

Elasticity Optimism

Jean Imbs

Paris School of Economics & CEPR

Isabelle Méjean

Ecole Polytechnique & CEPR

March 2011

- Essential for (at least) two reasons.
- First, directly related to the substitutability between domestic and foreign goods. Which is central to most calibrated models in international economics. A key calibration parameter.
- Second, a useful gauge of a country's trade performance. In this case, it is just a reduced form coefficient - with no immediate calibration consequences.
- Here try to discuss both. Corresponds to two papers: Elasticity Optimism, which is complete. And Trade Elasticities, which is in progress.

Elasticity Pessimism

- The substitutability between domestic and foreign goods is central to most calibrated models in international economics
- Its calibrated value draws from literally decades of empirical work
- Usually, calibration exercises infer its value from aggregate estimates of imports elasticity using:

$$\sigma = 1 - \eta, \quad \eta = \frac{\partial M}{\partial P} \frac{P}{M}$$

with M aggregate imports in value and P a measure of relative aggregate prices (e.g. domestic vs. imported bundles)

- Orcutt (1950), Houtakker-Magee (1969), Goldstein-Kahn (1985), Marquez (1990):

$$-2 \leq \eta \leq 0, \quad \text{i.e. } 1 \leq \sigma \leq 3$$

⇒ Elasticity Pessimism

- In micro data, the approach has been similar, estimating:

$$\sigma_i = 1 - \eta_i, \quad \eta_i = \frac{\partial m_i}{\partial p_i} \frac{p_i}{m_i}$$

with m_i the value of imports in good i and p_i a measure of its relative price.

- Identification often easier in micro studies, because exogenous movements in p_i given by dedicated changes in relative price of i , e.g. tariff changes. Or more generally via structural estimation.
- Bloningen-Wesley (1999), Head-Ries (2001), Romalis (2007):

$$0 \leq \sigma_i \leq 12$$

⇒ Elasticity Heterogeneity

Constrained Elasticity

- Macro estimates imply the constraint that

$$\sigma_i = \sigma_j$$

- Why? Consider simple regression on sectoral data, imposing $\eta_i = \eta$:

$$\Delta \ln M_{it} = \eta \Delta \ln P_{it} + u_{it}$$

- Aggregating across sectors i :

$$\sum_i w_i \Delta \ln M_{it} = \eta \sum_i w_i \Delta \ln P_{it} + \sum_i w_i u_{it}$$

- which is the aggregate estimate - up to residuals' behavior. Simple intuition generalizes to structural estimator we implement.

- Can one get an estimate of the aggregate elasticity of substitution (σ) allowing for heterogeneity in the sectoral elasticities (σ_i)?
- Orcutt (1950): “in aggregate trade equations, goods with relatively low price elasticities can display the largest variation in prices and therefore exert a dominant effect on the estimated aggregate price elasticity, thereby biasing the estimate downwards.”
- The response of aggregate quantities to aggregate prices can be a biased estimate of the aggregate elasticity of substitution. Presumably an estimate of the parameter that accounts for the well-documented cross-sector heterogeneity is more consistent with the data. Matters for calibration purposes.

⇒ Elasticity Optimism

What We Do

- Simple nested CES framework accounting for the heterogeneity in substitutability across goods. Ask from it how to properly aggregate microeconomic estimates.
- Estimate the disaggregated elasticities. Use the structural method proposed by Feenstra (1994) that identifies elasticities of *substitution* using the cross-country variation in trade flows towards the USA. Tackles endogeneity issues - at disaggregated level, and in aggregated version.
- Get sector specific elasticities vs. get **one**, constrained to be the same across sectors. That will be the macro elasticity.
- Use the model to aggregate former case adequately. Compare the outcomes when elasticity is constrained to homogeneity and when it is not

What We Get

- When all elasticities are forced to be equal across sectors, the estimated aggregate price elasticity of imports is around -1.9, *i.e.* within the ballpark of values used in the macroeconomic literature
- With heterogeneity, aggregate price elasticity of imports more than double (up to -5). The corresponding aggregate substitutability is around 7.
- Robust to various alternative measures or econometric procedures.

What It Means

- Accommodating the well-known unambiguous fact that some goods are more substitutable than others means calibrated models should use σ rather than 2.
- This matters quantitatively and sometimes qualitatively for calibrated international macro models.
- We discuss the implications of our results in various calibrated models concerned with the rebalancing of external imbalances (Obstfeld & Rogoff, 2005), the international diffusion of shocks (Kose & Yi, 2006, Corsetti, Dedola and Leduc, 2008), the extent of international risk sharing (Cole & Obstfeld, 1991), the composition of international portfolio holdings (Coeurdacier, 2005), international price differences (Atkeson & Burstein, 2008), the optimal conduct of monetary policy (Galí & Monacelli, 2005).
- We finish with an illustration in a 2-sector version of the Backus, Kehoe & Kydland (1994) model.

- Theory
- Empirical estimation
- Results
- Relevance
- Conclusion

$$C = \prod_{k \in K} \frac{C_k^{\alpha_k}}{\alpha_k^{\alpha_k}}$$

k a good, α_k preference parameter.

$$C_k = \left[\sum_{i \in I} (\beta_{ki} C_{ki})^{\frac{\sigma_k - 1}{\sigma_k}} + (\beta_{kd} C_{kd})^{\frac{\sigma_k - 1}{\sigma_k}} \right]^{\frac{\sigma_k}{\sigma_k - 1}}$$

i a foreign variety (an exporting country in the empirics), d the domestic variety.
 σ_k constant elasticity of substitution (different across goods, but identical across varieties). β_{ki} preference parameter.

- At the sectoral level:

$$C_{ki} = \beta_{ki}^{\sigma_k - 1} \left(\frac{P_{ki}}{P_k} \right)^{-\sigma_k} \alpha_k \frac{P}{P_k} C, \quad i \neq d$$

with

$$P_k = \left[\sum_{i \in I} \left(\frac{P_{ki}}{\beta_{ki}} \right)^{1-\sigma_k} + \left(\frac{P_{kd}}{\beta_{kd}} \right)^{1-\sigma_k} \right]^{\frac{1}{1-\sigma_k}}$$
$$P = \prod_{k \in K} P_k^{\alpha_k}$$

Aggregate substitutability

- Define σ as the response of aggregate quantities to changes in aggregate international relative prices, accounting or not for the heterogeneity in σ_k
- Focus on changes in all relative prices (no cross-sector reallocation) and on uniform shocks (no reallocation across exporting economies). It is relative quantities whose responses may be heterogeneous.
- A natural candidate is a domestic shock to relative production costs (“domestic wage” shock appreciating relative prices)

$$\sigma = 1 + \frac{\partial \ln \sum_k \sum_{i \neq d} P_{ki} C_{ki} - \partial \ln P_{kd} C_{kd}}{\partial \ln w_d}$$

Aggregate substitutability

$$\begin{aligned}\sigma - 1 &= \sum_k \sum_{i \neq d} n_{ki} (1 - \sigma_k) \frac{\partial \ln P_{ki}}{\partial \ln w_d} - \sum_k n_{kd} (1 - \sigma_k) \frac{\partial \ln P_{kd}}{\partial \ln w_d} \\ &\quad - \sum_k (n_k - n_{kd}) (1 - \sigma_k) \frac{\partial \ln P_k}{\partial \ln w_d}\end{aligned}$$

with

$$\begin{aligned}n_{ki} &\equiv \frac{P_{ki} C_{ki}}{\sum_{k \in K} \sum_{i \neq d} P_{ki} C_{ki}} \\ n_{kd} &\equiv \frac{P_{kd} C_{kd}}{\sum_{k \in K} P_{kd} C_{kd}} \\ n_k &= \sum_{i \neq d} n_{ki}\end{aligned}$$

No Firm Entry

- In the long-run, each domestic producer responds identically and proportionally to the shock $\frac{\partial \ln P_{kd}}{\partial \ln w_d} = 1$ while foreign producers do not respond at all, $\frac{\partial \ln P_{ki}}{\partial \ln w_d} = 0$.
- The aggregate substitutability is given by:

$$\sigma = \sum_k n_{kd} \sigma_k + \sum_k (n_k - n_{kd}) (\sigma_k - 1) (1 - w_k^M)$$

where $w_k^M = \frac{\sum_{i \neq d} P_{ki} C_{ki}}{P_k C_k}$

No Firm Entry (2)

- The second term captures response of industry-specific price indices to *macroeconomic* shocks. Partial vs. Total Elasticity.
- Partial aggregate elasticity of substitution is a weighted average of industry-specific preference parameters.
- In macroeconomic data, traded quantities are summed up to the country level before estimating substitutability. This implies $\sigma_k = \sigma, \forall k$ and induces a bias if n_{kd} and σ_k happen to be correlated.
- That bias is given by the difference between the unconstrained elasticity (σ) and its constrained version, imposing $\sigma_k = \sigma (\bar{\sigma})$.
- We use our estimates of σ_k and σ , and calibrations of n_k , n_{kd} and w_k^M to assess the magnitude of $\sigma - \bar{\sigma}$. It will be positive for positive correlations between n_{kd} and σ_k .

The Price Elasticity of Imports

- In most of the literature, the elasticity of substitution is inferred from the price elasticity of imports ($\sigma = 1 - \eta$).
- To compare our results with the literature, we also compute the price elasticity of imports:

$$\eta = \frac{\partial \ln [\sum_k \sum_i P_{ki} C_{ki}]}{-\partial \ln w_d}$$

- We get:

$$\eta = 1 - \sigma + \sum_k n_{kd}(\sigma_k - 1)w_k^M - \sum_k \alpha_k (1 - w_k^M)$$

- Second and third terms are responses of price indices. Smaller order of magnitude.
- ⇒ The linear relation between σ and η is only valid in terms of partial elasticities
- ⇒ The possibility that estimates based on macroeconomic data should be biased continue to prevail for the price elasticity of imports

- Estimate σ_k using Feenstra (1994)
- Estimate σ using Feenstra (1994) and imposing homogeneity.
- Compare with the literature in both cases (helps validate Armington assumption)
- Note both estimates are obtained with same data, same methodology, same estimator.

Microeconomic estimates (1)

- Use Feenstra's (1994) methodology: identify the substitutability using the observed cross-section of traded quantities and prices across exporters to one destination
- Crucial assumption of an Armington aggregator between varieties of each good, irrespective of their origin. This is what exonerates from having data on domestic production.
- Identification in the absence of any supply-shifting instruments. Augment the model with a simple supply structure with production decisions taken on the basis of the price net of transport costs, labeled in domestic currency.

Microeconomic estimates (2)

- Model at the root of the estimation:

$$\begin{cases} C_{kit} = \left(\frac{P_{kit}}{P_{kt}} \right)^{1-\sigma_k} \frac{\beta_{kit}^{\sigma_k-1} P_{kt} C_{kt}}{P_{kit}} \\ P_{kit} = \tau_{kit} \exp(\nu_{kit}) C_{kit}^{\omega_k} \end{cases}$$

ν_{kit} a random technology factor, independent from the taste parameter. ω_k the inverse supply elasticity.

- Functional form of supply can be derived from model of supply with firm entry.
- Implicitly assumes that price decisions are in LCP but assuming PCP pricing would be innocuous from an empirical standpoint.

Microeconomic estimates (3)

- Use expenditure shares instead of quantities to alleviate measurement error in unit values (Kemp, 1962):

$$s_{kit} \equiv \frac{P_{kit} C_{kit}}{P_{kt} C_{kt}}$$

- Observe data on traded goods only and measured in FOB. Define the observed counterparts of the theory-implied variables:

$$\tilde{P}_{kit} \equiv \frac{P_{kit}}{\tau_{kit}}, \quad \tilde{s}_{kit} \equiv \frac{\tilde{P}_{kit} C_{kit}}{\sum_j \tilde{P}_{kit} C_{kit}} \equiv \frac{s_{kit}}{\tau_{kit}} \mu_{kt}$$

Microeconomic estimates (4)

- After rearranging, we get:

$$\left\{ \begin{array}{l} \Delta \ln \tilde{s}_{kit} = (1 - \sigma_k) \Delta \ln \tilde{P}_{kit} + \Phi_{kt} + \varepsilon_{kit} \\ \text{with } \Phi_{kt} \equiv (\sigma_k - 1) \Delta \ln P_{kt} + \Delta \ln \mu_{kt} \\ \text{and } \varepsilon_{kit} \equiv (\sigma_k - 1) \Delta \ln \beta_{kit} - \sigma_k \Delta \ln \tau_{kit} \\ \\ \Delta \ln \tilde{P}_{kit} = \Psi_{kt} + \frac{\omega_k}{1 + \omega_k \sigma_k} \varepsilon_{kit} + \delta_{kit} \\ \text{with } \Psi_{kt} \equiv \frac{\omega_k}{1 + \omega_k \sigma_k} \left[\Phi_{kt} + \Delta \ln \sum_i (\tilde{P}_{kit} C_{kit}) \right] \\ \text{and } \delta_{kit} \equiv \frac{1}{1 + \omega_k \sigma_k} \Delta v_{kit} \end{array} \right.$$

- Identification on the cross-section of exporters in relative terms with respect to a reference country r

Microeconomic estimates (5)

- Estimable regression (see Feenstra, 1994):

$$Y_{kit} = \theta_{1k} X_{1kit} + \theta_{2k} X_{2kit} + u_{kit}$$

where $Y_{kit} = (\Delta \ln \tilde{P}_{kit} - \Delta \ln \tilde{P}_{krt})^2$, $X_{1kit} = (\Delta \ln \tilde{s}_{kit} - \Delta \ln \tilde{s}_{krt})^2$,
 $X_{2kit} = (\Delta \ln \tilde{s}_{kit} - \Delta \ln \tilde{s}_{krt})(\Delta \ln \tilde{P}_{kit} - \Delta \ln \tilde{P}_{krt})$ and
 $u_{kit} = \tilde{\varepsilon}_{kit} \tilde{\delta}_{kit} \frac{(\sigma_k - 1)(1 + \omega_k)}{1 + \omega_k \sigma_k}$

- Map directly with the parameters of interest:

$$\theta_{1k} = \frac{\omega_k}{(\sigma_k - 1)(1 + \omega_k)}$$
$$\theta_{2k} = \frac{\omega_k \sigma_k - 2\omega_k - 1}{(\sigma_k - 1)(1 + \omega_k)}$$

Microeconomic estimates (6)

- The correlation between u_{kit} , X_{1kit} and X_{2kit} disappears when taking time averages (Feenstra 1994). Instrument X_{1kit} and X_{2kit} with i -specific dummy variables.
- Identification therefore purely cross-sectional. Focus on long run.
- Standard errors corrected for heteroscedasticity across exporters
- Include a *hs6*-specific intercept that accounts for measurement error arising from using unit values to approximate prices
- Add common correlated effects to control for aggregate shocks (Pesaran, 2006)

⇒ Estimated equation:

$$Y_{kit} = \theta_0 + \theta_{1k} \hat{X}_{1ki} + \theta_{2k} \hat{X}_{2ki} + \theta_{3k} X_{1it} + \theta_{4k} X_{2it} + u_{kit}$$

Microeconomic estimates (7)

- Using the consistent (and sector-specific) estimates of θ_{1k} and θ_{2k} , it is straightforward to infer elasticities:

$$\hat{\sigma}_k = 1 + \frac{\hat{\theta}_{2k} + \Delta_k}{2\hat{\theta}_{1k}} \text{ if } \hat{\theta}_{1k} > 0 \text{ and } \hat{\theta}_{1k} + \hat{\theta}_{2k} < 1$$

$$\hat{\sigma}_k = 1 + \frac{\hat{\theta}_{2k} - \Delta_k}{2\hat{\theta}_{1k}} \text{ if } \hat{\theta}_{1k} < 0 \text{ and } \hat{\theta}_{1k} + \hat{\theta}_{2k} > 1$$

- For combinations of estimates that do not correspond to any theoretically consistent estimates of $\hat{\sigma}_k$, follow Broda and Weinstein (2006) and use a search algorithm that minimizes the sum of squared residuals over the intervals of admissible values. Standard errors obtained via bootstrapping using 1,000 repetitions.

- Estimate of aggregate substitutability allowing for heterogeneity:

$$\sigma = \sum_{k \in K} n_{kd} \hat{\sigma}_k + \sum_{k \in K} (n_k - n_{kd})(1 - w_k^M)(\hat{\sigma}_k - 1)$$

- Constrained estimate of aggregate substitutability imposing homogeneity:

$$\bar{\sigma} = \hat{\sigma} + (\hat{\sigma} - 1) \sum_{k \in K} (n_k - n_{kd})(1 - w_k^M)$$

with $\hat{\sigma}$ estimated using the same method but on a pooled dataset formed by observations on all sectors and imposing coefficient equality across sectors.

- Why should we expect $\bar{\sigma}$ to mimic macroeconomic estimates? Because constraining $\hat{\sigma}_k = \hat{\sigma}$ is in effect mimicking what aggregate data do.

Aggregation

- To see this, consider Feenstra's estimation imposing $\hat{\sigma}_k = \hat{\sigma}$, assuming CCE away for simplicity. Aggregating over sectors:

$$\sum_k w_{ki}^2 Y_{kit} = \theta_1 \sum_k w_{ki}^2 X_{1kit} + \theta_2 \sum_k w_{ki}^2 X_{2kit} + \sum_k w_{ki}^2 u_{kit}$$

where $Y_{kit} = (\Delta \ln \tilde{P}_{kit} - \Delta \ln \tilde{P}_{krt})^2$, $X_{1kit} = (\Delta \ln \tilde{s}_{kit} - \Delta \ln \tilde{s}_{krt})^2$,
 $X_{2kit} = (\Delta \ln \tilde{s}_{kit} - \Delta \ln \tilde{s}_{krt})(\Delta \ln \tilde{P}_{kit} - \Delta \ln \tilde{P}_{krt})$

- After simple but tedious algebra, this can be rearranged:

$$Y_{it} = \theta_1 X_{1it} + \theta_2 X_{2it} + \sum_k w_{ki}^2 u_{kit} + \Lambda_{it}$$

where $Y_{it} = (\sum_k w_{ki} \Delta \ln \tilde{P}_{kit} - \sum_k w_{ki} \Delta \ln \tilde{P}_{krt})^2$,
 $X_{1it} = (\sum_k w_{ki} \Delta \ln \tilde{s}_{kit} - \sum_k w_{ki} \Delta \ln \tilde{s}_{krt})^2$, $X_{2it} = (\sum_k w_{ki} \Delta \ln \tilde{s}_{kit} - \sum_k w_{ki} \Delta \ln \tilde{s}_{krt})(\sum_k w_{ki} \Delta \ln \tilde{P}_{kit} - \sum_k w_{ki} \Delta \ln \tilde{P}_{krt})$.

- Close to the estimator performed on Feenstra, up to the residuals' property, the approximation that $w_{ki} \simeq w_{kr}$, and the properties of Λ_{it}

- What do we know about the properties of Λ_{it} ? By definition:

$$\begin{aligned}\Lambda_{it} = & \sum_k \sum_{k \neq k'} w_{ki} w_{k'i} (\Delta \ln \tilde{P}_{kit} - \Delta \ln \tilde{P}_{krt}) (\Delta \ln \tilde{P}_{k'it} - \Delta \ln \tilde{P}_{k'rt}) \\ & - \theta_1 \sum_k \sum_{k \neq k'} w_{ki} w_{k'i} (\Delta \ln \tilde{s}_{kit} - \Delta \ln \tilde{s}_{krt}) (\Delta \ln \tilde{s}_{k'it} - \Delta \ln \tilde{s}_{k'rt}) \\ & - \theta_2 \sum_k \sum_{k \neq k'} w_{ki} w_{k'i} (\Delta \ln \tilde{P}_{kit} - \Delta \ln \tilde{P}_{krt}) (\Delta \ln \tilde{s}_{k'it} - \Delta \ln \tilde{s}_{k'rt})\end{aligned}$$

- All covariances across sectors. Using supply and demand model, can show these covariances will be non zero if supply shocks v_{kit} and/or demand shocks ε_{kit} are correlated across sectors. CCE precisely designed to purge these covariances.
- Constrained CCE estimation therefore equivalent to aggregate estimation, up to approximation $w_{ki} \simeq w_{kr}$.

Data (1)

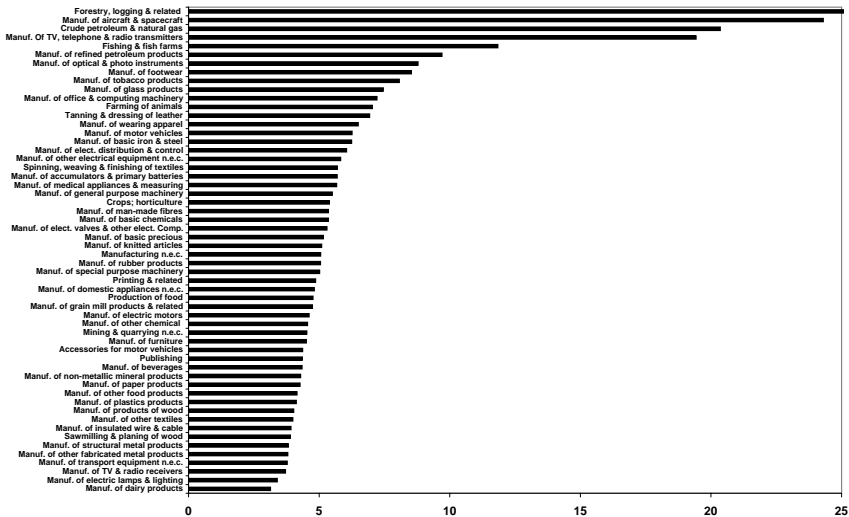
- Use the BACI database that describes bilateral trade at the sectoral level (6-digit level of the harmonized system, 5,000 products)
- Cover the 1996-2004 period
- Products grouped within industries as defined by the 3-digit level of the ISIC (revision 3) nomenclature (i.e. assume all HS6 goods to be equally substitutable within an ISIC industry)
- Sampling to limit the role of extreme outliers: Exclude annual variations in prices and market shares that exceed 5 times the median value of the sector
- Impose a minimum of 20 exporters for each HS6 good
- Data ultimately cover 73% of the total value of US imports

- In the model, n_k and n_{kd} depend directly on w_k^M and α_k :

$$n_k = \frac{\alpha_k w_k^M}{\sum_k \alpha_k w_k^M} \text{ and } n_{kd} = \frac{\alpha_k (1 - w_k^M)}{\sum_k \alpha_k (1 - w_k^M)}$$

- w_k^M computed as the 1997 ratio of imports over domestic gross output. Source: OECD-IO Tables
- α_k computed as the 1997 ratio of sectoral relative to total absorption. Source: OECD-STAN
- Sensitivity analysis: Imports from BACI, Output data from STAN, I/O used to compute n_k , Absorption in terms of value added or gross output

Microeconomic estimates



Comparison with existing studies

- Median value at the low end of the range of substitution elasticity estimates: Romalis (2007) between 6.2 and 10.9, Head & Ries between 7.9 and 11.4, Hanson (2004) between 4.9 and 7.6
- Similar to fundamental contributions to the literature on imports price elasticities, that evaluate import prices relative to their domestic counterpart: Houtakker & Magee (1969) -4.05 in manufactures, Kreinin (1967) -4.71 for manufactures. Higher estimates for manufactures, followed by semi-manufactures and crude foods and materials. The ranking is roughly prevalent in our results.
⇒ Vindicates the Armington assumption.

Macroeconomic estimates (1)

Table: Estimation with common correlated effects

	Import Elasticity η	Substitution Elasticity σ
Constrained total elasticity	-1.980 ^a (0.175)	4.124 ^a (0.300)
Constrained partial elasticity	-2.738 ^a (0.262)	3.738 ^a (0.263)
Unconstrained total elasticity	-4.508 ^a (0.745)	7.226 ^a (0.962)
Unconstrained partial elasticity	-6.553 ^a (1.100)	6.921 ^a (0.697)
Number of sectors	56	56
Number of grid searches	11	11

Note: Standard errors in parentheses (obtained by bootstrapping for grid searched sectors), ^a denotes significance at the 1% level.

Macroeconomic estimates (3)

- When it is constrained to be homogeneous across sectors, the estimated elasticity is -1.98 , i.e. at the high range of (but not significantly different from) values obtained in conventional estimates based on macroeconomic data (e.g. Goldstein & Kahn (1985) between -1.03 and -1.76). Consistent with the choices made in the vast majority of calibration exercises (Obstfeld & Rogoff, 2005, Backus *et al.*, 1992)
 - When the elasticity is left unconstrained across sectors, the aggregate price elasticity of imports is -4.5 and the aggregate substitutability jumps to more than 7.
- ⇒ Orcutt (1950): “in aggregate trade equations, goods with relatively low price elasticities can display the largest variation in prices and therefore exert a dominant effect on the estimated aggregate price elasticity, thereby biasing the estimate downwards.”
- ⇒ From a calibration standpoint, a value around 7 better reflects the preferences of a representative agent that perceives the substitutability to be heterogeneous across sectors.

Table: Variants on the weights

	Import elasticity		Substitution Elasticity	
	Unconst.	Constrained	Unconst.	Constrained
Benchmark	-4.51	-1.98	7.22	4.12
Variant 1	-5.17	-2.21	6.93	4.05
Variant 2	-4.38	-2.08	7.36	4.02
Variant 3	-4.60	-2.15	6.77	4.06
Variant 4	-4.41	-2.10	7.27	4.12

Note: Benchmark: w_k^M using imports and output from IO tables, α_k using STAN sectoral interior demand.
 Variant 1: w_k^M using imports from BACI and output from STAN, α_k using STAN sectoral interior demand.
 Variant 2: n_k and w_k^M using imports and output from IO tables, α_k using STAN sectoral interior demand.
 Variant 3: n_k and w_k^M using imports from BACI and output from STAN, α_k using STAN sectoral interior demand.
 Variant 4: w_k^M using imports and output from IO tables, α_k using STAN sectoral interior demand (absorption in terms of value added).

Table: Estimation without common correlated effects

	Import Elasticity η	Substitution Elasticity σ
Constrained total elasticity	-2.166 ^a (0.150)	4.442 ^a (0.257)
Constrained partial elasticity	-3.016 ^a (0.225.)	4.016 ^a (0.225)
Unconstrained total elasticity	-4.075 ^a (0.112)	6.584 ^a (0.145)
Unconstrained partial elasticity	-5.946 ^a (0.209)	6.321 ^a (0.138)
Number of sectors	56	56
Number of grid searches	12	12

Note: Standard errors in parentheses (obtained by bootstrapping for grid searched sectors), ^a denotes significance at the 1% level.

Table: Estimation at the HS6 level (no CCE)

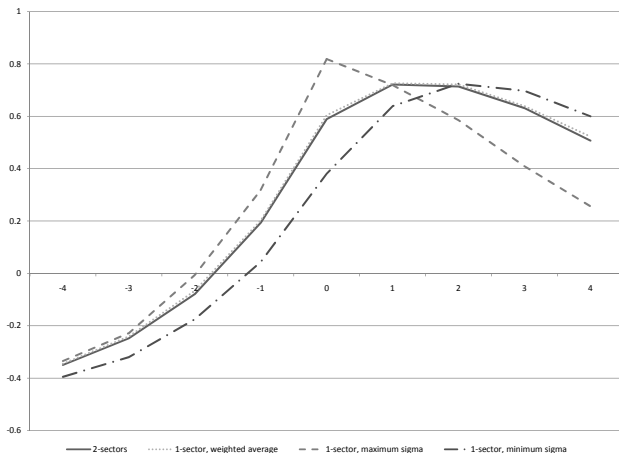
	Import Elasticity η	Substitution Elasticity σ
Constrained total elasticity	-2.166	4.442
Constrained partial elasticity	-3.016	4.016
Unconstrained total elasticity	-5.225	8.479
Unconstrained partial elasticity	-7.737	8.010
Number of sectors	4,021	4,021
Number of grid searches	3,366	3,366

What It Means

- Accommodating the well-known unambiguous fact that some goods are more substitutable than others means calibrated models should use 7 rather than 2. This matters quantitatively and qualitatively.
- **Obstfeld & Rogoff (2005)**: Use a calibrated model with a substitutability at 2 to argue a reversal of the US current account is compatible with a 30% depreciation of the real exchange rate. In a slightly simplified two-country version, we obtained depreciation rates of 22 or 21% for values of the parameter of 5 or 7.
- **Cole & Obstfeld (1991)**: The endogenous response of the terms of trade can deliver perfect insurance against country-specific shocks when the substitutability between domestic and foreign goods is unitary. Home equity bias can arise under low substitutability (Heathcote & Perri, 2008) while domestic consumers will want to hold foreign assets for high values of the parameter, when the terms-of-trade response to real shocks is muted (Coeurdacier, 2005)

What It Means (2)

- **Atkeson & Burstein (2008)**: Explain observed deviations from PPP in a model with trade costs, imperfect competition and variable markups. In their calibration, the elasticity of substitution between the (foreign and domestic) varieties equals 10; deviations from PPP virtually disappear for an alternative value set at 3.
- **Galí & Monacelli (2005)**: How exchange rates matter in the monetary policy rule. Use unitary substitutability. More generally, with non unitary elasticity policy shocks that affect the terms-of-trade also affect welfare, in a way that crucially depends on whether the calibrated parameter is above or below one. Benigno and Di Paoli (2008) or Di Paoli (2008).
- **Backus, Kehoe and Kydland (1994)**: we simulate a two-sector version, where the only difference between sectors is σ_k . We asked from a one-sector version what (aggregate, single) value of σ would reproduce the J-curve implied by model with heterogeneous σ_k . Calibration as in BKK except for the σ_k s and the weights, measured in our data.



⇒ The simulation of the 1-sector model with a substitutability equal to the weighted mean of the 2-sector model's elasticities clearly dominates the simulation using a simple average.

A point about calibration

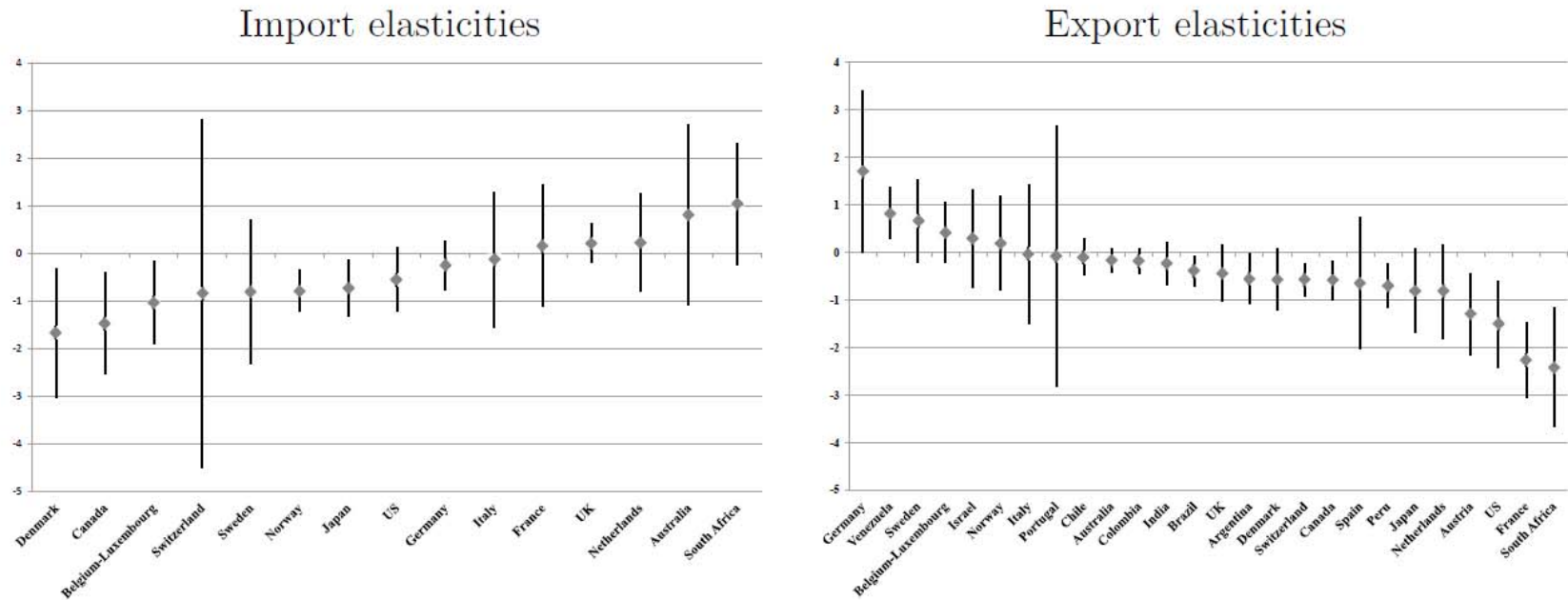
- Enormous evidence that elasticities of substitution are heterogeneous across goods and sectors. Must be accounted for when calibrating the aggregate average value of the parameter in macroeconomics. An estimation on the basis of aggregated data does NOT pin down the aggregate parameter.
- Estimates suggest the aggregate substitutability in the US is closer to 7 than to 2.
- This has important quantitative and qualitative implications for calibrated macro models

- Data is multilateral - so that estimation performed here for US can in fact be performed for many countries.
- In particular, can estimate import and export elasticities for large set of countries
- Import elasticity in country i given by a weighted average of σ_{ki}
- Export elasticity in country i given by a weighted average of σ_{kj} for all export markets j

Trade Elasticities

- Trade elasticities an object of interest in their own right. Gauge trade performance of a country - different from a calibration point now. Purely descriptive, a-theoretical.
- Decades of empirical work has failed to find much by way of cross-country differences.
- Most of the time, the comparison of trade elasticities is limited to a very small number of (rich) countries. Marquez (1995) surveys 39 papers comparing trade elasticities for Canada, Japan and the United States.
- The cross-section is limited by data constraints, especially for developing countries. E.g. China did not publish an import price index before 2005.
- Houthakker & Magee (1969): Import price elasticity for 15 OECD countries and export elasticities for 26 countries (OECD + a few Latin American countries).
- Marquez (2002): Import and Export price elasticities for 8 Asian countries.

Figure 1: Houtakker and Magee (1969) elasticity estimates



Note: The grey circles are the point estimates found in Houtakker and Magee (1969). Lines around the circles correspond to the confidence interval, at the 5% level.

Trade Elasticities Across Countries

- Despite voluminous literature and decades of econometric sophistication, strong uncertainty. Marquez (1995): import elasticities range between -0.3 and -4.8 for the US, -0.2 and -2.8 for Canada, 0.15 and -3.4 for Japan.
- While point estimates usually display some heterogeneity across countries, estimation uncertainty precludes any economic interpretation (differences are not statistically significant)
- Using micro data lends power to estimates.
- Almost certain large differences exist across countries. EMU members' responses to Euro shock. World response to China entry in WTO. We just have too little power to identify them.
- Implement approach based on structural estimates of σ_{ki} across countries i .

- Trade elasticities trade-weighted average of relevant elasticities of substitution.
- We can choose the dimensionality of trade weights (and elasticities of substitution) used.
- Run comparative statics exercises where trade response computed for variety of specific shocks - within EMU, EMU-wide, bilateral or multilateral, sectoral or aggregate.

- Model is the same as in previous exercise. Nested CES preferences.

Import Elasticity

- For imports:

$$\begin{aligned}\eta_j^M &= - \sum_k m_{kj}(\sigma_{kj} - 1) + \sum_k m_{kj}(1 - w_{kjj})(\sigma_{kj} - \gamma_j) \\ &+ (\gamma_j - 1) \sum_k w_{kj}(1 - w_{kjj})\end{aligned}$$

with w_{kjj} the share of domestic goods in country j 's consumption of products k and w_{kj} the consumption share of good k .

- The price elasticity of imports is a weighted average of sectoral elasticities of substitution:
 - ⇒ Impact of specialization $\{m_{kj}\}$: Share of substitutable Imported goods increases the aggregate price elasticity of imports
 - ⇒ Impact of differentiation $\{\sigma_{kj}\}$: Importing varieties that are more differentiated decreases the aggregate price elasticity of imports

- For exports:

$$\begin{aligned}\eta_j^X &= - \sum_k x_{kj} \sum_{i \neq j} x_{kji} (\sigma_{ki} - 1) + \sum_k x_{kj} \sum_{i \neq j} x_{kji} w_{kji} (\sigma_{ki} - \gamma_i) \\ &+ \sum_k x_{kj} \sum_{i \neq j} x_{kji} (\gamma_i - 1) \sum_k w_{ki} w_{kji}\end{aligned}$$

with x_{kji} the share of country j 's exports of product k sold in country i and w_{kji} the share of products from j in i 's consumption of k .

- The price elasticity of exports is a weighted average of sectoral elasticities of substitution in country j 's destination markets:
 - ⇒ Impact of specialization $\{x_{kj}\}$: Exporting homogeneous goods increases the aggregate price elasticity of exports
 - ⇒ Impact of differentiation $\{\sigma_{ki}\}$: Differentiating varieties sold abroad tends to reduce the price sensitivity of exports

Aggregation?

- Note purpose here is not to identify a "true" preference parameter.
- Rather, it is to mimic the aggregate dynamics of trade. It is therefore fair to use constrained estimates of σ_{ki} .
- But it is also possible to plug in unconstrained estimates - in which case, introduces a novel elasticity measure, one that responds to the specialization of trade - across sectors and across destinations.

Figure 2: Distribution of unconstrained import elasticities ($\gamma = 1$)

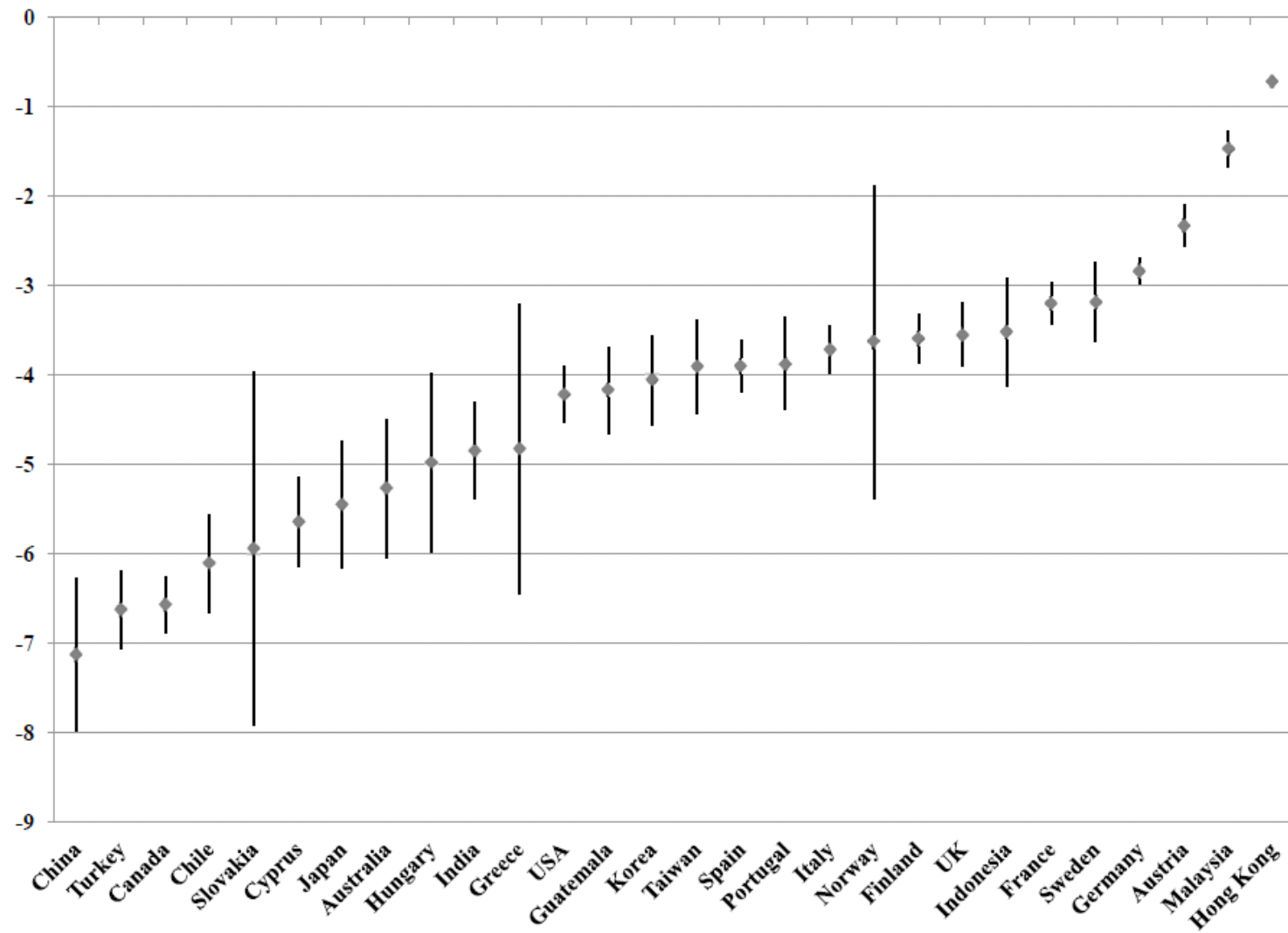
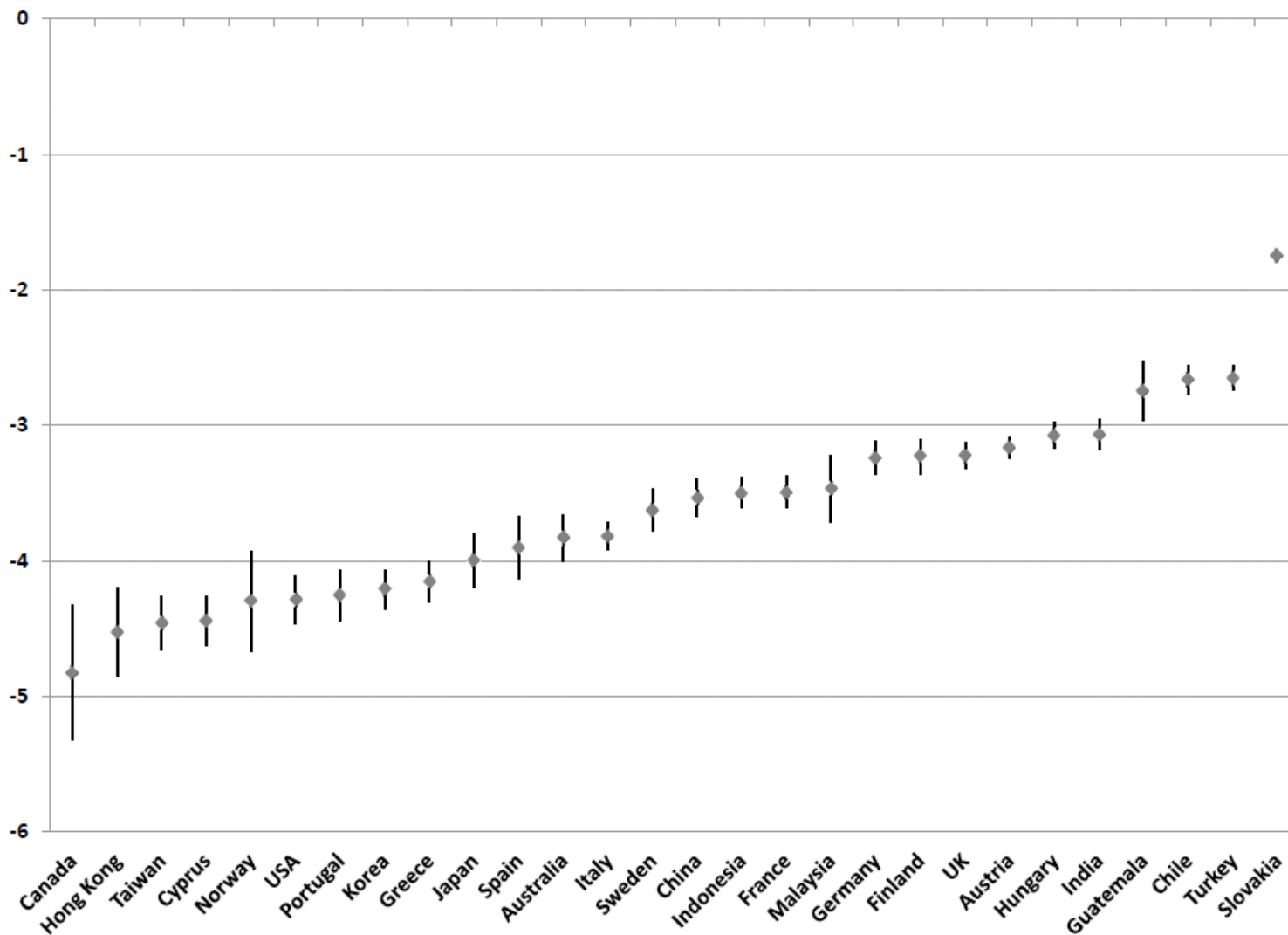


Figure 3: Distribution of unconstrained export elasticities ($\gamma = 1$)



What We Find

- Vast heterogeneity in both import and export elasticities. Slightly larger for imports
- Such dispersion is absent from conventional macro-based estimates
- We propose a decomposition of this dispersion. Heterogeneity in import elasticities comes mostly from σ . Heterogeneity in export elasticities reflects sectoral and geographic patterns of exports.
- We also focus on trade elasticities implied by EMU-wide shock. Heterogeneity survives demand-implied trade responses of EMU member countries to EMU-wide price shock - especially for imports.

This paper:

- Proposes an alternative methodology to estimate trade elasticities
- Provides elasticity estimates for a large cross-section of countries
- Emphasizes the interdependence between Ricardian specialization and within-industry differentiation in the determination of aggregate sensitivity to price shocks
- Uses the method to study the response of trade to aggregate shocks but also the impact of more specific nominal shocks