

Human Capital and Labour Mobility Determinants of Regional Innovation

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1. Introduction

This chapter looks at the role of human capital and labour mobility in determining regional innovation and growth. Innovation as a factor in regional growth is not a new notion and has been addressed in many of the classic antecedents of regional growth theory. The Marshallian tradition assumes local knowledge spillovers to be a central factor in the formation of agglomeration in space, supplemented by local labour pooling and non-traded local inputs (Marshall 1980). The Jacobian tradition similarly sees knowledge transfer as an important input to local growth although its source is somewhat different, emanating from outside the local production environment and grounded in scope and diversified economic activity rather than scale and concentrated production (Jacobs 1969). However, it has only been since the advent of New Growth Theory (NGT) that innovation has become an active component in understanding regional growth (Romer 1986). Prior to NGT, the region was understood as the arena in which knowledge creation took place. Within this environment, tacit and implicit knowledge was produced and exchanged and the demarcation of the region expressed the territorial limits in which growth could be expected.

NGT posits that growth is the result of increasing returns associated with new knowledge or technology. In contrast to previous theory, NGT internalizes (endogenizes) technological progress and knowledge into a model of how markets function. When individuals accumulate new skills and know-how they unwittingly impact on the productivity and human capital levels of others. As such, the production of technological progress becomes endogenized. The increasing returns and spillovers from human capital become the glue that holds cities and regions together. The region has thus progressed from the context in which innovation takes place to a more proactive role as a central component in this change.

However, commentators are not unanimous as to the centrality of the region in creating knowledge spillovers and explaining the existence of clusters of innovative activity. The original New Economic Geography (NEG) perspective on agglomeration sees these clusters purely as a product of labour market pooling behavior. In this growth model, firms and workers find it profitable to seek out locations where each are found in abundance (the market size effect), leading them to converge on locations that have an

early lead in a particular industry (Krugman 1991). The theoretical spatial outcome of this NEG approach is the formation of exaggerated ‘catastrophic’ agglomerations of economic activity in a given region and the ‘desertification’ of activity in its vicinity. To prevent this from happening, the NEG modeling strategy introduces technical fixes that allow for the existence of workers and firms in peripheral regions. These include distributing immobile low-wage labour across the region and manipulating transport costs to allow firms to cluster and produce under increasing returns. Whatever the cause, the logical conclusion of the NEG approach leads to over-concentration which is only prevented via technical rather than structural reasons. In contrast, the NGT view is that local externalities do not just stem from market size effects or pecuniary externalities but also from knowledge and technological externalities. Thus, while regional agglomeration is the outcome of NEG modeling efforts, under the NGT approach regional agglomeration is an endogenously determined cause of growth (McCann and van Oort 2009)

Aside from the NGT and NEG approaches, a further perspective on the role of innovation in regional growth is provided the evolutionary economic geography (EEG) approach (Boschma 2005). This sees local institutions, institutional arrangements and cultural practices as critical in generating regional growth. Under this view, knowledge externalities and spillovers are not just the result of the aggregate concentration of firms and workers but also the product of the cultural and institutional factors that influence knowledge flows. Therefore, cultural and institutional proximity is as important as spatial proximity. The implication of this view is that in contrast to the previous approaches, the region is neither the arena for innovation nor an active input into the production function. Instead it is a unique repository of specific historical and geographic features that cannot be easily reproduced by other places.

In the following sections, we analyze the mechanisms promoting regional innovation. In wake of the interest in the active role of the region as an innovative agent, we first question whether the region is really more than the passive backdrop for the generation of innovation. At essence, we show that this question relates to the way the region is conceived: as an individual unit or as a collective (group). Applying the notions introduced by NGT in a spatial context (Faggian and McCann 2009), we then proceed to

investigate the two specific mechanisms through which knowledge becomes an inherently regional asset. The first is through the generation of local externalities and the second is through human capital mobility and the individual decisions of workers and households. While each of these issues is treated separately, the interdependence between them is highlighted. Finally, we attempt to tie these notions together in a systematic framework by empirically estimating the way that human and physical capital, worker mobility and innovation level impact on regional productivity. Theory points to the fact that the higher the average level of human capital, the more rapid the diffusion of knowledge and the higher the levels of productivity and presumably earnings. Using spatial panel estimation in order to entangle issues of spurious relationships, we find that both human and physical capital impact on regional productivity but that a strong regional innovation effect can confound this impact.

2. Regions as Innovators?

The stylized causality of economic development points to knowledge generating innovation and innovation creating economic growth. However, knowledge does not flow freely along this continuum. It gets caught up at critical junctures that also have a territorial expression, accumulating at some while by-passing others. These critical nodes exist at different spatial scales: cities, metropolitan areas and regions. Along this continuum, the region features as a distinct unit of analysis. However the essence of the nature of a region is not clear. On the one hand, the region can be considered as the mirror image of the national economy, inexorably linked to the vagaries of macroeconomic policy, changing trade patterns and currency rate fluctuations. While regions are always more open than national economies and with freer factor movement, they are nevertheless miniature versions of the national economy. In many countries of all sizes, a booming regional economy can often dictate national macro performance. On the other hand, the region can be conceived as a group unit that comprises districts, municipalities and cities. Groups behave differently to individuals. They have different propensities to self-organize and their level of social cohesion is far more complex. They do not reflect the national economy and need to be given an independent identity.

This is not just idle philosophizing and has some very real consequences. For example, the exact way in which a region is conceived (individual unit or group) can have very real consequences in the measurement of regional inequalities (Portnov and Felsenstein 2010). A tradition exists in the regional growth literature that treats regions as individual units regardless of their size (Barro and Sala-i-Martin 1992). As such, when measuring regional convergence for example, large and small regions are assumed to carry equal weight just as tall and short people are treated equally when looking at inequality between them. However, if regions are conceived as groups, then the measurement of inter-regional inequality calls for taking scale into account. For example, the use of population weighted indices (such as a weighted Gini index of inequality) would highlight the independence of the constituent parts of the group.

This discussion has a distinct bearing on the role of regional innovation. A particularly fashionable notion in the regional innovation literature relates to the 'learning', 'creative' or 'innovative' region (Cooke and Morgan 1998, Maskell and Malmberg 1999, Rutten and Boekema 2007). These notions all seem to imply that the role of the region as a collective is greater than the sum of its constituent parts. When functioning as an organic unit, the region will be able to achieve higher growth levels than those attainable without collective action. In other words, increasing returns exist to acting 'regionally' and the corollary is that regions are conceived as groups rather than individual units.

Ironically however, recent work has begun to call into question the 'regions as innovators' thesis precisely on the grounds of the argument of regions as individual units. At the root of the innovative region concept is the notion of tacit knowledge. This refers to the non-codified informal behavior, local practices and untraded interdependencies that accompany formal codified production. Tacit knowledge is relatively spatially immobile and context specific. It is acquired through learning by doing and face to face contact and cannot be exchanged over distances. As such, it forms a key determinant of the spatial distribution of innovation (Maskell and Malmberg 1998). Recently this conception of tacit knowledge being grounded locally has been called into question and has been replaced by the idea that tacit knowledge is produced organizationally and not regionally

(Gertler 2007). According to this view, conventions, norms and business practices (corporate cultures) are developed within a community and not a territory. This organizational space is not territorially bounded and as such, the key ingredient to the 'regions as innovators' thesis - tacit knowledge- has been appropriated to a non-spatial realm. In this organizational space, the key units are atomistic firms which can in theory be scattered across large distances. In this view of the world, if regions are important at all, it is only as locations for these individual units.

Whatever the perspective on the region, a sine qua non of innovation research is that knowledge is distributed unequally across space and that it exhibits 'sticky' properties in that it is not always easily transferable (Markusen 1996, Ratanawaraha and Polenske 2007). Faggian and McCann (2009) have posited two main processes by which knowledge becomes embodied in a region and becomes part of the regional innovation infrastructure. The first relates to spatially grounded externalities that accompany the production of knowledge and the second to human capital decisions (with respect to residential location and migration) that lead to a reallocation of production factors as people move in response to economic opportunity. It is to these issues that we now turn.

3. The Spatial Externalities Perspective

Marshallian externalities are the natural springboard for any discussion of spatial spillovers. Marshall highlighted local knowledge spillovers, non-traded local inputs and specialized local labor pools in his speculations on the causes of spatial clustering in economic activity. For Marshall, 'if one man starts as idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further ideas' (Marshall 1920, p271). In identifying the causes of agglomeration, he distinguished between what today are referred to as the roles of 'first' and 'second' nature in economic development (Krugman 1993). He saw knowledge spillovers and externalities as key second nature determinants of external returns to scale which accounted for spatial agglomerations. Subsequently, the micro-economic foundations of local spillovers and externalities have been developed. Storper and Venables (2004) have shown how face to

face contacts among economic agents improve co-ordination, increase productivity and mitigate the incentives problem, leading to spillovers and greater innovative activity. For them, it is the 'buzz' of the agglomeration (i.e. the accidental and non scheduled spillovers) that gives places an edge. Several commentators point to the importance of 'cafeteria effects' (Charlton and Duranton 2004, Fu 2007) where important information is released randomly in both time and space leading to agglomeration as a strategic response. The more concentrated the agents, the more 'luck' in accessing cafeteria-type information and the more rapid the diffusion and growth of this knowledge. As knowledge percolates, total factor productivity grows. Scale is an important issue here. The larger the agglomeration or the region the greater the probability of meeting an information-rich contact so that total factor productivity will vary directly with scale. Conversely, scale may also impose a communication cost. As the proverbial café becomes crowded or the agglomeration overheats, total factor productivity will become reduced.

In this externality-based view, knowledge becomes embodied in the region through a cumulative growth process that is internally (endogenously) driven. The stock of regional knowledge accumulates as the level of average human capital rises and as scale increases. The regional knowledge base is not embellished on the basis of transfers or redistribution from other places (via migration) which represents regional accrual via a flow mechanism. Instead, the regional knowledge base grows on the basis of spillovers that are spatially bounded. These are generally intense, frequent and short-term transactions which only add to the importance of proximity and territorial compactness.

The fact that knowledge has spillover effects is non-controversial. It is well accepted that knowledge generates externalities due to its public-good nature, characterized by non-rivalry in consumption and non-exclusivity in production (Arrow 1962). It is also unchallenged that the marginal cost of transmitting tacit knowledge across space diminishes as frequency of contact increases. Feldman (1994) has added a further twist to this logic by pointing out that proximity reduces the uncertainty and risk inherent in innovative activity. This has been formalized in empirical studies that estimate knowledge production functions with specific reference to spatial units of observation (Jaffe 1989). From there only a short leap is needed to empirically estimate

the spatial extent of innovation spillovers and the break-points beyond which spatial effects are no longer felt (Anselin, Acs and Varga 1997).

4. The Human Capital/ Labour Mobility Perspective

At a general economy-wide level, Lucas (1988) has identified human capital as an endogenous source of economic growth. Human capital accumulation affects the productivity of the individual worker and also that of the economy as a whole. However a key element of human capital, in regional growth terms, is its mobility in response to economic opportunity. This mobility can occur over short distances (commuting) or long distances (migration). The former is generally in response to short term disequilibria between supply and demand while the latter represents a reallocation of factors of production. In fact, neoclassical theory predicts that labor migration should lower the rate of economic growth. However, if migrants are highly skilled, their propensity to migrate will increase and their effect on the growth of their destinations will be positive (DaVanzo 1976).

Knowledge therefore can be conveyed across regions through the collective decisions of migrants. The seminal work by Sjaastad (1962) looks at migration as a human capital investment decision with both costs and returns. The utility to individual i from migrating to region j is:

$$U_{ij} = \alpha_{ij}X_i + \beta Z_j + u_{ij} \quad (1)$$

where X denotes a vector of personal characteristics, such as age, family size etc, and Z a vector of destination characteristics, such wage rates, cost of living etc. The return to personal characteristics varies by person and region. Similarly, the utility in region k is specified as:

$$U_{ik} = \alpha_{ik}X_i + \beta Z_k + u_{ik} \quad (2)$$

Individual i will move from region j to region k when:

$$U_{ij} - U_{ir} + C_{jk} > 0 \quad (3)$$

where C_{jk} denotes the cost of moving from j to k . Generally, higher skilled workers will have lower costs and higher returns from migration due to lower information costs, more perfect information and lower psychic costs of attachment to place of origin and its social networks (DaVanzo and Morrison 1984). High skilled labour expects more compensation

for its investment in education and has higher expected net benefits from migration than non-skilled labour.

While labour mobility is a mechanism for raising the knowledge and innovation level of a region, confusion exists as to the exact causality of this relationship. Is the regional knowledge base the result of labour mobility or does labour move in response to regional knowledge opportunities? This in itself is tied up with the role of regions in generating human capital (i.e. the 'learning region' thesis). As noted earlier, regions have traditionally been considered the territorial unit in which the exchange and production of tacit knowledge takes place and spatially-based externalities then ensue. However, another view is that the region functions as a conduit for the flow of highly skilled and mobile labour that replaces similar sized outflows of other (skilled and non-skilled) labour. This is a labour market 'churning' mechanism in which the stock of labour may not grow but its knowledge base will be continually upgraded (Schettkat 1996). Regions that include a large concentration of knowledge centres and institutions such as corporate and government R&D centres, research universities and technological incubators are clear magnets for this kind of 'escalator' effect (Fielding 1992). The Greater London metropolitan region has filled this role for some time with education in the region playing a key role in the career paths of young people seeking to accumulate human capital and job experience. Over time, this skilled labour tends to disperse from the London area as life cycle patterns change and incumbents can capitalize on the housing market gains and human capital accumulation that they have amassed over their period in the region. The region therefore becomes an active element in inter-regional or even international flows of mobile labour. Recent work (Faggian and McCann 2006) has pointed to the 'flow-through' role of the university system for attracting potential high quality human capital to a region as more important than its traditional function as a node for regional knowledge production and diffusion (Florax 1992, Felsenstein 1996). Other evidence shows that for generating new innovations, mobile human capital attracted from other regions, is a more potent force than locally bred human capital (Simonen and McCann 2010).

Increasingly, human capital mobility is international and not just inter-regional. While international labour mobility may be too small to be detected at the economy-wide

level, at the regional level there is a wealth of evidence that immigrants do have a positive effect on wages and innovation levels measured by R&D and patents (Hunt and Gauthier-Loiselle 2008, Niebuhr 2010). Evidence from Israel highlights the distinction between economy wide and regional effects. The country provides an ideal laboratory setting for natural experiments in this area due to mass immigration in the 1990s that boosted the population by 15 percent. At the national level evidence shows that mass immigration may not have had any adverse effect on manufacturing productivity (Paserman 2008), employment or wages (Friedberg 2001). At the regional level the picture is more equivocal. Beenstock and Peleg (2000) have found that regional unemployment and wage rates are not sensitive to immigration. In a small country like Israel, employment is sufficiently mobile between regions to diffuse the effects of immigrants in the local labour market to the national labour market.

5. Some Empirical Evidence

5.1 Description of the Data

As shown above, knowledge is the bedrock of innovation. Two mechanisms are behind the process by which knowledge becomes a regional asset. The first is the externality effect whereby a region embellishes its stock of knowledge based on a contagion effects between workers and places. Through the generation of externalities within a given region total factor productivity will rise, as will the average level of regional productivity. Similar workers will therefore be more productive and receive higher wages if they operate in regions with large stocks of human capital externalities (Rauch 1993). The second mechanism relates to the human capital mobility effect and the way knowledge transfers to the region through the agency of individual migration decisions (Sjastaad 1962). In this section we present empirical evidence relating to these mechanisms and the way regional knowledge stocks are reflected in higher levels of regional wages (and presumably higher levels of regional productivity and growth). Previous work has shown that higher compensation is paid in cities and regions with higher levels of human capital (Glaeser and Mare 2001, Echeverri-Carroll and Ayala 2009). In contrast to previous cross sectional analyses, we attempt to investigate this

connection using spatial panel data for Israeli regions. The object of this empirical study is to show that regions with higher levels of human capital, physical capital and innovation, will also have higher productivity levels

The data used in this section relating to regional real earnings, education levels and immigrant population, have been described in detail elsewhere (Beenstock and Felsenstein 2007, 2008; Beenstock, Felsenstein and Ben Zeev 2010). These data represent the physical capital base of the region which reflects the region's knowledge assets, skills and technologies. For innovation levels, we follow a tradition that uses high tech employment as a proxy measure (Fingleton et al 2007) and utilize data constructed in earlier work on the regional knowledge base in Israel (Cooke and Schwartz 2006, Schwartz 2008). This work regionalizes the CBS Labour Force Survey employment data in order to create EU-equivalent NACE economic sectors.

To describe the data we plot regional shares for innovation, capital-labour ratios and wages in Figures 1-3. Each variable portrays a very different regional pattern. Regional innovation levels seem bifurcated with low, stable levels of high tech employment in the peripheral North and South regions and in the metropolitan regions of Haifa and Jerusalem. In contrast there seems to be evidence of regional convergence in high tech between the Central and Tel Aviv regions that function as a single labour market (Figure 1). With respect to regional physical capital we observe a picture of 'inverted' regional convergence with regional gaps being visibly smaller in 2006 than in 1995. However, the relatively affluent regions of the centre of the country (Centre, Tel Aviv, and Jerusalem) are observed to be leveling-up with the poorer peripheral areas (North and South) and the traditional heavy industry area (Haifa) (Figure 2). Historically, regional policy has favoured capital investment in the peripheral regions and subsidized investment there (Schwartz and Keren 2006). However since the mid-1980s, the map of regional assistance has been progressively rolled back and government policy has changed its emphasis. As a result, greater weight has been placed on supporting market forces in trade policy, labour market policy and on more selective regional assistance to R&D and incubator projects (Avnimelech, Schwartz and Bar El 2007).

Regional real wages are plotted in Figure 3. As can be seen, Tel Aviv increases its share of real wages throughout the study period and while there is some shifting in the

ranks of the other regions, the overall impression is one of regional stability. The North and South regions share of real wages are consistently low with some shifting between the Centre, Jerusalem and Haifa whose share drops over the study period. In sum, innovation levels and wages seem to be either sclerotic or divergent over the period studied with most of the divergence coming from the increasing shares captured by the Tel Aviv and Central regions. In contrast, there is a pattern of convergence in regional physical capital but this is in reverse to that anticipated with the richer, more innovative regions catching up with the poorer that were jump-started in the first place.

Figures 1-3 here

5.2 Do Innovative Regions Make Workers More Productive?

Given the role of externalities and human capital mobility decisions in generating the regional knowledge base, the question now is what are the relative contributions of regional innovation and stocks of human and physical capital to productivity? Do regions endowed with larger stocks make for more productive workers as a positive process of cumulative causation starts to set in? To test this proposition as predicted by human capital theory, we measure productivity by average wage in the region, human capital by the lagged effect of education, physical capital by the capital-labour ratio, migrant behavior by the regional share of foreign immigrants and innovation by high tech employment in the region. Specifically, we posit that:

$$\ln w_{jt} = \alpha_j + \theta_t + \gamma \ln k_{jt} + \delta e'_{jt} + \rho m_{jt} + \tau \ln i_{jt} + u_{jt} \quad (4)$$

where, subscripts j and t denote region and year respectively, $\ln w$ denotes wages deflated by national consumer prices, $\ln k$ denotes the capital-labor ratio, e' denotes the lagged regional share of human capital based on the premise that the effects of education are not felt immediately, m denotes the regional share of immigrants and $\ln i$ denotes gross high tech employment in order to proxy innovation.

Given the structure of the data, (observations on 6 regions for 12 time periods), equation (4) calls for panel data estimation. This means testing for non-stationarity in the data. The short panel means we cannot use lags of greater than 1 year. The coefficients α and θ represent the two-way fixed effects for the six regions and twelve years of data and

μ denotes the residual error. Table 1 reports the panel cointegration tests for the effect of regional human and physical capital stocks, mobility and innovative capacity on regional earnings. We present three specifications for equation (4) all estimated in first differences and varying in their level of heterogeneity.

Model 1 presents the most homogenous specification. It is estimated without regional fixed effects and assumes human capital is homogenous across regions. Immigrants have a very small but positive effect on productivity. The return to human capital is estimated as rather low, 3 percent for an extra year of education and is surprisingly insignificant. It should be noted that human capital and high tech employment are correlated ($r=0.65$) and that the high coefficient on the latter may incorporate some of the effect of the former. The elasticity of earnings with respect to physical stock is estimated as 0.290. The test statistics are significant and suggest that the non-stationary variables are cointegrated. However, the DW statistic (slightly above the critical value of 1.8) does not conclusively support this.

In Model 2, we allow human capital to vary by region but do not specify regional fixed effects. Labor mobility is surprisingly not significant but the impact of physical capital is more pronounced than in the previous model. The effect of innovation increases dramatically and when returns to human capital are allowed to vary by region, the result is larger estimated coefficients (return to education of 5-7 percent). The test statistics indicate that the model is cointegrated and the estimated coefficients are not spurious. This goes some way in allaying the concern that the self-selection of high-tech workers in more innovative regions creates the observed productivity effect.

Model 3 is the most homogenous form of estimation. The test statistics for panel cointegration decline seriously and the DW statistic is well over its critical value. The effect of mobility is again significant but the coefficients for human capital are either very small, insignificant (Haifa and Tel Aviv) or with counter-intuitive signs (Jerusalem and Center). Physical capital stock continues to exert a large and positive influence. In sum, within the constraints of the data we have evidence of both human and physical capital influencing regional productivity. If human capital is treated heterogeneously (left to vary by region) some of its effect becomes confounded with the strong regional innovation effect.

Table 1 here

6. Conclusions

This chapter has highlighted the role played by human capital in generating the regional knowledge base, and the two major mechanisms through which this human capital effect is expressed: spatial externalities and labour mobility. The issue of causality in this relationship is left unresolved; does human capital accumulation spawn innovation or do innovative places attract talent? In reality, both situations occur and from a dynamic perspective the causation is circular.

As the review section has shown, the literature has progressed beyond the primordial question of 'does space matter' in the generation of regional innovation. Rather the question would seem to be, what role does the region play in the innovation process? Is it the passive backdrop against which innovation occurs? Or is it an active ingredient in the innovation production function or perhaps a unique repository of non-reproducible traditions and business practices? The policy implications of this dilemma are clear. Only the second option presents intervention possibilities. The first implies that nothing can be done in the face of market forces while the third points to the futility of trying to replicate non-replicable processes.

This chapter has also discussed whether the innovation and human capital characteristics of a region contribute to productivity. We have tested for the possibility of spurious correlation in this relationship (in that more skilled workers self-select better paying regions) and have found strong effects for both human and physical capital with some of the former confounded with regional innovation. Labour mobility as measured by the import of human capital through migration is only found to have a small effect.

While knowledge spillovers are notoriously difficult to trace, it would seem that knowledge externalities are a prime source of regional productivity gains and probably more so than labour market processes of human capital migration and mobility. While we may be skeptical of much of the high-tech promotional hype that glorifies the Silicon Valleys and Research Triangles of the world, the basic story that these accounts tell, is not that far from reality. Innovative activity tends to cluster in relatively few choice areas

that attract further activity. Similarly, high skilled labour operates, communicates and enhances its productivity among clusters. This self-entrenching process is at the base of the observed productivity premium and makes it difficult for regions not caught up in this spiral, to ever close the gap.

Bibliography

Anselin L. Acs Z. J and Varga A (1997) Local Geographic Spillovers Between University Research and High Technology Innovation, *Journal of Urban Economics*, 42, 422-448.

Arrow K (1966) Economic Welfare and the Allocation of Resources for Invention, in Nelson R (ed) *The Rate and Direction of Inventive Activity*, Princeton University Press, Princeton.NJ.

Avnimelech G, Schwartz D. and Bar-El R (2007), Entrepreneurial High-Tech Cluster: Israel's Experience with Venture Capital and Technological Incubators, *European Planning Studies* 15(9), 1181-1198.

Barro, R.J. and Sala-i-Martin, X. (1992) Convergence, *Journal of Political Economy*, 100(2), 223-51.

Beenstock M. and Felsenstein, D. (2007) Mobility and Mean Reversion in the Dynamics of Regional Inequality, *International Regional Science Review*, 30 (4) 335-361.

Beenstock M. and Felsenstein D. (2008) Regional Heterogeneity, Conditional Convergence and Regional Inequality, *Regional Studies*, 42(4), 475- 488

Beenstock M. Felsenstein, D and Ben Zeev N (2010) Capital Deepening and Regional Inequality: An Empirical Analysis, *Annals of Regional Science* (forthcoming).

Beenstock, M., and M. Peleg 2000 *Regional Economic Effects of Immigration: Israel 1990 –1998*, presented at SCORUS Conference, Shenzhen.

Charlot S and Duranton G (2004) Communications Externalities in Cities. *Journal of Urban Economics* 56, 581–613

Cooke P. and Morgan K. (1998) *The Associational Economy*, Oxford University Press, Oxford.

Cooke P and Schwartz D (2008) Regional Knowledge Economies: An UK-EU and Israeli Perspective, *Tijdschrift voor Economische en Sociale Geografie*, 99(2) 178–192.

DaVanzo J. (1976) Differences Between Return and Non-Return Migration; An Econometric Analysis, *International Migration Review*, 10 (1), 13-27.

DaVanzo J. and Morrison F. (1981) Return and Other Sequences of Migration in the US, *Demography*, 18, 85-101.

- Echeverri-Carroll E. and Ayala S.G. (2008) Wage Differentials and the Spatial Concentration of High-Technology Industries, *Papers in Regional Science*, 88 (3)623-641
- Faggian A and McCann P (2006) Human Capital Flows and Regional Knowledge Assets: A Simultaneous Equation Approach, *Oxford Economic Papers*, 52 (3), 475–500.
- Faggian A and McCann P (2009) Human Capital and Regional Development, pp 133-151 in Capello R and Nijkamp P (eds) *Handbook of Regional Growth and Development Theories*, Edward Elgar, Cheltenham UK
- Feldman M.P. (1994) Knowledge Complementarity and Innovation, *Small Business Economics*, 6 (3), 363-372.
- Felsenstein D. (1996) The University in the Metropolitan Arena: Impacts and Public Policy Implications, *Urban Studies*, 1565-1580.
- Fingleton B, Iglioni D.C. Moore B and Odera R (2007) Employment growth and Cluster Dynamics of Creative Industries in England, pp 60-86 in Polenske K.R. (ed) *The Economic Geography of Innovation*, Cambridge University Press, Cambridge, UK
- Florax R. (1992) *The University: A Regional Booster*, Avebury, Aldershot.
- Friedberg R (2001) The Impact of Mass Immigration on the Israeli Labor Market, *Quarterly Journal of Economics*, 116 (4), 1373-1408.
- Fu S (2007) Smart café cities: Testing human capital externalities in the Boston Metropolitan Area. *Journal of Urban Economics*, 61, 86–111
- Gertler M.S. (2007) Tacit Knowledge in Production Systems: How Important is Geography?, pp 87-111 in Polenske K.R. (ed) *The Economic Geography of Innovation*, Cambridge University Press, Cambridge, UK
- Glaeser E.L., Mare D.C. (2001) Cities and Skills, *Journal of Labor Economics*, 19, 316–342
- Hunt J and Gauthier-Loiselle M (2008) *How much does Immigration boost Innovation?* NBER Working Paper No 14312, National Bureau of Economic Research, Cambridge, MA.
- Jacobs J. (1969) *The Economy of Cities*, Vintage, New York.
- Jaffe A.B. (1989) Real effects of Academic Research, *American Economic Review*, 79 (4), 957-970.
- Krugman P. (1991) Increasing Returns and Economic Geography, *Journal of Political Economy*, 99, 483-499.

- Krugman P. (1993) First Nature, Second Nature and Metropolitan Location, *Journal of Regional Science*, 33, 129-144.
- Lucas R.E. (1988) On the Mechanics of Economic Development, *Journal of Monetary Economics*, 22, 3-42
- Markusen A (1996) Sticky Places in Slippery Space: A Typology of Industrial Districts, *Economic Geography*, 72 (3), 293-313
- Marshall A (1890) *Principles of Economics*, Prometheus Books, New York.
- Marshall A (1920) *Industry and Trade*, Macmillan, London.
- Maskell P and Malmberg A (1999) Localized Learning and Industrial Competitiveness, *Cambridge Journal of Economics*, 23 (2), 167-186.
- McCann P and Van Oort F. (2009) Theories of Agglomeration and Regional economic Growth; A Historical Review, pp 19-32 in Capello R and Nijkamp P (eds) *Handbook of Regional Growth and Development Theories*, Edward Elgar, Cheltenham UK
- Niebhur A (2010) Migration and Innovation: Does Cultural Diversity Matter for Regional R&D activity? *Papers in Regional Science* (forthcoming)
- Paserman, Daniele M. 2008. Do High-skill Immigrants Raise Productivity? Evidence from Israeli Manufacturing Firms, 1990-1999. IZA Discussion Paper 3572.
- Portnov B. and Felsenstein D (2010) On the Suitability of Income Inequality Measures for Regional Analysis: Some Evidence from Simulation Analysis and Bootstrapping Tests, *Socio-Economic Planning Sciences* (forthcoming)
- Ratanawaraha A. and Polenske K.R.(2007) Measuring the Geography of Innovation; A Literature Review, pp 30-59 in Polenske K.R. (ed) *The Economic Geography of Innovation*, Cambridge University Press, Cambridge, UK
- Rauch J.E. (1993) Productivity Gains from Geographic Concentration of Human Capital: Evidence from the Cities. *Journal of Urban Economics* 34, 380-400.
- Romer P.M. (1986) Increasing Returns and Long Run Growth, *Journal of Political Economy*, 94, 1002-1037.
- Ruttan R. and Boekema F (2007) *The Learning Region*, Edward Elgar, Cheltenham
- Schettkat R (1996) Flows in Labor Markets: Concepts and International Comparative Results, pp 18-36 in Schettkat R (ed) *The Flow Analysis of Labor Markets*, Routledge, London.

Schwartz D. (2006) The Regional Location of Knowledge Based Economy Activities in Israel, *Journal of Technology Transfer*, 31, 31–44.

Schwartz D and Keren M. (2006) Locational Incentives and the Unintentional Generation of Employment Instability: Some Evidence from Israel, *Annals of Regional Science*, 40 (2), 449-460.

Simonen J and McCann P (2010) Knowledge Transfers and Innovation: The Role of Labor Markets and R&D Co-operation between Agents and Institutions, *Papers in Regional Science* (forthcoming),

Sjastaad L (1962) The Costs and Returns of Human Migration, *Journal of Political Economy*, 70 (5), 80-93

Storper M and Venables AJ (2004) Buzz: Face to Face Contact and the Urban Economy. *Journal of Economic Geography* 4, 351–370

Table 1: Effect of Regional Human Capital Stocks, Mobility and Innovative Capacity on Regional Earnings: Spatial Panel Regressions for Israeli Regions 1995-2006 (Dependent Variable = ln earnings)

	1. Without Regional Fixed Effects (Homogenous)	2. Without Regional Fixed Effects (Heterogenous)	3. With Regional Fixed Effects (Heterogenous)
Constant	4.603	6.021	4.670-7.461
Immigrants	0.002	0.001 ⁺	0.002
High Tech Emp. Share	0.183	1.416	2.705
Capital –Labor	0.291	0.369	0.415
Lag Education	0.030 ⁺	-	-
Center – Lag Education.	-	0.062	-0.127 ⁺
Haifa – Lag Education.	-	0.073	0.061 ⁺
Jerusalem – Lag Education	-	0.071	-0.040 ⁺
North – Lag. Education.	-	0.052	0.076
South – Lag Education.	-	0.060	0.051
Tel Aviv – Lag. Education.	-	0.070	0.036 ⁺
R ²	0.973	0.941	0.970
DW Statistic	1.977	1.872	2.176
<i>Cointegration Tests</i>			
ADF test	-0.744	-0.574	-3.179
PP test	-1.985	-1.984	-4.326

All coefficients significant $p < .01$ except for those marked with ⁺.
 Estimated by EGLS with SUR cross-section dependence.
 PP = Philips-Perron cointegration test (null hypotheses of no cointegration).

Fig 1: Relative Regional Employment in High Tech Sectors, 1995-2006

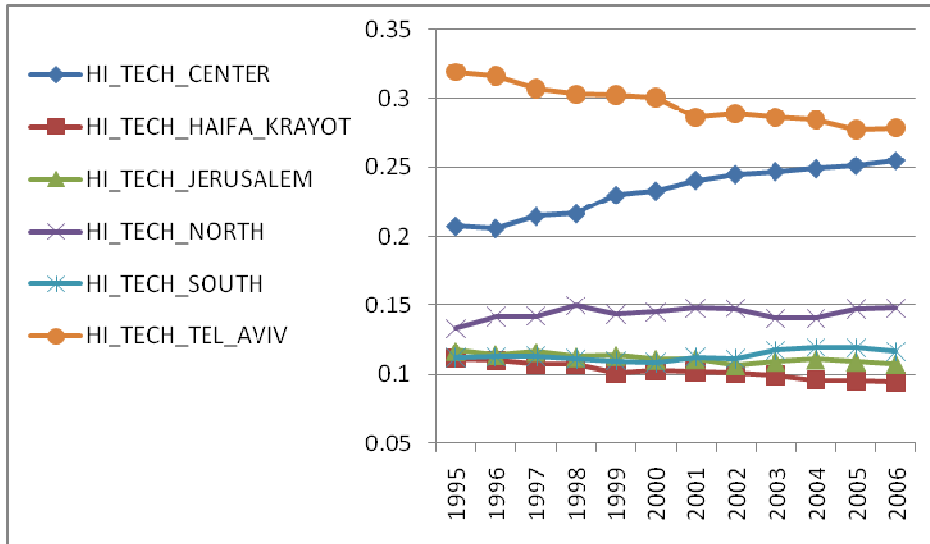


Fig 2: Relative Regional Capital-Labor Ratios 1995-2006

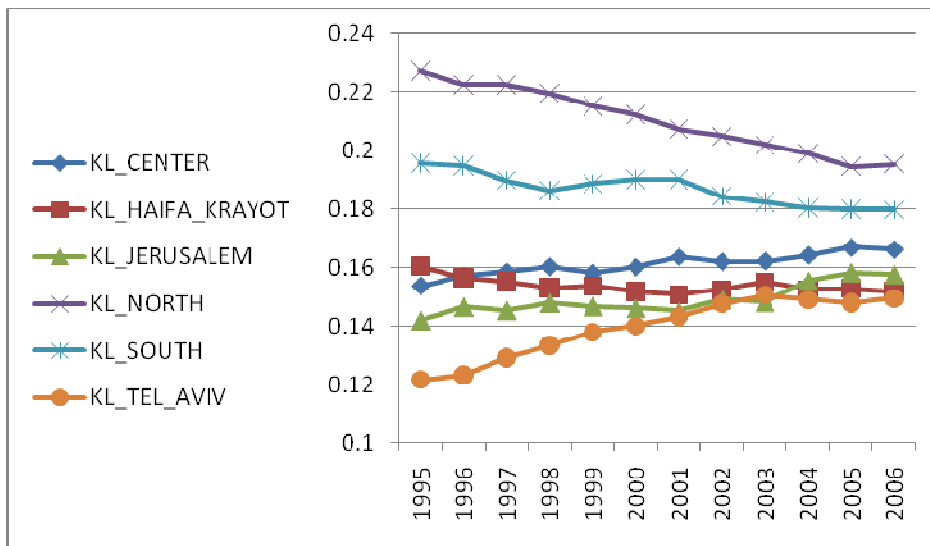


Fig 3; Relative Regional Real Wages, 1995-2006

