

Economic Complexity for Growth: Evidence from Productive Knowledge in Korean Value-Added Trade

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May 2014

Motivation

- The economic growth rate of Korea has been decreasing since 2000s.
- Invigoration of Korean economy requires improvement of productive structure.
 - Improvement of composition of products that firms can produce
 - Export high value-added products that embody productive knowledge
 - Improve productive knowledge embedded in products across the labor and knowledge intensive industries
- Economic complexity reflects the productive knowledge that is embedded in a country.
 - It reflects accumulation of productive knowledge at a social rather than individual level.
 - Product complexity measures the amount of productive knowledge held in a product
- Organization of the global value chain (GVC) and international outsourcing strategies of firms are changing the trade and investment patterns
 - Export activities are interdependent on imports as the global value chains (GVC) become more complex across countries
 - International outsourcing may generate improvement of productivity, innovation and competitiveness for the home country
- Raises questions related to how such GVC participation and the accumulation of productive knowledge will affect firm productivity in the manufacturing industries

Some Questions

- How does economic complexity affect structural transformation and economic growth in Korea?
- Does Korean trade in value-added affect productive knowledge in knowledge-based industries?
- To what extent could trade in value-add affect productive knowledge across products in the Korean manufacturing (labor-based and knowledge-based) industries?
- Does product complexity even after taking full account of other covariates affect firm level productivity growth?

Related Literature

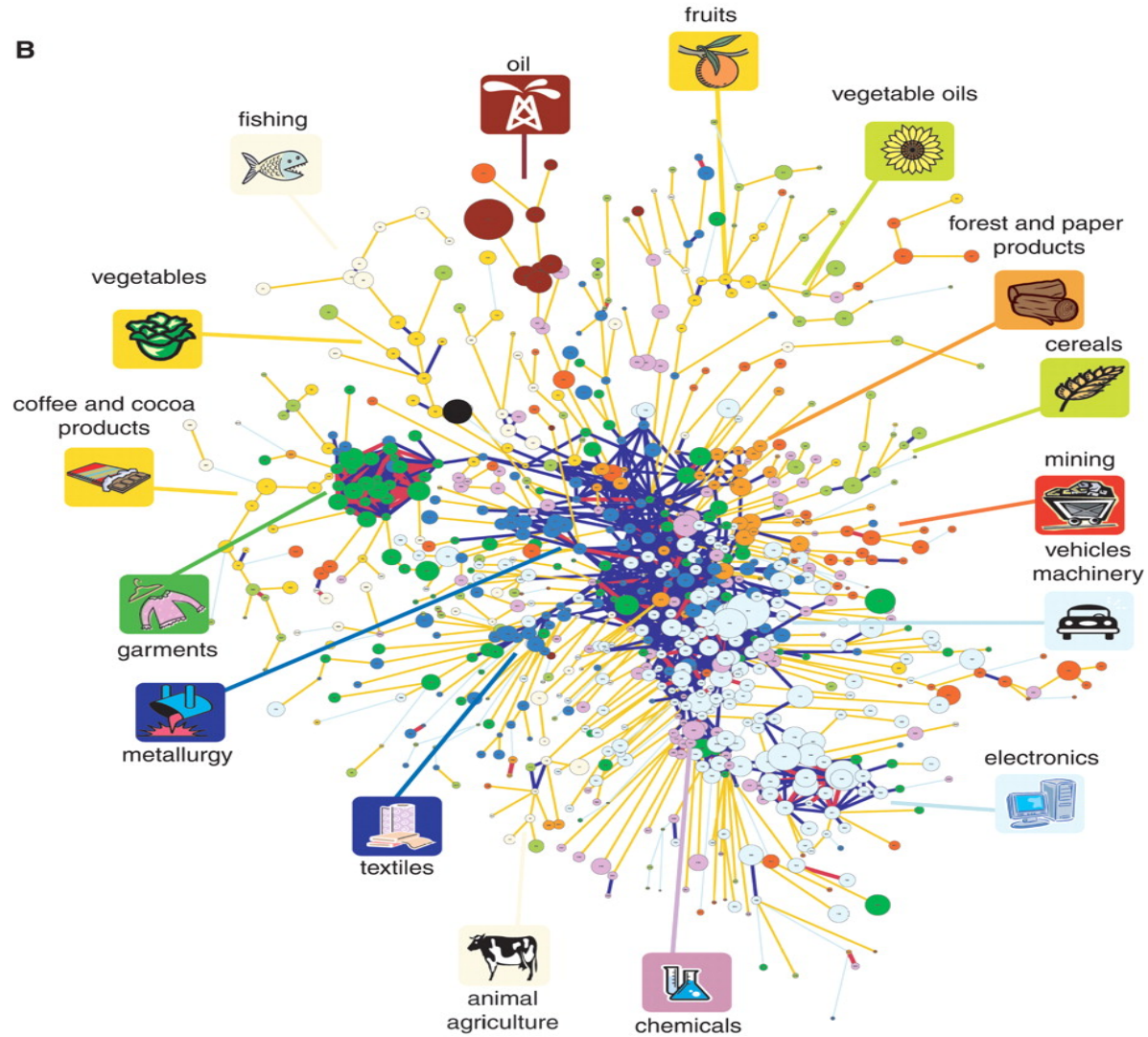
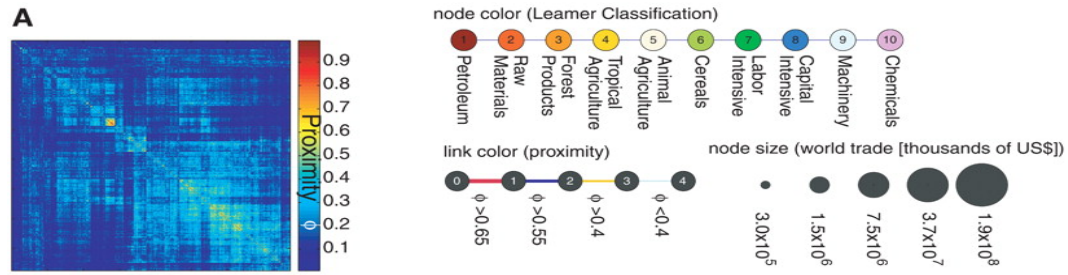
- First strand is that economic complexity is a driver of economic growth.
 - “Countries whose economic complexity is greater than what we would expect, given their level of income, tend to grow faster than those that are “too rich” for their current level of economic complexity.” (Hausmann, Hidalgo et al., 2014)
 - Economic complexity (the number of capabilities available in a country): the average ubiquity of the products that it exports; the average diversity of the countries that make those products
- Product space is the network of connecting pairs of product that are significantly likely to be co-exported by many countries.
 - It is the collection of proximities between a pair of products.
 - Product complexity (the number of capabilities required by a group): the average diversity of countries that make those products; the average ubiquity of the other products that these countries make
- A highly connected product space makes the problem of growing the complexity of an economy easier.
 - Connectedness: a measure showing how centrally located a community is in the product space.
 - The nearly 800 products in the SITC4 classification are grouped into 34 communities.

Related Literature

- Second strand is that participating in the global value chain improves firm productivity and employment.
 1. International outsourcing in knowledge intensive industries increases knowledge intensive intermediate imports
 - MNEs' integration-or-outsourcing decision depends on production stage's position in the global value chain (Antràs and Chor, 2013)
 - Prefer to outsource intermediate inputs in order to provide foreign supplier with strong incentives to invest and work hard (Antràs , 2003)
 2. Increasing knowledge-intensive intermediates trade broaden firm's choices on efficient intermediate inputs and product efficiency (Dixit and Stiglitz, 1977)
 3. Greater international outsourcing stimulates competitions among domestic and foreign input suppliers
 4. Trade in tasks increases complementarity between domestic and offshore workers, and positively affects competitiveness and employment of domestic workers
 - the effects of offshoring on jobs related to a direct displacement effect and an indirect productivity effect: Grossman and Rossi-Hansberg (2008) , Ottaviano et al. (2013)
 5. Firm heterogeneity explains the variation of employment in a typical sector associated with outsourcing. (Helpman, Melitz, and Rubinstein, 2008; Garetto, 2013).

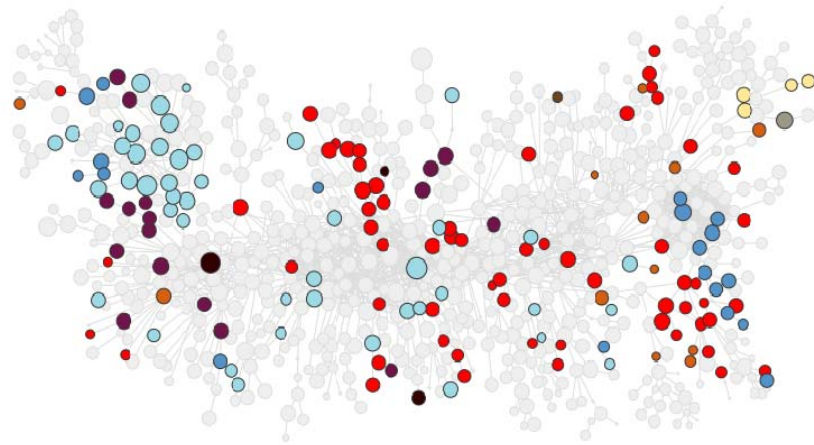
Plan of Talk

1. Motivation and Introduction
2. **Stylized Facts on Product Space and Korean Trade in Value-Add**
3. Empirical Evidence
4. Conclusion

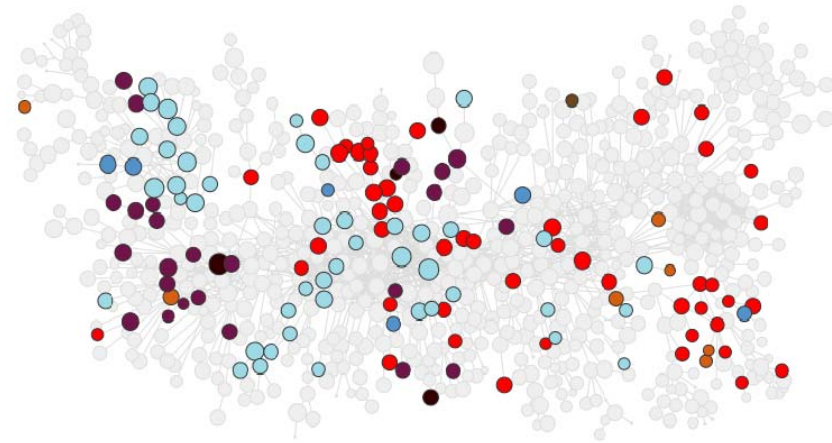


Evolution of the Product Space of Korea from 2000 to 2010

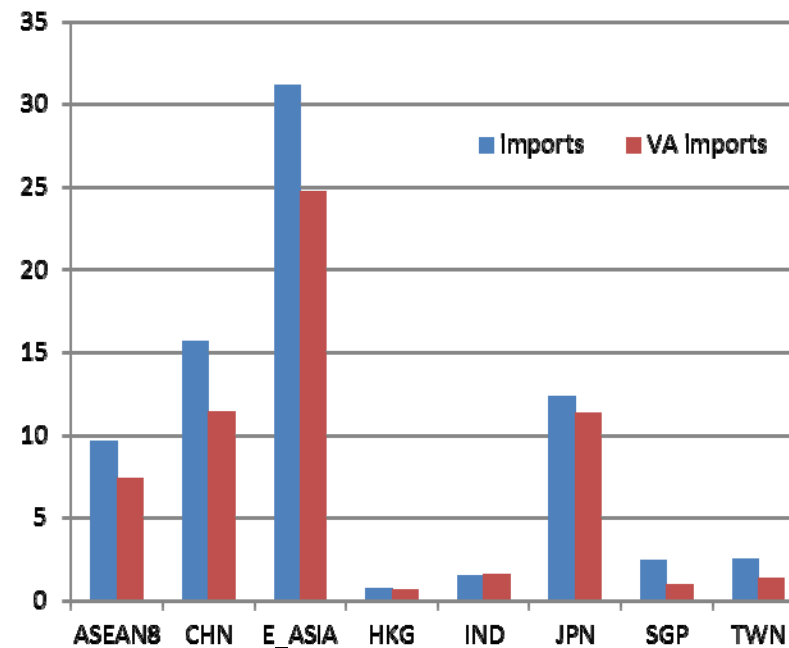
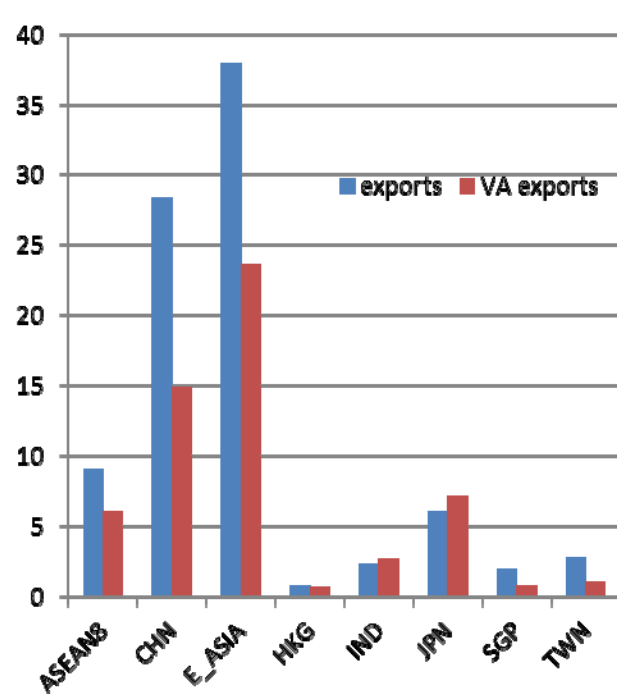
2000



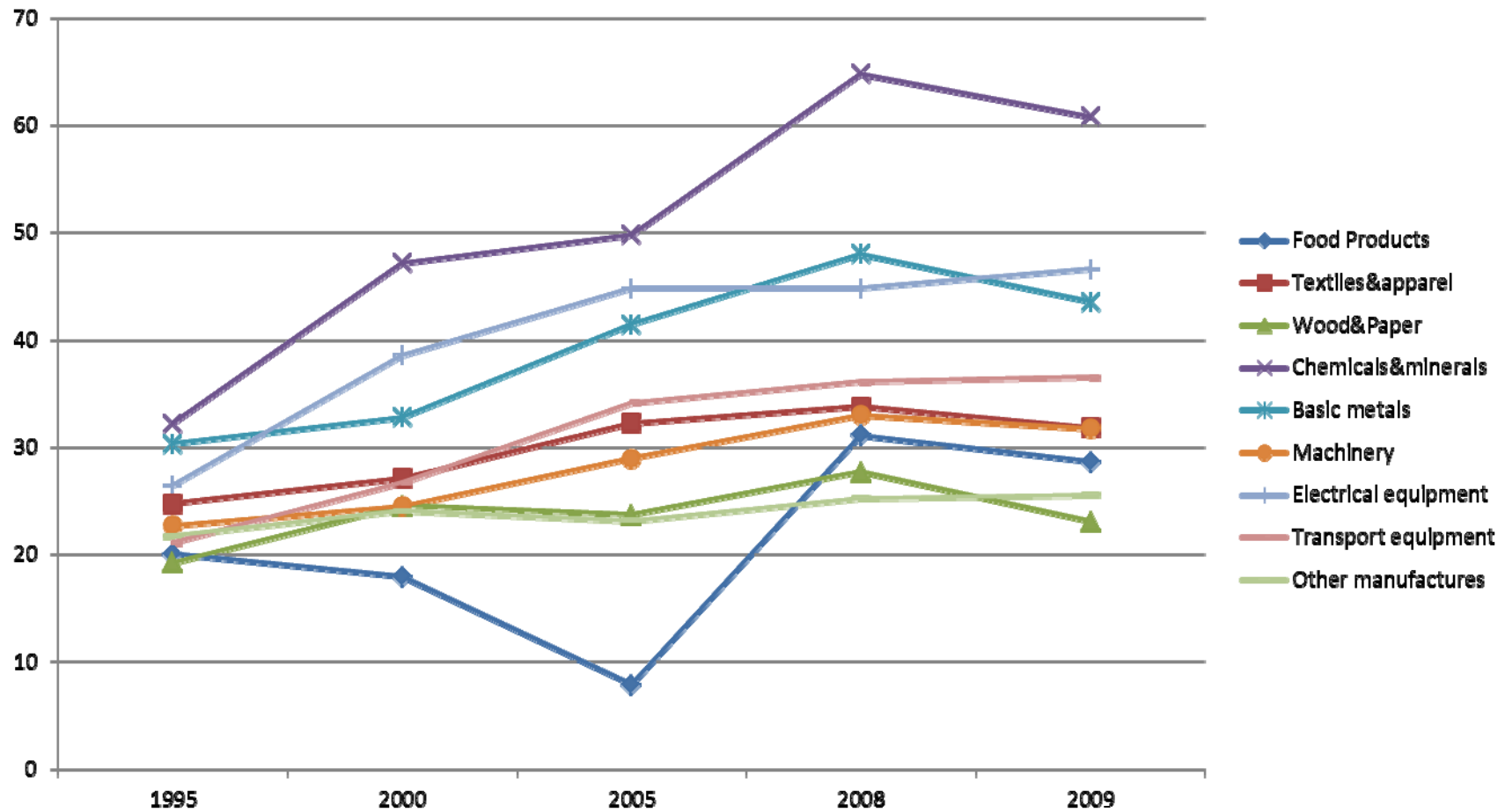
2010



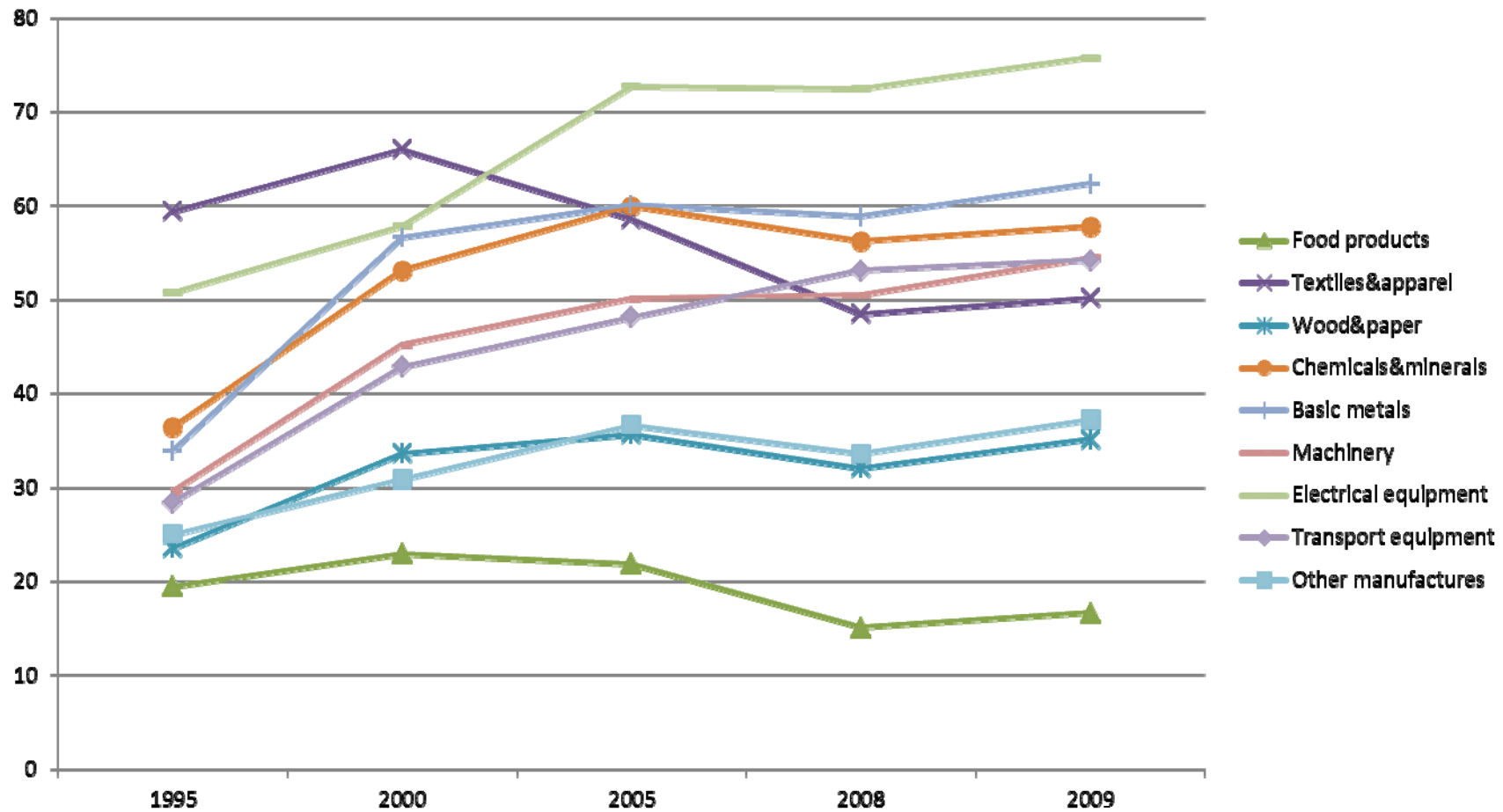
Exports and imports of Korea in gross and valued added terms, by partner country (as a % of total in year 2009)



Foreign value added content share of Korean gross exports by industries



Share of total intermediate imports that are re-exported by industry



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Hypothesis

- We want to show that manufacturing industries with a larger participation in GVC increases accumulation of productive knowledge and firm productivity growth (Ottaviano et al. 2013, Hausmann et al. 2014).
- The gap between a product complexity and level of firm productivity is an important determinant of future structural change: firms tend to converge to the level of productivity that can be supported by the productive knowhow that is embedded in the global value chain.
- We hypothesize that easier global value chain participation positively affect firm productivity in Korean manufacturing industries.
 - In particular, greater trade in value-added exports and international outsourcing may increase the accumulation of productive knowledge.
 - And the accumulation of productive knowledge affects firm's productivity enhancement.

Empirical Methodology and Specifications

$$\text{Product Complexity}_{ikt} = \beta_{10} + \beta_{11} \text{global value chain participation}_{ikt} + \beta_{12} \log(\text{capital intensity})_{ikt} + \beta_{13} \log(\text{R\&D intensity})_{ikt} + \beta_{14} \text{firm heterogeneity}_{kt} + \text{time fixed effects}_t + \varepsilon_{1l/jkt}. \quad (1)$$

$$\text{Productivity}_{ikt} = \beta_{20} + \beta_{21} \text{product complexity}_{jkt} + \beta_{22} \log(\text{capital intensity})_{ikt} + \beta_{23} \log(\text{R\&D intensity})_{ikt} + \beta_{24} \text{firm heterogeneity}_{kt} + \text{time fixed effects}_t + \varepsilon_{2l/jkt}. \quad (2)$$

- **Product Complexity_{ikt}** : the logarithm of the productive knowledge embedded in a product *k* of firm *l* at time *t*
- **Productivity_{ikt}** : the logarithm of the labor productivity of firm *l* at Industry *k* at time *t*
- **global value chain participation_{ikt}** : Value added exports or international outsourcing of firm *l* at Industry *k* at time *t*
 - Domestic value added embodied in foreign final demand
 - share of foreign value added content embodied in gross exports
 - share of total intermediate imports that are re-exported
- **log(capital intensity)_{ikt}, log(R&D intensity)_{ikt}**: Headquarters intensity of firm *l* in Industry *k* at time *t*
- **Firm heterogeneity_{kt}** : dispersion of firm productivity in Industry *k* and year *t*
- **time fixed effects in all specifications. $\varepsilon_{l/jkt}$** : errors that contains heteroskedasticity

Empirical Strategies

1. IV: global value chain participation may have endogeneity problem
 - 1st stage: international outsourcing costs (tariff)
–> Trade in value added
 - 2nd stage: fitted value of trade in value add (TiVA)
–> product complexity
2. 3SLS: Productivity and product complexity are jointly determined

Data

- Product complexity index: about 800 products in the SITC4 classification level from 2000 to 2012. Grouped into 34 communities.
- Productivity: Sales and employment data, Korean firm level business activity data from 2000-2011(KISLINE, 2013).
- International outsourcing: OECD-WTO's Trade in value added (TiVA)
 - Domestic content exports: domestic valued-added embodied in foreign final demand
 - Foreign content exports: Foreign value added contents share of gross exports, Share of Re-exported intermediate inputs of total intermediate imports
 - TiVA data 2000, 2005, 2008, 2009. Panel consists of 34 + major emerging countries
- Headquarter Intensity
 - Capital intensity, firm level physical capital stock
 - R&D intensity, R&D expenditure divided by industry level total sales
- Firm Heterogeneity
 - dispersion of firm productivity at the industry level (Helpman et al. 2004)
 - built by regressing log of firm ranking on log of firm size in the industry
- Merge variables for firm productivity at the industry level (KSIC), product complexity index at the product level (SITC), and valued-added trade at the industry level (ISIC) and compile a database.

Evidence: Effects of Korean Value-Added Trade on Product Complexity

Dependent Variable: ln(Product Complexity)				
	(1)	(2)	(3)	(4)
Specifications	IV	IV	IV	Direct OLS
ln(Value-added exports)	0.301*** (0.0227)			
Re-Exported intermediates		0.0195*** (0.00148)		
Foreign value added exports			0.0326*** (0.00250)	
ln(Capital intensity)	-0.0289*** (0.00361)	-0.0196*** (0.00359)	-0.0327*** (0.00395)	-0.0239*** (0.00364)
ln(R&D intensity)	0.0945*** (0.00829)	0.0860*** (0.00843)	0.170*** (0.00666)	0.129*** (0.00652)
Firm heterogeneity	0.0111 (0.0213)	0.0299 (0.0216)	-0.0226 (0.0254)	0.0303 (0.0212)
Year FE	YES	YES	YES	YES
First Stage:	ln(Value-added exports)	Re-Exported intermediates	Foreign value added exports	
Sector-specific tariffs	-0.0716*** (0.0008)	-1.106*** (0.0125)	-0.662*** (0.014)	-0.0216*** (0.00167)
Constant	9.632*** (0.048)	63.08*** (0.688)	38.80*** (0.769)	0.908*** (0.0587)
Observations	12,321	12,321	12,321	12,321
R-squared	0.145	0.174	0.045	0.096

Evidence: Effects of Korean Value-Added Trade on Product Complexity at the High Technology Industries

Dependent Variable: ln(Product Complexity)				
Specifications	(1)	(2)	(3)	(4)
	IV	IV	IV	Direct OLS
ln(Value-added exports)	7.469** (3.675)			
Re-Exported intermediates		0.0497*** (0.00450)		
Foreign value added exports			-0.159*** (0.0361)	
ln(Capital intensity)	0.0107 (0.0263)	0.00706* (0.00382)	-0.0153 (0.0101)	-0.00272 (0.00376)
ln(R&D intensity)	-0.0719 (0.221)	0.133*** (0.0276)	-0.0932 (0.109)	0.204*** (0.0196)
Firm heterogeneity	-11.07** (5.332)	0.0941 (0.0701)	4.826*** (1.134)	-0.310*** (0.0757)
Year FE	YES	YES	YES	YES
First Stage:	ln(Value-added exports)	Re-Exported intermediates	Foreign value added exports	
Sector-specific tariffs	-0.0114*** (0.0077)	-1.7146*** (0.1215)	-0.5365*** (0.1114)	-0.0853*** (0.00700)
Constant	10.33*** (0.086)	60.04*** (1.362)	52.90*** (1.249)	0.763*** (0.0856)
Observations	7,689	7,689	7,689	7,689
R-squared		0.253		0.088

Evidence: Effects of Korean Value-Added Trade on Product Complexity at the labor Intensive Industries

Dependent Variable: ln(Product Complexity)				
Specifications	(1) IV	(2) IV	(3) IV	(4) Direct OLS
ln(Value-added exports)	0.320*** (0.0235)			
Re-Exported intermediates		0.0199*** (0.00146)		
Foreign value added exports			0.0381*** (0.00286)	
ln(Capital intensity)	-0.0516*** (0.00783)	-0.0423*** (0.00779)	-0.0550*** (0.00811)	-0.0468*** (0.00772)
ln(R&D intensity)	-0.104*** (0.0155)	-0.0750*** (0.0145)	-0.208*** (0.0210)	-0.0424*** (0.0136)
Firm heterogeneity	0.0370* (0.0216)	0.0357* (0.0217)	0.0253 (0.0211)	0.0413* (0.0213)
Year FE	YES	YES	YES	YES
First Stage:	ln(Value-added exports)	Re-Exported intermediates	Foreign value added exports	
Sector-specific tariffs	-0.0699*** (0.0008)	-1.1276*** (0.0092)	-0.5875*** (0.0131)	-0.0224*** (0.00169)
Constant	9.639*** (0.078)	68.38*** (0.8378)	39.03*** (1.202)	1.167*** (0.118)
Observations	4,632	4,632	4,632	4,632
R-squared	0.079	0.081	0.042	0.079

Evidence: Effects of Product Complexity on Firm Productivity

Dependent Variable	ln(Value-added exports)	ln(Product Complexity)	ln(Firm Productivity)
	(1)	(2)	(3)
Specifications	3SLS	3SLS	3SLS
ln(Product Complexity)			0.524*** (0.0698)
ln(Value-added exports)		0.280*** (0.0161)	
Sector-specific tariffs	-0.0716*** (0.000929)		
ln(Capital intensity)	0.0191*** (0.00339)	-0.0311*** (0.00420)	0.119*** (0.00550)
ln(R&D intensity)	0.119*** (0.00569)	0.0954*** (0.00798)	-0.263*** (0.0146)
Firm heterogeneity	0.0571*** (0.0116)	0.0131 (0.0144)	0.0178 (0.0176)
Constant	9.578*** (0.0541)	-1.741*** (0.159)	10.30*** (0.0974)
Year FE	YES	YES	YES
Observations	11,003	11,003	11,003
R-squared	0.497	0.139	0.007

Evidence: Effects of Korean Value-Added Share of GDP on Product Complexity

Dependent Variable: ln(Product Complexity)		
Specifications	(1) IV at the firm level	(2) IV at the industry level
Value-added exports share of GDP	0.331*** (0.0249)	0.420*** (0.113)
ln(Capital intensity)	-0.0312*** (0.00379)	
ln(R&D intensity)	0.0150 (0.0131)	-0.0574 (0.0819)
Firm heterogeneity	-0.0124 (0.0257)	0.0491*** (0.00712)
Year FE	YES	YES
First Stage:	Value-added exports share of GDP	Value-added exports share of GDP
Sector-specific tariffs	-0.065*** (0.0018)	-0.059*** (0.0075)
Constant	2.756*** (0.101)	2.950*** (0.150)
Observations	12,321	480
R-squared	0.124	0.043

Evidence: Effects of Korean Value Added Trade on Product Complexity at the Industry Level

Dependent Variable: ln(Product Complexity)		
VARIABLES	(1) IV	(2) IV
ln(Value-added exports)	0.365*** (0.0974)	
Re-Exported intermediates		0.0232*** (0.00615)
ln(R&D intensity)	0.0554 (0.0542)	0.0582 (0.0511)
Firm heterogeneity	0.0516*** (0.00770)	0.0549*** (0.0103)
Year FE	YES	YES
First Stage:	ln(Value-added exports)	Re-Exported intermediates
Sector-specific tariffs	-0.0673*** (0.0039)	-1.057*** (0.055)
Constant	9.785*** (0.077)	59.34*** (1.101)
Observations	480	480
R-squared	0.131	0.153

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Concluding Remarks

- Empirically investigates the extent to which increasing participation in global value chains affects accumulation of productive knowledge across products in the Korean manufacturing industries
- Participation in the global value chain increases the accumulation of productive knowledge. Consequently, improvement in product complexity increases firm productivity.
 - Both domestic value-added exports and foreign contents exports (global interdependence in the production process) influence product complexity.
 - Product complexity affects firm productivity as firms interconnected in the global value chains.
- The effects of Korean value-added trade on product complexity differ across domestic content and foreign content exports
 - Domestic value-added exports: 1% increase -> increases product complexity by 0.30 %
 - Foreign content exports: 1% increase -> increases product complexity from 0.02 % to 0.03%
- The accumulation of product complexity in Korea associated with greater participation in global value chains affects firm productivity
 - Product complexity: 1% increase -> increases firm productivity by 0.52%

Concluding Remarks

- Empirical evidence shows that Korean firms' increasing participation in GVC through domestic and foreign content exports has positive and significant impact on the increasing firm productivity by accumulation of productive knowledge
- Interdependence between Korean firm productivity and participation in the global production process is recently increasing
 - Korean firms continually expand engagement in the global value chains to improve its global competitiveness in manufacturing sector.
- Trade-induced accumulation of productive knowledge causes firm productivity in manufacturing industries
 - As the share of value-added exports in GDP increases, product complexity increases. Consequently, firm productivity increases.
- Productive knowledge enhancement in the Korean manufacturing industries may help increase invigoration of Korean economic growth
 - Trade liberalization (FTA, elimination of Nontariff barrier, trade facilitation) affects the development of product complexity in exports
 - “Made in the world” associated with both domestic and foreign content exports may bring exports and domestic industries' competitiveness into balance.

Thank You