Product variety and technical change

Richard Frensch[a] and Vitalija Gaucaite-Wittich[b]

[a] Osteuropa-Institut München and Department of Economics, University of Regenburg. Scheinerstr. 11, 81679 München, Germany. Email: frensch@oei-muenchen.de

[b] Economic Commission for Europe, United Nations. Palais des Nations, 1211 Genève 10, Switzerland. Email: Vitalia.Gaucaite@unece.org

What is this paper about?

Measurement of technical change with product variety data

- New theories of growth suggest that the variety of capital goods (**CG**) used in production represents the state of technology
- We embed a technology gap approach (see below) into such a growth model, where **CG variety is technology** and derive a testable hypothesis on how a variety measure should behave to qualify as a measure of technology:
- **Average yearly rate of change of CG variety available for production (i.e., technology) depends negatively on initial variety and positively on human capital (**conditional technology convergence)

Change in variety/technology: a technology gap approach (Nelson and Phelps, 1966)

- Variety/technology frontier A_t expands at constant rate g
- Each country's change in variety/technology
  - is according to a weighted average of A_t and h_t
  - is limited by human capital

$$\frac{\dot{h}_t}{h_t} = \mu e^{\psi u} (h_t / A_t)^{-\gamma}$$

    - u: time spent accumulating skills instead of working
    - ψ: returns to human capital formation
    - μ: efficiency of human capital formation, i.e. institutional influences

  - Log-linearisation of this equation around the steady-state yields our conditional technology convergence

Trade-based measurement of variety

- Data for 46 OECD and transition countries' trade with ROW and 55 partner countries between 1992 and 2004
- Classification: SITC Rev. 3, 5-digit level, covering 3,114 *items*
- Classification by Broad Economic Categories (BEC) allows grouping items into three basic SNA categories: 471 *capital good items*, 1,899 *intermediate good items* and 704 *consumer good items*
- Let product differentiation also reflect country of origin. Then, *available product variety*: the number of imported items times the number of their countries of origin plus the number of exported items
  - Maximum count of available product variety of all items is 174,384

Variables for testing the conditional technological convergence hypothesis

- We test our hypothesis with two potential technology measures:
  - Variety of available capital goods relative to variety of available consumer goods, i.e. $CGV_{jt} = VarCap_{jt} / VarCon_{jt}$, and
  - Variety of available intermediate goods relative to variety of available consumer goods, i.e. $IGV_{jt} = VarInt_{jt} / VarCon_{jt}$.
    - each relative to consumer goods variety, to escape interdependence between technology, trade, and income.

- Dependent variables:
  - Average yearly rates of change of CGV_{jt} and IGV_{jt}

- State variables:
  - Initial state: log CGV_{jt} or log IGV_{jt} (-)
  - Steady state (human capital): $u25_{j,tT}$: avg. years of school of population aged 25 and over (+)

More variables for hypothesis testing

- Control variables:
  - *ReformMeasure_Level*$_{j,tT}$ × *Initial state*: *ReformMeasure_Level*$_{j,tT}$ are dummy variables indicating whether a country has within a certain reform field made the step towards a certain level on the EBRD scale within a given period.
  - We define a number of such measures to control for transition efforts in various reform fields and interact with initial variety (-)
  - Also: country size effects on specialisation and specific demand effects

Product Variety Growth Regressions

Dependent variables: Average yearly rates of change of CGV_{jt} and IGV_{jt}

	Capital goods variety	Intermediate goods variety
Explanatory variables:		
Initial variety		
$\log CGV_{jt}$	-0.028^{***}	-0.037^{***}
or $\log IGV_{jt}$	(-3.24)	(-4.09)
Average years of schooling, $u25f_{j,tT}$	0.0012^{**}	0.0003
	(2.07)	(0.49)
Microstate,		
$Micro1 \times \log CGV_{jt}$	0.020^{***}	-0.054^{***}
or $Micro1 \times \log IGV_{jt}$	(3.15)	(-5.19)
Investment-consumption ratio change, $inv\_con_{j,t+T} - inv\_con_{jt}$	0.071^{***}	0.034^{*}
	(4.57)	(1.92)
Banking reform,		
$Bank\_2_{j,tT} \times \log CGV_{jt}$	-0.065^{***}	0.039^{***}
or $Bank\_2_{j,tT} \times \log IGV_{jt}$	(-5.59)	(4.61)
Observations (1993–98, 1999–2004)	64 (25, 39)	64 (25, 39)
Adj. R-squared, (1993–98, 1999–2004)	0.59, 0.58	0.61, 0.46

Notes: 3SLS estimates over two 5-year period equations using lagged initial state variables as instruments. *t*-statistics in parentheses. * (**, ***): significance at 10, (5, 1) per cent. Interval dummies not reported.

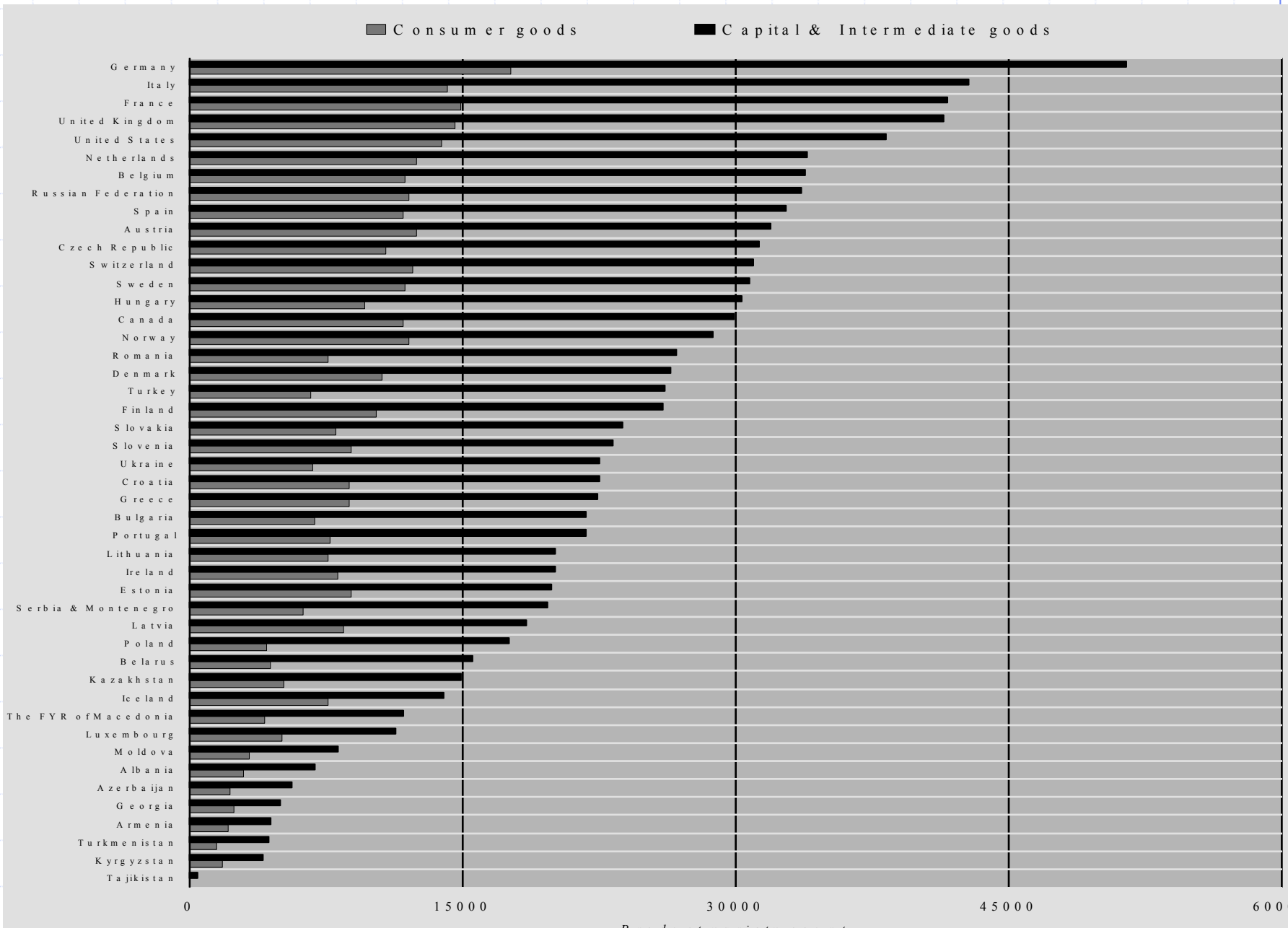
Conclusions: Product Variety Growth

Capital goods variety (CGV) versus intermediate goods variety (IGV)

- Trade-based count measures of available CGV behave ”as if” representing technology; IGV measures do not
- In CGV regressions:
  - conditional technological convergence among OECD and transition countries
  - speed of technological convergence corresponds to that of per capita income
  - (Only) Banking reforms exert a significant – and positive – effect on speed of technological convergence

Additional slides

Available product variety by Broad Economic Categories, 2001



Variety, trade and technology

- Interdependence between technology, trade, and income calls for simultaneous equations approach
- Short-cut: consumption goods variety is a pure trade measure, does not influence income via a technology channel
- Define two potentially technology-relevant variety measures as
  - the product variety of capital goods relative to the product variety of consumer goods, i.e. $CGV_{jt} = VarCap_{jt} / VarCon_{jt}$, and
  - the product variety of intermediate goods relative to the product variety of consumer goods,i.e. $IGV_{jt} = VarInt_{jt} / VarCon_{jt}$.
- Both measures do not depend on trade – and thus on income – unless there are asymmetrical effects on capital, intermediate, and consumption variety via trade, for which we have to control.

Estimating conditional technological convergence with panel data

- After data cleaning, we have observations for up to 39 countries between 1992 and 2004
- We follow Barro and Sala-i-Martin (2004, ch. 12, per capita income convergence testing):
  - Form two 5-year period equations and estimate as a system with 3SLS
  - Measurement bias from initial states dealt with by using lagged initial state variables as instruments
  - Less prone to measurement bias than other panel estimators, and appropriate when there is both heteroskedasticity and contemporaneous correlation across periods

Sensitivity of Product Variety Growth Results (1)

- Results are robust to sample composition
- Results are robust to measurement of schooling
  - *u*25, *u*15*f*, and *u*15
- Results are robust to the use of additional regressors
  - *population density,* share of *urban population*, mid-period logs of the sum of residents' and non-residents' *patent applications* and the sum of residents' and non-residents' *patent applications per employee*, respectively
- Results are robust alternative microstate definitions
  - *Micro*2 for a labour force of less than 1 million, and *Micro*3 for a labour force of less than 2 million

Sensitivity of Product Variety Growth Results

Sample composition

- With the full sample: we assume that countries are small (taking the expansion of frontier technology as given)
- "Small country" sample: excludes countries where this assumption seems in doubt due to their prominence in innovation activity (six G-7 countries in our sample), thus reducing potential country heterogeneity bias
- Results are robust to sample composition.

Sensitivity of Product Variety Growth Results (2)

- Alternative policy reforms in transition
  - Only banking reform and interest rate liberalisation up to EBRD level 2 exert a significant on speed of technological convergence in CGV regressions.
  - No significant effect from large scale privatisation, first stage reforms (i.e., liberalisation of prices and foreign trade plus small and large scale privatisation), or governance and enterprise restructuring.

Sensitivity of Product Variety Growth Results

Policy reform in transition

- 6 dummy variables from EBRD measures, $ReformMeasure\_level_{jt}$: whether a country has made the step towards some level in the EBRD scale within given period; interact with speed of convergence
- Godoy and Stiglitz (2006): no significant endogeneity problem in per capita growth and policy reforms context. Reforms exogenous
- Aghion et al. (2005) imply banking reform could have a positive impact on technical change over and above that on trade
- Results: only banking reforms exert a significant and positive effect on speed of technological convergence in CGV regressions; slightly increase the point estimate of estimated speed of convergence, leaving point estimate of schooling variable unchanged (at higher significance)
- I.e., results are robust to the introduction of policy reforms in transition with overall fit of estimations improved with banking reform