples in physical, social and virtual spaces. These perspectives cover a variety of time frames, but a practical distinction exists between those that consider mobility within day-to-day experiences and those interested in mobility that redefines the contextual environment in which day-to-day experiences occur. The focus of this literature survey is on the role of mobility in affecting technological and innovative competitiveness. Hence, primary consideration is given to approaches that examine mobility which transforms the contextual environment.

To facilitate discussion of the role played by mobility on technological and innovative competitiveness, this survey adopts a systems-of-innovation perspective. This chapter therefore begins with a discussion of the systems-of-innovation approach and its advantages and limitations in reviewing the diverse approaches to mobility of human resources. The next section considers distinct causal conditions leading to mobility. The chapter concludes with a discussion of the effects of mobility across four primary areas related to a system of innovation: (1) efficiency, (2) productive capacity, (3) human resource development and (4) social capital.

## Definitions

The systems-of-innovation approach arose in the 1980s. Building on examinations from the 1960s and 1970s about differences in national economic growth rates, it originally focused on differences in national research systems. While somewhat constrained by its appreciably theoretical nature, the systems-of-innovation approach requires a broad examination of interrelationships between social, labour, education, and science and technology (S&T) policies. While regional, urban, sectoral and technological systems of innovation may be distinguished, the systems-of-innovation approach originated in an examination of national systems of innovation (NSIs), as Lundvall et al. (2002) detail in their review of the NSI approach.

## Defining a system of innovation

There is a fundamental difference between *invention* and *innovation*. An invention may be a physical artefact (e.g. a prototype) or a disembodied idea (e.g. a theory), but it is not a good or service itself. An innovation is an invention subjected to validation by the dominant governance structure, be it collective, hierarchical or market.<sup>2</sup> An innovation is thus an invention put into practice to succeed or fail within the collective, hierarchy or market. The key point is that an invention is only

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<sup>2</sup> See Williamson (1975, 1985) for a distinction between market and hierarchy governance and Powell (1990) for an elaboration on the collective, networked governance structure.

potentially an innovation; becoming an innovation depends upon the invention's successful introduction into the dominant governance structure. Hence, this survey's concern with human resource mobility focuses not just on its effect on a system of invention, but more broadly on the mobilisation and application of inventions in a system of innovation.

While the creation, retention and loss of inventors is an aspect of the mobility of human resources, it is a subset of the overall mobility experience in a system of innovation. Similarly, formal research and development (R&D) activities are only part of the innovative activities that occur within an organisation. Innovations from formal R&D often require extensive organisational innovations before benefits are realised. Hence, analyses of systems of innovation also differ between narrow and broad conceptualisations.

In a limited sense, a system of innovation consists of R&D efforts and the recognised S&T system. A wider view of a system of innovation encompasses the totality of know-how in a firm, industry, cluster, nation or region, including organisational routines. This broader definition shifts the focus away from 'big-event' innovations resulting from formal scientific and R&D efforts to include more mundane, but equally significant, incremental innovations generated by routine activities in production, distribution and consumption.

A system of innovation need not be well coordinated and functional; it can be dysfunctional and beset by coordination problems. Liagouras et al. (2004) highlight a tendency in many popular discussions of systems of innovation, particularly at the national level, to focus on their functional and formal aspects. This is a dangerous perspective to adopt because it can breed unfounded complacency. Either functional or dysfunctional, a system of innovation is an institutional feature spanning the spectrum of micro and macro organisations. Definitions and objectives of technology policy also need to address what is working poorly or is difficult to identify.

### **Defining mobility within and between systems of innovation**

When conceptualising a system of innovation one must specify the nature of the system. Systems of innovation can be geographically defined, such as local, national or regional systems of innovation. Alternatively, the industry (a sectoral system of innovation) or technological discipline (a technological system of innovation) can define the nature of the system. Mobility of human resources carries a variety of impacts depending on the systems in which or between which it occurs.

#### *Mobility and national systems*

A great deal of popular literature on mobility focuses on the national level and on mobility between NSIs. This literature tends to focus on issues like 'brain drain', 'brain gain' and 'brain circulation', but as the OECD indicates, it is increasingly taking on board the role mobility plays in the systems approach to innovation (OECD 2001b). As with most of the literature dealing with mobility and its relationship to innovativeness, there is a tendency within the systems-of-innovation approach to

focus on the higher-skilled members of society who tend to be formally trained. This bias occurs despite the important role played by the spectrum of skilled workers in a society's economically active population in realising technological progress.

Historically, mobility of human resources has played an important role in transferring technology from more economically developed countries (MDCs) to less economically developed countries (LDCs). An early example of this type of international mobility in South Africa was the inflow of skilled British miners in the late nineteenth and early twentieth centuries to work underground in the gold mines of the Witwatersrand.<sup>3</sup> In the early eighteenth century, the international mobility of British migrants to the rest of Europe was important for the initial diffusion of early industrial technologies (Mathias 2001). In its establishment of a textile industry, Britain had in turn benefited from the international mobility of Flemish weavers fleeing Spanish occupation in the sixteenth century (Munro 1994).

#### *Mobility and regional systems*

In contrast to national systems, a regional system is typically based on geographic features that often span several horizontal and vertical political authorities.<sup>4</sup> Some regions encompass two or more nation states, such as the Southern African Development Community (SADC).<sup>5</sup> Other regions include several local governments, such as the Johannesburg–Tshwane urban agglomeration.<sup>6</sup>

Much of the mobility literature at the regional level focuses on mobility between rural and urban environments. As with the national systems, mobility also occurs between regional systems. Mobility between urban centres may be particularly important in this context and may also involve mobility at the national level, such as mobility between London and New York.

#### *Mobility and sectoral systems*

Sectoral mobility involves changing one's sectoral employment. While not a central focus of more traditional mobility literature, this type of mobility is often focused on in discussions of economic development as employment in one or more sectors grows or declines as part of a process of economic growth. Mobility at this level may also involve other types of mobility. An example might be a German working in the recreational boat-building industry moving to South Africa to work in the same industry. Defining this type of mobility is an individual's economic activity. A particularly urgent issue in this regard currently facing South Africa is mobility, or lack thereof, from the informal to the formal sector.

3 These expatriate miners had an extremely high mortality rate as a result of their excessive exposure to hazardous dust underground. See Katz (1994).

4 Horizontal political authorities might include two or more municipal or national governments, depending on the nature of the region. Similarly, vertical political authorities may include local, provincial and national governments, again depending on the nature of the region.

5 SADC currently consists of Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, United Republic of Tanzania, Zambia and Zimbabwe.

6 The Johannesburg–Tshwane urban agglomeration consists of more than three separate municipal authorities, including Ekurhuleni, Johannesburg and Tshwane.

*Mobility and technological systems*

Individuals possess an understanding and knowledge of specific technologies which they carry with them as they move geographically and organisationally within the economy. Historically, this type of mobility between organisations played an important role in technological transfer and diffusion.<sup>7</sup> In a modern context this type of mobility, or industrial espionage, is increasingly restrained by national and international legal systems, but it remains an important means of technological transfer. For example, in the 2002 America's Cup yacht race a sailing team, OneWorld, was penalised because it hired a designer from another team who utilised his knowledge of the competitor's sailboat in refining OneWorld's sailboat. This censure was criticised by Olin J. Stephens, then 93 years old, who designed numerous famous racing sailboats including six America's Cup winners. 'When I was active it was made clear to the client that the design was property of the designer and the owner had the right to use it. As the designer's property, the plans and calculations were part of his stock in trade, and he carried them along and developed them from project to project. The client had the right to expect the designer to reflect all his experience in his latest work. Certainly, in no profession can experience or the details [by] which it has been built be wiped from memory' (Letter to Louis Vitton Race Committee, 12 December 2002).

Inter-technology mobility is another important aspect of this type of mobility. It involves an individual changing or expanding his or her technological expertise, such as learning a new language. It may also involve adopting a new technological approach to a research problem, such as a move to optical computing from electronic computing. As with the other types of mobility discussed above, mobility in technological systems can involve many other forms of mobility. For example, the scenario of an American bringing 'just-in-time' computer manufacturing technology to a South African computer manufacturing company involves technological changes in the South African company's organisational routines and production technologies, technology mobility, as well as an inter-sectoral, inter-regional, and international mobility.

*Mobility and social systems*

Another form of mobility occurs between social systems. This sort of mobility may be based on a variety of social determinants such as class, income, race and religion. Mobility between social systems can form an important indicator of a society's dynamism and health. For example, inter-generational income mobility forms a useful indicator of social progress.<sup>8</sup> Mobility between and within social systems has also received increasing recognition in the literature on the economics of technological change because of the role it plays in facilitating, or in hindering, the establishment of networks of innovation.<sup>9</sup>

This section has discussed five types of mobility: that of national systems, regional systems, sectoral systems, technological systems and socio-economic systems. It

7 See Harris (1998) for a study of personnel mobility in technology transfer between Britain and France in the eighteenth century.

8 See Stokey (1996), Tomes (1981), Becker and Tomes (1979, 1986) and Menuchik (1979).

9 See Grabher (2002) and Jackson and Watts (1998).

showed that defining the type of mobility depends in large part on one's analytical focus. Mobility often spans several different systems, but distinct concerns are vested within each of these various levels. Hence, in its description of causes and effects of mobility, the remainder of this chapter offers characteristics of mobility analyses across these different focuses.

### **Causal conditions**

Many discussions of mobility focus on one or two factors as 'the cause'. In South Africa, crime and higher remuneration have been hailed as two of the more popular causes for the international mobility of highly skilled individuals out of the country. Before turning to a review of these and other explanations, it is important to reflect on what is actually meant by 'the cause' of mobility.

We typically have an interest in the cause of a phenomenon because we want to promote or prevent the effect of that phenomenon. For example, one may want to decrease outward and increase inward international mobility to enhance the domestic stock of skills. This focus typically leads to a description where Event A is said to have caused Event B. However, describing the cause of a phenomenon in this way is problematic because most events for which causal explanations are appropriate have many causes.

Carnap (1994) illustrates the multitude of causes through the example of the cause of a collision between two cars on a highway. Each individual looking at the total picture from a certain perspective selects a specific causal condition as the cause of the collision. The police say high speed caused the accident. A road engineer says a poor road surface caused the accident. A psychologist says the man's disturbed mental state caused the accident. A mechanical engineer says a structural defect in the car caused the accident. A mechanic says that a worn brake lining caused the accident. In each case one can say that if that condition had not existed, the accident might not have happened. Therefore, this review refrains from referring to 'the cause' of mobility, focusing instead on 'causal conditions'.

John Mackie (1974) provides a formal definition of causal conditions, called INUS conditions: '[They are] an Insufficient but Necessary part of a complex of conditions which together are Unnecessary but Sufficient for the effect' (p. 61). If we were omnipotent and knew all the causal conditions for mobility, we would know 'the cause'. However, being human we select factors relevant to our individual interests as causal conditions.

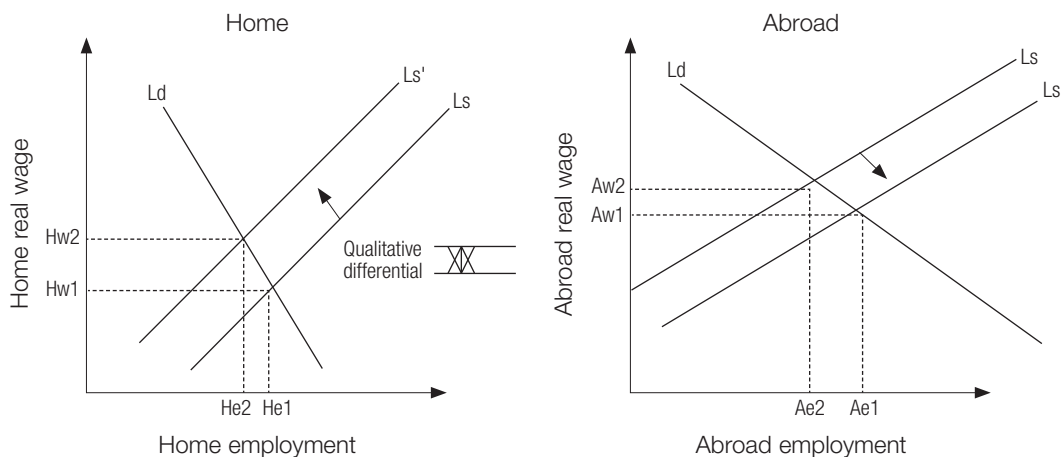
Any causal hypothesis in science depends on causal selection, that is, the choice of causal conditions for analysis among the multitude of causal conditions. In the literature on mobility a few causal conditions dominate most analyses and these are reviewed in turn below. Each is a partial explanation of the phenomenon of

mobility, but taken collectively these causal conditions form a much more nuanced representation of 'the cause' of mobility.<sup>10</sup>

### Market arbitrage as a causal condition for mobility

A fundamental cause in many approaches to mobility is the disequilibrium of markets. From this perspective mobility is caused by the movement of the labour force to establish inter-market equilibrium. As a means of introducing this process we can think of the two markets as being two nations. Figure 2.1 shows an initial situation where the labour markets of two nations, 'Home' and 'Abroad', have different prevailing real-wage and employment rates. For both Home and Abroad, labour demand is expressed by their respective downward-sloping labour-demand ( $L_d$ ) curves. The relative steepness or inelasticity of Home's  $L_d$  curve means that proportionally larger changes in real wages are required in order for Home's employers to effect a change in their demand for labour, that is, Home employment.

Figure 2.1: Labour emigration between locations



Home's initial equilibrium real wage,<sup>11</sup>  $Hw_1$ , is substantially lower than the initial equilibrium real wage,  $Aw_1$ , in Abroad. Given the real wage of  $Hw_1$  at Home, the associated level of equilibrium employment where labour supply equals labour demand ( $L_s = L_d$ ) is represented by  $He_1$ . Similarly, the initial level of equilibrium employment Abroad is represented by  $Ae_1$ . If there are no restrictions on mobility, or if existing restrictions are removed, this real-wage differential,  $Aw_1 - Hw_1$ , will lead Home workers to migrate Abroad in order to earn higher real wages. That migration reduces the labour force at Home and increases it Abroad, which is represented as a leftward shift in Home's  $L_s$  curve and a rightward shift in Abroad's  $L_s$  curve.<sup>12</sup> This migration of labour from Home to Abroad also changes the associated level

10 Recently, Massey et al. (2005) have attempted a synthesis of causal conditions for international mobility, but the present survey refrains from emulating that undertaking.

11 Inter-market nominal wage adjustments for real-wage equalisation will usually require cost-of-living adjustments more specific than aggregate national inflation indices.

12 See Mueller (1982). See also Hicks (1932), Lowry (1966) and Krugman (1991a; 1991b, 115–122).

of equilibrium employment in Home and Abroad, represented by  $He_2$  and  $Ae_2$  respectively.

While real-wage differentials are important, they are only an indication of real differences between the standard of living at Home and Abroad. In this instance an inherently superior quality of life at Home is represented in a qualitative differential,  $Aw_2 - Hw_2$ . This qualitative differential represents non-wage compensation, such as social benefits and amenities, from remaining at Home despite the higher wage available Abroad.<sup>13</sup>

The process of inter-market arbitrage applies to a variety of productive and innovative systems in exactly the same way so long as the skills and knowledge of the labour force are perfectly transferable between markets.<sup>14</sup> Hence, we can think of Figure 2.1 as representing an inter-urban equilibrating process between two cities, say Cape Town and Johannesburg. Alternatively, we could think of Figure 2.1 as representing an inter-sectoral equilibrating process, say for instance that between the public and private sectors. In these other contexts, the qualitative differential continues to represent non-wage differences between markets. For instance, employment in the public sector may also carry non-wage value from a perception that public-sector employees are making a difference to society or, more cynically, that less work is expected from an individual in that sector. Either way, under perfect mobility the qualitative differential represents the aggregate preference of labour for one market over another.<sup>15</sup>

In the late 1960s, large cities in LDCs were increasingly populated by rural migrants who were often unemployed or working in the informal economy. This phenomenon generated a class of 'Harris-Todaro models', which explained this seemingly irrational rural-urban migration.<sup>16</sup> These models and their extensions<sup>17</sup> demonstrated that an individual's expectation of employment and income resulted from the growing employment in the cities compared to the rural areas. Unfortunately for the rural migrants, rural expectations of employment outstripped the cities' absorptive employment capacity, leading to large informal economies around these cities. Another way of viewing this rural-urban migration is in the arbitrage framework. Thus, the presence of a socially mandated urban minimum wage creates a real-wage differential between the rural and urban markets. That wage differential causes rural-urban migration until there is equality between the actual rural wage and the expected urban wage.

13 The presence of a qualitative differential acknowledges the potential of other causal conditions for mobility, such as the social environment and/or the physical environment, which are discussed in the next two sections of this chapter.

14 Obviously, perfect transferability of skills and knowledge is an ideal.

15 Despite our present focus, it is important to note that labour demand is also mobile to some extent. In this case, lower real costs of production may lead enterprises to relocate, thereby shifting the demand curve for labour. In combination with shifts in the supply of labour, mobility of enterprises can form a countervailing dynamic. Thus, while labour mobility is obviously very important, considering it without reference to demand is deceptive.

16 The pioneering models were those of Harris and Todaro (1968, 1970) and Todaro (1969). Pre-dating the Harris-Todaro models, a class of economic-development frameworks differentiated modern and traditional sectors in an economy; see Lewis (1954, 1979) and Ranis and Fei (1961).

17 Among the many extensions see Bhagwati and Srinivasan (1974), Chao and Yu (1994), Corden and Findlay (1975), Fields (1975), Johnson (1971), Khan (1980), Lal (1973), McCool (1982), Neary (1981) and Stiglitz (1974, 1976).

People, like other factors of production, are not perfectly mobile. This reality is central to trade theory, with factor mobility potentially substituted by trade in the goods or services people produce. The predominant approach to analysing factor mobility, in particular mobility of labour, is the Heckscher–Ohlin (H–O) model.<sup>18</sup> Using the H–O model, Mundell (1957) showed that trade and international factor mobility are substitutes with increases (decreases) in trade causing decreases (increases) in factor mobility. Thus, assuming Abroad is abundant in capital and Home abundant in labour, increasing trade liberalisation reduces the Home–Abroad wage differential and thereby decreases migration.<sup>19</sup>

Human resources, like other factors, have associated transportation costs that also influence their rate of mobility. However, the nature of those costs is influenced by dynamics that are fundamentally different from other factors. In particular, migrants send home information about their destination, which informs other potential migrants. An established community of migrants with similar backgrounds lowers relocation costs by facilitating job and housing searches for subsequent migrants. The establishment of a community of migrants also replicates social and cultural institutions, which can reduce the qualitative differential between locations. These dynamics lower the costs of mobility for migrants and can form the basis for large-scale migration threshold events.<sup>20</sup>

Even when information and other migration costs are included, equalisation of real wages depends on comparable supply and demand.<sup>21</sup> Inter-market equalisation has been stratified by proxies for different characteristics of labour. Coelho and Ghali (1971) control for the industrial sector, while Bellante (1979) uses formal education and work experience as a proxy for different skill levels. In addition, the influence of age as an incentive for mobility has long been used to differentiate incentives to migrate.<sup>22</sup> The differences in relative development of the sending and receiving economies have also been investigated as an influence on mobility.<sup>23</sup> Nonetheless, despite the insights that market-arbitrage models offer, in many instances real-wage differentials may not be a dominant cause of mobility.

### **Social environment as a causal condition for mobility**

Typically, market-arbitrage models envision mobility as an individual decision. However, in many contexts migration is the result of broader social influences. In the discussion of market-arbitrage models one such influence, social networks, was

18 This model is also referred to as the Heckscher–Ohlin–Samuelson model. See Jones and Neary (1984), Jones (1956, 1965), Ohlin (1933) and Samuelson (1948, 1949).

19 H–O models make some important contextual assumptions. Typically these include constant returns to scale, identical technologies, perfect competition and no domestic market distortions. Trade and migration are then usually viewed as substitutes; for an example, see Wood (1995). Relaxation of certain assumptions can lead to trade and migration being complements; see Markusen (1983). However, the substitutability between trade and migration continues to hold under a range of other changes to these assumptions. For an overview see Schiff (1996); see also Krugman (1979), Faini and Venturini (1993), Schiff (1994, 1995), Lopez and Schiff (1995, 1998) and Ottaviano and Thisse (2002).

20 See Lee (1966), Da Vanzo (1981) and Carrington et al. (1996).

21 We must assume homogenous labour (supply) and production (demand).

22 See Ravenstein (1889), Rogers et al. (1978), Castro and Rogers (1983), Rogers and Watkins (1987), Findley (1988) and Rogers (1988).

23 See Williamson (1965), Zelinsky (1971), Alonso (1980), Wheaton and Shishido (1981), Massey (1988), Alperovich (1992, 1993), Gallup et al. (1999) and Tabuchi and Thisse (2002).

mentioned as playing a role in cost calculation associated with mobility. A body of literature has taken the role played by social networks even further, whereby the migrant networks are themselves causal conditions for mobility.<sup>24</sup>

This approach to mobility is distinguished by the fact that the decision to migrate is vested within a group rather than an individual. This group membership may be relatively voluntary, such as family membership,<sup>25</sup> or prescribed, like gender, race or ethnicity.<sup>26</sup> In either case the group is directly or indirectly part of the mobility experience.

### **Physical environment as a causal condition for mobility**

There exists a vast literature in which mobility is caused by the spatial-economic attractiveness of a location.<sup>27</sup> This approach to the cause of mobility encompasses several wide-ranging disciplines, including the new economics of geography, urban economics and regional science.<sup>28</sup> Essentially, all of these approaches consider mobility to be primarily driven by the economic activity of a particular physical location. That activity may be self-reinforcing or evolving as the result of natural-resource endowments and/or the built environment.

A related body of literature looks at the qualitative attractiveness of a physical location in determining mobility. One division of the literature focuses on the economy of a location and considers the natural resources, climate and other natural amenities as playing an important role in mobility decisions.<sup>29</sup> Another primary division of this literature concentrates on non-natural amenities, including schools, universities, art and cultural institutions, hospitals and sport facilities.<sup>30</sup> With many of these amenities there is a danger of disagglomeration economies, such as the degradation of natural resources because of overuse.

Distributed operations as an approach to mobility focuses on the interplay of productive, political and social authorities. The interaction of these systems across space forms a causal condition for mobility. The geography of political-economic authority is therefore central in this approach. Theoretically, distributed-operations

24 See Stouffer (1940), Bright and Thomas (1941), Taylor (1986), Massey et al. (1987) and Massey (1990).

25 See Rossi (1955), Bell (1958), Beshers (1967), Da Vanzo (1977), Stark and Bloom (1985), Stark et al. (1986, 1988), Stark and Lucas (1988), Stark and Taylor (1989, 1991), Stark (1991) and Poirine (1997).

26 See Phizacklea (1983), Tienda et al. (1984), Borjas (1985), Massey (1985), Simon and Bretell (1986), Chant (1992), Chiswick (1992), Bilborrow and United Nations (1993), Bujis (1993), Schenk-Sandbergen (1995), Allen and Turner (1996) and Kelson and De Laet (1999).

27 Some of the more important historic literature in this tradition includes Von Thünen (1826), Weber (1909), Christaller (1933), Marshall (1936), Lösch (1940), Hoover (1948), Harris (1954), Isard (1956), Stigler (1951), Perloff et al. (1960), Alonso (1964), Berry and Pred (1965), Bos (1965) and Pred (1966).

28 For an indication of the role of human resource mobility in these approaches see Kenen (1965), Henderson (1974, 1977, 1980, 1985a, 1988, 1994, 1997, 2003), Fujita and Ogawa (1982), Beckmann and Thisse (1986), Fujita (1988, 1989), Fujita et al. (1999), Fujita and Mori (1996), Fujita and Thisse (1996, 2002), Belleflamme et al. (2000), Henderson and Becker (2000), Henderson et al. (2001a, 2001b) and Davis and Weinstein (2002).

29 See Ullman (1954), Mills (1972), Graves and Linneman (1979), Graves and Clawson (1981), Rosen (1974, 1979), Henderson (1982a, 1996), Roback (1982), Greenwood (1985), Bilborrow (1987), Blomquist et al. (1988), Bilborrow et al. (1987), Knapp and Graves (1989), Courant and Deardorff (1993), Haas and Serow (1993), Clark and Knapp (1995), Mueser and Graves (1995), Goetz et al. (1996), Brueckner et al. (1999) and Deller et al. (2001).

30 See Tiebout (1956), Youngson (1967), Henderson (1982b, 1985a, 1985b, 1985c, 1985d, 1985e), Elhance and Lakshmanan (1988), Garcia-Milà and McGuire (1992), Shah (1992), Johansson (1993), Conrad and Seitz (1994), Saltz (1998) and Henderson and Thisse (2001).

literature recognises the importance of communications and networks in the spatial development and subsequent dynamics of population concentrations.<sup>31</sup> Agents' spatially defined authority is path-dependent. Therefore, in this approach mobility is a response to spatial inequalities and a social process that reinforces mobility.<sup>32</sup> Economic geography is linked with institutional and network analysis leading to nodes of authority that can support or undermine their associated location, thereby causing mobility.<sup>33</sup>

### **Knowledge and skill spillovers as a causal condition for mobility**

A distinction can be made between two analytical approaches in the examination of knowledge and skill transfers as a cause for mobility. Human-capital theory views mobility as an investment decision, based on lifetime benefit maximisation. Systems-of-innovation theory considers mobility resulting from knowledge and skill spillovers.<sup>34</sup>

In the human-capital approach, which is the core of labour-migration theory, individuals or social units continuously evaluate the value of their current location in comparison to the perceived utility they would derive from a new location. In its basic formulation, wages in the potential sending and receiving locations are assumed to reflect the individual's skills contribution to productivity.<sup>35</sup> Thus, migration occurs among individuals with the greatest lifetime income differentials between migrating and not migrating, while adjusting for migration costs.<sup>36</sup> Among the more important extensions to the human-capital mobility model have been considerations of the role played by information asymmetries,<sup>37</sup> the influence of regional differences in economic development,<sup>38</sup> and dynamic interactions between sending and receiving economies.<sup>39</sup>

The systems-of-innovation approach tends to focus on knowledge spillovers. Different types of knowledge and skill spillovers have been mentioned with respect to the level of innovative systems in or between which mobility occurs.<sup>40</sup> As knowledge and skill spillovers are central to the present discussion, it is useful

31 These population concentrations can be physical, such as nations, regions, cities and villages, or they can be virtual, such as economic sectors and fields of research.

32 See North (1955), Machlup (1960, 1962), Meier (1962), Berry (1964, 1973), Hansen (1972), Pred (1973, 1977), Braudel (1979), Wallerstein (1979), Zysman (1983), Massey (1984), Timberlake (1985), Scott and Storper (1986), Stöhr (1986), Berry et al. (1987), Henderson and Castells (1987), Muegge and Stöhr (1987), Salt (1988), Shrestha (1988), Sassen (1991, 1994, 2002), Gereffi and Korzeniewicz (1994), Findlay (1996), Kaplinsky (1998), Goss and Lindquist (1999), Raikes et al. (2000), Henderson et al. (2002), Samuel and George (2002) and Schmitz (2004).

33 An important body of this literature is only available in French; see Perroux (1950, 1955), Davin (1964), Aydalot (1965, 1976, 1985), Paelinck (1965), Higgins (1971), Salles (1972, 1983), Lipietz (1977), Jacquemin and Rainelli (1984), Benko (1991), Rallet (1991), Ravix and Torre (1991), Rallet and Torre (1995) and Sekia (1999).

34 Knowledge spillovers are assumed to include both knowledge diffusion and knowledge generation.

35 For details of the basic human-capital mobility approach see Schultz (1961, 1963), Becker (1962, 1964), Sjaastad (1962) and Vanderkamp (1971).

36 For details of further developments of the basic human-capital mobility model see Schultz (1971, 1972, 1975), Mincer (1974), Antel (1986) and Taylor and Martin (2002).

37 See, for instance, Katz and Stark (1984, 1987) and Eriksson (1991).

38 See Chiswick (1974), Straubhaar (1986) and Dierx (1988).

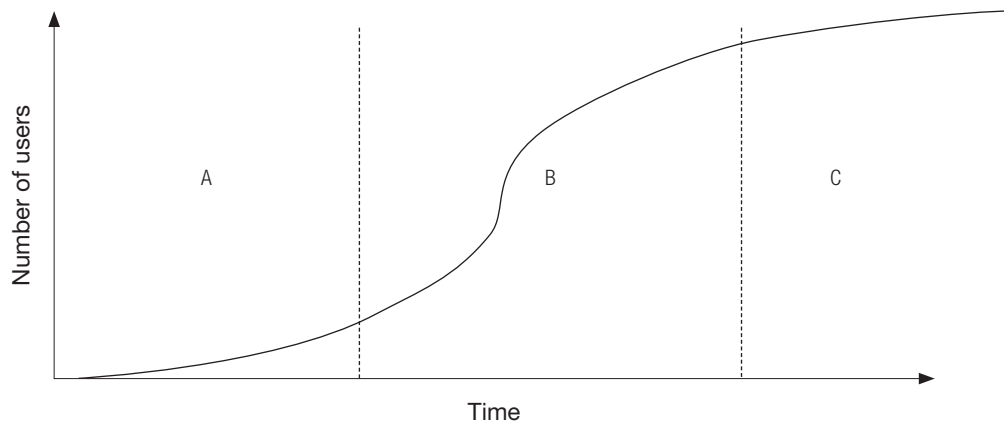
39 See Chiswick (1986), Salt and Findlay (1989) and Beinea et al. (2001).

40 See the section headed 'Defining mobility within and between systems of innovation' earlier in this chapter.

to reflect briefly on what is meant by these terms.<sup>41</sup> First, an important distinction can be made between *tacit* and *codified* knowledge. Tacit knowledge is implicit. It consists of unwritten rules, mental models, beliefs and experiences.<sup>42</sup> Tacit knowledge exists within individuals, groups and organisations. Codified knowledge is the complement of tacit knowledge, consisting of explicit knowledge and underlying data and information.<sup>43</sup> Codified knowledge contains the formal rules, models and procedures possessed by individuals, groups and organisations. Because of its implicit nature tacit knowledge is not transferable without direct interaction with someone or something that possesses it. Mobility therefore becomes a critical channel through which tacit knowledge is transferred.

Figure 2.2 depicts a stylised fact about technology diffusion: namely, the usage of a technology over time follows an ‘epidemic’ pattern that forms an S-curve. Without digressing into a critique of epidemic diffusion,<sup>44</sup> it is important to note that the dynamics underlying the S-curve illustrate important dimensions of a technology’s degree of tacitness (codification) that influence the nature and structure of associated human resource mobility. The first section of Figure 2.2, part A, represents the early period of a technology, when tacit knowledge is a highly significant component. In this early phase associated mobility will be undertaken to access the relatively few individuals, groups and organisations that possess the necessary tacit knowledge to diffuse the technology.

Figure 2.2: The S-shaped epidemic diffusion curve



As knowledge of the technology becomes increasingly codified, diffusion accelerates, as is seen in the sharp rise in part B of the figure.<sup>45</sup> Lastly, as a technology becomes highly diffused, its underlying knowledge is highly codified. When dealing with a

41 Knowledge and skills are taken to be similar manifestations of ‘know-how’, distinguished by the former’s cerebral and the latter’s physical manifestations. For simplicity, *knowledge* is used in the remainder of this discussion despite the different nature of the two types of know-how.

42 Michael Polyani originated the concept of tacit knowledge with his description of the implicit process of knowing. See Polyani (1958, 1966).

43 See the Appendix for a conceptualisation of the relationship between data, information and knowledge.

44 For a critique of the epidemic diffusion model see Geroski (2000).

45 Cowan and Foray (1999) review the processes through which codification occurs.

mature codified technology like that in part C of the figure, the structure of mobility associated to the technology no longer strongly corresponds to the innovative system and sources of tacit knowledge. In a mature technology, associated mobility is more likely to correspond to the absorptive capacity of the production system.<sup>46</sup>

The inherent difficulty in diffusing highly tacit knowledge is an important caveat. In many formulations the difficulty associated with transmitting predominantly tacit knowledge is ignored by assuming that once a new technology is created it has global spillovers. Spillovers can be global only if one assumes innovations are public goods, that is, non-rival and non-excludable.<sup>47</sup> Given the discussion above, it would appear reasonable to suppose that at least early in an innovation's life cycle its tacit nature makes it partially excludable.<sup>48</sup> The partial excludability of an innovation is also supported by a growing body of empirical evidence regarding geographically localised knowledge spillovers.<sup>49</sup> Another important implication is the separation of, but interrelationship between, innovative systems and productive systems.<sup>50</sup> Therefore, we can view the systemic analysis of human resource mobility associated with the innovative system as complementary to distributed operations' focus on mobility associated with the structure of the productive system. Naturally, the systems-of-innovation approach focuses on the innovation and technology dynamics in industrial and institutional capabilities as a primary cause for mobility.<sup>51</sup>

Lastly, scientific communities are worth special mention because of the prominence placed within them on priority of discovery.<sup>52</sup> By nature scientific communities operate on the frontier of their respective knowledge bases. Achieving this prominence requires codifying knowledge as patents, prototypes, articles, seminars and books. That codification is supported by intellectual property rights, but the underlying tacit knowledge also plays a significant role in encouraging or discouraging codification. Accessing that tacit knowledge can be a critical force of attraction for the mobility of individuals and organisations alike.<sup>53</sup>

46 For further information on phases in an innovation cycle and associated transfer characteristics see Polt et al. (2001) and Teece (1977).

47 Arrow (1962) popularised this conception of innovation, which is also retained in the 'New Growth Theory'. See Romer (1990) and Grossman and Helpman (1991).

48 Non-rival but partially excludable goods are also known as 'club goods'. Originating with Buchanan (1965), a vast literature has been written on club goods; see Cornes and Sandler (1996) for a selective review.

49 See Teece (1986), Cohen and Levinthal (1989), Jaffe (1989), Jaffe et al. (1993), Audretsch and Feldman (1996), Audretsch and Stephan (1996), Fagerberg and Verspagen (1998), Zucker et al. (1998a, 1998b), Yi and Shin (2000) and Feldmann (2002).

50 This separation is reviewed in Gersbach and Schmutzler (1999) and Kelly and Hageman (1999).

51 Coombs et al. (1996, 2003) provide an overview of the systems-of-innovation approach, which clearly differentiates it from the distributed-operations approach. Precedents can be traced back at least as far as Schumpeter (1943). See also Kamien and Schwartz (1975), Piore and Sabel (1984), Pyke et al. (1990), De Bresson and Amesse (1991), Freeman (1991), Saxenian (1994), Teece (1996), David et al. (1998), Ter Weel (1999) and OECD (2001a).

52 For details on the economics of science see Stephan's similarly titled article (1996). See also Bush (1945), Blank and Stigler (1957), Merton (1957, 1973), Nelson (1959), Polanyi (1962), Hagstrom (1965), Zuckerman (1977), Dasgupta and David (1994) and Cowan and Jonard (2003).

53 See Levin and Reiss (1988), De Bondt (1996) and Breschi and Lissoni (2002).

### Other causal conditions for mobility

There are many other possible causes for mobility. War and famine remain a principal cause of mobility for many people around the world. Other types of forced migration, such as human trafficking, also persist. Changes in life expectancy and population growth are further, more benign, causes of mobility. Government policies such as investment incentives, mandated retirement ages, and fiscal policy may also cause human resource mobility. The selection of causes for mobility reviewed above suggests a range of associated effects from mobility whose scope is far beyond the present endeavour. Given this survey's focus on literature that describes the role played by mobility in South Africa's system of innovation, a few primary effects of mobility on a system of innovation are now described.

### Effects

As the survey of causal conditions indicates, mobility of human resources encompasses many aspects of the human experience. Rather than attempt a superficial summary of the impacts of mobility across all its dimensions, this section considers four facets of mobility that are crucial to the systems-of-innovation perspective. Before considering the literature discussing the impacts of human resource mobility on the comparative static efficiency and productive capacity of an economy, it is important to briefly distinguish the concepts.

When both the microeconomic concept of technology diffusion and the macroeconomic concept of technical progress are held constant, mobility affects the static or comparative static efficiency of an economy. In contrast, discussion of human resource mobility as a means of knowledge spillovers considers its effects on productive capacity. However, even after an invention has proven its efficacy as an innovation, its impacts remain potential until it is adopted by the productive system.<sup>54</sup> Once the productive frontier of an economy is expanded, settling that frontier usually requires adjusting allocations of human and other resources.<sup>55</sup> Then interactions between innovative and productive systems are crucial determinants of an economy's ability to utilise its latent productive capacity.<sup>56</sup> Therefore, mobility in a comparative-efficiency sense and mobility in a productive-capacity sense are at least partially complementary.

54 This difference between the potential technical capacity of an economy and its actual productivity levels is discussed in Jaffe (1986), Soete and Turner (1984), Nordhaus (1980, 1981), Griliches (1979, 1980) and Denison (1979).

55 This phenomenon is one potential explanation of the lag between adoption of ICTs and its reflection in measures of productivity. See OECD (2004), Jorgenson (2001), Oliner and Sichel (2000) and Jorgenson and Stiroh (1999).

56 In this review, the effects of mobility on a system of innovation are not limited to the economic impacts of relatively skilled individuals alone. Less-skilled individuals are also central to the operations of economies. Hence, it is essential to remember the role played by the entire spectrum of skilled workers when discussing the relationship between mobility of human resources, the system of innovation and national productivity. Despite the importance of the full spectrum of skills, the literature on mobility of human resources and their relationship to systems of innovation tends to focus on relatively highly skilled individuals, but the interrelationship with the broader range of skills provides a broader context for the discussion which follows.

## Effects on efficiency

### *Brain drain and the effects of mobility on source sectors and locations*

In discussions of the effects of mobility on a system of innovation, mobility is traditionally viewed in the context of comparative static efficiency. Popular examples of this literature are discussions of brain drain and brain gain. Conceptually, the notion of brain drain pre-dates that of brain gain. Initially brain drain described the loss of highly skilled British and other European personnel to the United States after the Second World War. During the 1970s, the concept became identified with an exodus of skills from LDCs to MDCs.<sup>57</sup> LDC-focused literature viewed the migration of skilled human resources as harmful to the sending nations because of the greater importance of the emigrants' skills in their developing economies and the loss of public investment in the emigrants' skills and education.<sup>58</sup>

Despite the recurrent nature of this emigration of skills, it is a phenomenon whose scale and impacts are not well understood (Gaillard and Gaillard 1998). Given the diversity of causes, it is difficult to say with any degree of certainty what the effects of mobility are without considering its context. Therefore, efforts to provide quantitative information about the mobility of skills are of significant importance. The remainder of this section briefly reviews some recent work in this area.

Owing to their rich empirical resources, Scandinavian nations are better analysed than others are in terms of the nature and scale of mobility of human resources in science and technology (HRST). This is illustrated by Gaillard (2002), who describes Swedish HRST migration patterns along with the relative socio-economic importance of those resources. In an examination of mobility of skills in the United Kingdom using labour-force survey data, Tomlinson (2001b) demonstrates that internal circulation of skills is also a highly significant phenomenon. The importance of internal circulation of skills in Hungary is demonstrated by Viszt et al. (2001) using labour-force survey data. Internal mobility of skills in Belgium is analysed by Vandenbrande (2001) using Belgium's empirically rich labour-register data. Patterns in the international mobility of skilled human resources are analysed in a major destination nation, the United States, by Regets (2000, 2001) using immigration data which also demonstrate the significant role played by expatriates' skills in the US economy.

There is a noticeable difference in the pattern of mobility between mobility that originates in MDCs and mobility from LDCs. In particular, mobility between MDCs appears to be increasingly finite. This transformation from settlement emigration to temporary skilled-labour transfers facilitated by international recruitment agencies was noted by Finnie (1988) in his examination of British emigration during the 1980s. Similarly, Martinelli (2001, 2002) refutes popular impressions of a large brain drain from France to the United States, demonstrating that the majority of high-skilled

57 See Gaillard and Gaillard (1998) for a history and overview of the brain-drain concept as well as references to the massive associated literature.

58 See Grubel and Scott (1966), Adams (1968), Bhagwati and Hamada (1974) and Kwok and Leland (1982). See also Miyagiwa (1991), Ul Haque and Kim (1995) and Wong and Yip (1999) for brain drain in endogenous growth formulations.

mobility appears to be related to the attainment of temporary overseas educational experience.

Brain drain continues to be of real concern to many countries and evidence shows that it can be a highly significant relative factor, particularly in LDCs. Lowell and Findlay (2002) report on a number of recent studies on the emigration of skilled human capital from LDCs. Those studies demonstrate negative impacts from emigration, but with clear long-term returns that at least offset if not surpass the initial losses. The costs of emigration are highlighted in Thomas-Hope's review (1988) of the experience of Caribbean nations, which shows an ever-increasing proportion of skilled migrants since the mid-1960s. Even quantifying the scale of skilled human resource emigration can be difficult for LDCs because of data inadequacies, as Gokhberg and Nekipelova (2002) demonstrate in an attempt to quantify the scale of the Russian brain drain that resulted from the country's economic transformation in the early 1990s. Carrington and Detragiache (1998) focus on quantifying the magnitude of skill mobility among LDCs. In their analysis they construct emigration rates from US census and OECD migration data for 61 LDCs and demonstrate substantial brain drain for various nations/regions from these estimates. However, even in LDCs the outflow of skills is nuanced, as Gayathi (2002) demonstrates with early evidence of skilled human resource repatriation following large emigration in the ICT sector.

*Brain gain and the effects of mobility on source sectors and locations*

Subsequent reflection on the brain-drain phenomenon has led to the emergence of a range of literature that recognises that emigrants generate a variety of benefits for the sectors and locations they leave, even if those benefits do not necessarily offset the costs of their emigration. Perhaps the largest body of this literature looks at the effects emigration has on human resource development, or brain gain. Discussion of human resource development associated with mobility is reviewed later in this chapter in the section 'Effects on human resource development', while knowledge spillovers associated with emigration are reviewed below in the section headed 'Effects on capacity'. However, a variety of other effects from emigration have also been identified. These can be broadly divided between those effects associated with remittances from emigrants and effects from interactions with the diaspora.

Interactions with the diaspora have been identified as influencing both business opportunities and social capital in the source location.<sup>59</sup> To a certain extent, effects on social capital, which are discussed in a separate section in this chapter, underpin the effects on business opportunities. The existence of compatriots in other locations creates opportunities for the development of business and trade networks.<sup>60</sup> Interactions with the diaspora thereby create contacts that allow compatriots to leverage their authority and access across the international production systems. Evidence of this influence is difficult to quantify, but it is apparent in case studies of diaspora interactions.<sup>61</sup>

59 To the author's knowledge, this literature has not looked at sectoral impacts in this context.

60 See Rauch (2001), Ghosh (1997) and Mesnard and Ravallion (2001).

61 See Shain (2000), Ip et al. (1999) and Weidenbaum and Hughes (1996).

Remittances from emigrants have increasingly been recognised as a critical source of income for many economically developing locations.<sup>62</sup> Recent analyses have shown that internationally remittances exceed total international development aid.<sup>63</sup> In 2004, remittances were estimated to have equalled US\$126 billion (Ratha 2005). Hence it is not surprising that such remittances have been identified as representing a significant influence on poverty alleviation,<sup>64</sup> investment<sup>65</sup> and human resource development.<sup>66</sup>

*Mobility in the structural adjustment of sectors and locations*

Structural change in an economy is accompanied by mobility, be it geographic, sectoral or occupational. Structural adjustments because of increased trade liberalisation and adjustments in prevailing political–economic governance systems that have been distinct sources of structural transformation are prominent in recent literature. Wood (1995) reviews the effects on mobility of human resources from market liberalisation between MDCs and LDCs. This study demonstrates that increased trade presents qualified opportunities for LDCs to promote their economic development, but MDCs must contend with the fact that increased trade with the LDCs tends to result in increased skilled/non-skilled earning inequality.

The mixed results of trade liberalisation and mobility associated with this structural transformation are further examined by Wood (2000), where he considers the implications of the East Asian and Latin American experiences for South Africa. This analysis shows that the relatively lower skills base of East Asian nations allowed increased trade to decrease their income inequality during the 1960s and 1970s, but Latin America, with its legacy of import substitution, had a relatively higher-skilled composition in its economy and hence increased trade in the 1980s and 1990s actually increased income inequalities. Noting South Africa's structural similarities to Latin America, Wood's study advocates policies to facilitate economic development by increasing trade liberalisation.

The collapse of communism in Eastern Europe in the late 1980s and early 1990s has provided a range of examples for examining mobility associated with adjustments in the prevailing political–economic governance system. UNESCO hosted a migration conference in 1998 that reviewed the mobility experience among these 'transition' economies.<sup>67</sup> Radosevic and Sadowski (2004) present a range of studies illustrating how the structure of productive systems has influenced the transformation of central and Eastern European industry.

62 For overviews of the relationship between internal mobility and development see Ammassari (1994) and Jacobs (1984). On the relationship between international mobility and development see Lucas (2005) and Skeldon (1997).

63 See Maimbo and Ratha (2005) and Freund and Spatafora (2005) for surveys of international remittances.

64 The importance of remittances in alleviating poverty and inequality is discussed in Adams and Page (2005), Barham and Boucher (1998), Taylor and Wyatt (1996), Taylor (1992), Stark et al. (1986) and Lipton (1980). Contextual examples of the impact of remittances on inequality include those from Guatemala (Adams 2004, 2005), Mexico (McKenzie and Rapoport 2004), the Philippines (Rodriguez 1998) and Tonga (Ahlburg 1996).

65 For analysis of remittances as a source of investment funds in less economically developed areas see Chami et al. (2005), Ratha (2003, 2005), Leon-Ledesma and Piracha (2004), Massey (1988) and World Bank (2004). For a contextual example see Rozelle et al. (1999).

66 See the section headed 'Effects on human resource development' later in this chapter for a discussion of the effects of remittances in this context.

67 See UNESCO (1999).

The Czech Republic's economic transformation of the 1990s is analysed by Gottwald and Šimek (2001a). According to this analysis, which is based on Czech labour-force survey data, a lack of intra-national mobility limited the extent of economic transformation in the Czech Republic compared to other transitional economies. Despite this lack of intra-national mobility, Gottwald and Šimek's analysis (2001b) of brain gain/brain drain in the Czech Republic from 1993 to 2000 shows that it is both a significant destination and source of HRST in Europe.<sup>68</sup>

Structural adjustment is a complex process and its influences are diverse. This leads to multifaceted interaction between mobility and economic adjustment, as Jacoby (1983) illustrates in an analysis of internal labour mobility in the US. Jacoby observes that labour mobility in the US was higher before 1920 than in the mid-1980s. The decrease in labour mobility dating from 1920 is commonly associated with personnel policies designed to capture economies through a stabilised workforce. However, he proposes that in fact the decrease reflected employer efforts to curb the rise of unionisation.

*Mobility effects on human resource shortages in destination sectors and locations*

In a static or comparative-static sense, mobility in a global context can be a critical factor in facilitating economic growth as it allows a more efficient allocation of the global stock of skills. In an analysis of the impact of high- and low-skilled individuals on economic growth in Europe and the United States, Tomlinson (2001a) shows that mobility which effects economic growth encompasses the full spectrum of skilled individuals rather than the highly skilled alone. Similarly, Brixiova et al. (1999) examine relationships among skill levels and the potential for mobility and facilitating policies to help LDCs escape the constraints of domestically available skills in their economic growth experience.<sup>69</sup> These impacts of immigrant skills are demonstrated in Paltiel's analysis (2002) of mass immigration to Israel during the 1990s.

Coppel et al. (2001) review some of the principal factors driving immigration in a selection of MDCs. Economic, fiscal and social impacts suggest that mobility confers gains to destination countries, but with significant variance. While offsetting slower population growth, immigration does not appear to offer a solution to structural budgetary problems associated with the MDCs' ageing populations.<sup>70</sup>

Among recent literature that examines skilled human resource immigration, the majority looks at the effects of these inflows within relatively developed economies. For instance, South Korea's economic expansion since the 1980s has been supported by migration, although in this case by an inflow of foreign nationals. Abella et al. (1994) analyse the skills shortage that international migration has filled and point to its allowing Korean nationals to pursue relatively higher-skilled and desirable employment opportunities.

<sup>68</sup> This simultaneous source and destination of skilled human resources is similar to South Africa; see the section headed 'Evidence' in Chapter 3.

<sup>69</sup> Less positive views of international mobility in LDCs focus on emigration as an overflow because of the limited domestic capacity to absorb skills. See Hirschman (1970).

<sup>70</sup> In a similar examination, Borjas (1999) reviews the impact of international mobility within the European Union.

Increases in skilled human resources are considered in Barrett's analysis (2002) of the impact returning skilled Irish nationals had in the 1990s. Rollason (2002) reviews UK initiatives to attract skilled human resources, such efforts being particularly important because of potential lost competitiveness arising from skills shortages in strategic areas like the ICT sector. Kuptsch and Oishi (1995) analyse German and Japanese efforts to fill their skill shortages with regard to potential abuses these policies generate. These relatively recent experiences are contrasted with those of nations like Australia that have a long history of dependence on skilled human resource migration.<sup>71</sup>

### Effects on capacity

Formal and informal knowledge and skill externalities create new knowledge that underwrites the supply and demand for mobility.<sup>72</sup> However, the systems-of-innovation approach recognises the importance of technology diffusion, as well as innovation. Diffusion of a technology requires one to examine the mobility of human resources because of the tacit knowledge they often possess, which complements embodied technology.<sup>73</sup> Mobility of human resources, be it national, regional, sectoral, technological or social, is related to the movement of knowledge and skills among finite systems.

#### *Mobility as a source of knowledge spillovers*

Central to the impact of mobility on an economy's productive capacity is its role in transmitting knowledge spillovers. Lewis and Yao (2001) point out that this role of knowledge spillovers creates some difficulties for analysis as the mechanism of the spillovers and incentives for exchange remain poorly understood. Nonetheless, in various contexts human resource mobility recurrently appears to be a significant component of the knowledge-spillover transfer process. This can occur through horizontal movements of people between firms<sup>74</sup> and through geographic concentrations that form open communities of knowledge specialisation as a result of social and professional interactions.<sup>75</sup> Nonetheless, other channels of knowledge spillovers such as publications, patents and reverse engineering can complement or usurp mobility, making differentiation of the source of knowledge spillovers difficult.

Zucker et al. (1998a, 1998b) examine transfers of naturally excludable knowledge through labour mobility as the starting point. Analysing biotechnology, they find that higher levels of human capital are associated with higher mobility. They also find evidence that the tacit nature of knowledge creates an inherent intellectual knowledge appropriability mechanism and therefore encourages the release of codified knowledge without appreciably decreasing the labour-market value of this human capital. Using Taiwan as a case study, Pack and Paxson (1998) examine empirical evidence of labour mobility facilitating knowledge transfers. They find

71 Interestingly, Hugo (2002) draws attention to the fact that Australia only developed active state recruitment of skilled people in the 1970s.

72 See Patel and Pavitt (1991, 1994), Sjöholm (1996), Baptista and Swann (1998), Jørgensen (1999), Soubeyran and Thisse (1999), Tomlinson (1999) and Thornton and Thompson (2000).

73 For details on this distinction see Smith (2001) and Mahroum (1999).

74 See Gersbach and Schmutzler (1999).

75 See Saxenian (1994).

support for the hypothesis that worker mobility is an important source of knowledge transmission. Cowan and Jonard (2003) use simulations to examine how close collaboration and job mobility interact as a means of knowledge creation and diffusion. They demonstrate that in a community engaged in basic scientific research (as opposed to industrial R&D), both labour mobility and long-distance networking are effective in increasing knowledge production and distribution, but both operate with distinct mechanisms and dynamics.

*Mobility effects on capacity of a sector or location in the knowledge economy*

Globalisation of the labour market is different in nature from globalisation of goods and finance. With this in mind, Chiswick and Hutton (2005) examine international migration and the integration of labour markets. Their study begins with a review of periods of international migration during the past four centuries. Attention is then turned to the forces for and effects of mass migration during the two major eras of globalisation, the first 'mass migration' from 1850 to 1913 and the second 'constrained mass migration' since the Second World War. The influence on migration of structural changes in the world economy and changes in policy regimes are considered, followed by a conclusion with some reflections on what this legacy means for the future.

What differentiates historic globalisation from that associated with the modern knowledge economy is the specialisation of urban environments that encourages specific migration patterns as location-specific competitive advantages are pursued.<sup>76</sup> White (1988) examines highly skilled migrants in Vienna in the 1980s, noting their difference from previous migrants, who tended to be low-skilled. This experience in Vienna is held to be indicative of a more general phenomenon that was occurring throughout Western Europe. A more specific investigation and argument is made by Beaverstock and Smith (1996) on the international financial specialisation in London and its associated demands on the international labour market. They analyse the relationship between international skilled-labour mobility and the clustering of international finance within an increasingly globalised world as is demonstrated by London's transnational investment banking community. Luo and Wang (2002) examine the rise and complexity of contemporary international mobility and training of skilled human resources in Taiwan. In his consideration of 'scientific mobility', Mahroum (2000) argues that an aspect of this mobility is to enhance and reinforce scientific centres of excellence. Through mobility of scientists, scientific traditions from certain departments/schools are diffused socially and geographically. This is an inherent part of the process of scientific legitimacy, requiring human geographic mobility.

Trade and mobility are typically held to be substitutes in traditional economic analyses. As such, the North American Free Trade Area provides a useful environment to assess this reality as it supports trade, but not mobility. De Vortez (1999) examines, from the Canadian perspective, the relationship between labour mobility and technological change in an environment of (relatively) free trade.

<sup>76</sup> See Pritchett (2003), Criscuolo (2002) and Granstrand (1999).

The rich empirical data on labour mobility of Nordic nations has previously been mentioned. A selection from this literature indicates the type of analysis possible with better data. For instance, Graversen (2001) describes flows from various Nordic nations of employees from the higher-education system into the surrounding economy. Employee mobility is used to indicate linkages between knowledge accumulation and application in the economy. Fluctuations in worker-mobility rates over time and between various sub-groups are identified by Graversen et al. (2001a) in order to provide useful benchmarks for innovation policy instruments. Nås et al. (2001) use the data on skill mobility in an attempt to quantify and map patterns and dynamics of knowledge flows in the Nordic nations.

Lastly, while empirical studies conclude that circulation of knowledge improves economic performance nationally and within firms, there are no clear (if any) optimal migration rates from theory. Graversen et al. (2001b) therefore use the Nordic data to measure brain drain, brain gain and brain circulation and the roles these play in the various NSIs. The European Union (EU) has a broad policy initiative to promote greater mobility of its population, particularly its skilled human resources. These efforts to facilitate skill mobility within the EU aim to strengthen and develop research-based knowledge in Europe. However, there are also negative effects such as disruptions and skills gaps in personnel. It is these trade-offs that Hauknes (1994) focuses on. A survey of the recruitment practices of European employers is presented by Winkelmann (2002). Based on this survey, preliminary insights are given regarding critical factors that influence firms' demand for the highly skilled.

*Mobility effects on capacity of a sector or location to catch up*

Besides mobility's role in facilitating knowledge spillovers to ensure that a sector or location retains competitive advantage in an increasingly knowledge-intensive global economy, mobility also plays an important part in the process of bridging development divides and catch-up.<sup>77</sup> The majority of the 'catch-up' literature focuses on knowledge spillovers augmenting the production system in the source sector or location, rather than mobile individuals returning to create what they learned abroad while relatively divorced from subsequent interactions.<sup>78</sup> While the role of mobility is implicit, Keller (2002) highlights the importance of knowledge spillovers in perpetuating MDCs' competitive advantages and the potential for these knowledge spillovers to facilitate the catch-up process despite innate barriers created by language and cultural divides.<sup>79</sup>

Pack and Saggi (1997) examine evidence of MDC knowledge spillovers to LDCs. They show that human resources and their local interaction, particularly their connectivity with the local production system, play a critical role in determining the significance of spillovers. The importance of this finding is that it differentiates spillovers associated with foreign direct investment (FDI) from those associated with

77 For more on the notion of catch-up see Fagerberg and Verspagen (1998). See also Fagerberg (1994), Verspagen (1991), Abramovitz (1979) and Gerschenkron (1962).

78 Exceptions to this generalisation include Yang (2005), Domingues Dos Santos and Postel-Vinay (2003), Kapur (2001), Ul Haque and Khan (1997), Song (1997), Ul Haque and Kim (1995) and Yoon (1992).

79 Schiff and Wang (2004) review knowledge accumulation in the process of LDCs' catch-up with MDCs.

licensing.<sup>80</sup> In particular, if the LDC has the ability to absorb the technology, FDI can facilitate leading-edge technologies. However, if a substantial degree of catch-up is necessary, then licensing and joint ventures can provide spillovers with greater impact on the economy's development.<sup>81</sup>

Internal evidence of knowledge spillover associated with mobility also exists, as Dupont (1992) demonstrates in a case study of a middle-sized town in India connecting rural to urban landscapes. She demonstrates that human resource mobility had a major influence on the industrialisation process as well as providing significant feedbacks between rural and urban locales. Similarly, Chan (1995) traces the migratory effects of economic reforms in China since 1978. Here again, increased mobility is shown to be important in supporting economic growth.

### **Effects on human resource development**

Mobility to increase an individual's knowledge is among the oldest forms of human resource development. However, in modern times attention has focused on the effects of those left behind in what has already been discussed as brain drain.<sup>82</sup> This section looks at the debate over the effect of mobility on human resource development in these source sectors and locations, with particular attention given to the more recent literature that proposes brain-gain effects from the initial emigration of human resources. The section concludes with a brief review of the effects of human resource development in the destination sectors and locations, noting especially the increasing internationalisation of education.

#### *Mobility effects on human resource development in the source sector or location*

Evolving from the brain-drain literature, another set of literature has emerged that considers the potential positive influence skilled expatriates can have on the source sectors or locations.<sup>83</sup> This literature grew out of the human-capital approach, viewing mobility of skilled human resources as raising the expected returns on education and leading to an associated increased investment in human resource development, for example education.<sup>84</sup> Subsequently, as attention to the significance of remittances from emigrants grew, these were seen to be an additional incentive and means to invest in education.<sup>85</sup> In its more optimistic formulations, this literature proposes that the additional investments in education in the source locations can offset and surpass the loss of skills through emigration.

The net effect of this brain gain remains an open question. At least in the context of relatively low-skilled workers, the higher earning may not provide an incentive to invest in education and may in fact lead to less investment in education if

80 See also Saggi (1996), Kokko (1994) and Barton et al. (1988).

81 See also Blomström et al. (1994) and Wang and Blomström (1992).

82 See the section headed 'Effects on efficiency' earlier in this chapter.

83 Most of this literature is focused on mobility between nations.

84 See Mountford (1997), Stark et al. (1997, 1998), Vidal (1998), Beinea et al. (2001) and Stark and Wang (2002).

85 See Adams (2003), Yang and Martinez (2006), Cox-Edwards and Ureta (2003) and Stark (2004).

individuals in source locations drop out of school to pursue their fortunes abroad.<sup>86</sup> Schiff (2006) points to several additional factors to explain why this induced brain gain is not likely to offset the loss of skilled human resources. First, higher-ability individuals may emigrate first, leaving behind individuals less capable of human resources development. Second, the emigration of low-skilled or non-skilled labour will decrease the incentive to invest in education. Third, formal education investment is subject to some degree of uncertainty regarding the benefits that it will confer. Finally, if the domestic economy is incapable of adequately absorbing the additional human resources, the education investment will generate negative externalities because of the additional educational resources and forgone earnings of workers during their studies.

*Mobility effects on human resource development in the destination sector or location*

As mentioned previously, knowledge spillovers are another important aspect of mobility because of the significance of tacit knowledge and its transference through experience and proximity.<sup>87</sup> Møen (2000) demonstrates the value of this acquired tacit knowledge through lower salaries in R&D-intensive firms in employees' early careers, when significant tacit skills are acquired. Later in their careers, these employees are compensated through relatively higher salaries for these acquired tacit skills.

The legacy of mobility in human resource development among university students and educators is noted by Avveduto (2001). Nonetheless, despite the renown of certain locations of learning like Cambridge and Oxford, recent OECD studies provide some evidence of a new environment in which the internationalisation of higher education is emerging. In this new context, transnational cooperation is increasingly imperative. The changes in the nature of higher education carry significant implications for education policy with regard to mobile human resources.

Throsby (1998) also focuses on the increased internationalisation of higher education that has occurred over the past 20 years. Consideration is paid to the ever-increasing trend of international student flows and the impact on higher-education financing. With these changes, a revision in thinking about the cost and benefits of international higher education by both sending and receiving countries is needed. This analysis of the consequences of mobility for sending and receiving nations is further examined by Tremblay (2001). In this study, internationalisation of higher education is examined as a form of highly skilled labour mobility. The evaluation considers the scale, direction, characteristics and determining factors of student flows. Lastly, Guellec and Cervantes (2002) consider the significance of skilled human resource mobility, as well as the origins, destinations, impacts and forces motivating these flows. By way of tentative conclusions, their analysis points to the increasing and accelerating trends in mobility of education and employment as requiring revision of domestic policies and increased international cooperation.

<sup>86</sup> See Chiquiar and Hanson (2005), McKenzie and Rapoport (2005), McKenzie (2006) and Mora and Taylor (2006).

<sup>87</sup> Evidence of the importance of these spillovers for destinations is provided in Chellaraj et al. (2006).

### Effects on social capital

Social capital has increasingly been recognised as playing an important part in the quality of life.<sup>88</sup> It has been shown to be positively related to health, safety and education.<sup>89</sup> More narrowly, social capital brings important benefits by facilitating trust that lowers transaction costs and increases competitiveness.<sup>90</sup> Mobility's effects on social capital can have important impacts on an economy. This section focuses particularly on the importance of trust in facilitating interactions that generate knowledge spillovers.

#### *Mobility effects on development of social capital*

The history of scientific migrations and the benefits of knowledge circulation are discussed by Meyer et al. (2001). They point out that the global knowledge society has contributed to mobility of the highly skilled, but this is not an entirely new phenomenon. These migrations represent important cross-border migratory traditions with valuable social capital, which can increasingly span and reconnect socio-economic networks. Similarly, significant adjustments to radical changes in the economic environment through labour mobility are illustrated in the recent experience of formerly communist Eastern Europe. Kabalina (2001) describes the influences on labour mobility during Russia's economic transition in the 1990s.

#### *Mobility effects on erosion of social capital*

One aspect of the migration experience of skilled workers is their enrichment of skills. In these approaches, this feature is typically incorporated as a human-capital investment by the worker. Mobility of labour, although based on incentives to the individual, carries social costs and benefits. Schiff (1999b) demonstrates the externality costs of labour mobility on social capital as a result of labour-market integration, such as that in the EU.<sup>91</sup>

Late in 2005 newspaper headlines indicated the impact of negative externalities associated with mobility. Be it the riots in Paris and the rest of Europe or those in Australia, evidence of conflicting social cohesion associated with mobility was prominent. Despite this, mobility and immigrant labour is a cornerstone of many of the world's economies. For instance, in 2005 there were 6.7 million foreigners residing in Germany; migrants accounted for 11 per cent of private-sector workers in Greece; and in Saudi Arabia foreigners represented 30 per cent of the residential population of 23 million, but 70 per cent of the 6.5-million-member labour force (*Migration News* 2006).<sup>92</sup>

88 See OECD (2001c) for an overview of social capital and its effects on the quality of life.

89 See OECD (2001c) and Putnam (2000) for evidence of the beneficial impacts of social capital on the quality of life.

90 See Humphry and Schmitz (1998), Uzzi (1996, 1997), Granovetter (1985), Arrow (1972) and Cyert and March (1963).

91 See also Schiff (1992, 1999a).

92 For further discussion of the effects of mobility on social capital see Koser (2003), Espinosa and Massey (1997) and Levitt (1998).



# Empirical analyses of mobility and systems of innovation

### Traditions in the analysis of mobility

While a spectrum of skills is necessary for a well-functioning economic system, skilled and highly skilled individuals tend to be the most important human resources for innovation systems. Because of the diffused nature of innovation activities, quantifying associated human resources is empirically challenging. As formal R&D activities tend to be more clearly differentiated from other activities, most empirical analyses of mobility in a system of innovation focus on the human resources associated with the R&D system.

Analysis of human resource mobility in an R&D system requires the consideration of several dimensions: (1) human resources active in the system, (2) human resources who have left or will imminently depart from the system and (3) human resources who are qualified but not currently employed in the system. In terms of currently employed R&D workers, it is important to take into account (1) the actual stock of human resources and their quality with respect to the needs and absorptive capacity of the R&D system; (2) the percentage of these people in the system who are temporary or transient participants; (3) the scale, causes and effects of the internal mobility of these human resources; and (4) the actual and/or perceived match between the skills and experience of these human resources and the demands of the R&D system.

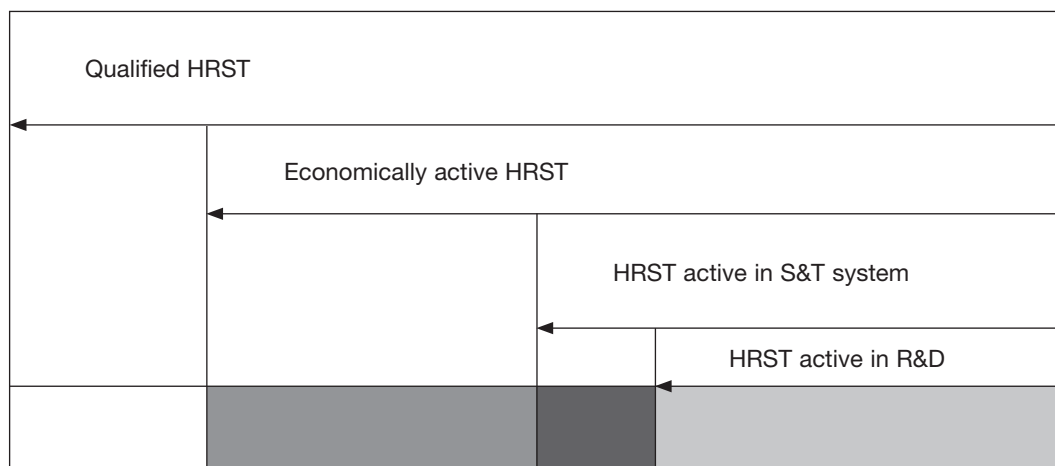
In terms of human resources who have left or are imminently departing the R&D system, one must consider the degree to which these 'expatriates' remain in close proximity so that their repatriation to the R&D or innovation system is relatively costless. In addition, skill and/or experience deficiencies (inefficiencies) created by their departure should be examined with respect to their quantitative and qualitative impacts. Finally, the relative extent and causes of this external mobility should be analysed.

With regard to human resources who are qualified but not currently employed in the R&D system, an initial division can be made between those who reside near the system and those who are far from the system. Proximate non-participants need to be analysed in terms of the R&D system's demand (or lack thereof) for their skills and experience. For example, why might there be exceptionally high unemployment rates for certain categories of recent university graduates? It is also important to identify potential non-permanent human resources who are qualified and have a high potential to join the R&D system. For both categories, it is necessary to identify the actual or potential influences on the R&D system this untapped pool represents.

Unfortunately, the empirical data needed to analyse the issues discussed above are limited. Because of this the human resources that are actually analysed are sometimes narrower and sometimes broader than that defined as strictly relevant to the R&D system. Analysing mobility of the R&D workforce requires assessing mobility of current, previous and potential human resources in the R&D system. In reference to this broader group, the term *human resources in science and technology* (HRST) is used. The R&D workforce is thereby derived as a subset of sector- or location-specific HRST, consisting of permanent and temporary members of the R&D system. Following the OECD Canberra methodology (OECD 1995), we can define HRST by occupation, qualification or a combination of both qualification and occupation. For a picture of both HRST supply and demand, the Canberra Manual advocates a definition based on qualifications and occupation. It states that HRST are individuals who either successfully completed education at the third level<sup>93</sup> in an S&T field of study, or who are not formally qualified in this way but are employed in an S&T occupation where such qualifications are normally required.

In this context, defining HRST depends on our specifying S&T occupations and qualifications that encompass individuals currently, previously or potentially active in the formal R&D system. Figure 3.1 is a representation of HRST stocks differentiated among (1) qualified HRST, including those not economically active (e.g. retired); (2) qualified HRST who are economically active but not using their skills/education (e.g. a professional football coach with a university degree in engineering); (3) those active in the S&T system; and (4) those active in the R&D system.<sup>94</sup>

Figure 3.1: Defining highly skilled human resources

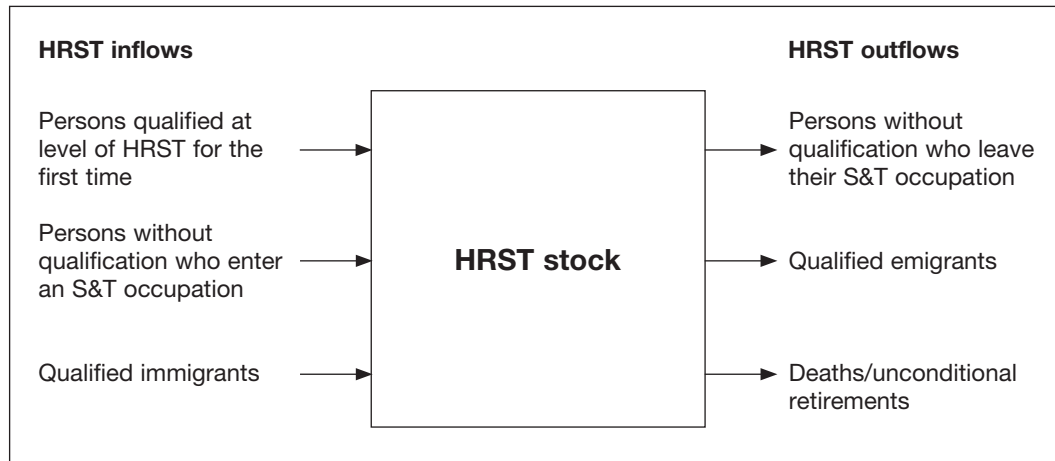


<sup>93</sup> In general, education at the third level begins at the age of 17 or 18 and lasts three or more years.

<sup>94</sup> This distinction between the S&T system and the R&D system is made in line with the fact that R&D activities, as defined by the Frascati Manual (OECD 1993), do not include S&T education and training nor scientific and technological services, but S&T activities include all three.

The Canberra Manual suggests a schematic model of the national stock and flows of HRST. This schematic is reproduced in Figure 3.2. There are two types of HRST flows: external and internal. External flows of HRST are depicted in Figure 3.2. Internal flows of HRST involve changes in the characteristics of the people who are part of the HRST stock (Figure 3.1) without their losing the essential characteristics for HRST inclusion.<sup>95</sup>

Figure 3.2: Dynamics of skilled human resources in a sector or location



### Methodologies for quantifying mobility in systems of innovation

Measurement of HRST stock and flows is inherently problematic. Ekeland (2001) observes that the importance of HRST is often acknowledged but rarely measured because of data inadequacy. He discusses the history of HRST measurement and notes that an early systematic international audit of HRST data was conducted in 1993 through an OECD and Eurostat initiative. In this regard, the OECD Canberra Manual was developed as a conceptual framework for discussion of HRST. Thus, while Canberra is a primary reference on HRST mobility, it is not a definition of HRST. Canberra frames the scope of HRST coverage, ensuring correspondence of the chosen definition with appropriate associated classifications. As a result of its origins, the Canberra Manual does not explicitly discuss issues related to data collection.

A long-standing and recurrent problem in discussions of mobility is defining the boundaries of mobility. Svanfeldt and Ullström (2001) take up this issue through an analysis of detailed Scandinavian data on firm and job mobility. They elaborate the practical problems associated with defining where mobility boundaries lie. Firms' mobility dynamics are often data-driven at the empirical level, a fact with associated pitfalls that Svanfeldt and Ullström take into account. They demonstrate that existing data on firm destruction and creation, as well as the associated labour-mobility rates, are frequently more legal than real.

<sup>95</sup> If our HRST-qualified football coach began working as an engineer for an R&D lab, he would represent an internal flow of HRST.

The consequences of adopting various definitions of HRST based on different combinations of educational and occupational information are investigated by Graversen and Friis-Jensen (2001). This study examines employee diffusion and circulation of knowledge through HRST. Mobility of these defined groups is taken to indicate how well knowledge is circulated, exchanged and accumulated in the economy.

An analytical method to determine the flow of highly educated employees into and out of workplaces characterised by high innovation intensities is discussed in Graversen (2000). In this study, which focuses on higher-education institutions and R&D institutions, mobility of individuals is taken as an indicator of knowledge and innovation potential in an economy. The mobility rates between sectors are then used to describe a spread and circulation of knowledge 'pyramid', which is an interactive conception of the knowledge-creation process rather than a science-based notion.

The feasibility of constructing an internationally comparable indicator on the mobility of highly qualified personnel is investigated by Åkerblom (1999). The study considered three types of mobility indicators: (1) those between firms and other organisations, (2) those between research-producing and resource-using sectors and (3) those on international mobility. In calculating these indicators four types of source data were identified as being available: (1) labour-force surveys, (2) national registers, (3) special longitudinal panels and (4) special surveys. The analytical focus was on MDCs, with efforts at indicator development on a selection of OECD nations. Noting differences in mobility from the various sources, the study concludes that, at present, there is limited promise of constructing indicators on international mobility.

The methodological difficulties in developing an internationally comparable indicator are illustrated in Cañibano (2000). Spanish HRST mobility was calculated as the highest in the EU, the European Free Trade Area and EU candidate countries for the period 1994 to 1999. The Spanish labour market's high mobility is considered to be a product of its structural transience in employment rather than true mobility. This situation is related to a general discussion of facts and methodological issues that explain some of the disparities obtained between national HRST mobility indicators.

Despite shortcomings in such indicators, they provide a useful if highly qualified picture of labour mobility. Laafia and Stimpson (2001) build on previous investigations and utilise European survey data to provide internationally comparable measurements of job-to-job mobility for the EU and beyond. Canada provides the setting for another example of HRST stock and flows estimation in Bordt (2002). This investigation surveys the scale of stock and flows as well as data sources used to derive descriptions of Canada's internal and external mobility for its large foreign population and well-educated general population.

Auriol and Sexton (2002) survey methods of measuring HRST. After acknowledging the limited capacity to analyse mobility of highly skilled labour because of poor internationally comparable data, they review available data sources, their associated

positive and negative characteristics, and the principal statistical issues related to measurement of international mobility of HRST.<sup>96</sup> Using European and American data, Auriol and Sexton derive estimates of HRST stock and flows.

As the foregoing analyses indicate, data limitations are major issues that have significant effects on the types of empirical analysis possible.

### **Types of data and sources**

Most empirical analyses of HRST mobility draw on data from MDCs, but even in these statistically rich nations, data shortcomings with respect to HRST mobility are notable. Mahroum (2001) provides a review of existing data and data sources in European OECD nations. He looks for potential new data sources and gives a framework of data requirements to sketch national scientific landscapes. The data available are typically collected as a by-product of data collected for other purposes. Mahroum's analysis discusses the problems with this, noting in particular the necessity for data collection to accommodate the structure of the NSI.

At least among OECD nations efforts are being made to improve data on HRST mobility. Efforts in this respect are reported by Rosengren (1998), who presents a summary of national data availability as part of OECD efforts initiated in 1996 to quantify mobility patterns of highly qualified personnel. The work in this regard is ongoing and Rosengren summarises and prioritises issues for further research. The availability of certain types and sources of data tends to dictate the nature of empirical analysis. Possible data types for analysis of HRST mobility include:

- Population data (location, demographics, education and occupation);
- Labour-force surveys;
- Industrial structure statistics (employment, wages, hours of work);
- R&D statistics (personnel by sector);
- Social capital measures;
- Intellectual property rights statistics;
- National and international immigration and emigration data;
- National register data;
- Case studies of S&T institutions and organisations;
- CV studies of personnel at S&T institutions and organisations, and
- Personnel records and profiles.

Possible data sources on skilled human resource mobility include:

- Business organisations;
- Higher-education institutions;
- Parastatal organisations;
- Professional societies;
- Non-government organisations;
- Labour organisations;

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<sup>96</sup> An issue they raise is the systemic bias towards measuring HRST inflows. Efforts to account for this bias in the South African mobility experience have led to several analyses that adjust for unofficial emigration. See Blankley et al. (2004), Borat et al. (2002) and Brown et al. (2000b).

- Business associations, and
- National and local government departments/offices.

## Evidence

This section surveys a selection of African mobility analyses with a primary focus on South Africa. As with most aspects of the contemporary South African experience, the post-apartheid era, for a variety of reasons, denotes a major watershed in South African migration. In a historical overview and analysis of contemporary migration experiences, Smit (2001) demonstrates that despite tremendous strains African families are very adaptive to migrant effects and resilient in sustaining cultural values.<sup>97</sup> Until the late 1990s, the vast majority of the South African migration literature was concerned with mobility of relatively low-skilled labour for employment in farming and mining. Even within this literature, rural migration experiences are largely neglected, which Rogerson (1995) highlights in his overview of migration research.

With the new government in place in 1994, South Africa found itself in an increasingly open society and one in which foreign workers were looked upon negatively. Results of a nationally representative survey of 3 500 South Africans are used by Mattes et al. (2000c) to provide some background to South African attitudes towards foreigners. Most of this xenophobic sentiment has been directed towards migrants from other African nations. McDonald et al. (1998) present the results of interviews with 2 300 people in Lesotho, Mozambique and Zimbabwe. They show that there is not a flood of immigrants waiting to rush to South Africa, but those that are interested in migration to South Africa are typically highly entrepreneurial. That analysis of potential immigrants was further substantiated by McDonald et al. (2000), who interviewed 500 foreign African nationals in South Africa from nations other than Botswana, Lesotho, Mozambique, Namibia, Swaziland and Zimbabwe.

An important feature of migrant Africans in South Africa is their generation of economic activity. This in turn creates employment opportunities for South African nationals, as is pointed out in Rogerson's study (1997) of expatriate African small, medium and micro enterprises in Johannesburg. Although at a lower level of skill than that which is of concern for this investigation, expatriate workers are identified by Rogerson (1999) as a significant and growing feature of the South African construction industry. In this case, there is some evidence that foreigners are doing relatively undesirable work and filling a domestic skills gap.

Geographic proximity is reasonably assumed to be correlated to one's migration potential. Therefore, Dodson (2000) and Taylor and Barlow (2000) give useful, if general, indications of the immigration potential from South Africa's neighbours. Dodson investigates the influence of gender on potential migrants to South Africa from Lesotho, Mozambique and Zimbabwe. Taylor and Barlow use historical migration data from the same nations to generate some long-term migration

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<sup>97</sup> In this respect, South Africa seems to share what Ferguson (1990a, 1990b) considers to be distinctly African migration characteristics.

scenarios. Anyone roughly familiar with the discussion of South African labour mobility during the last decade knows that emigration has been at least as significant an issue as immigration. As such, results of a survey of South Africans emigrating to Australia presented by Polonsky et al. (1995) raise issues of principal importance for our study of HRST mobility. Namely, Polonsky et al. found a representative group of emigrating South Africans to be highly skilled and relatively uninformed about their country of destination, with many retaining strong family ties in South Africa.

By the late 1990s, the international mobility of skilled South Africans (that is, brain drain) had become part of a significant public debate about skills migration in South Africa. In this environment, several rigorous research efforts were initiated to quantify the 'skills crisis'.<sup>98</sup> Kaplan (1998) reviews some of South Africa's principal S&T institutions, demonstrating their large scale in comparison to those in the rest of Africa. He then gives a preliminary analysis and periodisation of South African data on HRST mobility and its effect on the S&T system. Empirical shortcomings in South African migration data are adjusted for bias using immigration data from the top destination countries in Kaplan et al. (1999), Brown et al. (2000b, 2001) and Meyer (2002). Predictions about the future scale of permanent and temporary HRST mobility are offered by Crush et al. (2000) as they review two studies on the mobility of HRST employees and their employers.

Bhorat et al. (2002) analyse the scale and nature of South Africa's brain drain. They find emigration rates to be much higher than official figures and highlight the significance of brain drain for South Africa because of its comparative level of development. Blankley et al. (2004) confirm the underestimation of South African emigration by official statistics. They also highlight the important fact that since 1994 South Africa has become both a significant source of and destination for skilled human resources. In particular they identify the internationalisation of South African higher-education institutions as an important potential source of skills for South Africa, but one that needs to be carefully managed to enhance benefits and limit negative externalities on other African countries whose citizens make up a large number of the skilled expatriate population. Lucas (1987) examines the impacts of remittances from expatriate workers on South Africa's mines and shows significant poverty and investment effects associated with them.<sup>99</sup>

International mobility is not the only dimension to South African HRST mobility. Domestic mobility is a principal source of tacit knowledge diffusion, but rapid turnover of personnel can generate more costs in turbulence than is gained through facilitating communications. At a general level, Bhorat (2000) presents employment trends in South Africa by sector and skills for the period from 1970 to 1995. He shows an increasing reliance on skilled and highly skilled labour. His analysis shows that while increased international trade has contributed to employment growth across all occupations, it has been growth-biased towards skilled personnel in the

<sup>98</sup> The Southern African Migration Project has been prominent in this research, as have researchers associated with the South African Network of Skills Abroad.

<sup>99</sup> See also Lucas and Stark (1985), Gustafsson and Makonnen (1993) and Adams (1989).

labour market. The changing demand for skills in South Africa is also reflected in an investigation by Whiteford et al. (1999). They use a survey of employers to forecast labour-market demand over the period from 1998 to 2003. Comparisons are then made with the current stocks and estimates of future domestic flows of skilled labour. South Africa's public-sector losses in S&T skills are analysed in a study conducted by the Department of Arts, Culture, Science and Technology (DACST 1996).

An important characteristic of South Africa's S&T system is its relatively developed state, particularly in comparison to most other African nations. While South Africa shares with many LDCs a real and significant loss of its best personnel to MDCs, it is itself a country which attracts HRST. Mattes et al. (2000a, 2000b) review popular attitudes and policies towards skilled immigrants (that is, brain gain) in South Africa. These are compared to actual profiles based on interviews with 400 skilled foreign nationals in South Africa. Their findings show that skilled immigration prior to 1994 was mostly of white permanent immigrants, while that since 1994 has been primarily of black temporary immigrants (migrants). Given its relatively advanced economic state, South Africa must retain and attract HRST. An aspect of this is found in Ramphela's analysis (1999) of South Africa's tertiary institutions. She notes that a balance must be struck between an international environment, carrying potential brain gain, and national development needs.

In an analysis complementary to that by Whiteford et al. (1999), Rogerson and Rogerson (2000a, 2000b) present results from a survey of business organisations regarding the significance of and their responses to HRST shortages. Motivations for high skilled-labour mobility are examined by Mattes and Richmond (2000a, 2000b) as they identify areas of potentially chronic and damaging skills shortages through a survey of highly skilled South African employees. Demographic characteristics, particularly gender, are analysed by Dodson (2002) in terms of the influence they have on emigration by South Africa's HRST. She finds women less likely to emigrate and gender more of a determinant to migration than race.

In the Western literature on migration there is often a strong distinction made between urban and rural populations and their respective socio-economic dynamics. Ferguson (1990a, 1990b) critiques this proposition based on Zambia's twentieth-century migration experience. Zambia has demonstrated enduring ties to the rural hinterland, as opposed to establishing a permanently settled and separated urban class. Based on this study caution is proposed when using Eurocentric assumptions in developing typologies and models of African migrations.

As part of its efforts to provide an analytical base for migration in southern Africa, the Southern African Migration Project (SAMP) has conducted a series of surveys concerning attitudes towards migration in southern African countries. While general, these surveys gather information of particular relevance for estimating the regional migration potential to South Africa, as well as popular attitudes towards migration policy reform. The Namibian survey results are presented by Frayne and Pendleton (1998, 2000). The survey consisted of a nationally representative sample of

600 Namibians and, among other features, was notable in its finding that, in contrast to other nations, Namibians see migration as negative in its consequences to families, communities and the nation as a whole. The Lesotho survey consisted of a nationally representative sample of 692 individuals; its findings with respect to general attitudes towards migration are presented by Gay (2000a). A survey of southern Mozambique was conducted with 661 individuals and its results described by De Vetter (2000). Zimbabwe, being similarly surveyed in a sample of 947, is described by Zinyama (2000). Finally, Botswana was also analysed, but with particular attention since it is second only to South Africa as a destination country within SADC for migrants. General Botswana attitudes towards migrants are presented from a similar survey instrument by Mukamaambo (2000), while Oucho (2000c) uses national migration data to periodise migration trends since 1981.

The mobility of HRST in Lesotho and Botswana was also analysed in the SAMP project. Gay (2000b) gives results of the Lesotho study, which covered 306 skilled nationals and 67 skilled foreigners. South Africa and Botswana were found to be the principal destination nations, with limited employment opportunities being the biggest force for migration. A survey of 226 skilled Botswana is reviewed by Campbell (2000a, 2000b). The survey indicates that a large-scale exodus of Botswana's HRST is unlikely, as the relatively dynamic national economy curbs long-term mobility. In a complementary study, Oucho (2000a, 2000b) presents results from a survey of 124 skilled foreigners working in Botswana. Skilled immigrants provide a very important resource for Botswana's economy, and the generally favourable impression of their employment experience in Botswana is encouraging. However, an undercurrent of resident hostility towards them was also noted.

Migration in southern Africa is reviewed by Crush (2000). Four distinct migration streams are discussed: contract migration, informal migration, white settler migration and refugee migration. Contract migration is primarily established around the mining industry and can be divided into three major phases: from 1850 to 1920, from 1920 to 1970, and from 1970 to the present. Informal migration emerged as alternative employment opportunities for black Africans outside of mining developed; a large portion of these migrants worked in the agricultural sector. White settlers were the principal source of highly skilled human resources until 1986 as black Africans were prohibited from immigrating to South Africa. Finally, amid the political turmoil in Mozambique in the 1980s, South Africa experienced its first refugee migration.

The general southern African migratory setting is surveyed by McDonald (2000) against the post-apartheid backdrop and with new immigration legislation pending. The centrality of migration in contemporary southern Africa is highlighted by Oucho (2002), who reviews the relationship between migration and poverty in the region. The study points to the necessity for a broad and systematic migration research agenda as a practical precondition for realising the region's economic growth potential. Williams (2002) discusses the practical role that SADC, the region's most prominent institution, can play in migration.

Campbell (2002) gives a brief overview of the mobility of skilled individuals in southern Africa. He notes that in addition to South Africa, Botswana and Namibia are significant destinations for skilled immigrants. An overview of primary dimensions in the mobility of skilled labour in southern Africa is provided by Meso (2000) and McDonald and Crush (2000). The latter study notes the evolution of skilled labour mobility in southern Africa following independence. Reliable data have been lacking, which motivated the SAMP investigations throughout the region in 1998. Regional integration must come to terms with the mobility of skilled personnel and a reconceptualisation of the brain drain that includes a degree of regional brain circulation representing a potential win-win condition.

Migration has been fundamental to African society and history. In pointing this out, Adepoju (1995, 2000) notes the different nature of migration during the colonial era. With peace and political stability imposed by the colonial government, population movements became linked to an economic system focused on development of a foreign export sector. In this context migration was largely short-term, primarily male and reinforced through poor earnings. Immediately after the end of colonial rule, the pre-existing development pattern of the colonial era was pursued with increased vigour. This gave an additional impetus to urban migrations, and under the guise of nationalism increased border controls emerged during the 1960s. By the 1970s and 1980s, political-economic mismanagement generated a poor economic climate in many African nations and large numbers of skilled Africans began to migrate to MDCs.<sup>100</sup> These flows have continued throughout the 1990s, with some changes in the source and destination nations following their economic progression and regression.

In his discussion of migration, Aina (1995) points to the traditional focus on rural-urban migrations as being inadequate for the African migratory experience, which also includes significant rural-rural, urban-rural and urban-urban migrations. He holds that these migrations reflect the structural importance of non-metropolitan communities, small and medium-size towns as well as rural areas in the political-economic systems of African nations. The extent of non-metropolitan migration limits the relevance of methodological approaches in the centre-periphery tradition with their hierarchical conception of metropolitan control.

As part of an international effort to advance understanding of migration, an international conference of regional experts on sub-Saharan African migration was held in Gaborone in 1998 (UNESCO 1998). Among the many significant issues raised was the tendency to view migration negatively, despite its potential to contribute positively to social and economic transformation within the sub-Saharan region. Regional integration efforts obviously need to incorporate a functional role for migration in their strategies. Reintegration and accessing the African diaspora is yet another area of significant, if largely untapped, potential for sub-Saharan nations.

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100 See Amin (1974, 1995).

Most of the literature discussing mobility of African HRST does so within the context of general migration patterns. Gould (1988a, 1988b) reviews government policies and mobility of skilled workers from sub-Saharan Africa. Focusing on geographical issues, he observes significant HRST mobility both within the continent and between African nations and non-African MDCs. Intra-African HRST mobility is determined in large measure by relative levels of national economic activity. Gould's analysis holds that government education policies have failed to match supplies with demands for skills. Socialist government policies aimed at limiting income disparities are also held to have reduced incentives for skills acquisition. While foreign African workers are often touted, Gould's analysis shows that there have been few practical initiatives in this regard by African nations. With limited resources and scale for specialisation, Africans increasingly pursue their tertiary education away from the continent. While this represents potential brain drain, the best way to reduce it is by promoting a climate with favourable opportunities for these students to return to.

As a global phenomenon, improved communication technologies are also altering mobility of African HRST. In light of this, Teferra (2000) considers existing efforts and potential opportunities for African nations to benefit from the international mobility of their HRST. Ever-improving ICT is facilitating greater scope for financial and intellectual remittances of a nation's expatriate population. In particular, the Internet is facilitating transfers of tacit knowledge, the lack of which have traditionally been a major barrier to economic development and promotion of competitiveness. The successes of India, Taiwan and South Korea are held to hold promise and justify a revision of the brain-mobility paradigm in Africa.



# Policies to influence mobility

This part of the survey reviews policies, primarily international in scope, intended to influence the mobility of highly skilled labour. Following a brief overview of South Africa's innovation policies and their relationship to skilled human resources mobility, three types of mobility policies are discussed: (1) brain-drain policies aimed at retaining or repatriating South African nationals or preventing the local loss of skilled human resources, (2) policies focused primarily on increasing national/local skilled human resources and (3) policies that attempt to account for existing patterns of skilled human resources mobility and utilise the positive aspects of them while minimising their disruptive features.

South Africa's national innovation policy since 1994 is reviewed by Mani (2001). This review notes South Africa's sophistication in framing policies and institutions to facilitate domestic technological development and absorption of foreign technologies. The results of these efforts have been limited by a severe shortage of R&D scientists and engineers. Stagnant enrolment in science and engineering subjects and the emigration of qualified personnel are given as reasons for this shortage. Without suggesting specific policies to address the situation, the review highlights how this structural deficiency has inhibited the stimulation of R&D activity by South Africa's financial instruments.

### **Policies that discourage unidirectional mobility**

The concern over South Africa's brain drain was discussed in the last section of Chapter 3. While the ability of a government to forcibly retain its nationals is limited or non-existent in a nation that recognises the right of individuals, some governments, particularly those of LDCs, have introduced a variety of reactive policies to discourage emigration. These have largely failed, as the pull of various incentives to emigrate outweigh the punitive consequences held out by the government concerned. This has not spelled the end of policies to curb the brain drain, however. Increasingly, proactive policies are being used to stem the outflow of skilled human resources.

Abella and Lönnroth (1995) review these attempts to reduce brain drain through domestic policies aimed at lessening the need for emigration. These proactive policies seek to alter the economic incentives in favour of people who feel they have to move abroad in order to improve their own condition. Accordingly, nations need to generate 'economic opportunities to enable individuals to have access to employment and incomes, as well as the equitable distribution of gains from growth to the population so as to prevent and combat poverty and marginalization' (Abella and Lönnroth 1995, 25). Abella and Lönnroth suggest that the nation's macroeconomic determinants be targeted, labour-market efficiency promoted, and target labour-market policies be designed for strategic groups who are under particular emigration pressure.

### **Policies that encourage unidirectional mobility**

The unravelling of the historical legacy of division and arbitrary geographic relocation of South Africans will generate more efficient labour mobility. Although this internal mobility is likely to be limited in its influence on skilled human resources mobility because of the educational opportunities associated with these groups, some skills gains would seem reasonable from the general improvement of human-capital mobility. It is this sort of efficiency through relocation that Serres (1994) appears to be concerned with in noting the effects of the Canadian government's subsidies of Inuit at Davis Inlet. This study suggests that in the promotion of immobility through government subsidies, efficiency gains through labour mobility are forgone.

In an increasingly globalised world, highly skilled personnel are being targeted more and more in national brain-gain policies. Germany's skill-acquisition policy, including efforts to target temporary migrants, is reviewed by Werner (2002). The change in US immigration policy towards a greater focus on selective immigration to increase strategically skilled personnel is reviewed by Martin (2002). A structural bias in the admission process towards temporary visa admission is noted as part of the increased US admission of foreigners with professional, technical and kindred skills as immigrants and non-immigrants.

Finally, MDCs are not the only nations to benefit from the inflow of skills. Doornik (1998) proposes a methodology by which low- and middle-income nations can assess their policies aimed at integrating foreign workers. Low-cost improvements to national data-collection systems are suggested in order to facilitate evaluation of the effectiveness of immigration and integration policies.

### **Policies that encourage multidirectional mobility**

A major development in thinking about mobility of skilled human resources has been the recognition that mobility is not necessarily a unidirectional phenomenon and that significant benefits can occur through feedbacks along social and professional networks. In South Africa this reality has been central to the efforts of researchers associated with the South African Network of Skills Abroad (SANSA) project.

A history of the diaspora option and comparison to physical repatriation is found in Meyer et al. (1997) and Meyer (1996). They discuss the role improved communication technology has played in increasing the viability of the diaspora. In this context and following the pattern of other developing countries that increasingly look towards their expatriates overseas, the Colombian diaspora network is reviewed and the viability of a similar operation in South Africa is considered. The use of the diaspora in the context of a knowledge-based economy increasingly relying on science and technology is considered by Meyer and Brown (1999). This study summarises the potential of the diaspora and its associated circulation as a positive-sum cooperative gain between LDCs and MDCs.

In an examination of South Africa's intellectual diaspora, Kaplan (1997) provides estimates of its size, international location and characteristics. This overview introduces and reports on the SANSA project to tap the expatriate network for local development. Several additional overviews of the South African diaspora initiative to network expatriates with local projects and researchers are provided by Kaplan and Meyer (1998), Brown and Van Staden (1998) and Brown et al. (2000a). This effort is particularly significant in that it marks a government-supported policy initiative to take advantage of brain circulation complemented with policies to decrease brain drain and increase brain gain, all three of which mark a more comprehensive and systemic policy approach to skilled human resources mobility.



# Conclusion

The world economy appears to be transforming from industrial-based to knowledge-based.<sup>101</sup> Granstrand (2000) refers to this economic transformation as the emergence of intellectual capitalism. He posits that a driving force behind this transformation is technological change and accumulation of new technologies. More particularly, Granstrand holds that ICTs are playing a pivotal role in the emergence of intellectual capitalism. ICTs lower the transaction costs associated with the exchange of information, enabling a more adequate privatisation of gains from production and making possible the distribution of information on a commercial basis. ICTs also enhance the connectivity and excludability of agents, and augment our ability to codify information.<sup>102</sup>

This review has surveyed contemporary international literature associated with the mobility of highly skilled personnel. In so doing, it has raised some issues of particular importance for analysing mobility of skilled South African human resources. By way of conclusion, a few of the more significant and recurrent topics from the survey are briefly mentioned here.

Globalisation was noted as encouraging greater mobility of highly skilled personnel. Increased openness and communication has allowed an increased specialisation of local districts. While physical mobility is not always required, the large stock of tacit knowledge held by highly skilled individuals entails an associated specialisation of diverse labour around increasingly narrow competitive foundations. To some extent, then, South Africans may simply be following their international specialisation as they relocate beyond the country's borders.

African integration has raised some prospects for the development of regional specialisation. As a relatively developed African nation, South Africa represents a destination for other highly skilled Africans – that is, a regional emigration alternative to Europe and North America when highly skilled personnel are faced with limited domestic employment opportunities in their specialisations. This reality, its present scale and potential future scope are significant features of skilled human resource mobility in the South African experience. It offers potential benefits to South Africa in meeting shortages of highly skilled labour and, through the emigrants' linkages with their home nation, a possibility to facilitate regional economic growth and development.

The increasing structural preference for skilled labour associated with the emergence of the knowledge economy has not eliminated lower-skilled occupations, but it has facilitated an increased role for low-skill mobility from LDCs. As skilled human resources become increasingly important, it is important to realise the critical role of education and skills training in the economy. A better understanding of this process is

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101 For an overview, see the special volume of the *International Social Sciences Journal* (vol. 54(171), 2002).

102 For a study of the role played by ICTs in codifying knowledge see Cowan (2001).

a major area of investigation as it is interrelated with the potential use of other lower-skilled immigrants to augment and support South Africans' enrichment. In this regard, it is necessary to assess the extent of temporary and permanent emigration from South Africa. In a global environment, skilled South Africans may move overseas to enrich their skills development with direct or indirect benefits for the nation.

Knowledge is a non-standard good with varying degrees of codification and tacitness. As the tacitness of knowledge rises, it becomes increasingly rooted in practices and not easily transmitted through formal media like journals and reports. With high degrees of tacitness, the most efficient transmission of knowledge is through structures that facilitate direct interaction. In general, when a new group of innovations, like biotechnology in the 1990s, emerge, tacit knowledge is high and we would expect the role of mobility in facilitating the diffusion and development of those innovations to be high as well. This is precisely the scenario seen in the geographic concentration of biotechnology organisations in Silicon Valley. Similar evidence has also been identified and examined in more rigorous empirical analyses.<sup>103</sup>

The literature reviewed here has shown the critical and fundamental role mobility has in the dynamics of a system of innovation. If South Africa is to develop its productive capacity and redress historical inequities, its NSI must bridge the existing gap between it and more developed nations. From this perspective, systemic monitoring and evaluation of South Africa's stock and flows of skilled human resources will be a critical component in guiding policy-making and promoting national development.

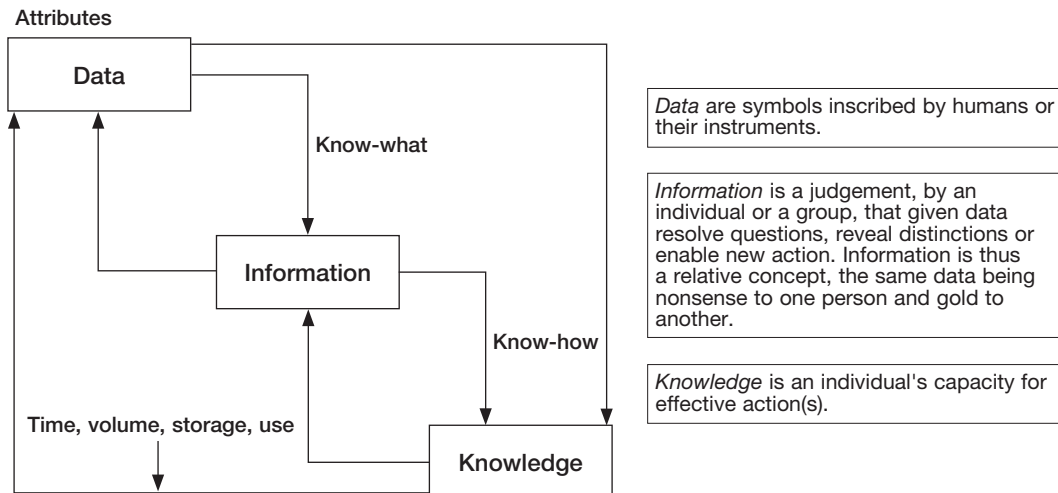
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103 See Jaffe et al. (1993), Audretsch and Feldman (1996) and Feldman and Lichtenberg (1997).

## Conceptualising knowledge, information and data

Knowledge can be conceptualised in different ways. Figure A.1 presents a conventional hierarchy of data, information and knowledge. However, one can also think of a reverse hierarchy in which knowledge precedes the data-to-information process. Modern ICT facilitates data processing, but not knowledge generation. The actual generation of knowledge is presumed to reside solely within conscious beings. As Spiegler (2003, 536) notes, ‘As a working definition, we can state that knowledge is the process of knowing, a reflexive process that takes data and information, in a social context, mixes the ingredients and factors listed above, to generate new data, information, and/or knowledge.’

Figure A.1: Data, information and knowledge





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