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China's Transition Towards the Knowledge Economy:

Regional Evidence on Knowledge Spillover using Panel Data Models

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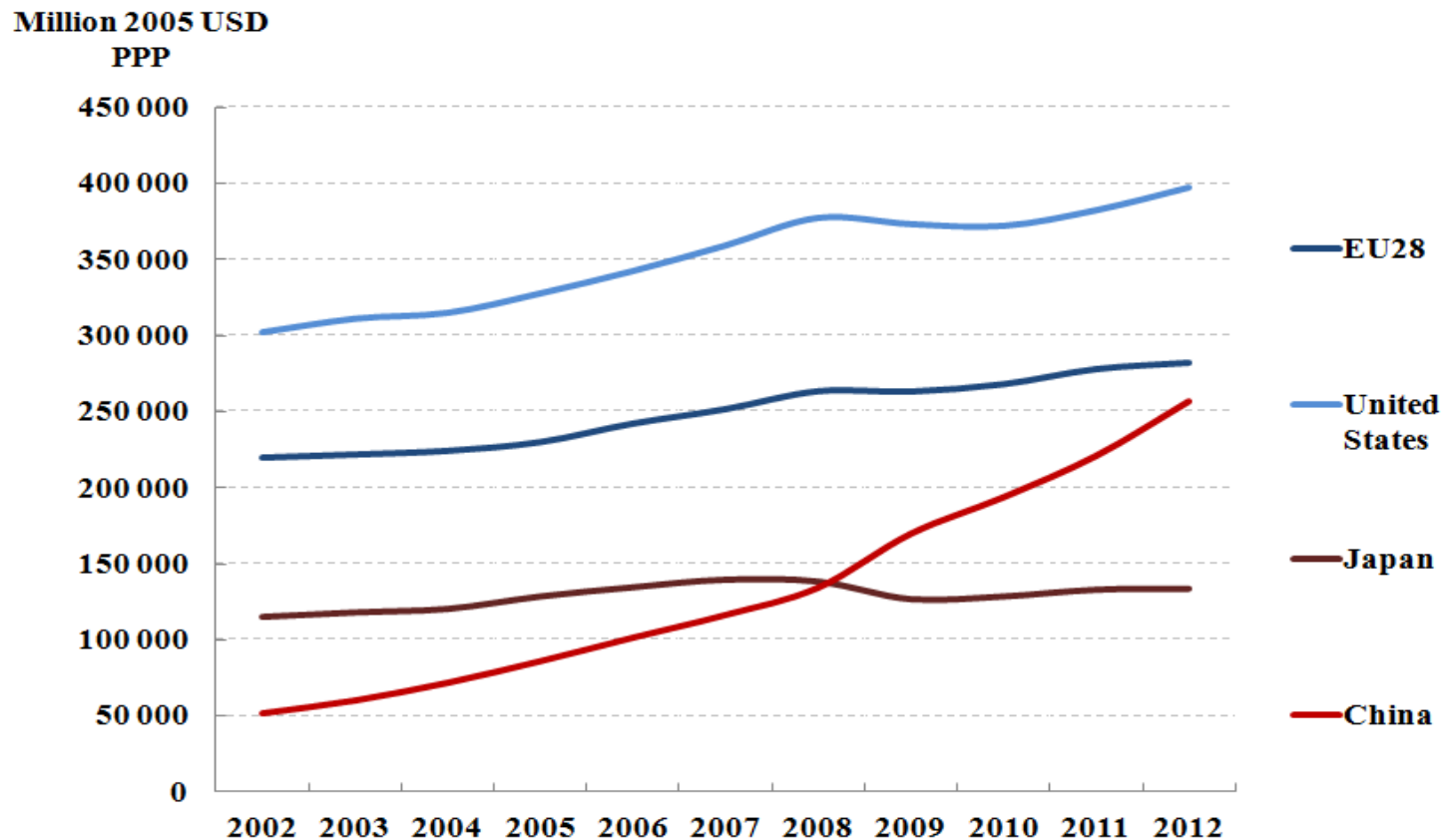
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Outline

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Motivation: Is China's economy knowledge-based?

R&D expenditures in Mio. US PPP, 2002 - 2012



Source: OECD (2014)

Research gap

Importance of cross-firm **knowledge spillovers** for economy-wide growth (Arrow 1962; Griliches 1979; Stiglitz and Greenwald 2014)

China's distinctive geography of innovation calls for **regional level analysis**

- Increasing spatial concentration of R&D expenditures, patenting and labour productivity (Crescenzi et al. 2012)
- Emerging clusters of R&D-intensive firms – ICT & pharmaceutical industries



What about knowledge spillover effects to industry in China?

- We lack evidence on social benefits to overall industry from massive knowledge investment in China, in particular on knowledge externalities

Research questions

1. Can we observe and estimate knowledge spillover effects from patenting activities
 - on **total factor productivity** (TFP),
 - using a spatial **panel data modelling** framework (Elhorst 2012),
 - at the **regional level** in China?

2. Do we observe spillover effects from regional knowledge production
 - on region-industry **new business formation** (NBF),
 - in particular R&D-intensive NBF,
 - using a **panel data** on newly established Chinese manufacturing firms,
 - at the **regional level** in China?

Literature: Regional development

Regional development = regional structural change and its characteristics

Causes and principal regularities of regional development?

- New neoclassical urban economics (NNUE): Sorting of labour (Glaeser et al. 1992)
- New economic geography (NEG): Specialisation of regions due to external economies to the firm (Krugman 1991; 2005)
- Geography of innovation:
 - Firm learning curve: R&D, learning-by-doing (Arrow 1962; Romer 1986)
 - Competence-theory of the firm (Hunt and Morgan 1995)
 - **Localised learning externalities** (Feldman 1994)

Mechanisms of knowledge spillovers

- Patents, patent citations and patent licenses (Jaffe, Trajtenberg and Henderson 1993; Mowery and Ziedonis 2004)
- Entrepreneurship (Acs et al 1992; 2009; Audretsch and Feldman 1996; Feldman 2005)
- Local mobility of labour (Zucker, Darby and Brewer 1998; Kogut 1999)
- Social networks:
 - Forward and backward linkages between firms and their suppliers and customers (Marshall 1890; Krugman 1990)
 - Collaborative research networks: Co-patenting, co-publications (Scherngell and Hu 2011)



However, evidence for China in this regard is scarce (Crescenzi et al. 2012)

Research question I

Effects of knowledge capital on TFP in China:

A Spatial Econometric Perspective

Theoretical background

Knowledge production function approach for region i

$$Q_{it} = K_{it}^{\beta_1} K_{it}^{*\beta_2} L_{it}^{\alpha} C_{it}^{1-\alpha} u_{it} \quad \text{for } \begin{matrix} i = 1, \dots, N; \\ t = 1, \dots, T \end{matrix} \quad (3)$$

Knowledge Capital Stock Knowledge Spillover Pool

Reduced form relationship between productivity and knowledge capital

$$y_{it} = \beta_1 k_{it} + \beta_2 k_{it}^* + u_{it} \quad \text{for } i = 1, \dots, N; t = 1, \dots, T \quad (4)$$

TFP Region-internal Knowledge Capital Stock Knowledge Spillover Pool

Model (4) may be estimated using **spatial panel data modelling** techniques

Data

$N = 29$ regions of mainland China

1988 to 2007 ($T = 20$)

Data on gross regional output, labour, and gross fixed capital formation and price deflators for the measurement of TFP are collected from the National Bureau of Statistics of China

Patent data for the knowledge capital variables are collected from the Chinese Patent Statistic Database

SIPO patent database

Patent ID

Publication date

Assignee

Inventor

Assignee's address

压电陶瓷电机

申请公布（公报）

摘要：

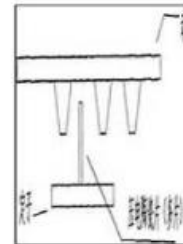
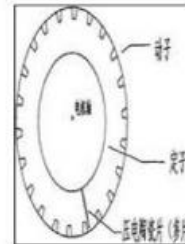
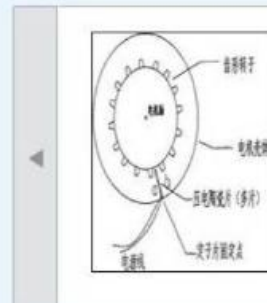
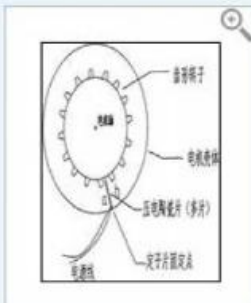
本发明涉及压电陶瓷电机。现行电机技术：利用定子铜线圈将电能经多次能量转换后输出机械能，造成能源浪费严重；结构复杂、制造成本高、不节能、有电磁辐射。本发明技术是利用压电陶瓷的压电逆效应原理，把多片条形已极化的压电陶瓷片的一端固定，构成一圈，再将其分成一组或多组构成供电的一相或多相，并在其两面电极加交变电压，压电陶瓷片另一端会产生机械摆动（拨动）。使其同时在电源的频率和电压控制下按相应的频率和幅度拨动齿形转子，使齿形转子产生旋转。即构成压电陶瓷电机。也可将多个这样的电机级联叠加做到更大功率。本发明的压电陶瓷电机结构简单、制造成本低、制造工艺简单、节能效率极高，是现行电机的换代产品。可用于低转速、大扭矩、断电时自锁要求的场合，包括军事国防、航空航天领域有着广阔的应用前景。

主权项：

前序部分一种压电陶瓷电机。利用压电陶瓷的压电逆效应原理，将电能转化为可利用的机械能。特征部分其特征是：给压电陶瓷定子片加电使其产生机械摆动，使其拨动齿形转子或动子，产生机械运动。

摘要附图：

说明书附图：



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优先权: 无

国际申请: 无

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Estimation results of TFP

Variable	1988-1997	1998-2007
$W*\ln p (\rho)$	0.110 (0.084)	0.042 (0.085)
$\ln k (\beta_1)$	0.188*** (0.061)	0.302*** (0.049)
$W*\ln k (\beta_2)$	-0.006 (0.092)	0.211** (0.098)
σ^2	0.032	0.022
R ²	0.705	0.861
Corrected R ²	0.029	0.242
Model specification tests		
Log Likelihood	41.773	85.063
Wald test spatial lag (1988-2007)	16.791 ($p < 0.01$)	
Wald test spatial error (1988-2007)	18.724 ($p < 0.01$)	

Notes: Pooled Spatial Durbin Model with spatially lagged dependent variable, spatial random effects and time-period fixed effects. Standard errors in parentheses. Corrected R² is R² without the contribution of fixed effects. ***, ** and * denote significance at the 1, 5, and 10% levels, respectively.

Research question II

Determinants of new business formation in China:
Regional Evidence from a Panel Data Model

Objective and hypotheses

The objective is to provide empirical estimates on the effects of regional knowledge production and new product sales

- on region-industry NBF rates, particularly R&D-intensive NBF rates
- using a panel data on newly established Chinese manufacturing firms covering 266 prefectures (including municipalities) from 1998 to 2007.

Emergence of new sectors higher up the value chain is strongly linked to new business formation (NBF) – in line with **Acs and Audretsch 2008**

Hypothesis 1: Knowledge-intensive NBF rates are higher in prefectures with higher levels of patent stocks.

Hypothesis 2: Knowledge-intensive NBF rates are higher in prefectures with lower share of new product sales in output sales of incumbent firms.

Empirical model of regional new business formation

Reduced form relationship between NBF and knowledge production to be estimated

$$y_{it} = \lambda_i + \alpha k_{it} + \beta n_{it} + \gamma z_{it} + u_{it} \quad \text{for } \begin{matrix} i = 1, \dots, N; \\ t = 1, \dots, T \end{matrix} \quad (5)$$

NBF Regional Patent Stock Region-industry new product intensity Region-level characteristics

Model (5) may be estimated for region-industry pairs using **panel data modelling** techniques

Data

What is a new business formation?

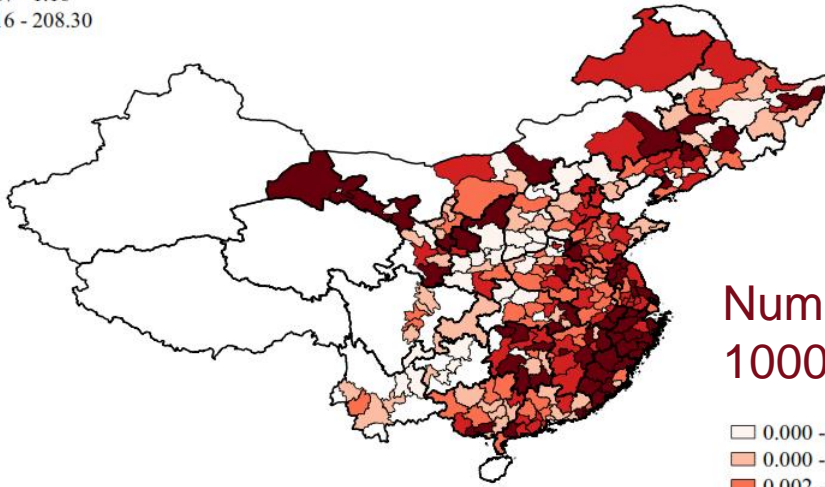
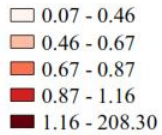
- Single plant (unique firm identifier) – firm privatisations accounted for
- Establishment between 1998 and 2007

$I = 43624$ observations on prefecture-industry pairs:

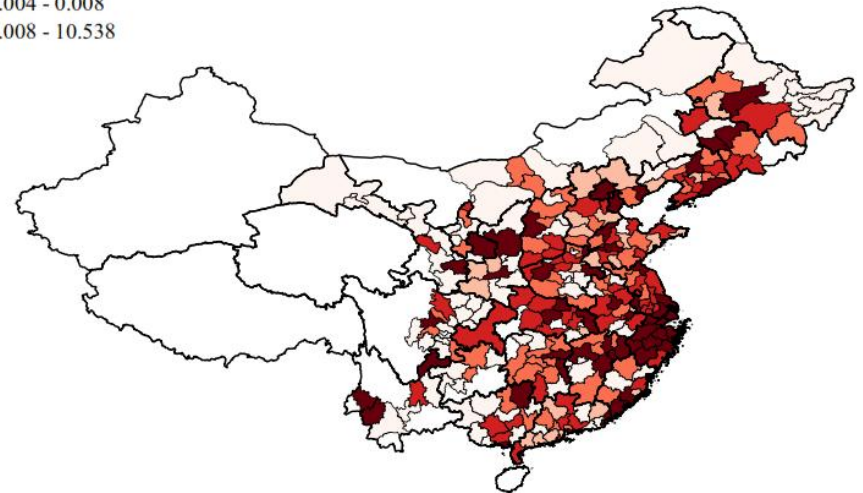
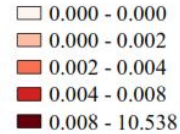
- $N = 266$ prefecture-level cities (地级市 - dijíshì) of mainland China, including four municipalities and 15 sub-provincial cities (covering 92% of population)
- $N = 164$ SIC3 level manufacturing industries
- $T = 10$ 1998 to 2007

Firm-level data collected from the Annual Survey of Industrial Enterprises (ASIE) in China

Number of new businesses per 1000 active labour force, 1998 - 2007



Number of R&D-intensive new businesses per 1000 active labour force, 1998 - 2007



Poisson estimation results of NBF

Variable	(i)	(ii)	(iii)	(iv)	(v)
<i>Employment in prefecture-industry</i>	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000*** (0.000)	0.000*** (0.000)
<i>Prefecture population</i>	0.001*** (0.000)	0.001*** (0.000)	-0.001*** (0.000)	-0.002*** (0.000)	-0.001 (0.001)
<i>Patents granted in prefecture(α)</i>		-0.002 (0.001)		0.015 (0.013)	0.016 (0.013)
<i>New product intensity in prefecture-industry(β)</i>		-0.141*** (0.010)		-0.141*** (0.010)	-0.203*** (0.042)
<i>Share of population with tertiary education</i>			-0.030*** (0.010)	-0.020* (0.011)	-0.014 (0.042)
<i>Share of finance in prefecture value added</i>			0.114*** (0.008)	0.111*** (0.008)	0.061 (0.040)
<i>Share of private-owned firms in prefecture-industry</i>			0.229*** (0.010)	0.240*** (0.010)	-0.050 (0.037)
<i>Share of HMT-owned firms in prefecture-industry</i>			0.159** (0.064)	0.208** (0.062)	-0.060** (0.365)
<i>Relative specialisation index of mfg. employment in prefecture</i>			0.005 (0.008)	0.006 (0.008)	-0.059 (0.068)
<i>Chinitz measure of small suppliers in prefecture</i>			-0.537*** (0.044)	-0.576*** (0.051)	-0.166* (0.061)
<i>Input/Supplier strength measure in prefecture</i>			2.456*** (0.103)	2.336*** (0.107)	4.506*** (0.714)
<i>Output/Customer strength measure in prefecture</i>			2.750*** (0.109)	2.639*** (0.113)	5.165*** (0.743)
<i>Prefecture real GDP per capita</i>			0.000*** (0.000)	0.000*** (0.000)	0.000* (0.000)
N	139948	129025	139132	128328	127432
Log-likelihood	-3960013	-3515168	-3770983	-3348995	-35400000
AIC	7920030	7030344	7541989	6698017	70900000
BIC	7920049	7030383	7542097	6698143	70900000
Fixed effects	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses. ***, ** and * denote significance at the 1, 5, and 10% levels, respectively.

Poisson estimation results of R&D-intensive NBF

Variable	(i)	(ii)	(iii)	(iv)	(v)
<i>Employment in prefecture-industry</i>	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000* (0.000)
<i>Prefecture population</i>	0.003*** (0.002)	0.003 (0.002)	-0.012 (0.001)	-0.010*** (0.003)	-0.004 (0.003)
<i>Patents granted in prefecture(α)</i>		0.028*** (0.006)		0.066*** (0.020)	0.071** (0.029)
<i>New product intensity in prefecture-industry(β)</i>		-3.355*** (0.564)		-2.970*** (0.515)	-3.426*** (0.679)
<i>Share of population with tertiary education</i>			0.283*** (0.018)	0.278*** (0.097)	0.001 (0.190)
<i>Share of finance in prefecture value added</i>			0.461*** (0.010)	0.371*** (0.072)	0.244 (0.205)
<i>Share of private-owned firms in prefecture-industry</i>			0.825*** (0.017)	0.978*** (0.108)	0.975*** (0.219)
<i>Share of HMT-owned firms in prefecture-industry</i>			-1.287 (0.458)	-1.485** (0.725)	-0.777 (0.926)
<i>Relative specialisation index of mfg. employment in prefecture</i>			-0.042** (0.052)	-0.038 (0.043)	0.357 (0.262)
<i>Chinitz measure of small suppliers in prefecture</i>			-0.091 (0.090)	0.259 (0.225)	0.200 (0.657)
<i>Input/Supplier strength measure in prefecture</i>			0.265 (0.000)	2.186*** (0.833)	1.931 (1.766)
<i>Output/Customer strength measure in prefecture</i>			0.358 (0.593)	2.287*** (0.857)	2.839 (1.955)
<i>Prefecture real GDP per capita</i>			0.000 (0.142)	0.000*** (0.000)	0.000*** (0.000)
N	12599	12034	12549	11987	11894
Log-likelihood	-73194	-51816	-64284	-45225	-571282
AIC	146392	103640	128591	90476	1142590
BIC	146406	103670	128672	90573	1142686
Prefecture-industry fixed effects	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses. ***, ** and * denote significance at the 1, 5, and 10% levels, respectively.

Conclusion and outlook

The present thesis set out to provide evidence on the crucial question whether TFP and NBF in China are increasingly based on knowledge production and diffusion

- **Knowledge capital** does have a significantly positive impact on productivity and R&D-intensive start-up rates across Chinese provinces, in particular after 1998
- Presence of **knowledge spillover effects** across Chinese regions in the period 1998-07
- **R&D-intensive NBF** co-locate with patenting incumbent firms

Dissemination of results:

- Scherngell T, Borowiecki M and Hu Y (2014) *China Economic Review* 29, 82–94.
- Borowiecki M and Leitner K-H *In preparation*.



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Thank you for your attention!

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Appendix: Measures of NBF

Population-ecological approach: Rate of new business formation N_{it} equals number of entering businesses E_{it} per 100 active incumbent businesses I_{it}

$$N_{it}^e = \frac{E_{it}}{I_{it}} \cdot 100 \quad \text{for } i = 1, \dots, N; t = 1, \dots, T \quad (6)$$

Labour market approach: Rate of new business formation N_{it} equals number of entering businesses E_{it} per 1.000 active labour force L_{it}

$$N_{it}^l = \frac{E_{it}}{L_{it}} \cdot 1000 \quad \text{for } i = 1, \dots, N; t = 1, \dots, T \quad (7)$$