The Brexit Vote, Inflation and UK Living Standards

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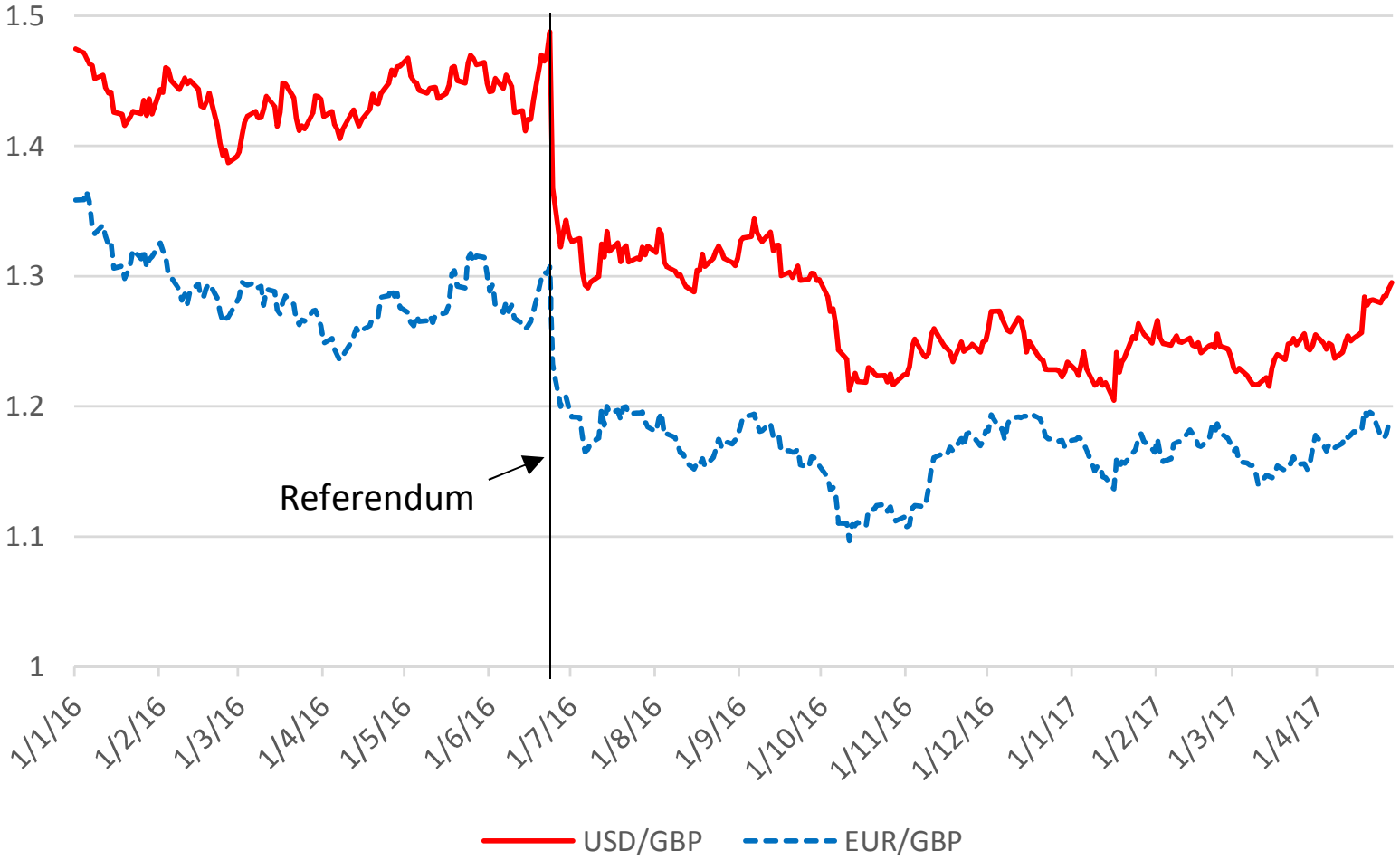
Brexit vote

- UK voted to leave the EU in June 2016
- Brexit is currently scheduled for March 2019
- Ex-ante economic analysis predicts Brexit will reduce UK living standards (Dhingra et al. 2017, Sampson 2017)
  - Plausible estimates put costs at between 1% and 10% of income per capita
  - To minimise economic costs UK should remain in the Single Market and the Customs Union

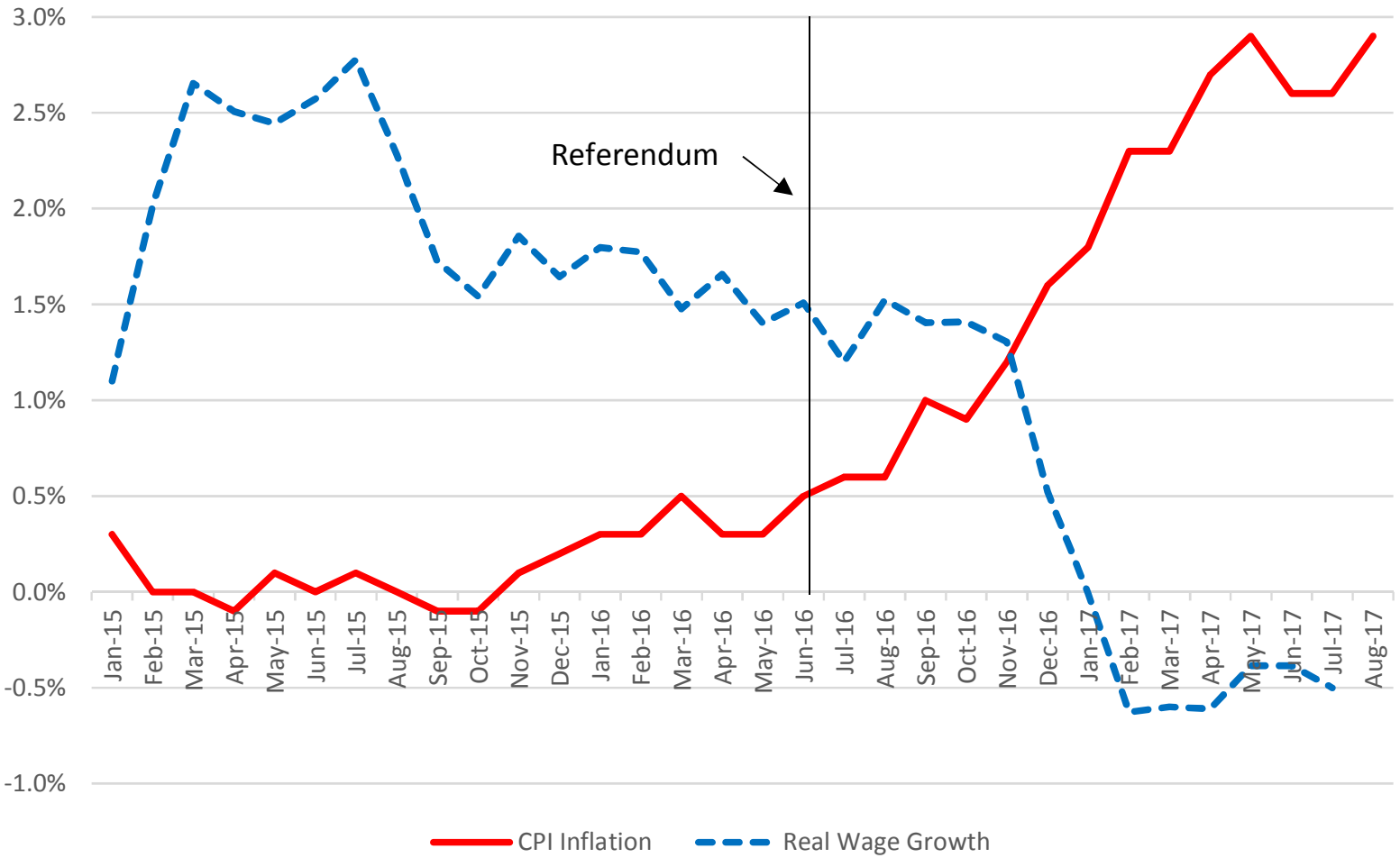
Referendum as natural experiment

- Referendum was unanticipated shock to the UK economy
  - Increased uncertainty over future economic policy
  - Decreased expected future openness of UK to trade, investment and immigration with the EU
- How has the Brexit vote affected the UK economy so far?

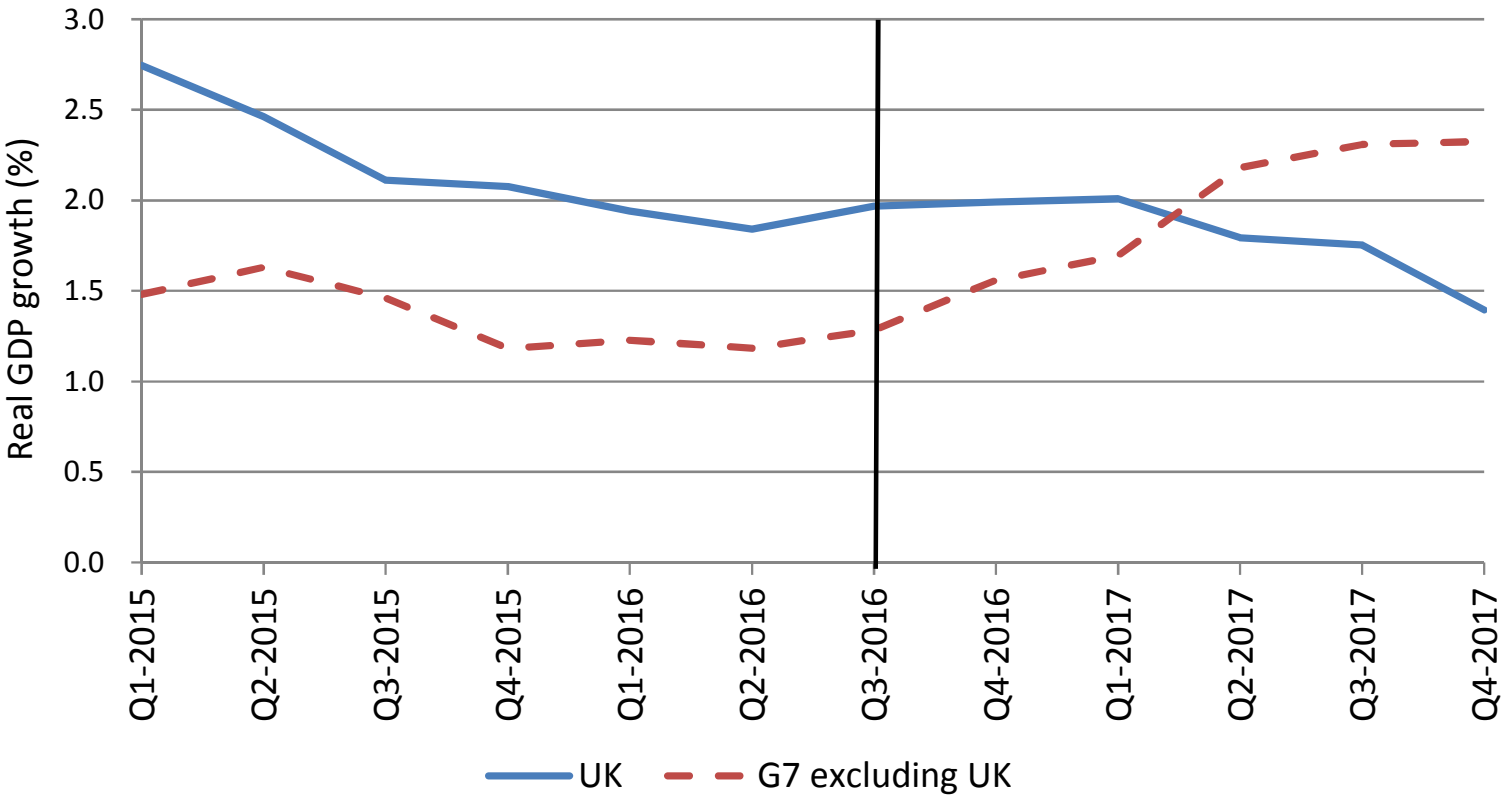
Sterling depreciation



Inflation and real wages



GDP growth


3.0
2.5
2.0
1.5
1.0
0.5
0.0
Real GDP growth (%)
Q1-2015
Q2-2015
Q3-2015
Q4-2015
Q1-2016
Q2-2016
Q3-2016
Q4-2016
Q1-2017
Q2-2017
Q3-2017
Q4-2017
UK
G7 excluding UK

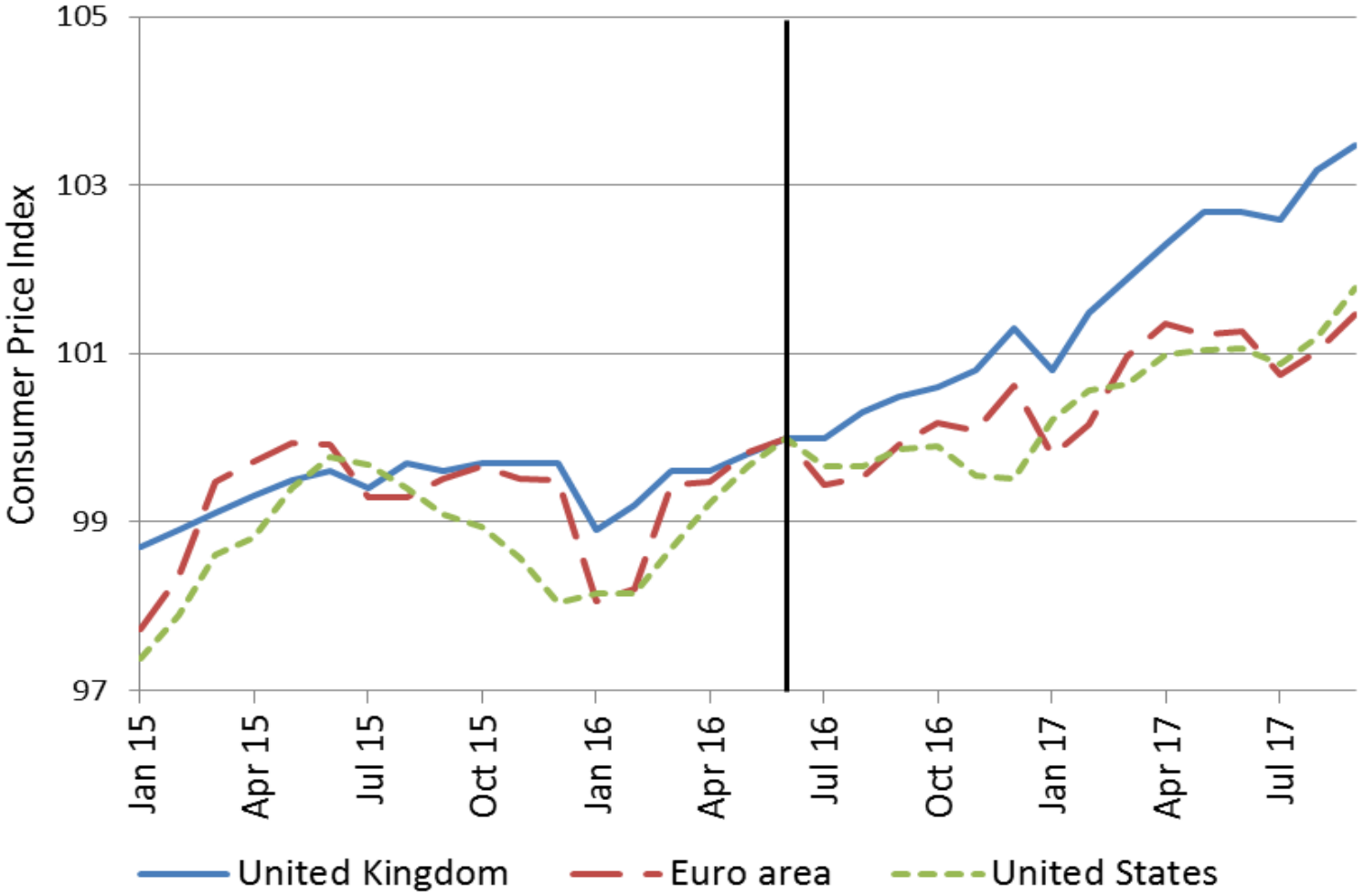
This paper

- Study effect of Brexit vote on UK living standards
- Estimate impact on inflation and real wage growth

Brexit vote and inflation

- Is the Brexit vote responsible for the rise in UK inflation after June 2016?
- Other possible factors: oil price movements, global inflationary pressures
- Isolate referendum effect by comparing changes in inflation for product groups with differential exposure to import costs
- Goal is to understand consequences of Brexit vote not a generic exchange rate depreciation . . . source of exchange rate shock matters

International inflation comparison



Motivating theory

- Suppose households consume G product groups indexed by $g = 1, \ldots, G$
- Consumption C_g of product group g is composite of imported good M_g and domestic good D_g

$$C_g = M_g^{\gamma_g} D_g^{1-\gamma_g}$$

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- Price growth can be expressed in terms of price indices P as

$$\ln\left(\frac{P_{g,t}}{P_{g,t-1}}\right) = \gamma_g \ln\left(\frac{P_{gM,t}}{P_{gM,t-1}}\right) + (1-\gamma_g)\ln\left(\frac{P_{gD,t}}{P_{gD,t-1}}\right)$$

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- Direct import share γ_g measures share of consumer expenditure on imports
- Indirect import share defined as share of consumer expenditure on imported intermediate inputs used in domestic production

Domestic good production

- Suppose domestic good g produced using labour l, domestic input i_{Dg} and imported input i_{Mg} according to

$$y_g = \phi_g l^{1-\alpha_g} \left({i_{Dg}}^{1-\varepsilon_g} {i_{Mg}}^{\varepsilon_g} \right)^{\alpha_g}$$

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- Complete pass-through from costs to output prices implies

$$\frac{P_{gD,t}}{P_{gD,t-1}} = \left(\frac{\phi_{g,t}}{\phi_{g,t-1}} \right)^{-1} \left(\frac{w_t}{w_{t-1}} \right)^{1-\alpha_g} \left(\left(\frac{P_{gID,t}}{P_{gID,t-1}} \right)^{1-\varepsilon_g} \left(\frac{P_{gIM,t}}{P_{gIM,t-1}} \right)^{\varepsilon_g} \right)^{\alpha_g}$$

- Assume TFP and factor prices do not change over time

Input-output linkages

- Intermediates produced using output of all other sectors

$$\frac{P_{gID,t}}{P_{gID,t-1}} = \prod_{j=1}^{G} \left(\frac{P_{jD,t}}{P_{jD,t-1}} \right)^{\psi_{jg}}, \qquad \frac{P_{gIM,t}}{P_{gIM,t-1}} = \prod_{j=1}^{G} \left(\frac{P_{jM,t}}{P_{jM,t-1}} \right)^{\mu_{jg}}$$

- ψ_{jg} equals share of domestic good j in cost of producing domestic intermediate g
- μ_{jg} denotes share of imported good j in cost of producing imported intermediate g
- Solving this system of equations gives $\ln\left(\frac{P_{gD,t}}{P_{gD,t-1}}\right)$ in terms of shock to import prices

Indirect import share

- Indirect import share is defined as share of consumer expenditure on imported intermediate inputs used in domestic production
- Under our assumptions indirect import share also equals $(1 - \gamma_g)$ times elasticity of domestic good price $P_{gD,t}$ to import costs
- Suppose $\ln\left(\frac{P_{gM,t}}{P_{gM,t-1}}\right) = \beta \ \forall\, g = 1, \ldots, G$. Then

$$\ln\left(\frac{P_{g,t}}{P_{g,t-1}}\right) = \beta \times (\text{Direct import share } + \text{Indirect import share})$$

Use this expression as basis for our estimation equation

Data

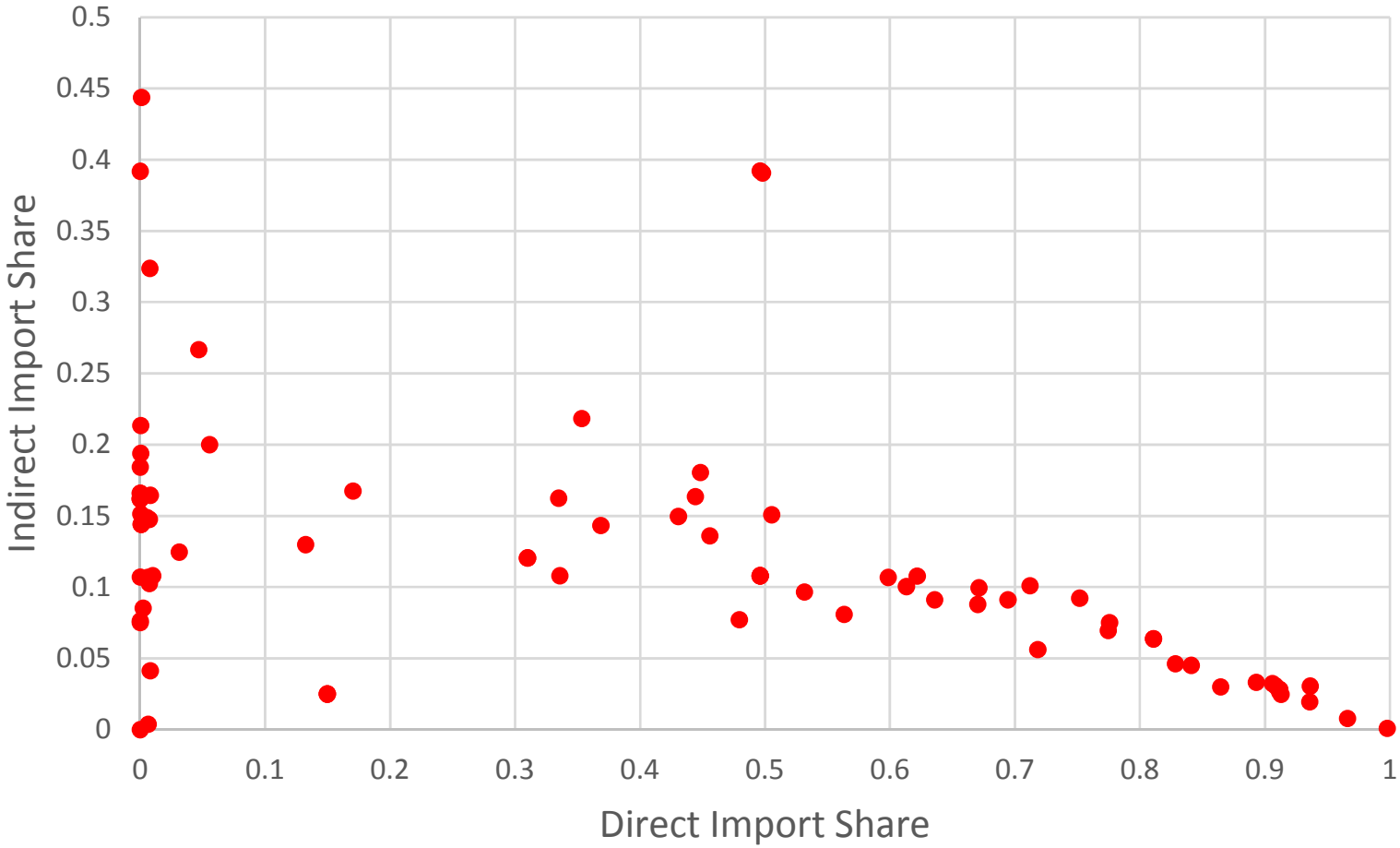
- Import shares calculated from 2013 UK input-output tables
  - Direct import share equals share of household expenditure on imports
  - Indirect import share equals share of household expenditure on intermediate inputs embedded in domestic production (using all input-output linkages)
  - Total import share equals sum of direct and indirect measures
- Price data for 84 product groups corresponding to COICOP classes
- Euro area inflation by product group from Eurostat
- Oil price exposure by product group calculated using input-output tables as consumer expenditure share on imported oil used in domestic production

Import shares

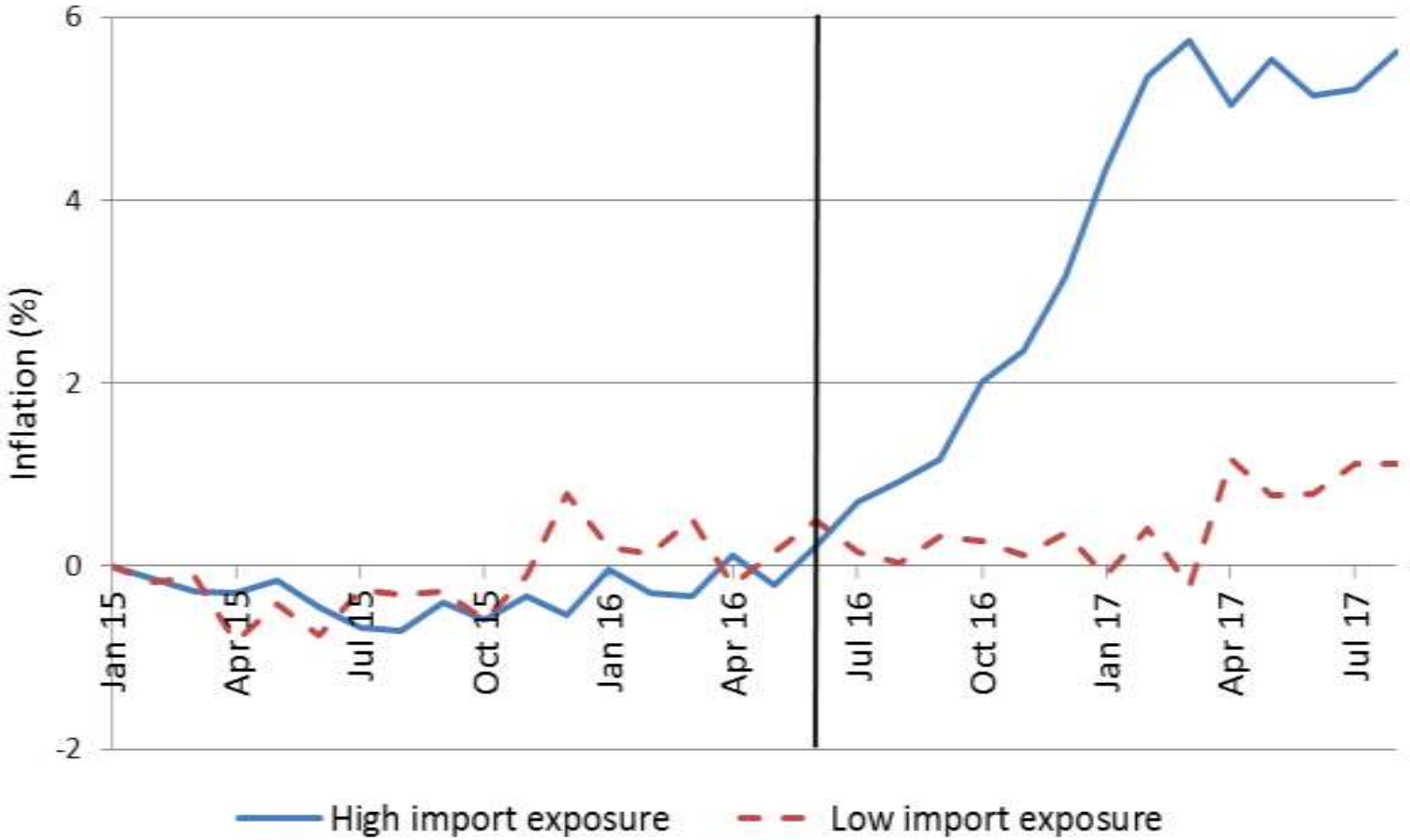
Table 1: Import shares in consumer expenditure by COICOP division

	Import share in consumer expenditure		
	(1)	(2)	(3)
COICOP division	Direct	Indirect	Total
Food and non-alcoholic beverages	50%	14%	63%
Alcoholic beverages and tobacco	50%	11%	60%
Clothing and footwear	88%	2%	90%
Housing, water, electricity, gas and other fuels	1%	17%	18%
Furniture, household equipment and maintenance	66%	6%	72%
Health	42%	4%	47%
Transport	31%	20%	51%
Communication	43%	14%	57%
Recreation and culture	34%	10%	44%
Education	1%	4%	5%
Restaurants and hotels	0%	17%	17%
Miscellaneous goods and services	36%	9%	45%
Average	39%	12%	51%
Standard deviation	0.35	0.09	0.32

Import shares



Import shares and inflation



Empirical specification

$$\ln\left(\frac{P_{g,t}}{P_{g,t-1}}\right) = \beta Post_t \times ImportShare_g + \alpha X_{gt} + \delta_t + \delta_g + \varepsilon_{gt}$$

- $Post_t$ is a dummy for periods after June 2016
- $ImportShare_g$ is the total import share of product group g
- X_{gt} includes controls for oil price movements and Euro area inflation
- δ_t and δ_g are period and product group fixed effects
- Estimate on both annual (year ending in June) and quarterly data
- Annual sample June 2015-17. Quarterly sample ends December 2017
- Standard errors clustered by product group

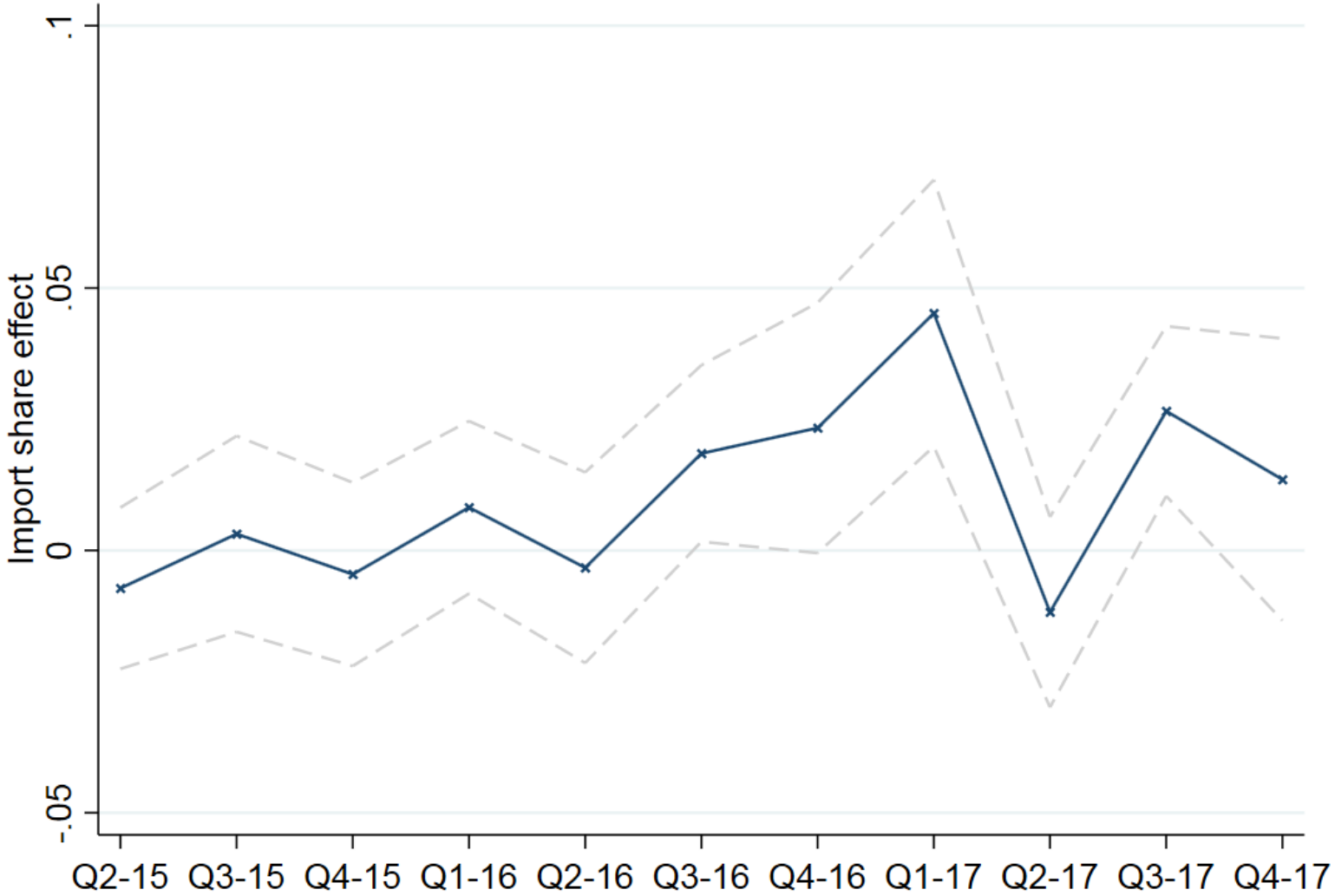
Annual estimates

VARIABLES	(1) Inflation	(2) Inflation	(3) Inflation	(4) Inflation Difference	(5) Inflation
Post × Import share	0.0760***	0.0709***	0.0709***	0.0706***	
	(0.0185)	(0.0148)	(0.0140)	(0.0141)	
2016 × Import share					-0.00295
					(0.0106)
2017 × Import share					0.0694***
					(0.0155)
Oil		0.846**	0.672**	0.232	0.673**
		(0.393)	(0.296)	(0.164)	(0.297)
Euro area inflation			0.282		0.283
			(0.201)		(0.200)
2015 dummy	-0.00996**	-0.00449	-0.00510	-0.00666	-0.00659
	(0.00394)	(0.00410)	(0.00399)	(0.00499)	(0.00637)
2017 dummy	-0.0123*	-0.0136**	-0.0146**	-0.0170*	-0.0153**
	(0.00735)	(0.00662)	(0.00693)	(0.00861)	(0.00720)
Observations	252	252	252	252	252
R-squared	0.337	0.459	0.491	0.256	0.491
Number of products	84	84	84	84	84
Product fixed effects	YES	YES	YES	YES	YES

Direct & indirect import shares

VARIABLES	(1) Inflation	(2) Inflation	(3) Inflation	(4) Inflation Difference	(5) Inflation
Post × Direct import share	0.0916***	0.0760***	0.0719***	0.0612***	
	(0.0209)	(0.0147)	(0.0126)	(0.0126)	
Post × Indirect import share	0.310**	0.138**	0.0850*	-0.0520	
	(0.125)	(0.0597)	(0.0499)	(0.0669)	
2016 × Direct import share					-0.00606
					(0.0122)
2017 × Direct import share					0.0673***
					(0.0154)
2016 × Indirect import share					-0.0479
					(0.0572)
2017 × Indirect import share					0.0432
					(0.0778)
Oil		0.729*	0.651*	0.447*	0.741*
		(0.391)	(0.328)	(0.227)	(0.393)
Euro area inflation			0.277		0.264
			(0.206)		(0.207)
2015 dummy	-0.00996**	-0.00524	-0.00525	-0.00527	-0.0128
	(0.00395)	(0.00399)	(0.00396)	(0.00498)	(0.0100)
2017 dummy	-0.0466**	-0.0231**	-0.0166**	0.000453	-0.0182**
	(0.0204)	(0.00989)	(0.00736)	(0.00978)	(0.00717)
Observations	252	252	252	252	252
R-squared	0.409	0.462	0.491	0.268	0.492
Number of products	84	84	84	84	84
Product fixed effects	YES	YES	YES	YES	YES

Quarterly estimates



Results summary

- For each 10 percentage point increase in total import share, product group inflation estimated to be 0.71 percentage points higher in year after referendum
- Both direct and indirect import exposure led to higher inflation. Cannot reject hypothesis of equal effects
- Pass-through to import prices peaked in Q1 2017, but still ongoing in Q3 2017

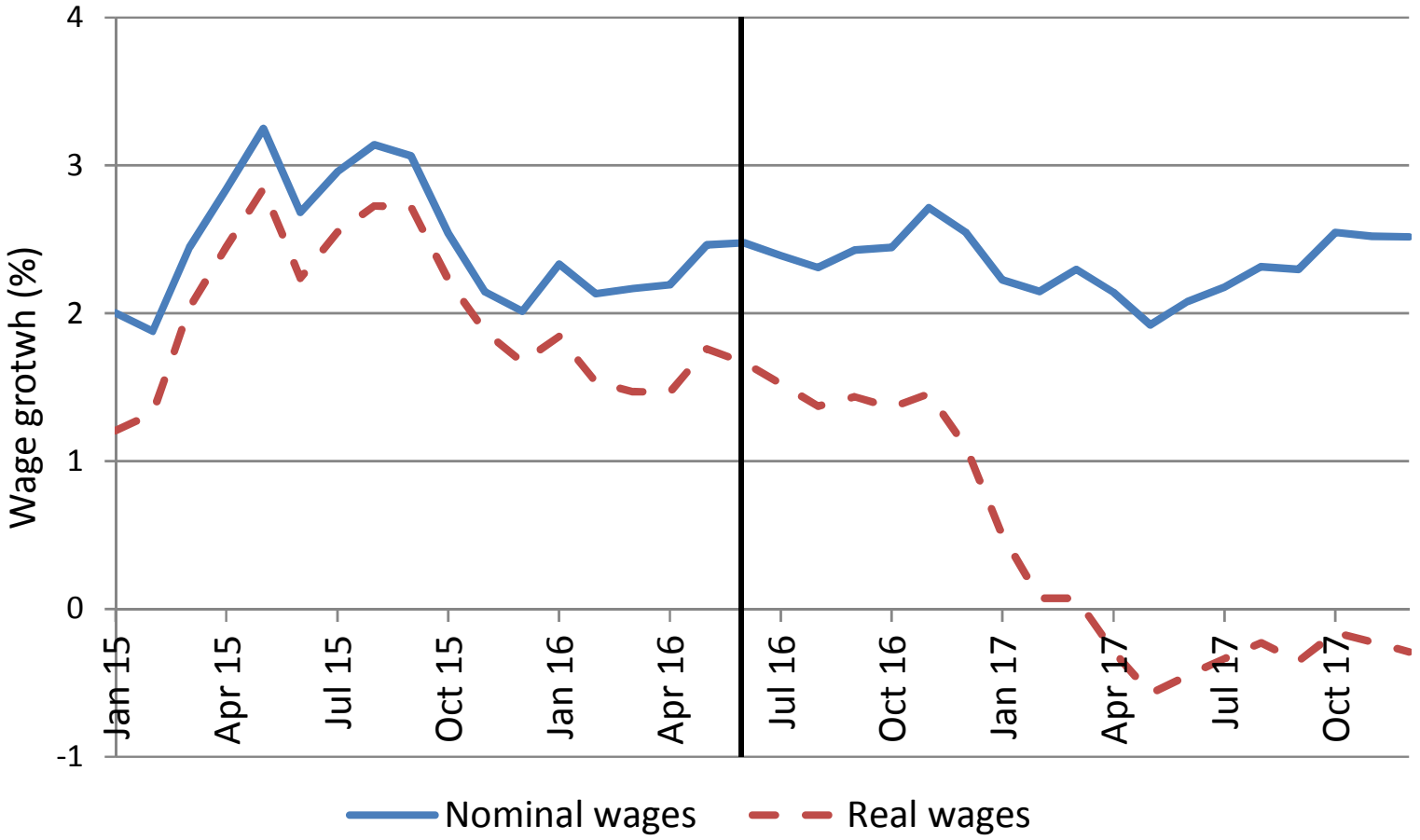
Aggregate inflation

- Did the referendum affect inflation through channels other than import prices?
- Estimated period fixed effect is negative and significant in year after the referendum
- To obtain a conservative estimate of the Brexit vote effect, we attribute this negative general equilibrium estimate to the referendum
- Aggregating across product groups we find that the Brexit vote increased inflation by 1.7 percentage points in year to June 2017 (inflation increased from 0.5% to 2.6% from June 2016 to June 2017)
- Equivalent to £404 per year higher expenditure for average UK household (almost one week's wages)
- For the UK in total, this corresponds to roughly £11bn per year, or £210m per week.

Wage growth

- Nominal wages grew at around 2%-2.5% throughout 2016 and 2017
- Real wage growth fell from 1.7% in June 2016 to -0.3% in December 2017
- Assuming nominal wage growth unaffected by referendum, our estimates imply Brexit vote reduced real wages in June 2017 by 1.7%
- Equivalent to loss of 4.4 working days' wages for average worker

Wage growth


4
3
2
1
0
-1
Wage grotwh (%)
Jan 15
Apr 15
Jul 15
Oct 15
Jan 16
Apr 16
Jul 16
Oct 16
Jan 17
Apr 17
Jul 17
Oct 17
Nominal wages
Real wages

Robustness checks

[label=robustness]

- Findings robust to alternative estimation specifications

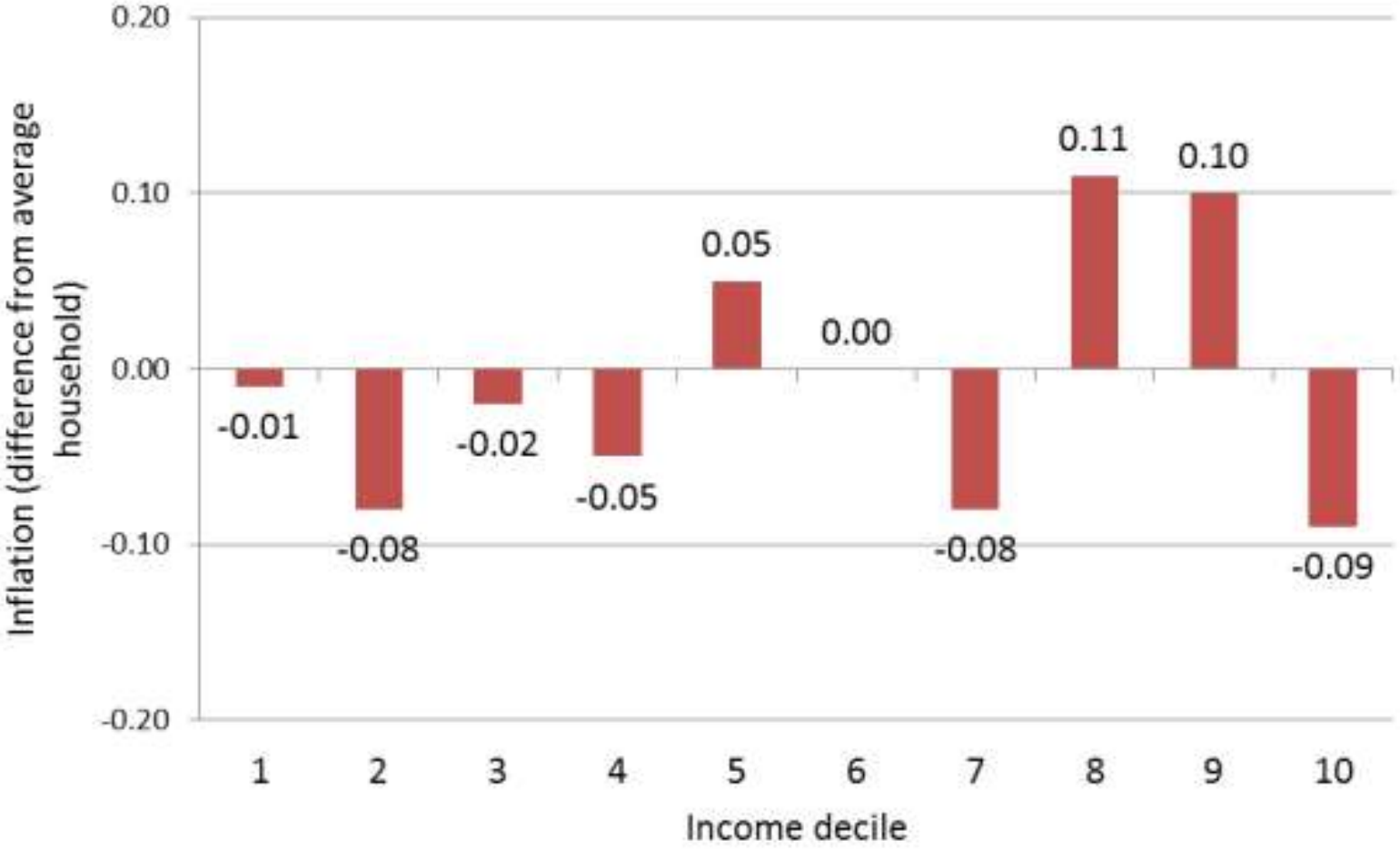
  1. Inclusion of distribution costs in calculation of import shares Details
  2. Interact import shares with observed exchange rate changes Details

Distributional effects

- Share of expenditure allocated to different product groups varies by household
- Use this variation to calculate effect of referendum on inflation for different household types
- Distributional consequences are independent of general equilibrium effects

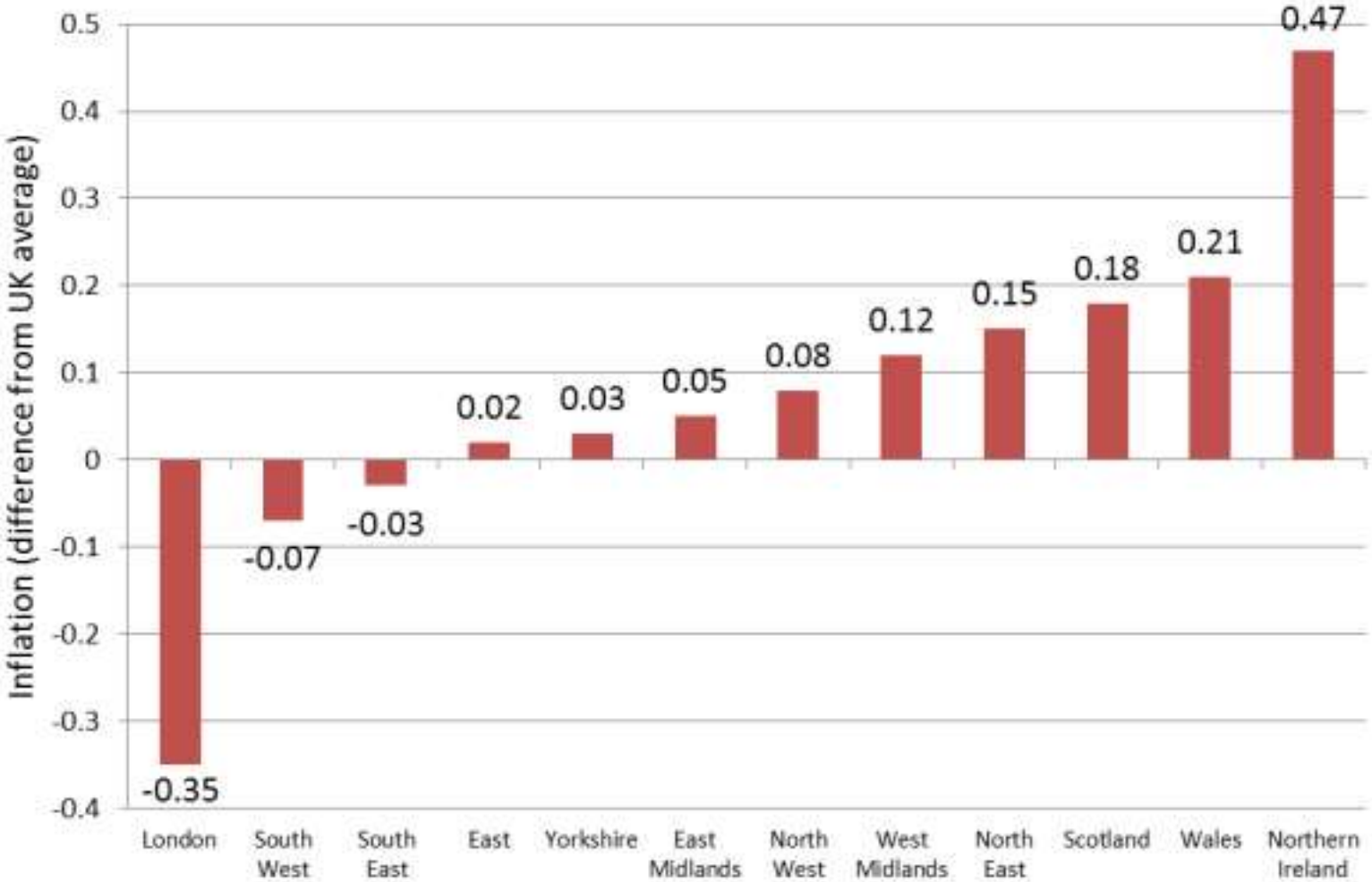
Income deciles

Inflation costs of Brexit vote evenly shared across the income distribution



Regions

Scotland, Wales and Northern Ireland hit hardest – higher expenditure on food, drink, and fuel, lower expenditure on rent



Conclusions

- Brexit vote was an unanticipated negative shock to the UK economy
- Product groups with larger import shares have experienced higher inflation since the vote
- Estimates imply referendum increased inflation by 1.7 percentage points in the year to June 2017
- UK households are already paying a price for voting to leave the EU (see also Born, Müller, Schularick & Sedláček 2017 for GDP costs)

Distribution costs

- Baseline estimates use import shares calculated at basic prices excluding distribution costs and taxes on products
- Suppose good g produced using distribution sector R in addition to imported and domestic goods

$$C_g = \left(M_g^{\gamma_g} D_g^{1-\gamma_g} \right)^{1-\lambda_g} R^{\lambda_g}$$

λ_g is share of distribution sector in consumer expenditure at purchasers' prices net of product taxes

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- Price growth now given by

$$\ln\left(\frac{P_{g,t}}{P_{g,t-1}}\right) = (1-\lambda_g)\gamma_g \ln\left(\frac{P_{gM,t}}{P_{gM,t-1}}\right) + (1-\lambda_g)(1-\gamma_g)\ln\left(\frac{P_{gD,t}}{P_{gD,t-1}}\right) + \lambda_g \ln\left(\frac{P_{R,t}}{P_{R,t-1}}\right)$$

- Recalculate direct import share as $(1-\lambda_g)\gamma_g$ and indirect import share to include expenditure on imported intermediate inputs used in distribution sector

Estimates with distribution costs

VARIABLES	(1) Inflation	(2) Inflation including distribution	(3) Inflation	(4) Inflation including distribution
Post x Import share	0.0709***	0.123***		
	(0.0140)	(0.0277)		
Post x Direct Import Share			0.0719***	0.123***
			(0.0126)	(0.0294)
Post x Indirect Import share			0.0850*	0.101**
			(0.0499)	(0.0493)
Oil	0.672**	0.530*	0.651*	0.559*
	(0.296)	(0.289)	(0.328)	(0.314)
Euro area inflation	0.282	0.236	0.277	0.241
	(0.201)	(0.183)	(0.206)	(0.189)
2015 dummy	-0.00510	-0.00611	-0.00525	-0.00591
	(0.00399)	(0.00394)	(0.00396)	(0.00394)
2017 dummy	-0.0146**	-0.0175**	-0.0166**	-0.0169**
	(0.00693)	(0.00868)	(0.00736)	(0.00768)
Observations	252	252	252	252
R-squared	0.491	0.467	0.491	0.476
Number of products	84	84	84	84
Product fe	YES	YES	YES	YES

Distribution cost results

- For each 10 percentage point increase in total import share, inflation estimated to be 1.2 percentage points higher in year after referendum
- Sterling depreciated by $\approx 10\%$ following referendum. Estimates consistent with 100% pass-through of exchange rate depreciation to import prices and of import costs to consumer prices
- Aggregating across product groups and attributing negative 2017 fixed effect to referendum estimates imply Brexit vote increased inflation by 1.9 percentage points in year to June 2017

Back

Exchange rate controls

- Alternative specification: interact import share with observed exchange rate changes (import-weighted)
  - Advantage: controls for pre-referendum exchange rate movements
  - Disadvantages: pre-referendum exchange rate changes not exogenous; assumes symmetry between Brexit vote effect and impact of pre-referendum exchange rate movements
- Quarterly estimates show positive effect of Import share-Exchange rate interaction with one and two lags
- Implied increase in aggregate inflation is 1.6-2.3 percentage points

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