A New Geography of Knowledge?
From Global Production to Innovation Networks
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Storyline

1. What does the literature tell us about the prime movers and defining characteristics of Global Production Networks (GPNs)?
2. What distinguishes Global Innovation Networks (GINs)? And what drives their increasing diversity and complexity?
3. The New Geography of Knowledge is not a Flatter World
1. What does the literature tell us about the prime movers and defining characteristics of Global Production Networks (GPNs)?


Global Production Networks (GPNs) – from Partial to Systemic Globalization

Limits to Partial Globalization:

- MNCs invest in a loose patchwork of stand-alone affiliates, joint ventures, and suppliers, that
  - are scattered across the globe
  - co-exist without much interaction and coordination across functions and locations

  The MNC cannot reap the full benefits of international specialization.

Ernst, D., 1997
Systemic Globalization:

- A firm (a “network flagship”) proceeds to integrate its dispersed operations and inter-firm relationships worldwide, both across functions and locations.
- Cost-effective coordination of these interactions enables the firm to internalize & combine resources and capabilities without running into the constraints of excessive centralization.

Ernst, D., 1997
GPN = a major organizational innovation which enables ‘flagships’ to combine fragmentation & integration.

- **Fragmentation** → separates labor-intensive processes (that move to low-cost locations) from capital- and knowledge-intensive processes.

- **Integration** of the dispersed production, supplier and customer and knowledge bases is necessary to reduce the high coordination costs and risks of cross-border exchanges of products, people, information and knowledge.

Asymmetry

- MNCs dominate as network flagships & define network organization and strategy.
- Control over network resources plus coordination of information flows & decision-making enables the flagship to directly affect the growth, strategic direction, and network position of lower-end participants (e.g., specialized suppliers and subcontractors).

Variable governance includes…

- loose linkages, formed to implement a particular project & that are dissolved after the project is finished (“virtual enterprises”)
- highly formalized networks (“extended enterprises”) with clearly defined rules, common business processes, & shared information infrastructures → with or without common ownership.

Ernst, 2012
Outsourcing is the main driver

- By outsourcing volume manufacturing & related support services to lower-cost locations (Mexico, China), the flagship expects substantial cost savings.

- Over time, the focus of outsourcing has shifted from assembly-type manufacturing to knowledge-intensive support services (supply chain management, engineering services & new product introduction).

- Network flagships increasingly rely on the skills and knowledge of specialized suppliers to enhance their core competencies.

Knowledge sharing is the glue that keeps GPNs growing

- Network flagships transfer both explicit and tacit knowledge to local suppliers through formal and informal mechanisms.

- This is necessary to upgrade the local suppliers’ technical and managerial skills so that they can meet the flagships’ specifications.

- Once a network supplier successfully upgrades its capabilities, this creates an incentive for flagships to transfer more sophisticated knowledge, including engineering, product and process development.

- This process is NOT automatic → To stay on the GPN, local suppliers must constantly upgrade their capabilities.

Upgrade or perish!!

Ernst and Linsu KIM (Research Policy, 2002)
Three-dimensional model of a GPN

Lazzarini, Chaddad, and Cook, “Integrating Supply Chain and Network Analyses.”
The nodes of a Global production network

Ernst, D. and Linsu Kim, 2002,
Inter-Firm Networks - Notebooks

- Tier 1: Flagship
- Tier 2: ODM
- Tier 3 - Suppliers
- Tier 4 (and below) - Suppliers

Core Component Suppliers
(HDD, Displays, CPU)

Flagships outsource & offshore manufacturing & knowledge-intensive support services

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Focus of outsourcing shifts to knowledge-intensive support services
The value chain for a personal computer manufacturer.

Pre- and post-production knowledge-intensive support services
Each value chain process consists of sub-processes.
Apple iPhone 3G  2008

SST SST25VF080B 1 MB Serial Flash

SAMSUNG Application Processor and DDR SDRAM

ST MICROELECTRONICS LIS331 DL Accelerometer

INFINEON SMP3i SMARTi Power Management IC

SKYWORKS SKY77340 Power Amp. Module

INFINEON UMTS Transceiver

NATIONAL SEMICONDUCTOR LM2512AA Display Interface

BROADCOM BCM5974 Touchscreen Controller

WOLFSON WM6180C Audio Codec

INFINEON PMB2525 Hammerhead II GPS

LINEAR TECHNOLOGY LTC4088-2 Battery Charger/USB Controller

NXP Power Management

INFINEON Digital Baseband Processor

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iPhone Plus 6 tear-down, E&T, 11/10/14
<table>
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<th>Manufacturer</th>
<th>Part Number</th>
<th>Description</th>
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<td>Primary Camera Module - 8MP, BSI CMOS, Auto Focus Lens</td>
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2. Global Innovation Networks (GINs)


What distinguishes Global Innovation Networks?

- Offshore outsourcing also includes product development, design and research.
- There is an important element of continuity – GINs emerge as a natural extension of GPN and hence share most of their characteristics.

- Until recently, the lack of good data gave rise to the perception that GINs “are still limited in number and mostly concentrated with big firms” (OECD, 2008)
Measurement problems

- Econometric analysis dominates policy debates & focuses on highly aggregated data that are often lagging by a number of years.
  - “imperfect macroeconomic proxies provide a surprisingly low level of R&D globalization” (Mowery et al, 2008)
- But even those imperfect proxy indicators document the scattering of the innovation process across borders
- IMF Balance of Payment data → rapid growth of international payments, especially for patent licensing & copy right.
- Surveys of innovation offshoring by leading MNCs
EWC- GIN research

- Interviews with > 150 ICT companies (US, Japan, Asia, EU)
- Diverse sample (size, ownership, business model):
  - large global brand leaders
  - specialized technology suppliers and service providers
  - trans-pacific VC funded start-ups
  - international public-corporate R&D consortia
- Drivers and characteristics of GINs
- Impacts on learning, capability formation and innovation at diverse locations in China, Taiwan, Korea, Malaysia and India.
Systemic pressures to internationalize innovation

- ROI → contain rising cost, complexity and uncertainty of innovation
- Rapid growth of emerging markets → move R&D and product management close to lead customers in these markets
- Shorter product-life-cycle → speed-to-market
- Surging demand for low-cost knowledge workers → new sources in emerging markets
- New competitors and emerging centers of excellence
- Regulatory arbitrage = exploit differences in IPR regimes, incentives, tax laws [transfer pricing], regulations [finance; environment; health]
Enablers

- Modular design enables vertical specialization (slicing & dicing of innovation value chain)
- Liberalization/privatization → ‘deregulated’ markets
- ICT-enabled information management
- Globalizing markets for technology, knowledge workers and innovation finance
- Growing innovative capabilities in emerging economies
- Globalization of IP protection & standards (TRIPS-Plus; ITA; TISA; TPP; TTIP)
Increasing diversity and complexity of GINs

- GINs now involve multiple actors and firms that differ substantially in size, business model, market power & nationality of ownership, giving rise to a variety of networking strategies and network architectures.
- New network flagships from emerging economies, especially from Asia, construct their own GINs.
- Asian countries are also quite active now in global sourcing through cross-border public-private partnerships.
- Splintered GINs with diverse network flagships which increasingly complement the erstwhile dominant hierarchical networks.
Global innovation networks – increasing diversity

Hierarchical

- **Intra-firm networks** - Global companies “offshore” stages of innovation to Asian affiliates
- **Inter-firm networks** - Global firms “outsource” stages of innovation to specialized Asian suppliers
- **Asian firms** construct their own GINs (**Huawei**)

**International public-private R&D consortia**

- **ITRI** – global knowledge sourcing from the erstwhile periphery

**From hierarchical to splintered GINs**

- **Foxconn** – contractors can shape strategic direction as junior network flagships

Adapted from Ernst, D., 2009, *A New Geography of Knowledge?*
Hierarchical GIN - Intel’s integrated product development

- **US** (>11 R&D labs)
- **Europe** (> 12 R&D labs)
  - **Israel** (Haifa: 2400, since 1974), processor research
  - **Russia**: Nizhny Novgorod (450++): software
- **Asia** (7 labs, more planned)
  - **Bangalore** (1998, 2,700 + = largest lab outside US), leading-edge processor & platform development
  - **Penang** (500), component design; **Shanghai** (100++) Linux based solutions for telecom; new applications for emerging markets; **Beijing** (50++), platform and architecture lab

Sources: company website and interviews
China’s integration into Intel’s GIN

Intel USA

Intel R&D, Russia

Intel Global Network

Intel R&D, India

Intel China Research Center

Chinese Govt. Standards & regulations

Chinese software firms, OEMs & other vendors. Software & hardware development.

Chinese universities, e.g., Beijing, Fudan, Tshinghua, etc. Research cooperation

Chinese Academy of Sciences (CAS). Research coopm.
Huawei’s Global Innovation Network

Plus: Belgium (close to IMEC); Ireland (software) & Finland (mobile devices)

25 plus R&D centers worldwide

> 800 R&D specialists across 14 R&D sites in 8 EU countries

Sources: company website and interviews

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ITRI’s global knowledge network – U.S. (select examples)

**Universities**: Carnegie Mellon; Case Western Reserve; Columbia; Cornell; Georgia Tech; Harvard; Johns Hopkins; Kent State; Lawrence Berkeley National Laboratory; MIT Media Lab; MIT-CSAIL; MIT-Harvard Clinical Consortium; National Renewable Energy Laboratory; Ohio State University; Purdue University; Rensselaer Polytechnic; Texas Tech University; UC Berkeley; UCLA; UC San Diego; UC Santa Barbara; University of Central Florida; University of Cincinnati; University of Illinois; University of Missouri; University of Washington, Seattle; Virginia Polytechnic

**Companies**: Corning; DuPont; e-Meter Corporation; Eastman Kodak; Exactech; IBM; InVisage; Johnson & Johnson; Qualcomm MEMS Technologies; Texas Instruments; etc

- ITRI’s network interacts with & complements Taiwanese corporate GINs (e.g., TSMC)
Power shift? From hierarchical to splintered GINs

Hierarchical GINs: Brand leaders like Apple act as network flagship which …
- controls key resources and shapes strategic direction;
- uses its purchasing power to force corrosive price concessions on suppliers (production & R&D) and distributors.

Splintered GINs: diverse network flagships:
- core component suppliers (Intel, MS; ARM; QCM; TSMC) control platforms
- Mega-contractors (Foxconn) can co-shape strategic direction & provide integrated solutions
- Mega-distributors (e.g., Arrow Electronics; Avnet) can provide integrated solutions
Honhai/Foxconn Global production & innovation network

**Canada:** co-develop Blackberry 4G smart phone

**US**
- Harrisburg
- Carnegie Mellon (robots)
- MIT-CSAIL (AI)
- Florida, Indiana, Texas, Arizona

**Mexico**
- Chihuahua
- Juarez (ex-Motorola; Ex-Cisco)

**EU:**
- Hungary, Slovakia, Czech Rep, Finland, Turkey Denmark

**China:** 15 mega-locations
- Honhai/Precision, the **network flagship**, controls > 230 holding companies, affiliates, subsidiaries and divisions; expands R&D cooperation with top universities

**Brazil**
- Manaus
- Indaituba
- Jundiai
- Sorocaba
- Santa Rita do Sapucai

**EMS, ODM & R&D services** for
- Acer, Amazon, Apple, Blackberry, Cisco, Dell, Google, HP, Microsoft, Motorola, Nintendo, Nokia, Sonay, Toshiba, Vizio, Micromax Mobile (India), and many more customers

**Japan:** Display R&D Osaka

**Korea**
- Taiwan HQ

**Texas**, Arizona

**Mexico**
- Chihuahua
- Juarez (ex-Motorola; Ex-Cisco)

**EU:**
- Hungary, Slovakia, Czech Rep, Finland, Turkey Denmark

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**Korea**
- Taiwan HQ

**Sources:** Company website & interviews

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3. An unequal distribution of innovation gains defines the New Geography of Knowledge

- Asia’s role in GINs is increasing (from initially low level)
- new (large) Asian players develop their own networks and unique (‘hybrid’) networking strategies
- established centers in the US, Europe and Japan retain their dominance
- Asia competes within a new global hierarchy of innovation hubs
A new global hierarchy of innovation hubs

- **Global centers of excellence** (US, Japan, EU)
- **Advanced locations** (Israel, Korea, Taiwan, [Ireland], [Russia])
- **Catching-up locations** (Beijing, Shanghai, Shenzhen in China; Bangalore, Chennai, Hyderabad, Delhi in India) → rapid learning; intense competition for talent pool; experience gap
- ‘**New frontier’ locations** (lower-tier cities in China & India, plus Romania, Armenia, Bulgaria, Vietnam, etc)
  - low-cost, highly motivated and trainable engineers and technicians
  - weak infrastructure, widespread market imperfections and limited exposure to modern US-style management system

Ernst, 2009
Population 2015; Mexico = 125,235,587; Malaysia = 30,432,000
Established innovation centers retain dominance

- all 15 leading companies with the best record on patent citations are based in the United States (9 in the IT industry)
- The 700 largest R&D spenders (mostly large U.S. firms) account for 50% of the world’s total R&D expenditures and >2/3 of the world’s business R&D
- > 80 percent of the 700 largest R&D spenders come from only five countries (United States dominates, followed by Japan, Germany, United Kingdom, France)
Who controls ICT standard consortia?

- about 50 global corporations determine what 250 ICT standard consortia do, and more importantly, how they do it.
- Of the 50 major players, 25 are from the US, 12 from the EU, and 8 from Japan.
- Only 5 companies from emerging countries (all from Asia) are members (Samsung, Huawei, LG, Lenovo, ZTE)
Last thoughts

- The New Geography of Knowledge is not a Flatter World
- Concentrated dispersion of capabilities through GPNs and GINs results in an unequal distribution of innovation gains

- What does this imply for industrial & innovation policies?
- What does this imply for Mexico?