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Quality and variety of exports from the new EU member states: evidence from very disaggregated data

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Introduction
Extensive and quality margins

- The volume and price are not the only important characteristics of international trade:
  - Monopolistic competition models as in Krugman (1979) stress the extensive margin
  - Vertical differentiation models like in Flam and Helpman (1987) feature a quality margin

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Introduction
Goal of the paper

- The goal of this paper is to evaluate variety and quality of exports from NMSs in 1999-2009:
  - Highlight the effect of EU membership on extensive margin of NMS exports
  - Allows extracting quality part from the export price dynamics and leads to better understanding of price competitiveness

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Introduction
Definition of quality

- The quality is defined to be any tangible or intangible attribute of a good that increases all consumers' valuation of it
- Therefore product quality encompasses both:
  - physical attributes (e.g., durability)
  - intangible attributes (e.g., product image due to advertising)
- Usually observed export prices (unit values) are used as proxies
- This measure is unsatisfactory, as export prices may vary for reasons other than quality:
  - different production costs
  - different composition of goods

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Introduction
Definition of variety

- The definition of variety may be different in different theoretical and empirical papers.
- Variety is commonly defined as a brand produced by a firm, the total output of a firm, the output of a country, or the output within an industry within a country
- In our research we define variety as a brand produced by a firm
  - Closer to those in Krugman (1979)

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Introduction
Bibliography

- The methodology is mainly based on three papers:
  - Feenstra (1994) “New Product Varieties and the Measurement of International Prices”, AER, vol.84, No.1, pp.157-177
  - Hummels and Klenow (2005) “The Variety and Quality of a Nation’s Exports”, AER, vol.95, No.3, pp.704-723
  - Broda and Weinstein (2006) “Globalization and the Gains from Variety”, QJE, vol.121, No.2, pp.541-585

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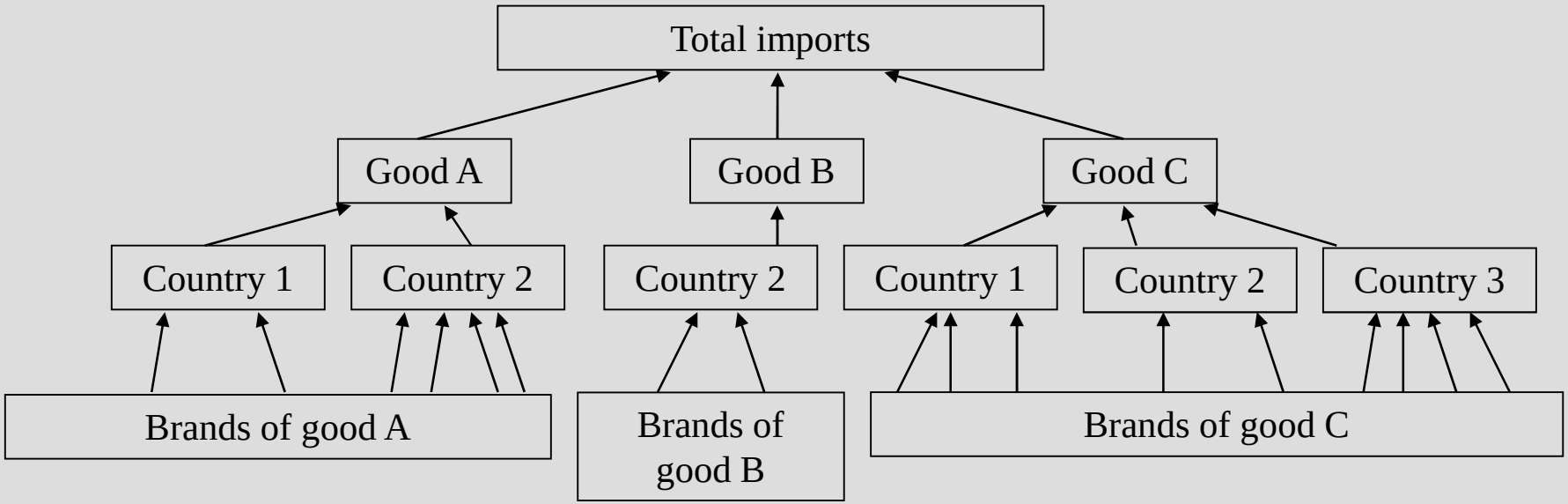
Theoretical model
Goods and brands

- Consumers buy *I* observable goods from up to *J* countries
- Goods are further differentiated into brands
  - For example, beer and red wine are different categories of goods, beer is further differentiated into brands (Leffe, Stella Artois, Guiness etc.), which could come from different countries.



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Theoretical model
Consumers' utility function

- The utility function of a representative agent can be denoted by a two-level utility function.
- Consumers utility given by CES function:

$$U = \left(\sum_{i=1}^{I} M_i^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}}, \quad \gamma > 1$$

  - M_i is the sub-utility derived from the consumption of good i
  - γ denotes the elasticity of substitution among goods
  - I number of differentiated goods

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Theoretical model
Consumers' sub-utility function

- Each sub-utility depends not only on total quantity and elasticity of substitution, but also on quality and variety:

$$M_i = \left(\sum_{j=1}^{J} Q_{ji} N_{ji} x_{ji}^{\frac{\sigma_i - 1}{\sigma_i}} \right)^{\frac{\sigma_i}{\sigma_i - 1}}, \quad \sigma_i > 1$$

  - Q_{ji} is the average quality of a good i from country j
  - x_{ji} is the average quantity of a single brand of a good i from country j
  - N_{ji} is variety (the number of different brands) of good i from country j
  - σ_i denotes the elasticity of substitution among varieties of good i
  - J is the total number of countries

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Theoretical model
Utility maximization problem

- Consumers maximize utility:

$$U = \left(\sum_{i=1}^{I} M_i^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}} \xrightarrow{x_{ji}} \max$$

$$M_i = \left(\sum_{j=1}^{J} Q_{ji} N_{ji} x_{ji}^{\frac{\sigma_i - 1}{\sigma_i}} \right)^{\frac{\sigma_i}{\sigma_i - 1}}$$

- Subject to budget constraint:

$$\sum_{i=1}^{I} \sum_{j=1}^{J} N_{ji} p_{ji} x_{ji} \leq Y$$

  - p_{ji} is the price of each of the units
  - Y is consumers' income

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Theoretical model
Equation for relative quality

- First order conditions:

$$U^{\frac{1}{\gamma}} M_i^{\frac{1}{\sigma_i}-\frac{1}{\gamma}} Q_{ji} x_{ji}^{-\frac{1}{\sigma_i}} = \lambda N_{ji} p_{ji}$$

- Taking logs and using ratios for the same good from different countries (j and k) we obtain:

$$\ln\left(\frac{Q_{ji}}{Q_{ki}}\right) = \ln\left(\frac{p_{ji}}{p_{ki}}\right) + \frac{1}{\sigma_i}\ln\left(\frac{x_{ji}}{x_{ki}}\right)$$

- Relative quality is indicated by relative price level and relative quantity of one brand. Elasticity of substitution is important

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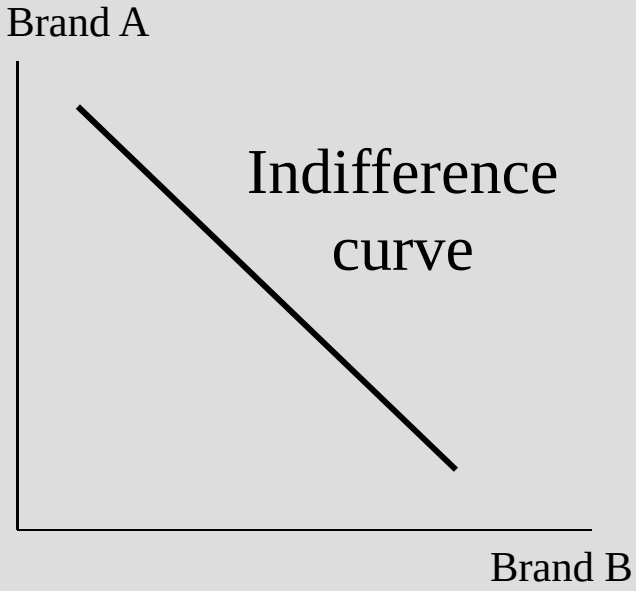
Theoretical model
Perfect competition case

- If σ_i is very high, different brands are perfect substitutes
- This is situation of a perfect competition
- Relative quality is equal to relative price level

$$\ln\left(\frac{Q_{ji}}{Q_{jk}}\right) = \ln\left(\frac{p_{ji}}{p_{jk}}\right)$$



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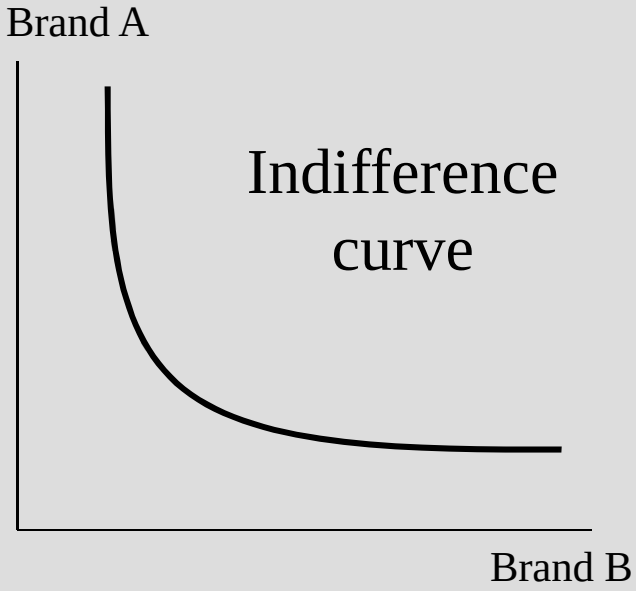
Theoretical model
Monopolistic competition

- If σ_i is close to 1, different brands are not perfect substitutes, producers have market power
- This is situation of a monopolistic competition
- Relative quality is also positively linked to relative quantities



$$\ln\left(\frac{Q_{ji}}{Q_{ki}}\right) = \ln\left(\frac{p_{ji}}{p_{ki}}\right) + \frac{1}{\sigma_i}\ln\left(\frac{x_{ji}}{x_{ki}}\right)$$

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Theoretical model
Modified equation for relative quality

- Relative quality could be also described by the following equation:

Observable from unit values (euro per kg)

Observable from trade volumes (kg)

$$\ln\left(\frac{Q_{ji}}{Q_{ki}}\right) = \ln\left(\frac{p_{ji}}{p_{ki}}\right) + \frac{1}{\sigma_i}\ln\left(\frac{N_{ji}x_{ji}}{N_{ki}x_{ki}}\right) - \frac{1}{\sigma_i}\ln\left(\frac{N_{ji}}{N_{ki}}\right)$$

Unobservable

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Database
Very detailed EU 27 imports data

- Data on NMSs exports comes from EU27 import side – good proxy, as EU is the main partner of NMSs
- Very disaggregated data on external trade – HS 8-digit classification
  - We need high level of disaggregation to interpret unit value indices as prices
  - To account for structural changes, all observations with outlying unit value indices were excluded from the database
- EU27 import data
  - Annual data from 1999 until 2009
  - 14520 goods
  - From 50 countries:
    - European Union (all 27 countries)
    - CIS countries (Russia, Ukraine, Belarus, Kazakhstan)
    - Other important countries (US, Japan, Canada, China, India, Brazil, etc.)

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Proxy for variety
Poisson distribution

- No data available for variety (number of brands). However, the number of 8-digit products in a 2-digit sector for which country has strictly positive export, is observed
- It can serve as an indicator of export variety in this sector *per se*
- This usual measure underestimates variety, as it implicitly assumes that umber of trademarks exported is either one or zero

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Proxy for variety
Poisson distribution

- The number of exporting firms is large, while the probability that a firm is exporting a particular product is small
- We assume that number of brands of 8-digit products in each 2-digit sector follows the Poisson distribution:

$$f(n_s) = \frac{\mu_s^{n_s} e^{-\mu_s}}{n_s!}$$

  - n_s is the number of brands of 8-digit products in 2-digit sector s
  - μ_s is a positive real number, equal to the expected number of brands of 8-digit product in 2-digit sector s

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Proxy for variety
Poisson distribution

- We observe *f(0)*, which is the share of 8-digit products in which country has no exports in a 2-digit sector
- From this, it could be derived that:

$$\mu_s = -\ln(f(0))$$

  - μ_s is a proxy for the average number of brands of 8-digit products in 2-digit sector *s*
- To use Poisson distribution we need to assume that events (exporting of a particular product) occur independently:
  - of course, the latter assumption is not plausible, as technology and information spillovers should ensure a positive correlation between events
  - However, for the moment we don't have better alternative

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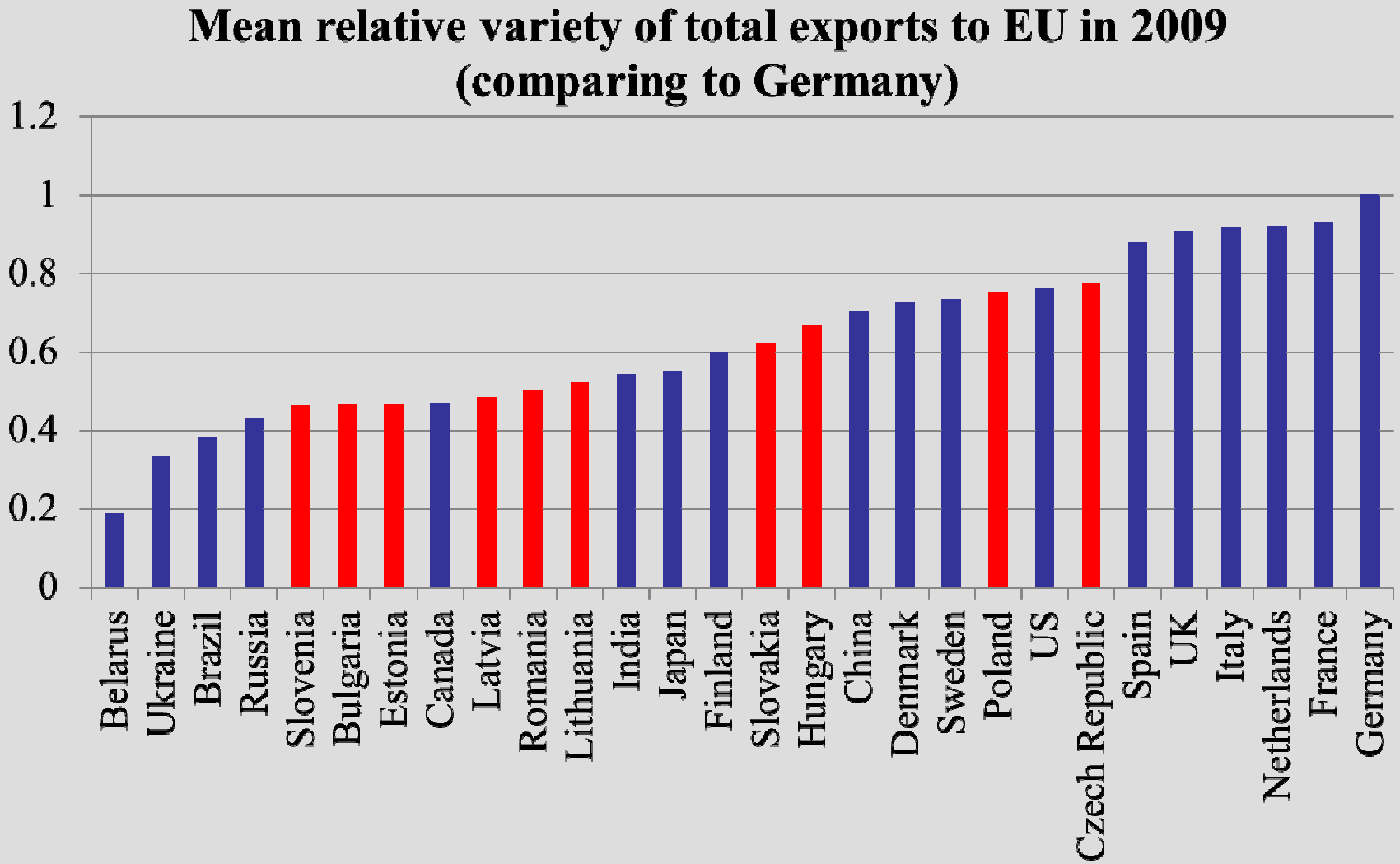
Proxy for variety
Estimated relative varieties



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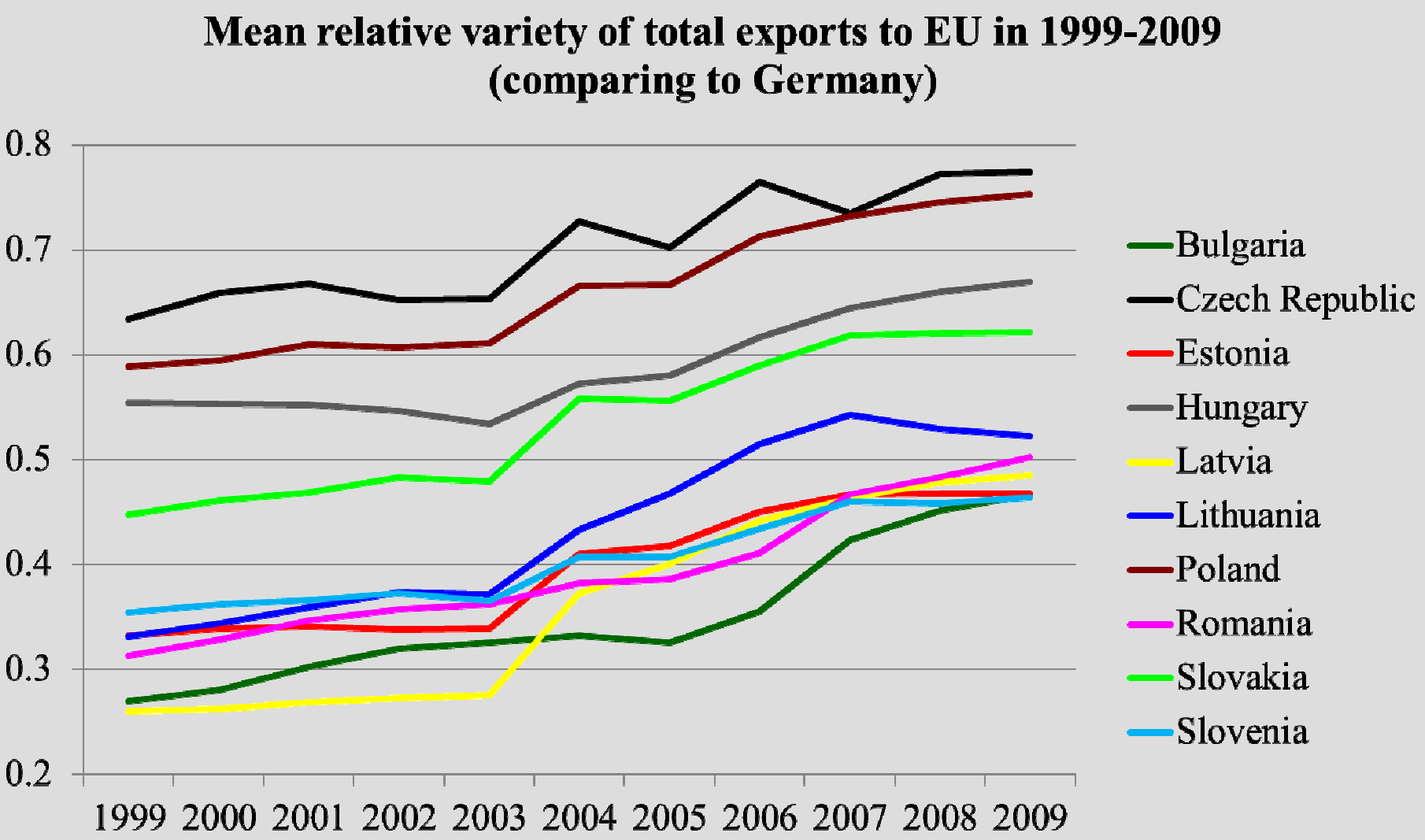
Proxy for variety
Dynamics of estimated relative varieties



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Elasticity of substitution
Demand function

- Following Feenstra (1994), we can define demand function for good *i* from utility maximization problem:

$$\ln s_{ji,t} = (\sigma_i - 1)\ln P_t - (\sigma_i - 1)\ln p_{ji,t} + \ln N_{ji,t} + \sigma_i \ln Q_{ji,t}$$

$$s_{ji,t} = \frac{x_{ji,t} p_{ji,t} N_{ji,t}}{\sum_{j=1}^{J} x_{ji,t} p_{ji,t} N_{ji,t}}$$

  - s_{ji} is share of country *j* in total imports of good *i*.
  - P is minimum cost of obtaining one unit of good *i*.
- Assume, that $\ln Q_{ji,t}$ is random walk process

$$\ln Q_{ji,t} = \ln Q_{ji,t-1} + e_{ji,t}$$

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Elasticity of substitution
Demand function

- By taking first differences:

$$\Delta \ln s_{ji,t} - \Delta \ln N_{ji,t} = \phi_{i,t} - (\sigma_i - 1)\Delta \ln p_{ji,t} + \varepsilon_{ji,t}$$

$$\phi_{i,t} = (\sigma_i - 1)\Delta \ln P_t$$

$$\varepsilon_{ji,t} = \sigma_i e_{ji,t}$$

- Market share of one brand negatively linked to price level
- $\varepsilon_{ji,t}$ appears as an error term

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Elasticity of substitution
Supply function

- Supply curve is specified in following way:

$$\Delta \ln p_{ji,t} = \omega_i \Delta \ln x_{ji,t} + \xi_{ji,t}$$

$$\omega_i \geq 0$$

  - ω_i is the inverse supply elasticity
- Quantity is positively linked to price level
- $\xi_{ji,t}$ is a random error that is assumed to be independent on $\varepsilon_{ji,t}$

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Elasticity of substitution
System of two equations

- Rearranging demand and supply curves and using ratios, we obtain system of two equations:

$$\left(\Delta \ln\left(\frac{s_{ji,t}}{s_{ki,t}}\right) - \Delta \ln\left(\frac{N_{ji,t}}{N_{ki,t}}\right)\right) + (\sigma_i - 1)\Delta \ln\left(\frac{p_{ji,t}}{p_{ki,t}}\right) = \tilde{\varepsilon}_{ji,t}$$

$$(1-\rho_i)\Delta \ln\left(\frac{p_{ji,t}}{p_{ki,t}}\right) - \frac{\rho_i}{\sigma_i - 1}\left(\Delta \ln\left(\frac{s_{ji,t}}{s_{ki,t}}\right) - \Delta \ln\left(\frac{N_{ji,t}}{N_{ki,t}}\right)\right) = \tilde{\delta}_{ji,t}$$

$$\tilde{\varepsilon}_{ji,t} = \varepsilon_{ji,t} - \varepsilon_{ki,t}$$

$$\tilde{\delta}_{ji,t} = \delta_{ji,t} - \delta_{ki,t}$$

$$\delta_{ji,t} = \frac{\xi_{ji,t}}{1+\omega_i\sigma_i}$$

$$0 \le \rho_i = \frac{\omega_i(\sigma_i - 1)}{1+\omega_i\sigma_i} < 1$$

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Elasticity of substitution
Transformation of the system

- In order to take advantage of the independence of $\tilde{\varepsilon}_{ji,t}$ an $\tilde{\delta}_{ji,t}$, these two equations are multiplied together to obtain:

$$Y_{ji,t} = \theta_{1,i} X_{ji,t} + \theta_{2,i} Z_{ji,t} + u_{ji,t}$$

$$Y_{ji,t} = \left(\Delta \ln \left(\frac{p_{ji,t}}{p_{ki,t}} \right) \right)^2, \qquad X_{ji,t} = \left(\Delta \ln \left(\frac{s_{ji,t}}{s_{ki,t}} \right) - \Delta \ln \left(\frac{N_{ji,t}}{N_{ki,t}} \right) \right)^2,$$

$$u_{ji,t} = \frac{\tilde{\varepsilon}_{ji,t} \tilde{\delta}_{ji,t}}{(1-\rho_i)(\sigma_i - 1)}, \quad Z_{ji,t} = \left(\Delta \ln \left(\frac{s_{ji,t}}{s_{ki,t}} \right) - \Delta \ln \left(\frac{N_{ji,t}}{N_{ki,t}} \right) \right) \left(\Delta \ln \left(\frac{p_{ji,t}}{p_{ki,t}} \right) \right),$$

$$\theta_{1,i} = \frac{\rho_i}{(\sigma_i - 1)^2 (1-\rho_i)}, \quad \theta_{2,i} = \frac{2\rho_i - 1}{(\sigma_i - 1)(1-\rho_i)}$$

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Elasticity of substitution
Ignoring variation over time

- Since the prices and shares are correlated with $\delta_{ji,t}$ and $\varepsilon_{ji,t}$, then $u_{ji,t}$ is correlated with $X_{ji,t}$ and $Z_{ji,t}$. A consistent estimator can be obtained by averaging over all t:

$$\overline{Y}_{ji} = \theta_{1,i}\overline{X}_{ji} + \theta_{2,i}\overline{Z}_{ji} + \overline{u}_{ji}$$

$$E\left(\overline{X}_{ji}\overline{u}_{ji}\right) = 0, \quad E\left(\overline{Z}_{ji}\overline{u}_{ji}\right) = 0$$

- This equation is estimated for every good i

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Elasticity of substitution
Equations for elasticities

- As long as $\hat{\theta}_{1,i} > 0$, the estimates of ρ_i and σ_i are as follows:
  - If $\hat{\theta}_{2,i} \geq 0$

$$\hat{\rho}_i = \frac{1}{2} + \left(\frac{1}{4} - \frac{1}{4 + \left(\hat{\theta}_{2,i}^2 / \hat{\theta}_{1,i} \right)} \right)^{\frac{1}{2}}$$

  - If $\hat{\theta}_{2,i} < 0$

$$\hat{\rho}_i = \frac{1}{2} - \left(\frac{1}{4} - \frac{1}{4 + \left(\hat{\theta}_{2,i}^2 / \hat{\theta}_{1,i} \right)} \right)^{\frac{1}{2}}$$

$$\hat{\sigma}_i = 1 + \left(\frac{2\hat{\rho}_i - 1}{1 - \hat{\rho}_i} \right) \frac{1}{\hat{\theta}_{2,i}}$$

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Elasticity of substitution
Estimation

- Estimation was made for each of 7428 goods *i*, using 2-step GMM
- It is required that $\hat{\theta}_{1,i} > 0$, otherwise σ_i is imaginary number
- If $\hat{\theta}_{1,i} \leq 0$, then we make a grid search that finds the minimum sum of weighted least squares of residuals over the different values of σ_i and ρ_i
- Elasticities are calculated only for those goods, where there are at least 15 countries exporting to EU27

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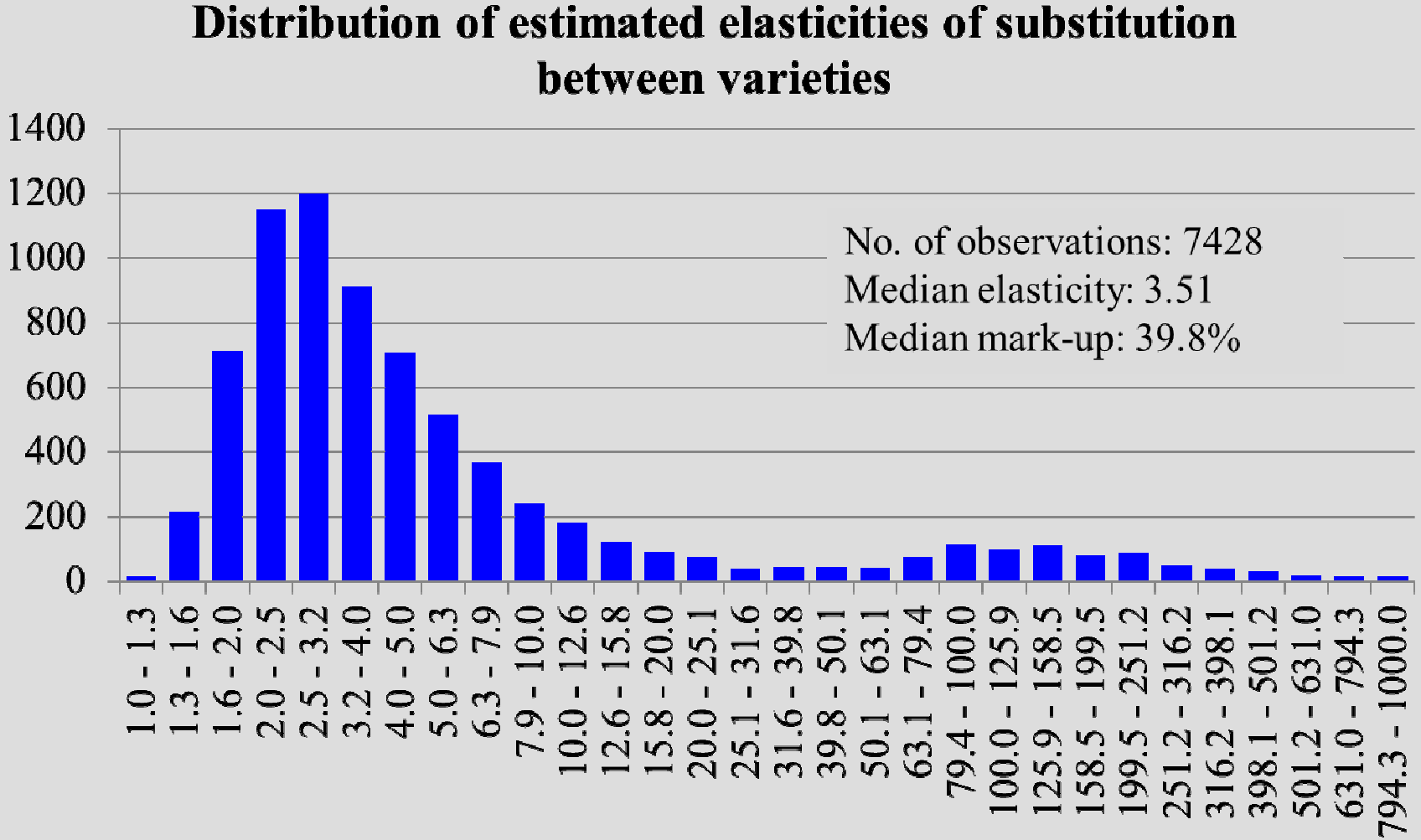
Elasticity of substitution
Results



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Aggregation
Relative quality

- For aggregation of relative quality in a particular time period we use the Sato-Vartia index:

$$\ln Q_{jk,t} = \sum_{i \in I_{jk}} W_{i,t} \ln \frac{Q_{ij,t}}{Q_{ik,t}}$$

$$S_{ij,t} = \frac{N_{ij,t} p_{ij,t} x_{ij,t}}{\sum_{i \in I_{jk}} N_{ij,t} p_{ij,t} x_{ij,t}}$$

$$W_{i,t} = \frac{\left(\frac{S_{ij,t} - S_{ik,t}}{\ln S_{ij,t} - \ln S_{ik,t}} \right)}{\sum_{i \in I_{jk}} \left(\frac{S_{ij,t} - S_{ik,t}}{\ln S_{ij,t} - \ln S_{ik,t}} \right)}$$

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Aggregation
Changes in relative quality

- For aggregation of changes in relative quality we use different Sato-Vartia index:

$$\ln q_{jk,t} = \sum_{i \in I_{jk}} w_{ij,t} \Delta \ln \frac{Q_{ij,t}}{Q_{ik,t}}$$

$$w_{ij,t} = \frac{\left(\frac{S_{ij,t} - S_{ij,t-1}}{\ln S_{ij,t} - \ln S_{ij,t-1}} \right)}{\sum_{i \in I} \left(\frac{S_{ij,t} - S_{ij,t-1}}{\ln S_{ij,t} - \ln S_{ij,t-1}} \right)}$$

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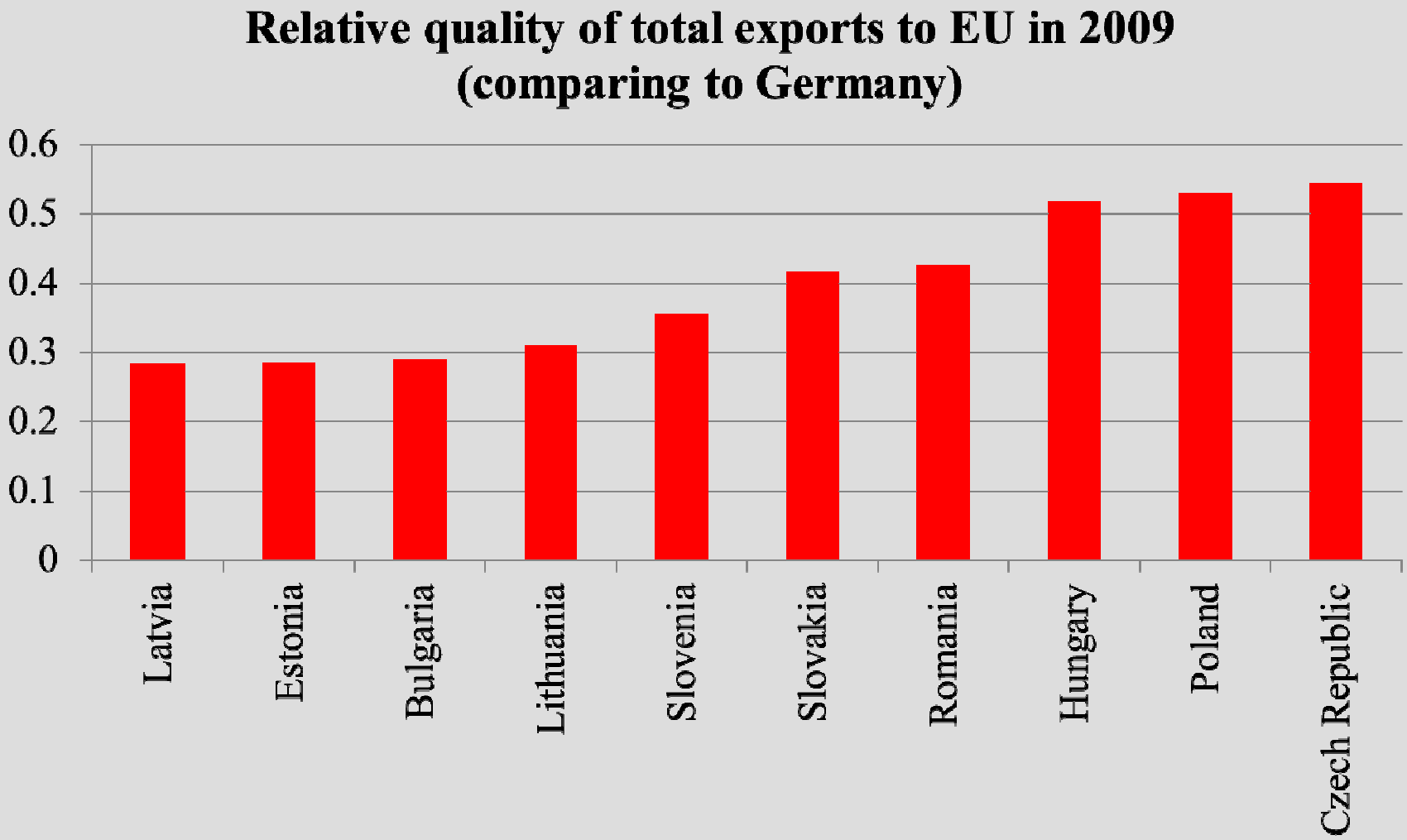
Main results
Relative export quality



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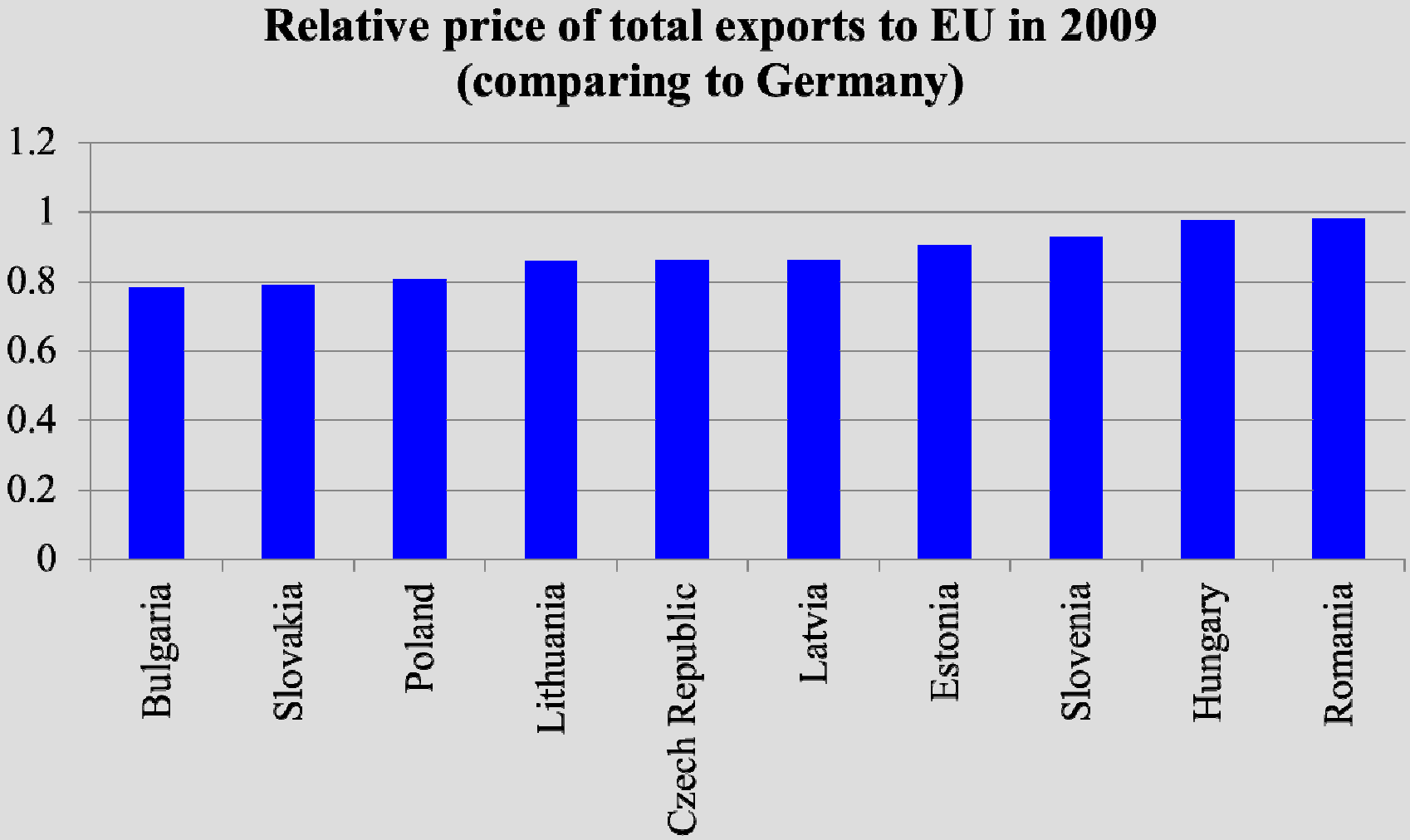
Main results
Relative export price



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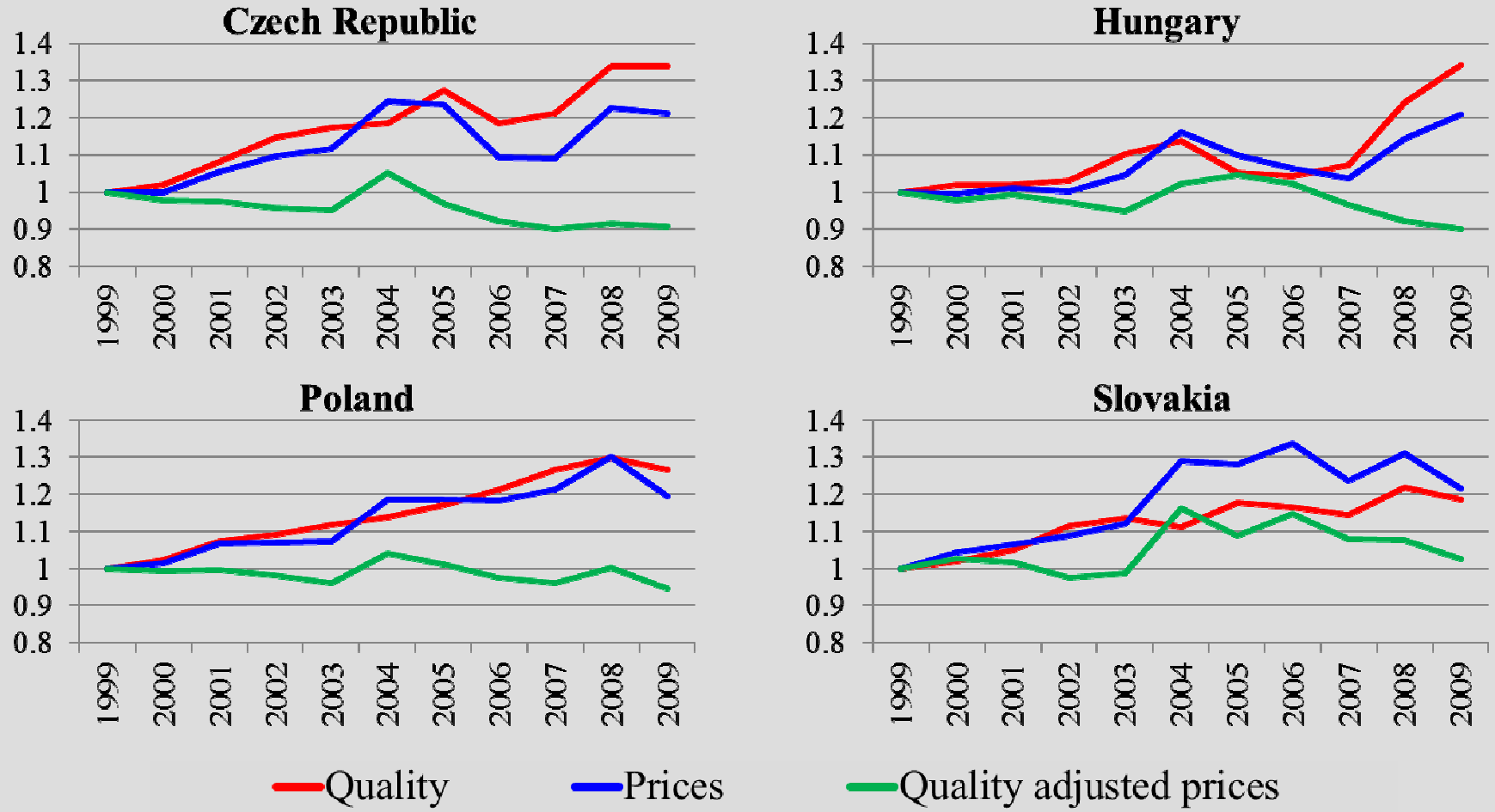
Main results
Price and quality changes in V4 countries

Dynamics of relative quality, price and quality adjusted price, 1999-2009 (comparing to Germany, 1999=1)



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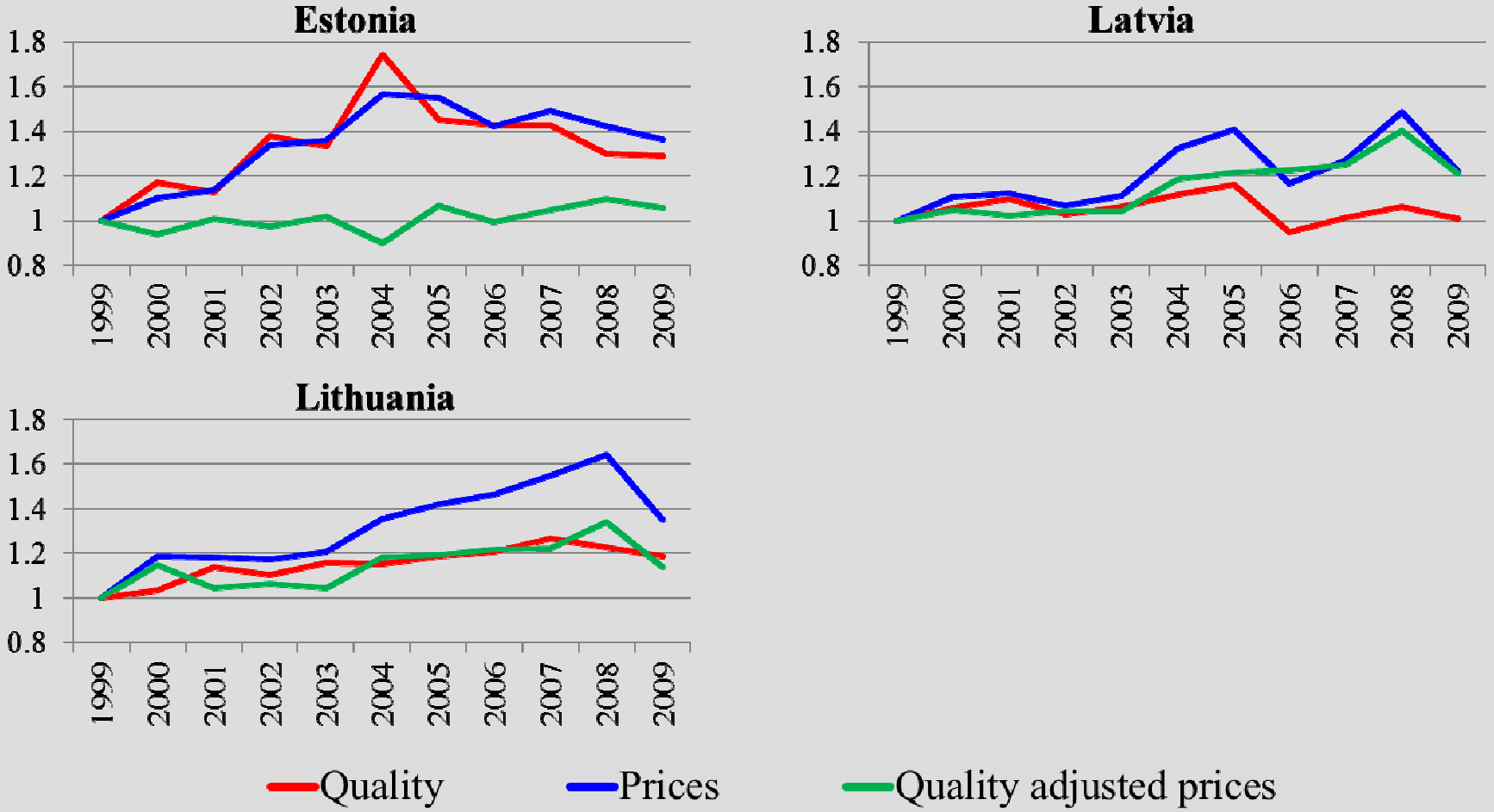
Main results
Price and quality changes in the Baltics

Dynamics of relative quality, price and quality adjusted price, 1999-2009 (comparing to Germany, 1999=1)



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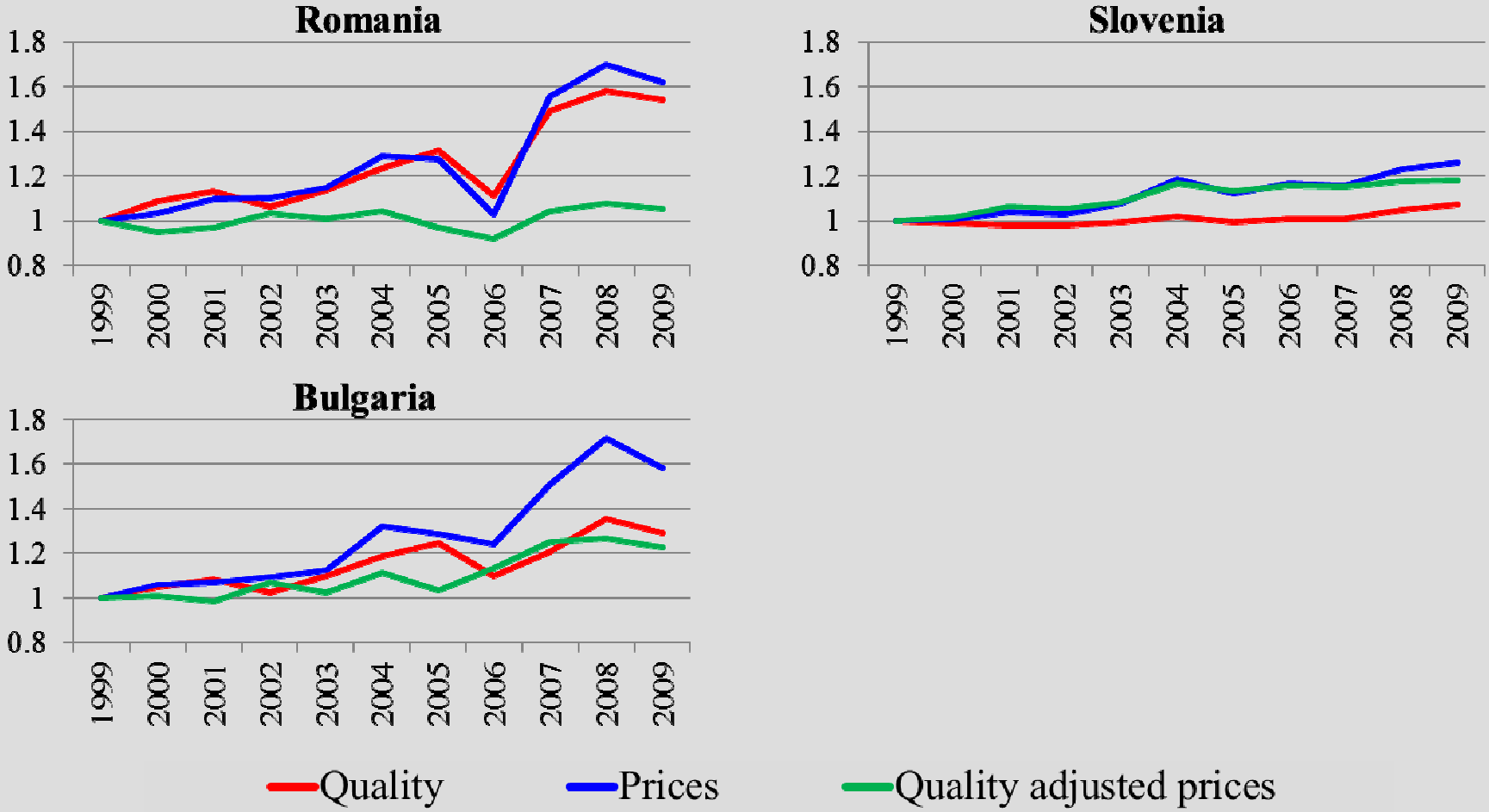
Main results
Price and quality changes in other NMSs

Dynamics of relative quality, price and quality adjusted price, 1999-2009 (comparing to Germany, 1999=1)



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Conclusions
Extensive dimension of integration

- Integration into the EU market went not only in the intensive but also in the extensive dimension:
  - all NMSs increased significantly the average number of brands exported to the EU and the most rapid increase was observed in 2004 and further years

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Conclusions
Relatively low level of quality

- NMS exports compared with German exports were of lower quality in 2009:
  - the Baltic States and Bulgaria appear at the lower end with relative quality of around 30 percent of German quality
  - the highest quality was observed in Hungary, Poland and the Czech Republic (around 55 percent of German quality)

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Conclusions
Quality was increasing

- All NMSs increased average quality of exports during the 10-year period:
  - the highest cumulative increase in quality in Romania, Hungary and the Czech Republic
  - the lowest increase in Latvia and Slovenia
- Increase in prices adjusted by quality was significantly smaller than increase in prices:
  - large part of export price increase in NMSs was the result of improving quality and did not lead to loss of competitiveness