Factors Affecting Regional Productivity and Innovation in Israel:

Some Empirical Evidence

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Motivation

- How do regions maintain and entrench their competitive edge?
- How is regional innovation related to regional productivity?
- Can this be estimated in a panel data (and not a cross-section) framework?

Background

Knowledge distributed unequally across space. Become entrenched in a region via:

1.Embellishing Stock: externalities, local spillovers, cafeteria effects, internal returns to scale (Marshall 1920).

- Process is endogenous
- Importance of scale: stock of regional knowledge grows as human and physical capital rises and scale increases

2.Increasing Flows: human capital labor mobility: redistribution of knowledge (Sjaastad 1962)

- Process is exogenous
- Causality unclear: regions become innovative because they attract skilled labor or labor moves due to regional innovation opportunities?

Estimation Strategy

- **Dynamic process** – best tackled in panel framework
  - We use estimable GLS (EGLS) with SUR cross section dependence.
  - EGLS model: the error variance covariance matrix is estimated, not assumed.
- **Serial cross sectional correlation is likely across the regions**: therefore OLS estimation for each cross section is inefficient.
- **SUR weighting**: takes into account information about possible correlations between the errors correcting for both cross-section heteroskedasticity and contemporaneous correlation.

Econometric Specification:

System of equations formulated in general terms as:

$$\boldsymbol{Y}_{jt} = \boldsymbol{X}_{jt} B_{jt} + e_{jt}\,, \quad j = 1 \ldots 6, \quad t = 1 \ldots .12 \qquad (1)$$

where :

$\boldsymbol{Y}_{jt}$ is a $N \times 1$ vector of observations on the dependent variable (region earnings or innovation level)

$\boldsymbol{X}_{jt}$ denotes a $N \times n_{jt}$ matrix of observations on n_{jt} non-stochastic explanatory variables (human capital, physical capital and mobility variables) including a constant term

$\boldsymbol{N}$ = the number of observations per equation and n_{jt} =the number of rows in the vector B_{jt}

$\boldsymbol{e_{jt}}$ denotes a $N \times 1$vector of random errors with $E(e_{jt}) = 0$

Regional productivity estimate:

$$\ln w_{jt} = \alpha_j + \theta_t + \gamma \ln k_{jt} + \delta e_{jt} + \rho m_{jt} + u_{jt} \quad (2)$$

where:

ln w = wages deflated by national consumer prices,

ln k = capital-labor ratio,

e = regional share of human capital

m = regional share of foreign immigrants

subscripts *j* and *t* denote region and year respectively,

Regional innovation estimate:

$$\ln i_{jt} = \alpha_j + \theta_t + \gamma \ln k_{jt} + \delta e_{jt} + \rho m_{jt} + \tau \ln w_{jt} + u_{jt} \quad (3)$$

where:

ln i = innovation measured by employees in high tech sectors.

Panel data structure: N=6, T=12.

Short panel means we cannot use lags of greater than 1 year.

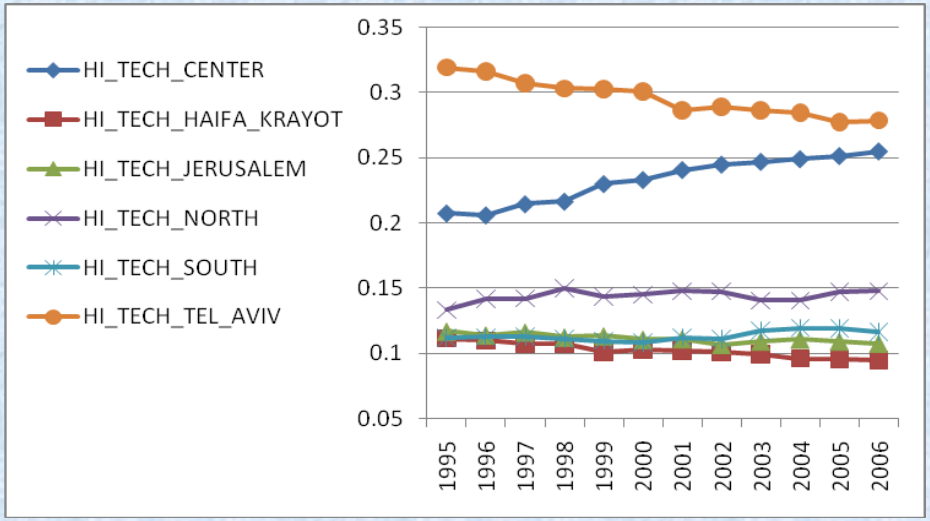
α and θ = two-way fixed effects for the six regions and twelve years of data and μ denotes the residual error.

Data

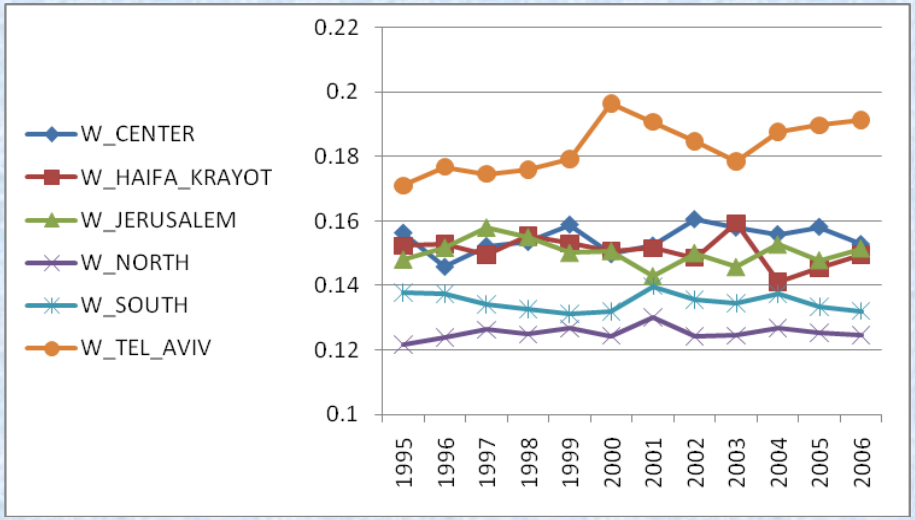
- Source: regional averages: aggregations from annual micro data- CBS HIS and LFS (innovation)
- Panel data: test for non-stationarity
- Panel unit root tests show: earnings, immigrants, innovation and human capital, all non-stationary

Describing the Data:

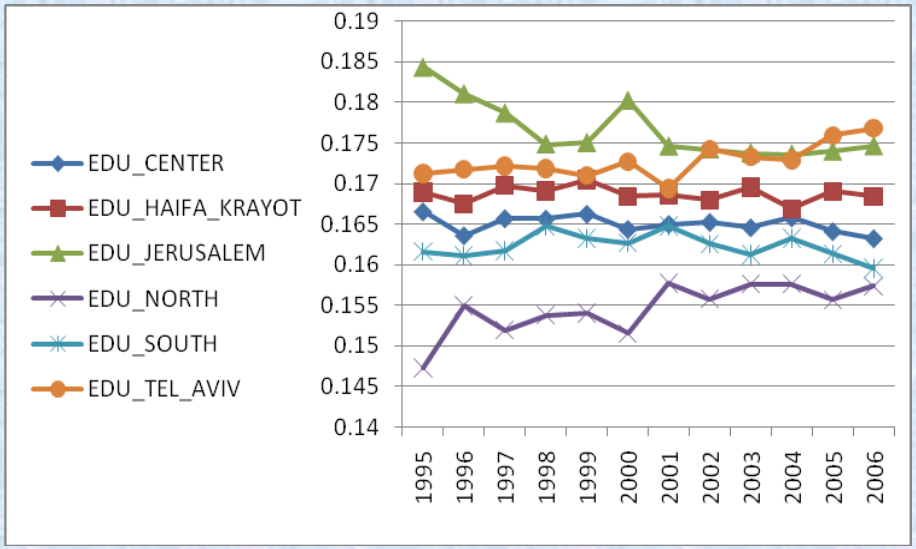
a. Relative Regional Innovation



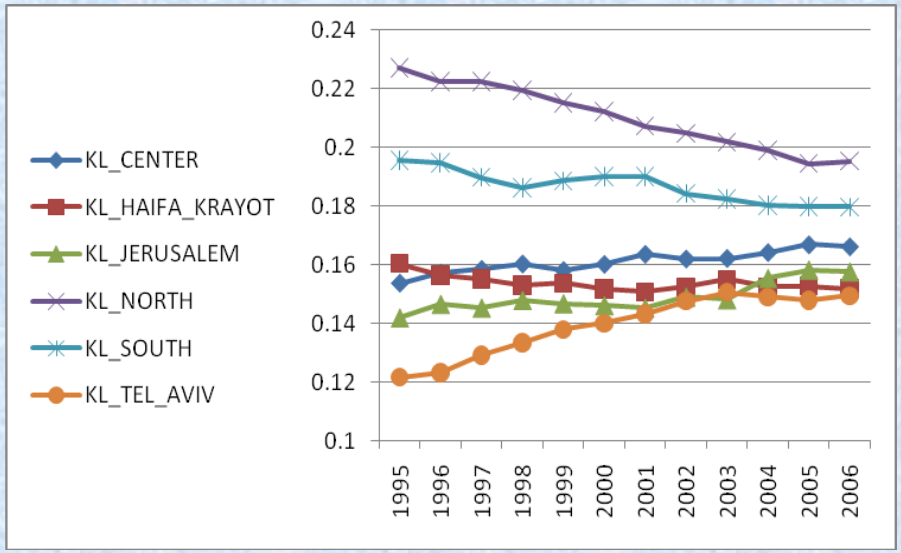
b. Relative Regional Real Wages,



c. Relative Regional Human Capital



d. Relative Regional Capital-Labor Ratios



Results: Panel Unit Root Tests

	IPS		CIPS	
	d = 0	d = 1	d = 0	d = 1
Earnings (ln)	-2.041	-3.318	-2.037	-3.386
Physical Capital (ln)	-3.263	-2.067	-2.682	-2.501
Human Capital	-1.983	-4.611	-1.354	-3.727
Immigrants	-1.523	-4.368	-1.708	-5.121
Innovation (ln)	-1.169	-4.290	-1.107	-3.328

Note: critical values of IPS statistic when N = 6 and T = 12 are -2.42 ($p<0.05$) and -2.21 ($p<0.01$) (Im , Pesaran and Shin 2003, p.61)

- Earnings, immigrants, innovation and human capital are non-stationary.
- They might be spuriously correlated and may make any assumptions about independence untenable.
- Therefore estimate the equations in first differences and use panel cointegration.

Determinants of Regional Productivity: Spatial Panel Regressions for Israeli Regions 1995-2006 (Dependent Variable = ln earnings)

	1. Homogeneity in Regional Human Capital	2. Heterogenity in Regional Human Capital	3. Heterogeneity in Regional Human Capital
Regional Fixed Effects	No	No	Yes (4.810-6.636)
Immigrants	-0.001	0.0006^{+}	0.001^{+}
Capital –Labor	0.038^{+}	0.417	0.067
Human Capital	0.143	-	-
Center – Human Capital	-	0.106	-0.001^{+}
Haifa – Human Capital	-	0.102	0.040
Jerusalem – Human Capital	-	0.098	-0.024^{+}
North – Human Capital	-	0.086	0.080
South – Human Capital	-	0.090	0.111
Tel Aviv – Human Capital	-	0.117	0.010^{+}
R^2	0.81	0.94	0.97
DW Statistic	1.17	1.43	1.88
Cointegration Tests			
ADF test	-0.404	-1.637	-4.900
PP test	-0.523	-1.087	-2.898

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) based on Pedroni (2004).

Determinants of Regional Innovation: Spatial Panel Regressions for Israeli Regions 1995-2006 (Dependent Variable = ln High Tech Employment)

	1. Homogeneity in Regional Earnings	2. Heterogenity in Regional Earnings	3. Heterogeneity in Regional Earnings
Regional Fixed Effects	No	No	Yes (3.737-7.700)
Immigrants	-0.016	-0.006	-0.005
Capital-Labor	0.046+	0.285	0.358
Human Capital	-0.312	0.149	0.137
Earnings	0.758		
Center – Earnings	-	0.049	0.348
Haifa – Earnings.	-	0.073	0.165+
Jerusalem – Earnings	-	0.071	0.605
North – Earnings.	-	0.052	0.721
South – Earnings.	-	0.060	0.541
Tel Aviv – Earnings	-	0.070	0.202+
R2	0.64	0.97	0.98
DW Statistic	1.19	1.50	1.79
Cointegration Tests			
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) based on Pedroni (2004).

Conclusions

- **Spurious correlation:** Q:do more skilled workers self-select high paid areas? A: only in most heterogeneous specification can we discount this.
- **Regional physical capital:** more important and less volatile in determining innovation than productivity
- **Immigrant mobility:** surprisingly small and counter-intuitive effect. Needs to be better specified:
  - Differentiate high and low skilled immigrants
  - Impacts of immigrants on regional innov/prod needs to be jointly determined with their location using house prices.