Estimating Plant-level Marginal Costs and Mark-ups in the Turkish Manufacturing Industry

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Introduction

- Marginal cost and mark-up estimates for the Turkish manufacturing from 1990 to 2000
- Using price data for multiple inputs and outputs we first obtain material input and output price indices for all plants
- We use Olley-Pakes framework to correct for the simultaneity bias in plant level production/cost function estimates.
- Once we obtain plant-level marginal costs and mark-ups we study how they behave over time.
- We then focus on the effects of the customs union between Turkey and the European Union
- CU had an important impact on imports from the EU resulting in 23 per cent increase in import penetration from the EU from 1995 to 1998.

Trade liberalization and productivity

- Productivity gains, largely stemming from disciplining effects of imports, especially in import competing sectors (Tybout 2001).
- Intra plant improvements that are unrelated to external and internal economies of scale (Pavcnik 2002; Muendler 2002; and Hay 2001).
- Participation in international activities is associated with higher productivity (Clerides, Lach and Tybout 1998; Aw, Chen and Roberts 1997; and Kraay, Soloaga, and Tybout 2001).

Trade liberalization and productivity

- Ozler & Yılmaz (2009): Trade liberalization of 1980s and the rapid wage hikes (1988-92) explains most of the productivity gains in Turkish manufacturing industry until 1996.
- Taymaz & Yılmaz (2007): After the CU firms in the import competing sectors experienced productivity gains
- de Loecker et. al (2014) Obtain plant level marginal costs, mark-ups from production function estimates for Indian manufacturing and study how they react to trade liberalization.

Plant Level Production Function

- Correlation between input levels and the unobserved firm-specific shocks is a cause for concern since Marschak and Andrews (1944)
- Production function

$$y_t = \beta_0 + \beta_p l_t^p + \beta_a l_t^a + \beta_m m_t + \beta_e e_t + \beta_k k_t + \epsilon_t \qquad (1)$$

  where $\epsilon_t = \omega_t + \eta_t$.
- Simultaneity bias arises when there is contemporaneous correlation between shocks to the production function (ϵ_t) and the inputs over firms and time.
- Olley and Pakes(1996) introduces a framework that addresses the simultaneity bias problem more satisfactorily compared to the instrumental variables and within estimators.

Plant Level Cost Function

- We focus on the dual cost minimization problem:

$$c_t = \beta_0 + \frac{\beta_p}{\tilde{\beta}} w_t^p + \frac{\beta_a}{\tilde{\beta}} w_t^a + \frac{\beta_e}{\tilde{\beta}} p_t^e + \frac{\beta_m}{\tilde{\beta}} p_t^m + \frac{\beta_k}{\tilde{\beta}} k_t + \frac{1}{\tilde{\beta}} y_t + \epsilon_t \quad (2)$$

  where $\tilde{\beta} = \beta_p + \beta_a + \beta_e + \beta_m + \beta_k$

- OP uses investment as a proxy for the cost term ω_t which controls for the part of the error correlated with inputs, where investment demand function is then written as follows:

$$i_t = i_t(\omega_t, k_t) \quad (3)$$

- For positive values of investment $i_t(\omega_t, k_t)$ is inverted to yield ω_t as a function of capital and investment, $\omega_t(i_t, k_t)$.

Plant Level Cost Function

- We can now rewrite the short-run variable cost function for firm i in year t as:

$$\tilde{c}_t = \alpha_p \tilde{w}_t^p + \alpha_e \tilde{p}_t^e + \alpha_m \tilde{p}_t^m + \alpha y_t + \phi(i_t, k_t) + \eta_t \quad (4)$$

  where

$$\phi(i_t, k_t) = \alpha_0 + \alpha_k k_t + \omega_t(i_t, k_t)$$

- Consistent parameter estimates of the coefficients on the variable inputs can then be obtained using a semi-parametric estimator instrumental variables and within estimators.

Olley-Pakes Framework - Second Stage

- A separate effect of capital on output from its effect on a plant's investment is obtained in a second stage by assuming that ω_t follows a first order Markov process and capital does not immediately respond to the innovations in production cost, which is defined as :
  $\xi_t = \omega_t - E\left[\omega_t | \omega_{t-1}\right]$
- Under these assumptions consistent estimates of β_k is obtained from the estimation of the following equation:

$$\tilde{c}_t^* = \tilde{c}_t - \alpha_p \tilde{w}_t^p - \alpha_e \tilde{p}_t^e - \alpha_m \tilde{p}_t^m - \alpha_y y_t = \alpha_k k_t + g(\omega_{t-1}) + \eta_t^* \tag{5}$$

Olley-Pakes Framework - Second Stage

where,

$$g(\omega_{t-1}) = \alpha_0 + E\left[\omega_t | \omega_{t-1}\right]$$

and

$$\eta_t^* = \xi_t + \eta_t$$

- Since a by-product of the first stage is an estimate of ω, a consistent estimate of $E\left[\omega_t | \omega_{t-1}\right]$ can be obtained and estimation of equation (4) yields consistent estimate of α_k.

Data

- Data set collected by TurkStat (Turkish Statistical Institute).
- Our sample consists of plants with 25 or more employees and private establishments.
- In the resulting sample we have 49,915 plant-years for 11,733 plants in 23 three-digit SIC industries.
- The data includes value of sales, number of employees, total wage payments, values of material inputs, electricity, fuels and investment, as well as product prices.
- We create the plant level capital stock series using a *perpetual inventory method*.
- We estimate cost functions for 13 3-digit industries.

Cost Function Estimate a la Olley-Pakes

sic3	Wage	Elect	MatInp.	Output	Capital	Nobs
311	0.0686	0.4929	0.4153	0.9575	-0.0204	2907
	(5.8)***	(26.0)***	(23.6)***	(138.4)***	(-3.2)**	
312	0.0308	0.6069	0.3326	0.9913	-0.0700	765
	(1.3)	(15.7)***	(9.4)***	(76.0)***	(-4.4)**	
321	0.1454	0.5540	0.2916	0.9512	-0.0131	4961
	(15.4)***	(38.7)***	(22.2)***	(178.5)***	(-4.4)**	
322	0.2056	0.4424	0.3470	0.9448	-0.0271	3582
	(18.4)***	(26.5)***	(22.6)***	(138.5)***	(-3.0)**	
331	0.1467	0.6294	0.1753	0.9342	-0.0181	425
	(4.23)**	(15.2)***	(6.3)***	(47.2)***	(-1.6)	
352	0.187	0.713	0.122	0.877	-0.098	774
	(6.82)***	(22.3)***	(5.39)***	(50.4)***	(-2.11)*	
356	0.0474	0.6818	0.2402	0.9585	-0.0707	1221
	2.49	25.38	11.09	78.06	-3.08	

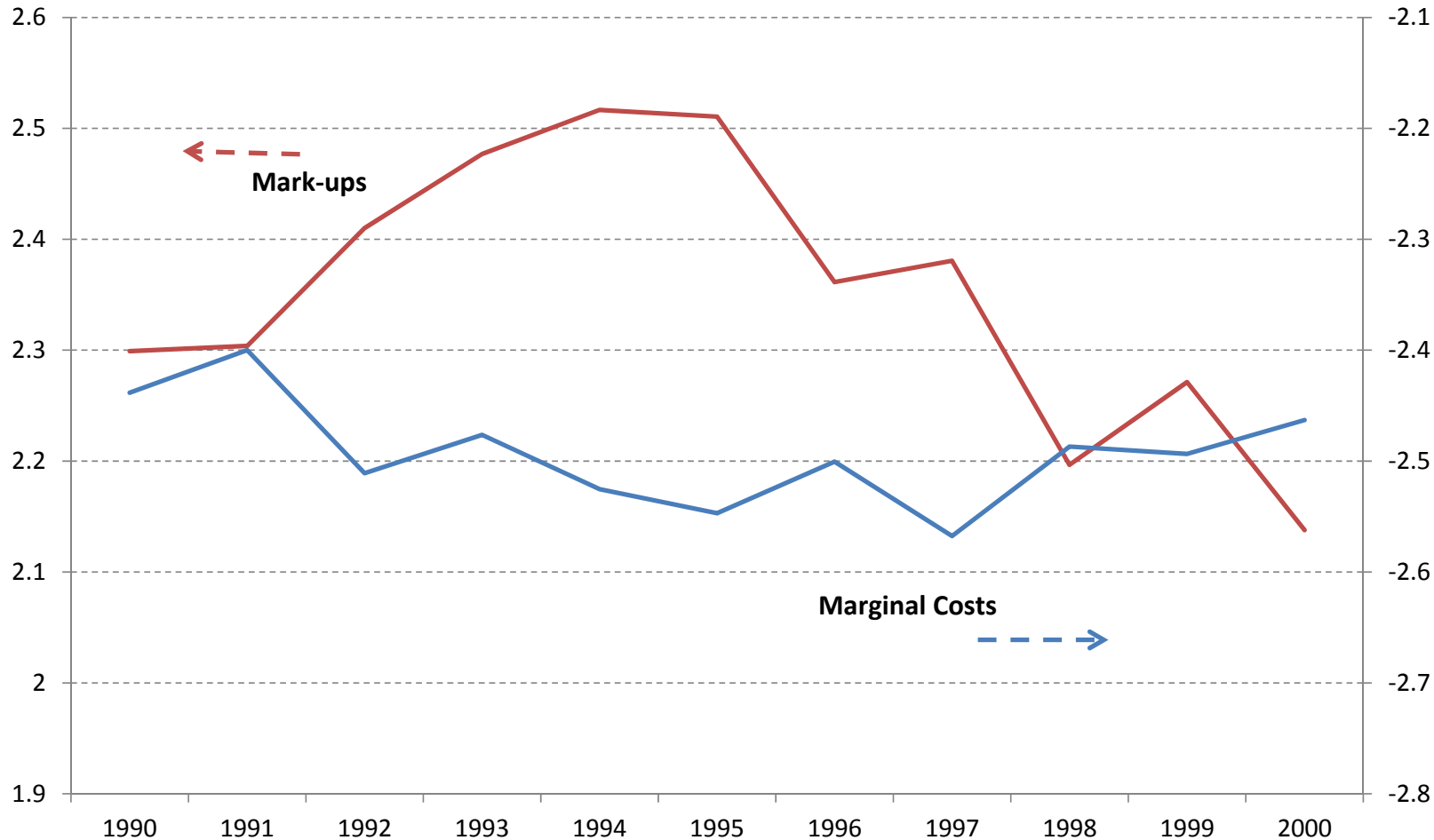
Cost Function Estimate a la Olley-Pakes

sic3	Wage	Elect	MatInp.	Output	Capital	Nobs
369	0.1636	0.7376	0.0722	0.8443	-0.0069	1239
	(8.1)***	(31.5)***	(4.9)**	(67.8)***	(-0.25)	
371	0.0140	0.6206	0.3197	1.0582	-0.0762	791
	(0.62)	(18.4)***	(11.2)***	(101.3)***	(-15.5)***	
381	0.1073	0.6847	0.2122	0.9326	-0.0145	2074
	(7.5)***	(34.9)***	(12.7)***	(103.7)***	(-2.02)*	
382	0.1414	0.6854	0.1458	0.8917	-0.0123	1493
	(7.38)***	(30.9)***	(8.8)***	(70.5)***	(-1.6)***	
383	0.1112	0.8071	0.0839	0.9404	-0.0115	1250
	(6.03)***	(40.6)***	(6.9)***	(78.4)***	(-1.5)	
384	0.0887	0.7620	0.1214	0.9655	-0.0333	1166
	(4.54)***	(29.5)***	(6.2)***	(75.6)***	(-4.4)**	

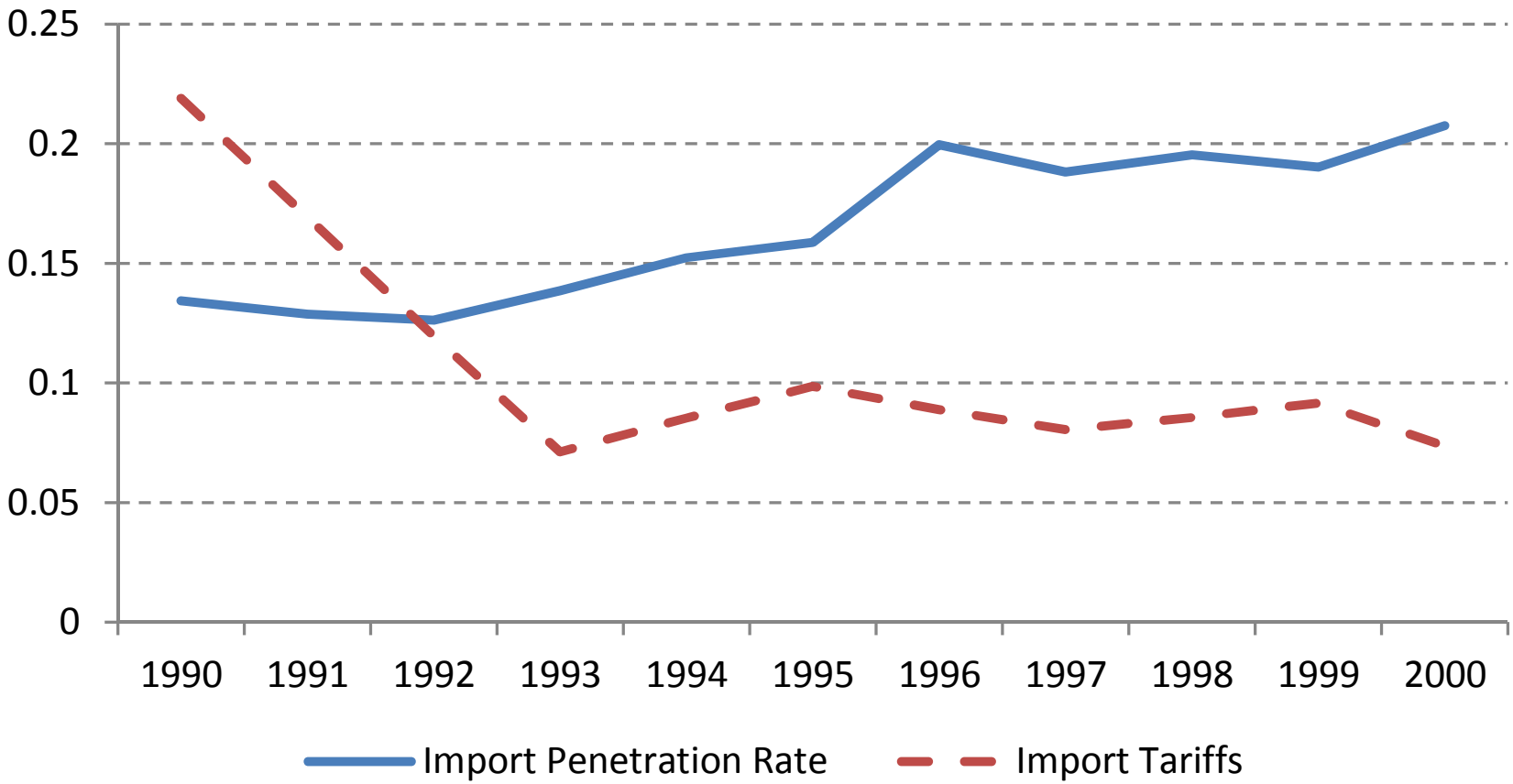
White-Collar Wages Coefficient and CRS Hypothesis

Sector	White-Collar Wage	Constant Returns to Scale Hypothesis
311	0.023**	0.958**
312	0.029+	0.991
321	0.009	0.951**
322	0.005	0.945**
331	0.049*	0.934**
352	-0.022	0.877**
356	0.031**	0.959**
369	0.026*	0.844**
371	0.045**	1.058**
381	-0.004	0.933**
382	0.028*	0.892**
383	-0.002	0.940**
384	0.028*	0.965**

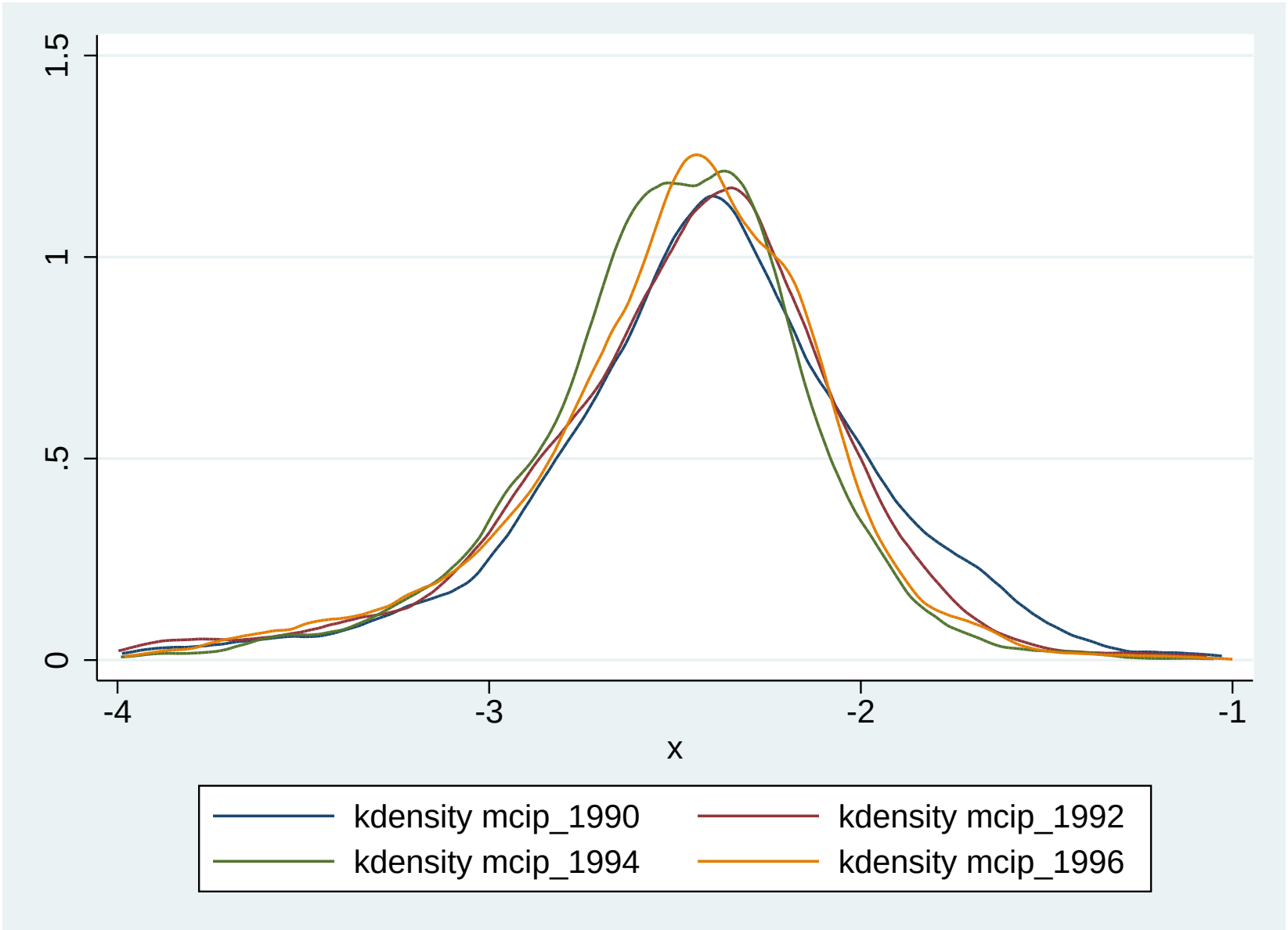
Marginal Costs and Mark-ups Over Time (1990-2000)



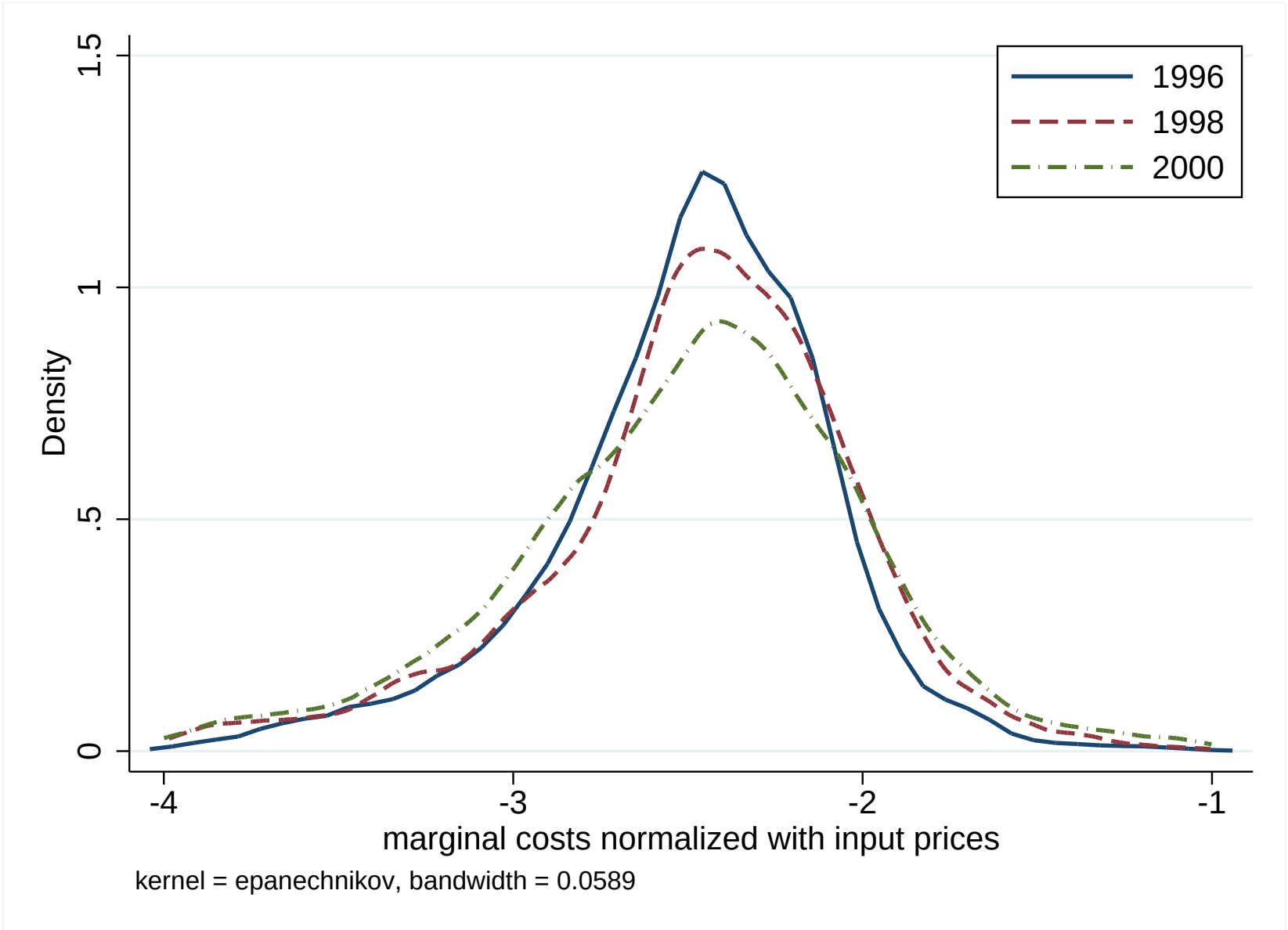
Average Tariffs and Import-Penetration (1990-2000)



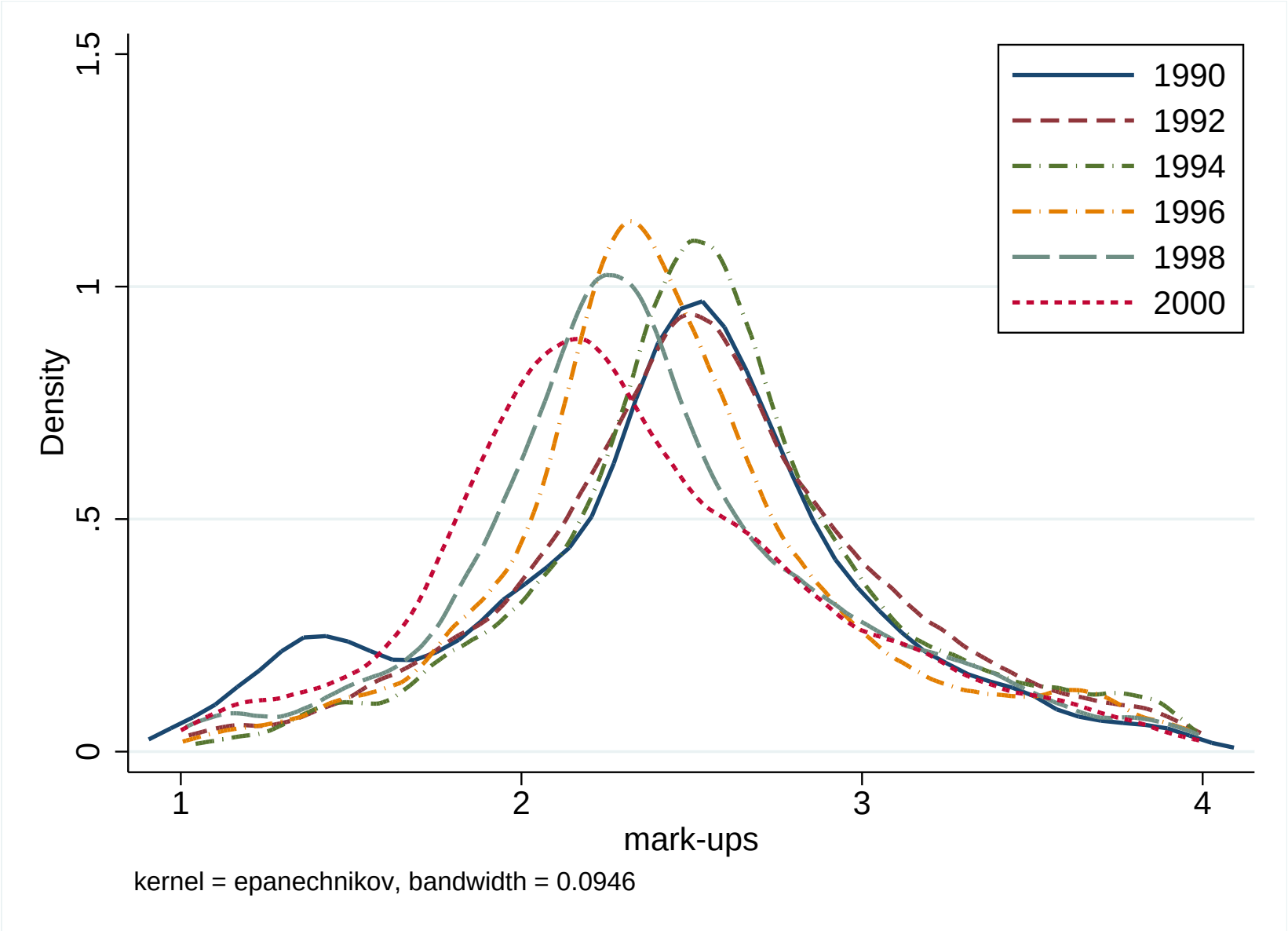
Distribution of Marginal Costs Before CU



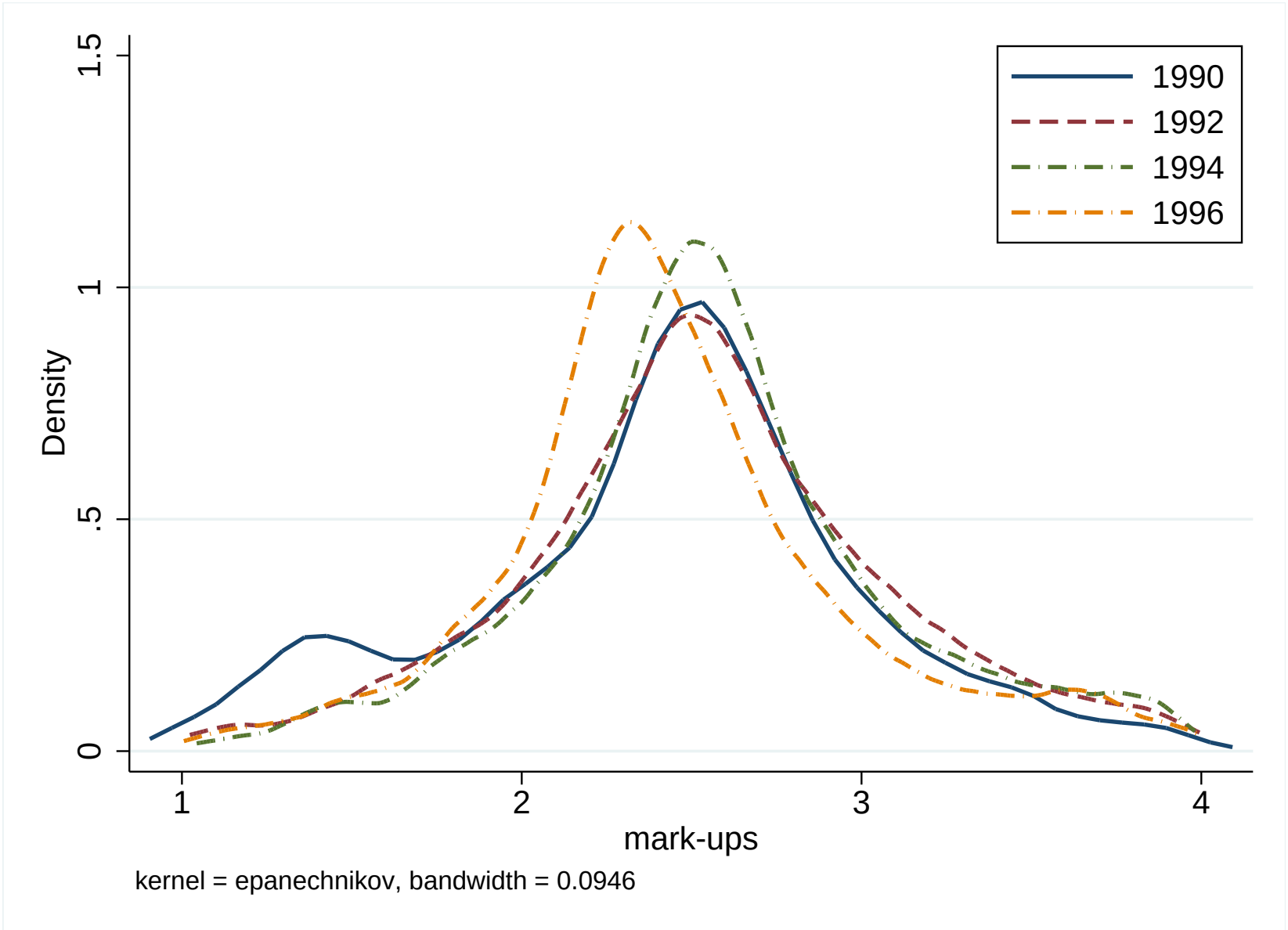
Distribution of Marginal Costs After CU



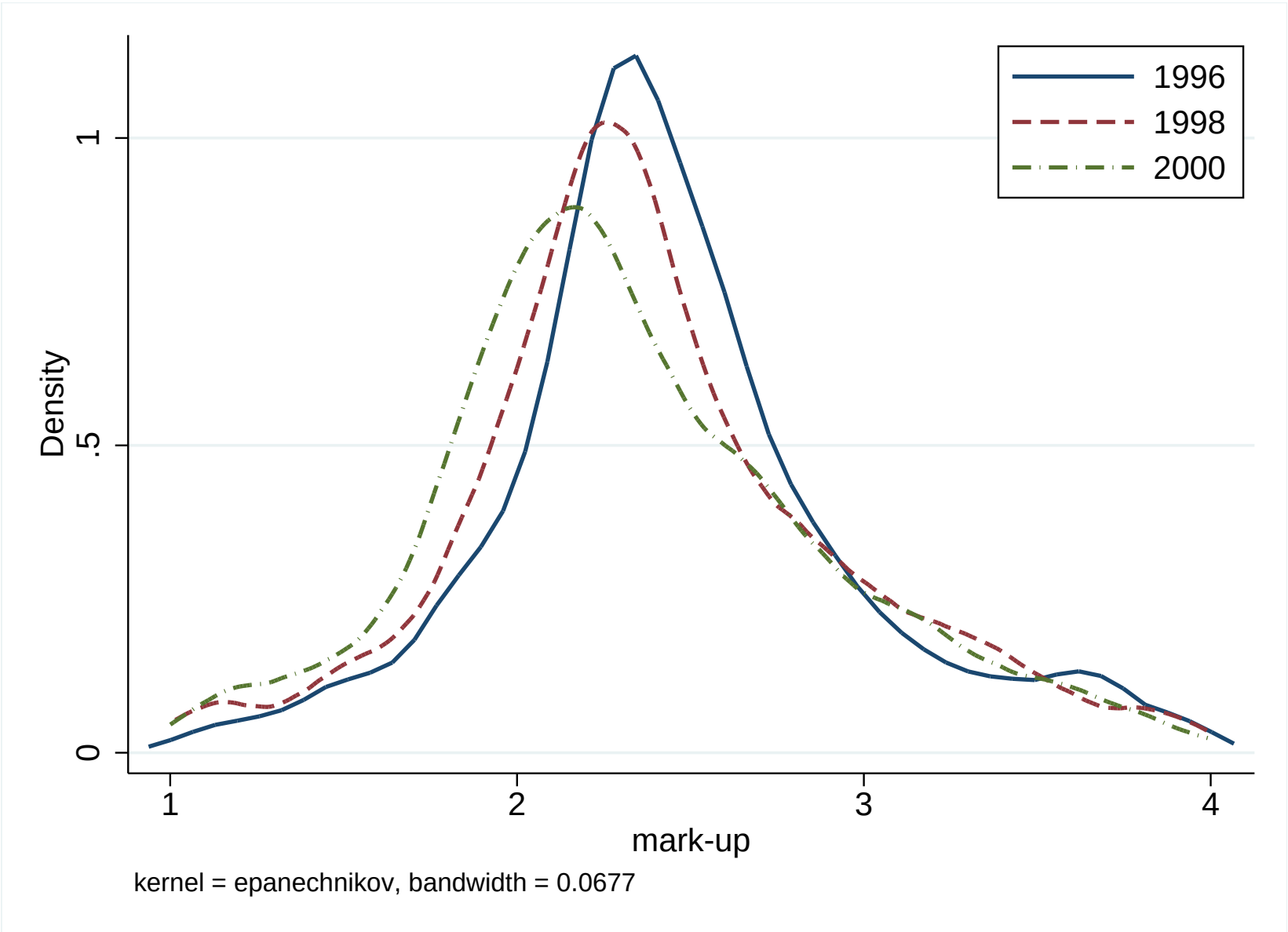
Distribution of Mark-ups (1990-2000)



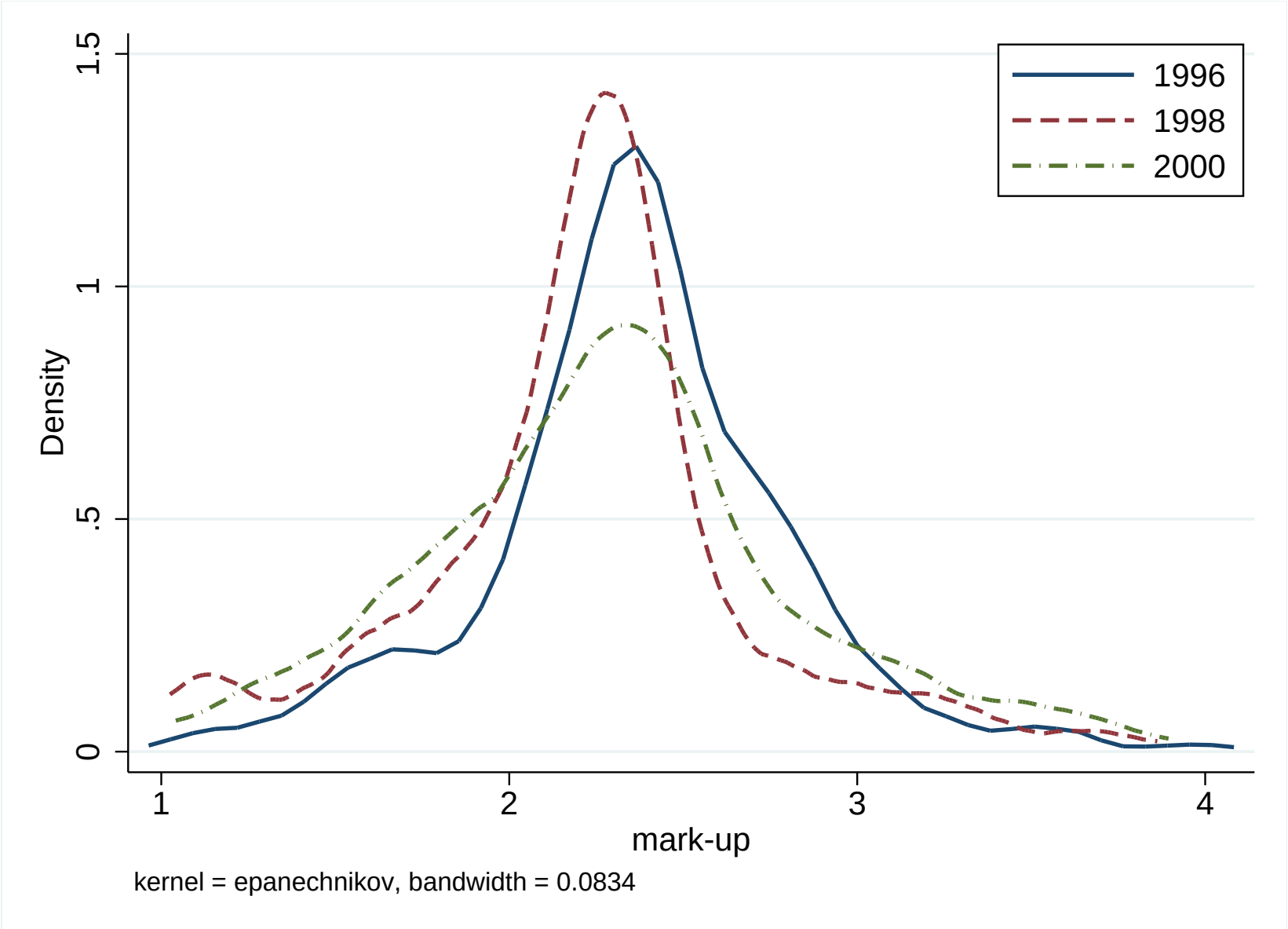
Distribution of Mark-ups Before CU



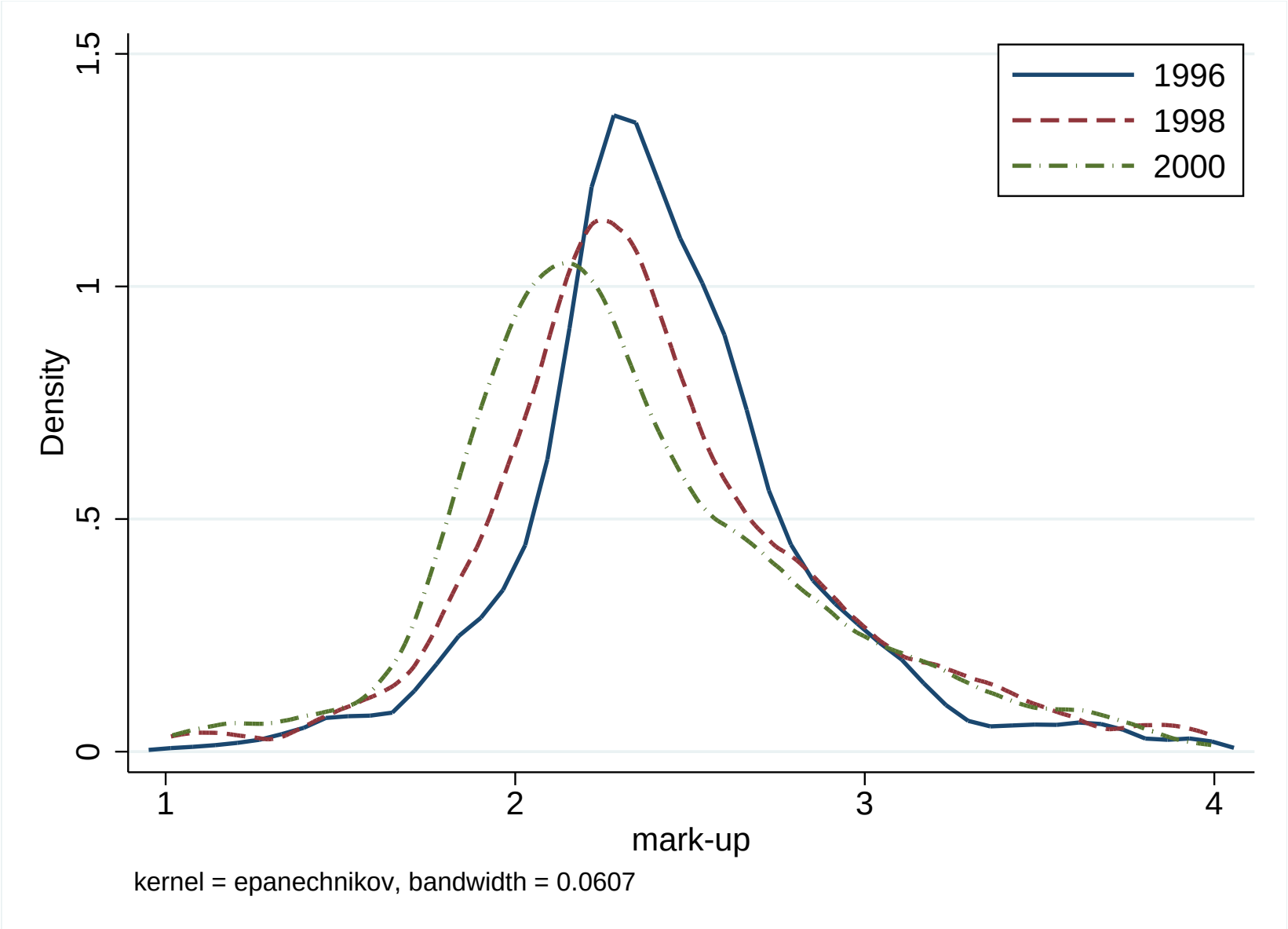
Distribution of Mark-ups After CU



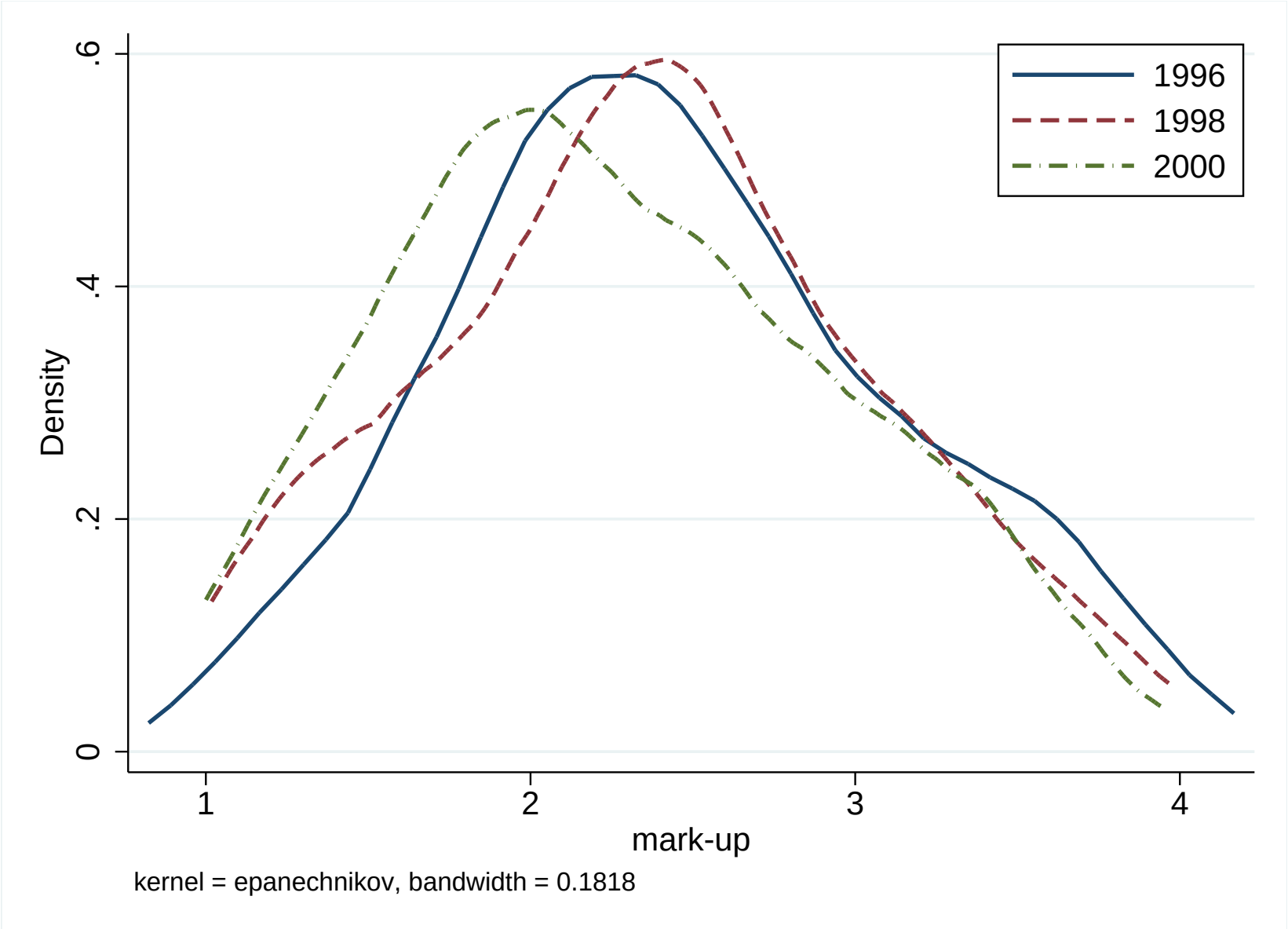
Distribution of Mark-ups after CU – Resource Intensive Sectors



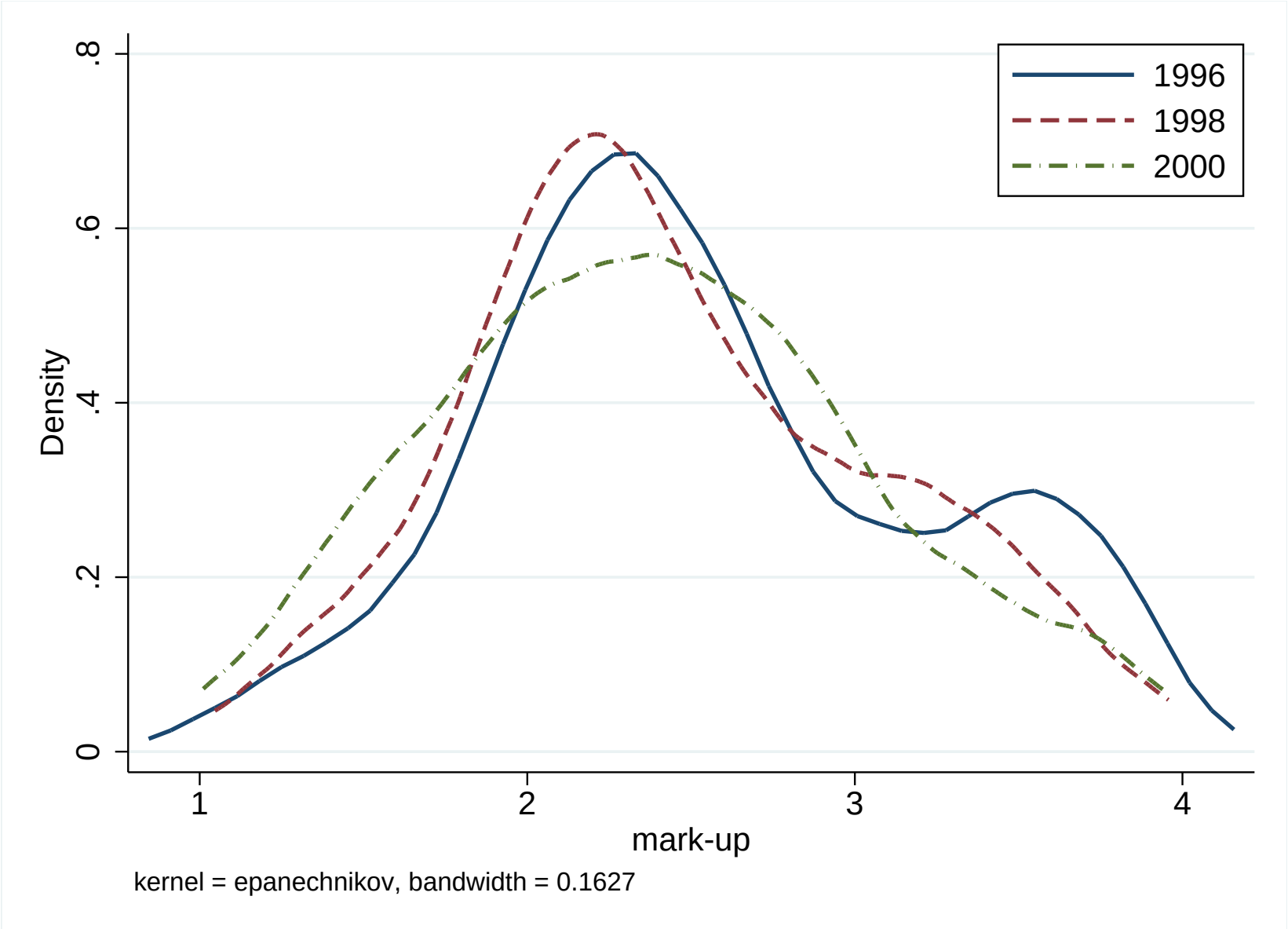
Distribution of Mark-ups after CU – Labor Intensive Sectors



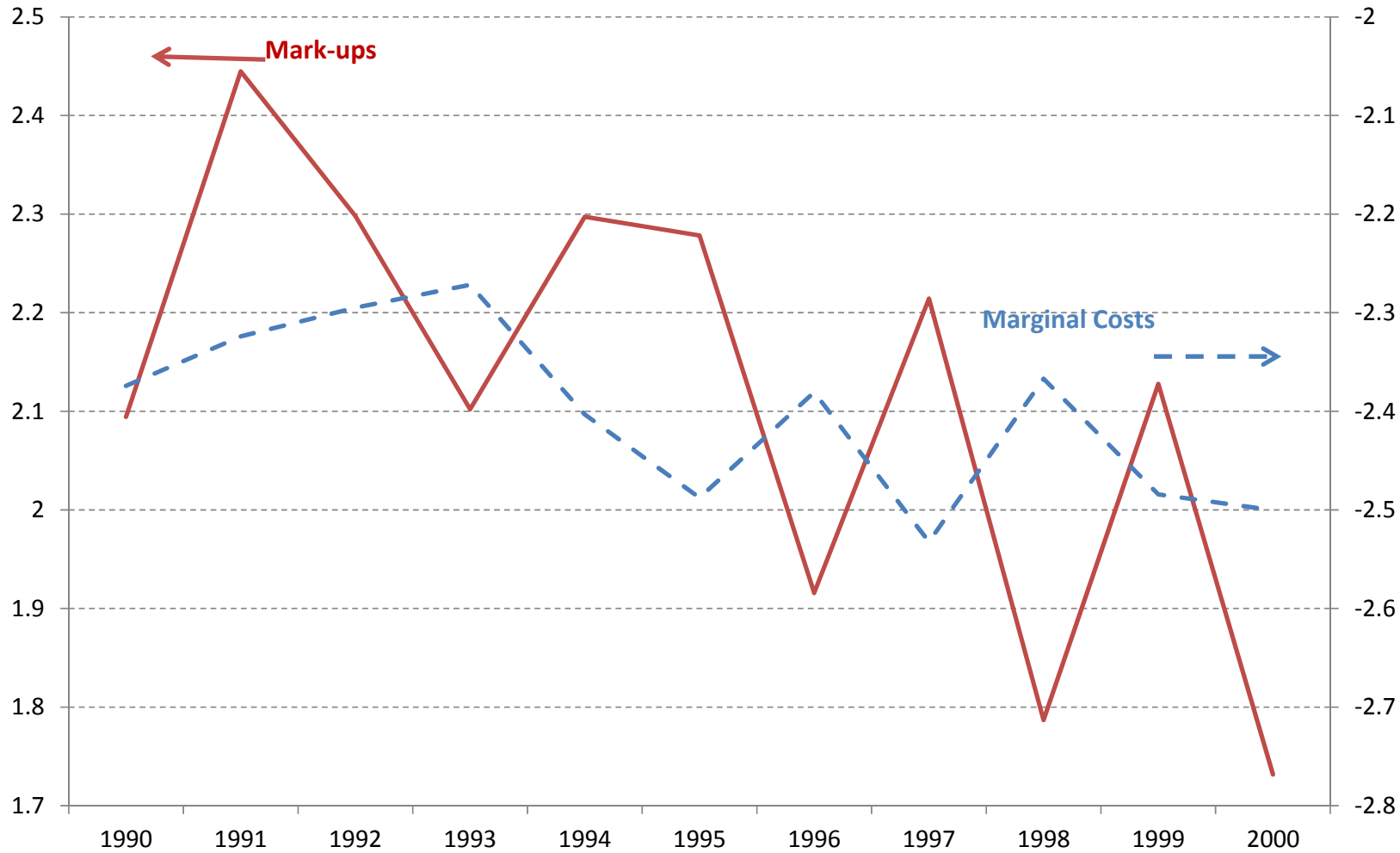
Distribution of Mark-ups after CU – Specialized Supplier Sectors



Distribution of Mark-ups after CU – Scale Intensive Sectors



Marginal Costs and Mark-ups – Auto Industry



Marginal Costs and Import Tariffs

	(1)	(2)	(3)	(4)
Current Import Tariffs	0.066		0.059	
	(0.004)**		(0.006)**	
Lagged Import Tariffs		0.063		0.056
		(0.005)**		(0.005)**
Lagged Marginal Cost			0.105	0.104
			(0.014)**	(0.014)**
R^2	0.97	0.97	0.97	0.97
N	33,802	24,452	24,452	24,452

With year and 4-digit sector dummies; * $p < 0.05$; ** $p < 0.01$

Marginal Costs - Current Explanatory Variables

Import Tariffs	0.042 (0.006)**	0.042 (0.006)**
Import Penetration Rate	0.043 (0.007)**	0.043 (0.007)**
Export-Output Ratio	-0.027 (0.006)**	-0.027 (0.006)**
Capital-Output Ratio		-0.016 (0.005)**
Share of Foreign Capital		0.001 (0.000)
Skilled Labor Share		0.013 (0.023)
Imported M&E Share		-0.012 (0.009)
Lagged MC	0.101 (0.014)**	0.101 (0.014)**
Adjusted R^2	0.98	0.98
N	24,445	24,391

Marginal Costs - Lagged Explanatory Variables

Import Tariffs	0.050	0.049
	(0.006)**	(0.006)**
Import Penetration Rate	0.028	0.029
	(0.006)**	(0.006)**
Export-Output Ratio	0.003	0.003
	(0.005)	(0.005)
Capital-Output Ratio		-0.009
		(0.005)
Share of Foreign Capital		0.000
		(0.001)
Skilled Labor Share		-0.017
		(0.024)
Imported M&E Share		-0.023
		(0.009)**
Lagged MC	0.103	0.103
	(0.014)**	(0.014)**
Adjusted R^2	0.98	0.98
N	24,444	24,386

Import tariffs and Mark-ups

	(1)	(2)	(3)	(4)
Current Import Tariffs	0.042		0.028	
	(0.014)**		(0.019)	
Lagged Import Tariffs		0.053		0.048
		(0.017)**		(0.016)**
Lagged Mark-ups			0.135	0.135
			(0.020)**	(0.020)**
Adjusted R^2	0.35	0.34	0.35	0.35
N	33,804	24,452	24,452	24,452

Mark-ups – Current Explanatory Variables

Import Tariffs	0.047 (0.022)*	0.044 (0.022)*
Import Penetration Rate	-0.096 (0.022)**	-0.096 (0.022)**
Export-Output Ratio	-0.042 (0.017)*	-0.043 (0.017)*
Capital-Labor Ratio		-0.011 (0.028)*
Foreign Share		0.039 (0.015)*
Skilled Labor Share		-0.005 (0.002)*
Imported M & E Share		-0.063 (0.072)
Lagged Mark-ups	0.134 (0.020)**	0.133 (0.020)**
Adjusted R^2	0.35	0.35
N	24,445	24,391

Mark-ups – Lagged Explanatory Variables

Import Tariffs	0.065	0.066
	(0.018)**	(0.018)**
Import Penetration Rate	-0.047	-0.049
	(0.016)**	(0.016)**
Export-Output Ratio	0.007	0.006
	(0.015)	(0.015)
Capital-Labor Ratio		0.003
		(0.028)
Foreign Share		0.028
		(0.016)
Skilled Labor Share		0.001
		(0.002)
Imported M & E Share		0.014
		(0.075)
Lagged Mark-ups	0.134	0.134
	(0.020)**	(0.021)**
R^2	0.35	0.35
N	24,444	24,386