Quantifying the Welfare Effects of Trade and Trade Policy

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Introduction

- Considerable recent progress quantifying the welfare effects of trade and trade policy
- Entire class of theoretical models with simple sufficient statistics for the welfare effects of trade
  - Share of country's trade with itself (domestic trade share)
  - Constant elasticity of trade with respect to trade costs (trade elasticity)
- Tractable framework for undertaking counterfactuals for changes in trade policy in this entire class of models
  - Trade wars (Ossa 2019)
  - Brexit (Dhingra, Huang, Ottaviano, Pessoa, Sampson, Van Reenen 2017)
- Methodology enables ex ante policy assessment, that can be enriched with ex post data, to enable evidence-based welfare and policy analysis

Outline

1. Welfare gains from trade
2. Trade policy counterfactuals
3. Application to Brexit

Simple Model of Trade

- Consider the simplest Armington (1969) model of trade
- The UK (country 1) and countries $i = 2, \ldots, N$, each produce a good, differentiated by country of origin
- Consumers in country n choose consumption of each country i's variety to maximize their CES utility, taking prices and incomes as given:

$$U_n = \left(\sum_{i=1}^{N} \left(q_{ni} \left(p_{ni}, w_n \right) \right)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \qquad \sigma > 1.$$

- Goods produced with labor under constant returns to scale

$$Y_i = L_i / a_i$$

- Supply of labor is inelastic and given by $\bar{L}_i$
- Markets are perfectly competitive

Trade and Welfare

- Real income in the UK is

$$\mathbb{W}_1 = w_1/P_1$$

- The Price Index faced by UK consumers is

$$P_1 = \left[\sum_{i=1}^{N} p_{1i}^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

Trade Share and Trade Elasticity

- UK firms charge UK consumers a price

$$p_{11} = a_1 w_1 \qquad \textbf{Domestic Price}$$

- w_1 is UK's wage rate and a_1 is the number of hours needed to make the UK good.

- Foreign firms from country i pay trade costs $\tau_{1i} > 1$ when shipping to the UK.
- Foreign firms charge UK consumers

$$p_{1i} = \tau_{1i} p_i = \tau_{1i} a_i w_i \qquad \textbf{Import Price}$$

Trade Share and Trade Elasticity

- Share of UK consumer's expenditure on country i's goods

$$\pi_{1i} = \left(p_{1i}/P_1\right)^{1-\sigma} \qquad \textbf{Trade Share}$$

- As p_{1i} rises, UK consumers reduce their expenditure on goods from i by $-\left(\sigma - 1\right)\%$.

- As $p_{1i} = \tau_{1i} a_i w_i$, the *trade elasticity* given by the gravity equation:

$$\ln \pi_{ni} = -\left(\sigma - 1\right) \ln \tau_{ni} + \ln a_n w_n + \epsilon_{ni}$$

Domestic Trade Share, Trade Elasticity and Welfare

- $w_1 = p_1/a_1$ (Domestic Price)
- $\pi_{11} = \left(p_{11}/P_1\right)^{1-\sigma}$ (Domestic Trade Share)
- Real income in the UK is

$$\mathbb{W}_1 = \frac{w_1}{P_1} = \frac{1}{a_1}\left(\pi_{11}\right)^{-\frac{1}{\sigma-1}}$$

- Therefore real income is increasing in own productivity $(1/a_1)$ and decreasing in domestic trade share (π_{11})

- Open economy domestic trade share (π_{11}^T) and trade elasticity $-(\sigma-1)$ are sufficient statistics for the welfare gains from opening the closed economy to trade $(\pi_{11}^A = 1)$

$$\frac{\mathbb{W}_1^T}{\mathbb{W}_1^A} = \left(\pi_{11}^T\right)^{-\frac{1}{\sigma-1}}$$

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Open Economy Equilibrium

- UK income = Expenditure of the World on UK goods

$$
\begin{aligned}
w_1 \bar{L}_1 &= \sum_{i=1}^{N} \pi_{i1} w_i \bar{L}_i \\
&= \sum_{i=1}^{N} \frac{\left(\tau_{1i} a_i w_i\right)^{1-\sigma}}{\sum_{k=1}^{N} \left(\tau_{ik} a_k w_k\right)^{1-\sigma}} w_i \bar{L}_i
\end{aligned}
$$

- N such equations from each country.
- Determines unique values for the N equilibrium wages.

Counterfactual Open Economy Equilibrium

- Consider a counterfactual change in trade costs from τ_{1i} to τ'_{1i}, holding all else constant
- We have analogous counterfactual equilibrium conditions
- Income equals expenditure

$$w_1 \bar{L}_1 = \sum_{i=1}^{N} \frac{\left(\tau'_{1i} a_i w_i\right)^{1-\sigma}}{\sum_{k=1}^{N} \left(\tau'_{ik} a_k w_k\right)^{1-\sigma}} w_i \bar{L}_i$$

- Real income

$$\mathbb{W}'_1 = \frac{w'_1}{P'_1} = \frac{1}{a_1} \left(\pi'_{11}\right)^{-\frac{1}{\sigma-1}}, \qquad \sigma > 1$$

Exact Hat Algebra

- We can rewrite the counterfactual equilibrium in terms of
  - Observed values of the endogenous variables in the initial equilibrium
  - Assumed relative changes in trade costs ($\hat{\tau}_{ni} = \tau'_{ni}/\tau_{ni}$)
  - Relative changes of the endogenous variables ($\hat{x}_n = x'_n/x_n$)

$$\hat{w}_1 Y_1 = \sum_{i=1}^{N} \frac{\pi_{1i} \left(\hat{\tau}_{1i} \hat{w}_i\right)^{1-\sigma}}{\sum_{k=1}^{N} \pi_{1k} \left(\hat{\tau}_{ik} \hat{w}_k\right)^{1-\sigma}} \hat{w}_i Y_i$$

- $Y_i = w_i \bar{L}_i$ is initial income (GDP)
- Provides a system of N equations that determines unique values for the N counterfactual changes in wages
- Counterfactual change in real income

$$\hat{\mathbb{W}}_n = \left(\hat{\pi}_{nn}\right)^{-\frac{1}{\sigma-1}}, \qquad \sigma > 1$$

Extensions

- Other reasons for trade
- Intermediate inputs
- Multiple sectors
- Factor mobility (next lecture)
- Multiple factors and distributional consequences of trade
- Endogenous choice of trade policy

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The Economic Impact of Brexit

- What would be the impact of Brexit on the UK economy?
- Long-term economic impact of higher trade costs after Brexit on welfare

$$\mathbb{W}_1^{\tau'} / \mathbb{W}_1^{\tau}$$

- Quantitative trade model of 35 regions and 31 goods and services sectors (Dhingra et al. 2017)

CEP Quantitative Trade Model

- Welfare changes from Leaving the EU, compared to staying are

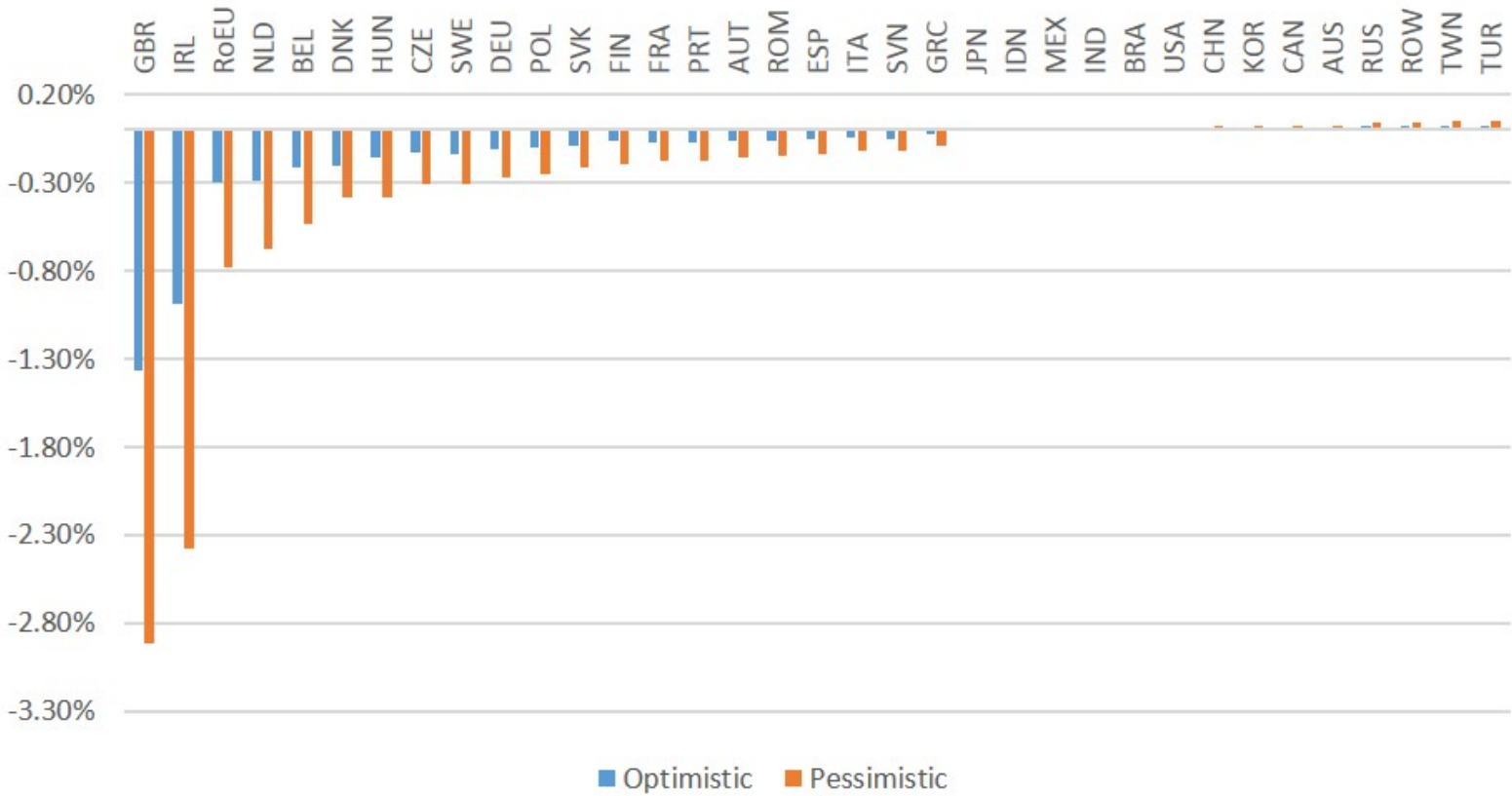
$$\hat{\mathbb{W}}_1 = \frac{1-T}{1-T'} \prod_{s,s'=1}^{S} \left(\hat{\pi}_{11,s}\right)^{-\beta_{s'}\epsilon_{ss'}/(\sigma_s-1)}, \quad s, s' \in \{1, 2, \ldots S\}$$

- $\pi_{11,s}$ = share of expenditure on domestic outputs of sector s.
- $-\left(\sigma_s - 1\right)$ = *trade elasticity* = % fall in import share from a 1% change in bilateral trade costs, holding incomes constant.
- T = share of tariff revenue in aggregate expenditure
- $\epsilon_{ss'}$ = elasticity of sector s price to changes in sector s' price.
- β_s = share of sector s in UK consumption
- Data on initial expenditure shares, income levels of different countries, consumption shares and worldwide input-output tables.

Brexit Impacts from Quantitative Trade Model

Welfare Changes due to UK Withdrawal from the EU	
Soft Norway-style Brexit (0% Tariffs)	% GDP
Due to Increase in EU/UK Tradable Tariffs (0%) +	
Due to Increase in EU/UK Non-Tariff Barriers	-1.37%
(2% current + 5.7% future)	
Due to Fiscal Benefit	+0.09%
Total Welfare Change (£850 per household per year)	***-1.28%***
Hard No-Deal Brexit (MFN Tariffs)	
Due to Increase in EU/UK Tradable Tariffs (MFN EU Tariffs) +	
Due to Increase in EU/UK Non-Tariff Barriers	-2.92%
(6% current + 12.8% future)	
Due to Fiscal Benefit	+0.31%
Total Welfare Change (£1,700 per household per year)	***-2.61%***

Brexit Impacts Globally



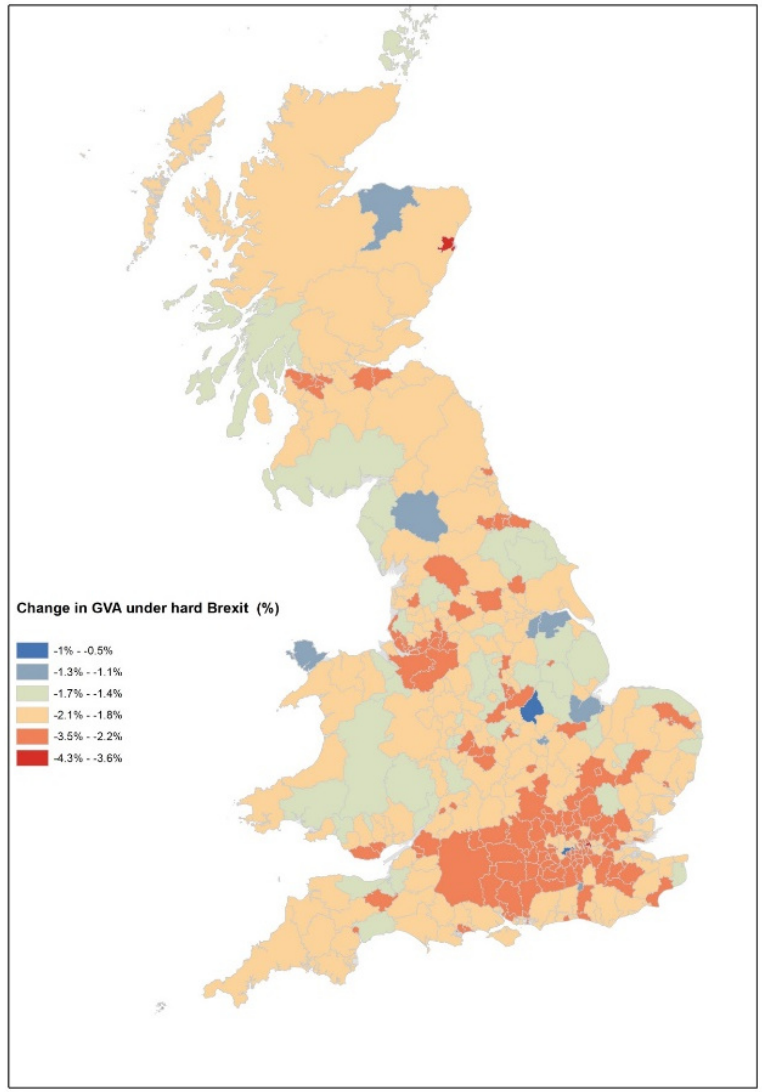
Brexit Impacts Locally

- For a Local Authority l with different sectors s,

$$Aggregate\ GVA\ change\ in\ l =$$

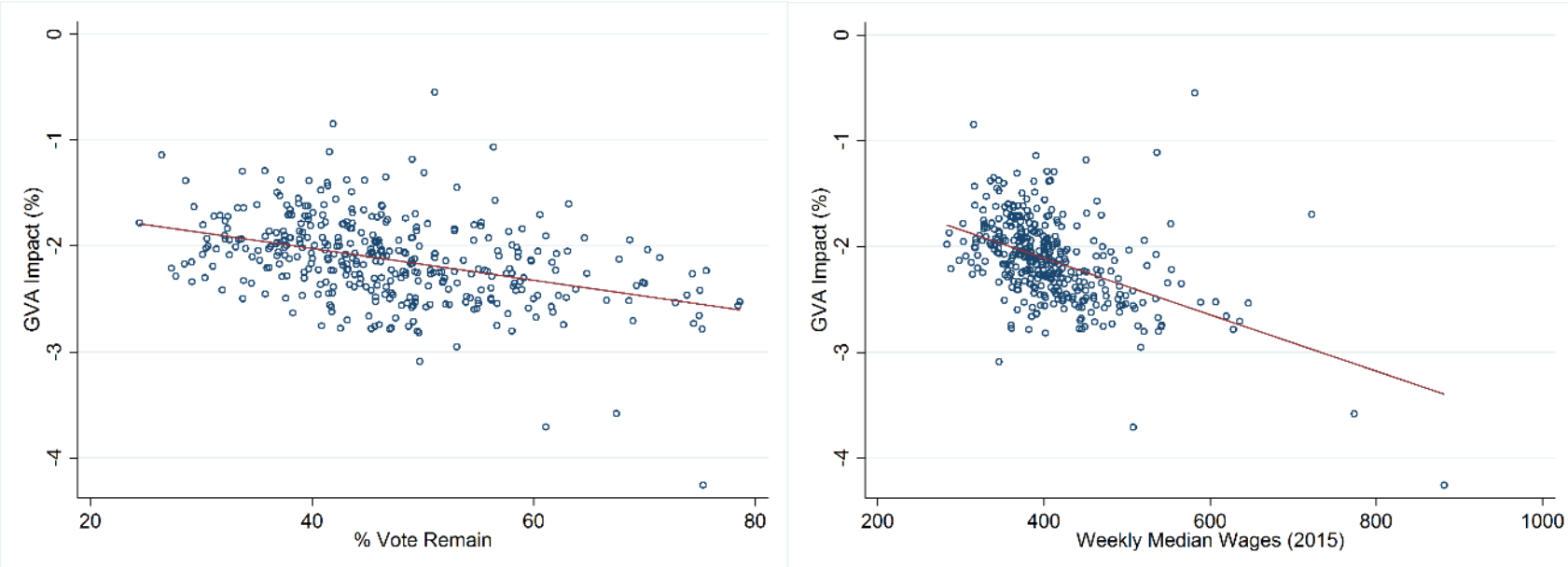
$$\sum_{s=1}^{S} Employment\ Share_{sl} \times National\ GVA\ Shock_{s}$$

Local Impacts under Hard Brexit



Source: Dhingra, Machin and Overman (2017)

Local Brexit Impacts to Policy

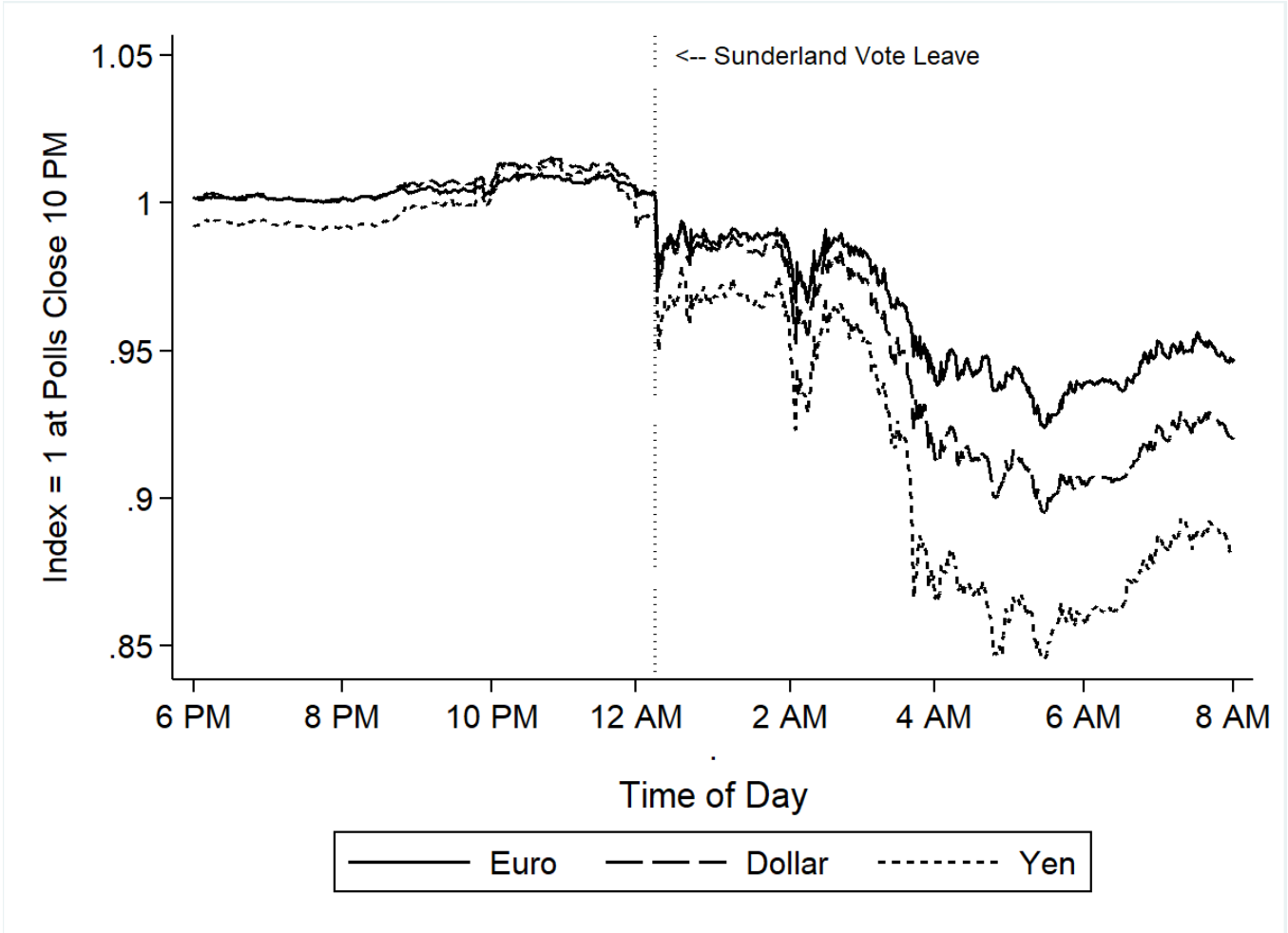


Source: Dhingra, Machin and Overman (2017)

Developing Evidence-based Policy

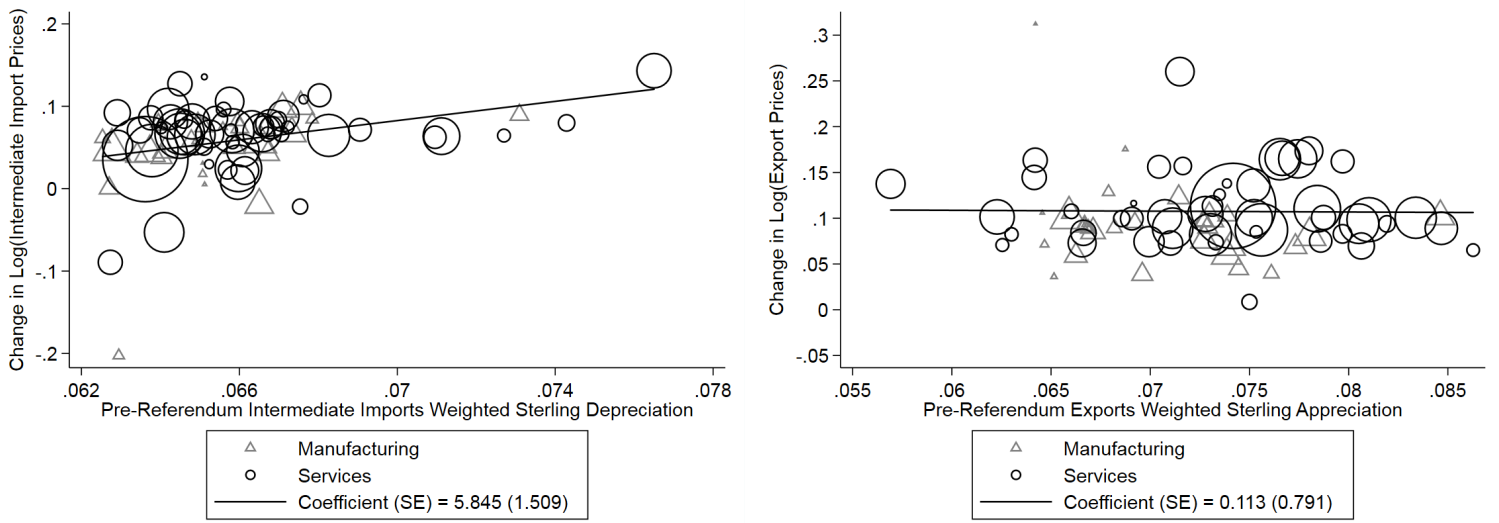
- Quantitative modelling enables ex ante assessment of trade policy.
- It can be combined with ex post data to enrich ex ante assessments with
  - Complex channels of impacts other than trade shares
  - Early signs of detection using actual ex post data
  - Unbiased and precise elasticities of economic outcomes to trade

Complex Channels: Sterling Depreciation from the EU Referendum



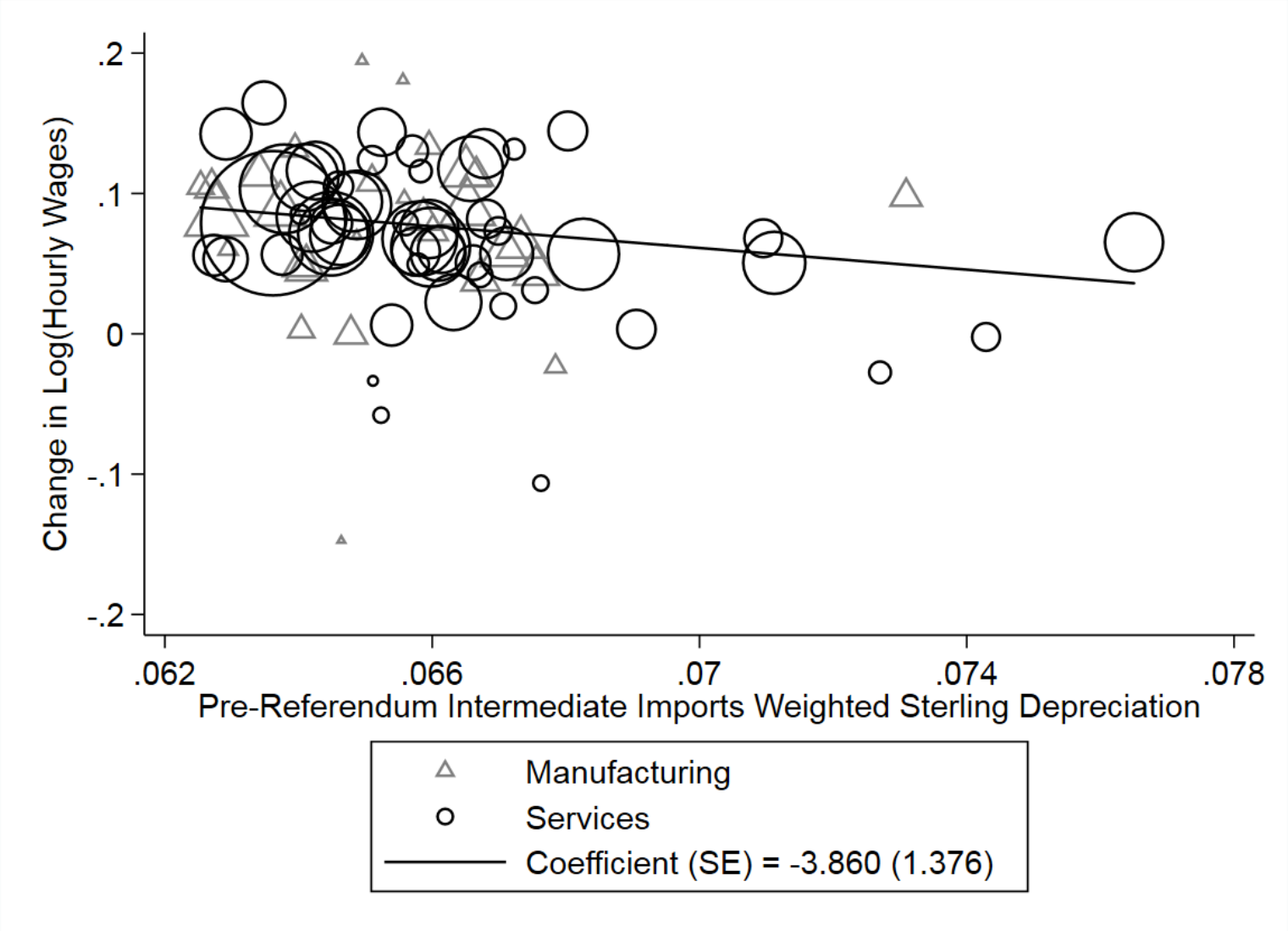
Source: Costa, Dhingra and Machin (2019)

Early Signs: Sterling Depreciation and Trade Prices



Source: Costa, Dhingra and Machin (2019)

Margins of Adjustment: Sterling Depreciation and Wages



Source: Costa, Dhingra and Machin (2019)

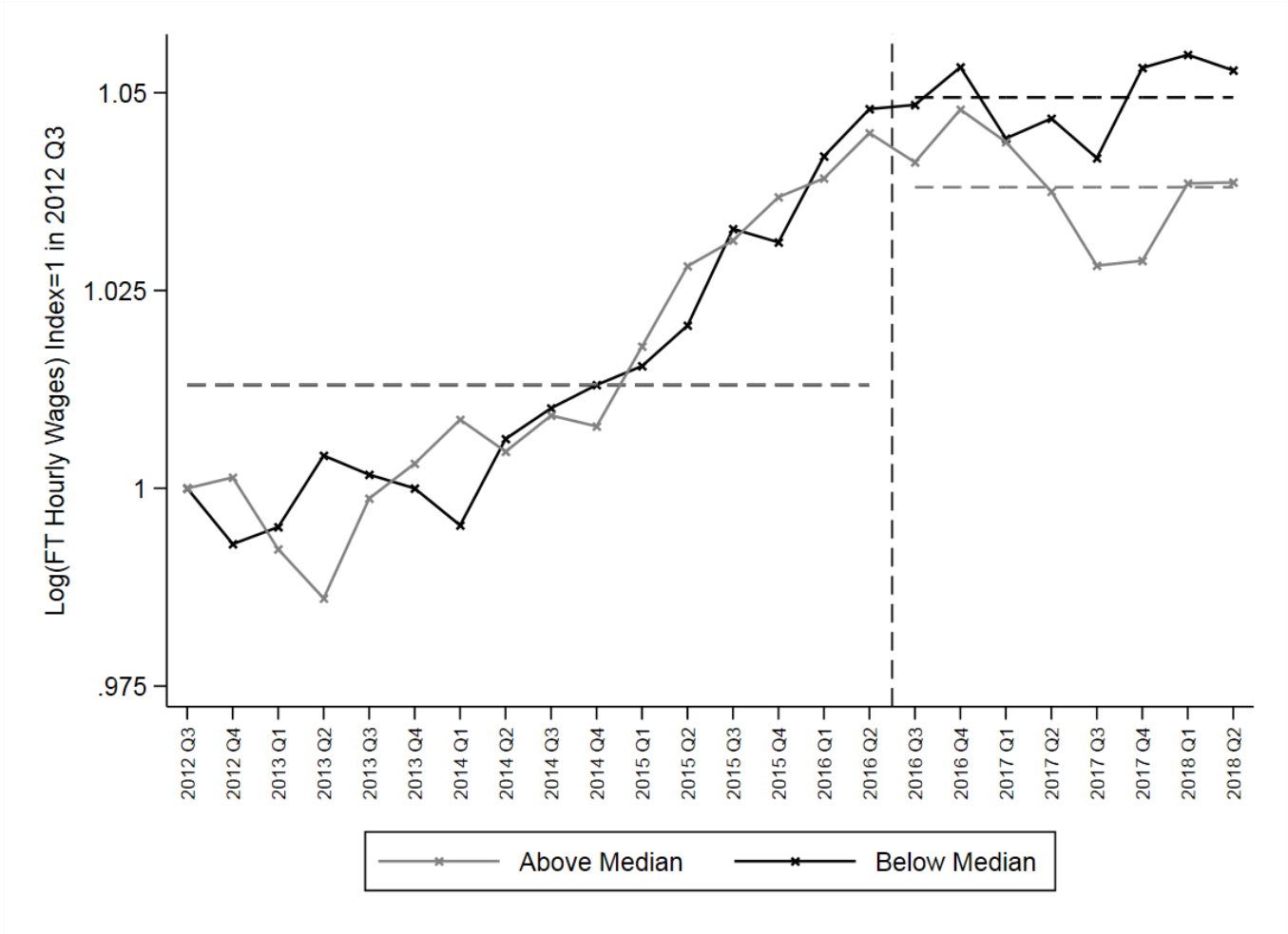
Elasticities

- $p_{11,s} = C_s\left(w_{1s}, p_{1s}^M\right)$ where p_{1s}^M is the price of intermediate goods and services needed to make sector s output in the UK

	Log(Intermediate Import Price)	log(Wage)
	(1)	(3)
Log(Intermediate Imports Weighted	0.375	-0.201
Depreciation) X Post-Referendum	(0.100)	(0.075)
Controls, Time Dummies, Sector Dummies	Yes	Yes
Sample Size	2040	123,489

- When p_{1s}^M rises by 1%, wage in the sector w_{1s} fall by $-0.201/0.375 = -0.54\%$
- Estimated elasticities range from -0.34 to -0.54
- Calibrating to theory, the elasticity of substitution in production between workers and intermediate imports ranges from -1.82 to -3.80

Elasticities: Real Wage Responses



Source: Costa, Dhingra and Machin (2019)

Conclusion

- Quantitative trade models bring powerful tools for ex ante and ex post assessment of trade policy.
- Statistical methods provide ways of early detection of impacts and capture complex adjustments that are not summarized by trade flows and initial values.
- Together, quantitative and statistical tools in economics enable evidence-based welfare and policy analysis.