CHAPTER 2

THE RISE OF CORPORATE MARKET POWER AND ITS MACROECONOMIC EFFECTS Online Annex

Annex 2.1. Data Sources and Sample

Data Sources and Country Coverage

All data sources used in the chapter are listed in Annex Table 2.1.1. The country coverage for the different sections is presented in Annex Table 2.1.2.

Annex Table 2.1.1. Data Sources

Indicator	Source
Gross Domestic Product, Current and Constant Prices	IMF, World Economic Outlook database; World Bank and OECD, National Accounts databases
Gross Investment, Current Prices	Penn World Tables 9.0
Corporate Net Operating Surplus	United Nations and OECD, National Accounts database
Tobin's Q, Current Prices	World Inequality Database
10-year Government Bond Rates	OECD, Main Economic Indicators database
Capital Stock, Current Prices	Penn World Tables 9.0
Market-value National Wealth, Current Prices	World Inequality Database
Labor Share of GDP	OECD, National Accounts database
National Currency per U.S. Dollar, End of Period	IMF, International Financial Statistics database
Gross Capital Formation, Current and Constant Prices	World Bank and OECD, National Accounts database
Price Level Ratio of PPP Conversion Factor (GDP) to Market Exchange Rate	World Bank, International Comparison Program database
Production (Gross Output), Deflators (sectoral)	OECD, STAN database for Industrial Analysis
Value Added, Deflators (sectoral)	OECD, STAN database for Industrial Analysis
Gross Domestic Product, Current and Constant Prices (sectoral)	CEIC
Domestic Producer Prices (Manufacturing)	Eurostat, Industry Trade and Services database
Output Price Index (Construction)	Eurostat, Industry Trade and Services database
Index of Turnover (Retail Trade)	Eurostat, Industry Trade and Services database
Index of Deflated Turnover (Retail Trade)	Eurostat, Industry Trade and Services database
Total Output Price Index (Industry)	Eurostat, Industry Trade and Services database
Gross Output Relative Prices for 2005 (Industry)	Inklaar and Timmer (2014)
Intangible Fixed Assets (firm)	Orbis
Tangible Fixed Assets (firm)	Orbis
Total Assets (firm)	Orbis
Number of Employees (firm)	Orbis
Costs of Goods Sold (firm)	Orbis
Operating Profit Loss EBIT (firm)	Orbis
Material Costs (firm)	Orbis
Costs of Employees (firm)	Orbis
Operating Revenue Turnover (firm)	Orbis
Patent Application Authority	PATSTAT
Patent Application Filing Year	PATSTAT
Patent Earliest Filing Year	PATSTAT
Patent Publication Identification	PATSTAT
Identification of Cited Patent Application	PATSTAT
Patent Publication Date	PATSTAT
Effective Federal Funds Rate (US)	Federal Reserve Economic Database
Real Personal Consumption Expenditures (US)	Federal Reserve Economic Database
Real Gross Domestic Product (US)	Federal Reserve Economic Database
Nonfarm Business Average Weekly Hours (US)	Federal Reserve Economic Database
Civilian Employment 16 Years and Over (US)	Federal Reserve Economic Database
GDP Implicit Price Deflator (US)	Federal Reserve Economic Database
Civilian Unemployment Rate (US)	Federal Reserve Economic Database
Nominal 3-month Interest Rate, Euribor (EA)	Areawide Model Database (ECB/Eurostat)
Real Consumption Expenditure (EA)	Areawide Model Database (ECB/Eurostat)
Real Gross Domestic Product (EA)	Areawide Model Database (ECB/Eurostat)
Harmonized Index of Consumer Prices, All Items Excluding Energy (EA)	Areawide Model Database (ECB/Eurostat)
Unemployment Rate, Total (EA)	Areawide Model Database (ECB/Eurostat)

Source: IMF staff compilation.
Note: Data is aggregate unless specified otherwise.

Annex Table 2.1.2. Sample of Economies Included in Analytical Exercises

Group[1]	Economies[2]	Exercise[3] I	II	III	IV
A	Austria; Belgium; Denmark; Finland; France; Germany; Greece; Italy; Ireland; Japan; Korea; Netherlands; Portugal; Spain; United Kingdom; United States.	X			
B	Austria; Belgium; Bulgaria*; Czech Republic; Denmark; Estonia*; Finland; France; Germany; Greece; Hungary*; Ireland; Italy; Japan; Korea; Latvia*; Netherlands; Poland*; Portugal; Romania*; Russia*; Slovak Republic*; Slovenia*; Spain; Turkey*; United Kingdom; United States		X	X	
C	Euro area; United States				X

Source: IMF staff compilation.

1Group of countries according to their use in different analytical exercises.

2Asterisk (*) denotes emerging market and developing economies as classified by the IMF, World Economic Outlook.

3Analytical exercises performed in the chapter: I = macroeconomic trends (Main Text Figure 2.1); II = aggregate market power trends (Main Text Figures 2.2–2.5); III = innovation (Main Text Figures 2.6, 2.7), investment (Main Text Figure 2.8), and labor share (Main Text Figure 2.10); IV = DSGE model (Main Text Figure 2.9).

Annex 2.2. Assessing Corporate Market Power: Methodologies and Further Stylized Facts

This annex provides additional technical details and facts regarding changes in market power across countries, industries, and firms.

A. Data

The main data source of the chapter is Orbis, provided by Bureau van Dijk, a Moody's Analytics company. Orbis contains information on millions of companies across the globe although the coverage varies by country. The main strength of the dataset lies in the availability of harmonized cross-country financial information for both privately held and publicly listed firms since the mid-90s. The data were obtained through the "Orbis Historical" product that provides the best time series coverage. The analysis focuses on the sample of countries for which the firms included in Orbis represent at least 40% of the total output reported in official sources. The United States is included in the sample, even when having a somewhat lower coverage in some years, given its relevance in the global economy.[1] In addition, to avoid concerns regarding the representativeness and comparability of the sample across countries, the analysis focuses on the sample of firms with an average employment greater or equal to 20 employees. For most countries the data span from 2000 to 2015. Due to data coverage, however, some countries have a slightly shorter time series: Austria, Czech Republic, Germany, Ireland, Korea, Romania, Russia, Slovak Republic, and Turkey.

The "raw" data requires intensive cleaning prior to estimation. The cleaning procedure follows closely Kalemli-Özcan and others (2015), Gopinath and others (2017) and Gal (2013). The cleaning steps first involve dealing with basic reporting mistakes (i.e., negative sales, total assets, employment, cost of employees, tangible fixed assets or liabilities; missing or zero values for the cost of materials, operating revenue, total assets and missing NACE industry code). Second, the cleaning procedure conducts further quality checks that verify the age of the firm, the ratio of short-term to long-term liabilities, the ratio of employees to capital, tangible fixed assets to total assets, capital to shareholder funds, and total assets to shareholder funds. The procedure also applies filters on the annual growth rates of sales, operating revenues and number of employees by company size category. Finally, the main balance sheet variables are deflated and PPP-adjusted (that is, adjusted by purchasing power parity) to allow cross-comparability. The details of the data construction are provided in Díez, Fan and Villegas-Sánchez (2019).

B. Measures of Market Power

Markup

A firm's markup is defined as the ratio of the price (P) to the marginal cost (MC). Empirically, it is challenging to estimate for many reasons, one of which being that most firm-level databases (including ORBIS) do not include information on firm-level prices. The analysis follows De

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[1] Despite the lower coverage, the results for the United States are consistent with those obtained in recent studies using more comprehensive data; see De Loecker, Eeckhout and Unger (2018).

Loecker and Warzynski (2012), who derive the following expression for the markup (μ_{it}) from the firm's cost-minimization problem:

$$\mu_{it} = \frac{P_{it}}{MC_{it}} = \frac{\partial F_{it}(\cdot)}{\partial V_{it}} \frac{V_{it}}{F_{it}(\cdot)} / \frac{P_{it}^{V_{it}} V_{it}}{P_{it} Q_{it}} = \frac{\beta_{it}^{v}}{\alpha_{it}^{v}}, \quad (2.1)$$

where *i* and *t* are the subindexes for the firm and year considered, respectively. $F_{it}(\cdot)$ is the firm's production function and V_{it} refers to any given flexible input. The firm's markup is thus estimated as the ratio of the output elasticity of the variable input considered (β_{it}^{v}) to the expenditure share of that input (α_{it}^{v}). While the latter can be readily computed, the former has to be estimated. These output elasticities are obtained from the estimation of an industry-specific (two-digit NACE Rev. 2) Cobb-Douglas production function, following the method proposed by Ackerberg, Caves and Frazer (2015). See Díez, Fan, and Villegas-Sánchez (2019) for further details on the estimation.

Firm and Country-Industry-Level Lerner Indexes

The firm-level Lerner index, or price-cost margin, is computed as:

$$l_{it} = \frac{EBIT_{it}}{OPER_{it}}, \quad (2.2)$$

where $EBIT_{it}$ refers to earnings before interest and tax and $OPER_{it}$ refers to operating revenue. In main text Figure 2.2 (middle panel), only values between -1 and 1 are kept.

The (four-digit NACE Rev. 2) country-industry-level markup is the simple average of firm-level markups in the country and industry considered.

Industry-Level Concentration

Market concentration is measured as follows. First, the ratio of sales of the top 4 firms to those of the top 20 firms is computed for each country-industry-year. Next, national concentration measures are computed by taking simple country-year averages across (four-digit) industries. Finally, the global measure reported in main text Figure 2.2 (lower panel) is the median across countries for each year.

C. Decomposition of Aggregate Markup Changes

Following the method proposed by Melitz and Polanec (2015), the change in the estimated aggregate markup is decomposed into a within-incumbent firm component and a reallocation effect, where the latter in turn captures reallocation between incumbents, firm entry and firm exit. Specifically, there are three groups of firms—continuing firms (incumbents), entrants and exiting firms (group $G = c, e, x$). Let $s_{Gt} = \sum_{i \in G} s_{it}$ be the aggregate market share of a group G of firms. The aggregate markup change between two periods 1 and 2 can then be expressed as:

$$\frac{M_2 - M_1}{\bar{M}} = \frac{M_{c2} - M_{c1}}{\bar{M}} + s_{e2}\frac{M_{e2} - M_{c2}}{\bar{M}} + s_{x1}\frac{M_{c1} - M_{x1}}{\bar{M}}$$
$$= \frac{1}{1-\overline{\widetilde{cov}_c}}\frac{\overline{M_c}}{\bar{M}}\left(\frac{\Delta\overline{\mu_c}}{\overline{M_c}} + \Delta\widetilde{cov}_c\right) + s_{e2}\frac{M_{e2}-M_{c2}}{\bar{M}} + s_{x1}\frac{M_{c1}-M_{x1}}{\bar{M}}, \tag{2.3}$$

where M is the firm-sales-weighted average markup; $\bar{M} = 1/2(M_1 + M_2)$ represents time averages of that average markup across periods 1 and 2; $\widetilde{cov} = cov\left(s, \frac{\mu}{M}\right) = cov(s, \mu)/M$ where cov denotes the covariance operator, μ is the firm's markup and s is the market share; $\overline{\widetilde{cov}_c} = 1/2(\widetilde{cov}_{c2} + \widetilde{cov}_{c1})$ representing time averages over periods 1 and 2.

Therefore, the first term in the second row shows that it is possible to split the contribution of continuing firms into two components, one reflecting within-firm changes in markup levels (via the change in their unweighted mean $\Delta\overline{\mu_c}$) and the other reflecting the change in the covariance between firms' markups and market shares (between-firm change). The latter between component reflects the impact on aggregate markups of the reallocation of market shares across continuing firms (incumbents).

D. Characteristics of High-Markup Firms

The chapter reports several characteristics of high-markup firms (top decile of the firm-average markup distribution) vis-à-vis other firms, such as their productivity, profitability or propensity to invest in intangible assets. Simple econometric analysis confirms that these characteristics hold not only in general (unconditionally, as shown in Figure 2.5 in the chapter) but also within narrowly-defined industries in each country.

Annex Table 2.2.1. Characteristics of High-Markup Firms

Conditional correlations between markups and individual firm characteristics

	(1) log (TFP)	(2) Lerner	(3) Intangibles
High Markup	0.181***	0.028***	0.025***
	(0.000)	(0.000)	(0.002)
Log Operating Revenue	0.035***	0.005***	0.058***
	(0.000)	(0.000)	(0.000)
Country-Industry[1] Fixed Effects	Yes	Yes	Yes
Number of Observations	6,089,141	6,088,230	6,065,734
R^2	0.980	0.160	0.460

Source: IMF staff calculations.

Note: The dependent variable in column (1) is the natural logarithm of total factor productivity (TFP); the dependent variable in column (2) is the Lerner index computed as the ratio of EBIT to Operating Revenue (EBIT: Earnings Before Interests and Taxes); the dependent variable in column (3) is a dummy variable that takes the value one if the firm reports positive values of intangible fixed assets. High Markup is a dummy varaible that takes the value of one for those firms in the top ten percent of the average markup distribution over the period. Sample is of annual frequency from 2000 to 2015. See Annex Table 2.1.2 for countries in sample. Standard errors clustered at the firm level.

Standard errors in parentheses. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

[1]Industries are NACE revision 2 4-digit sectors.

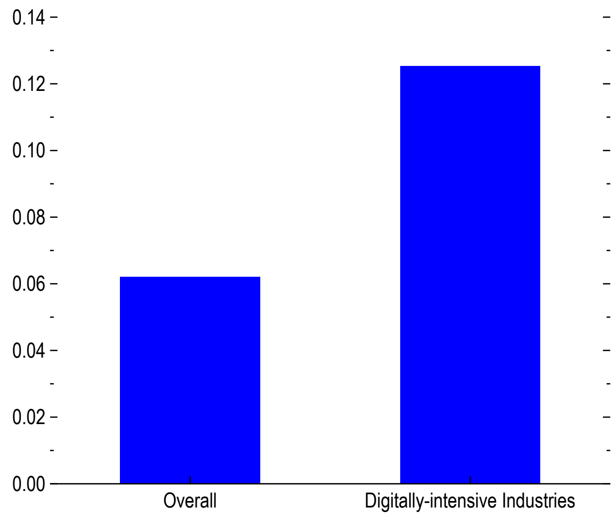
Annex Table 2.2.1 shows that the positive association between being a high-markup firm and being more productive, more profitable, and more intensive in the use of intangible assets is also found in an econometric setup that controls for firm size as well as for country-industry-year fixed effects. Indeed, the results show that within narrowly-defined industries in each country, high-markup firms are on average 18 percent more productive, 2.8 percent more profitable and 2.5 percentage points more likely to invest in intangible fixed assets. All of these correlations are statistically significant at the one percent confidence level.

E. Markup Increases in Digitally-Intensive Industries versus Others

Industries are identified as digitally-intensive based on measures put together by Calligaris, Criscuolo and Marcolin (2018). In particular, an industry is considered to make intensive use of digital technologies if it ranks in the upper half of the cross-industry distribution in at least three of the following categories: Software investment, ICT tangible investment, Intermediate ICT goods, Intermediate ICT services, and Robot use. Building on this definition, Annex Figure 2.2.1 shows that firm markups have risen about twice as much in digitally-intensive industries than in the average industry since 2000.[2]

Annex Figure 2.2.1. Markup Increases in Digitally-Intensive versus All Industries

(Percentage change, cumulative 2000–15)



Source: Orbis; and IMF staff calculations.
Note: Bars plot the markup increase for the overall sample and for firms in digitally-intensive sectors. Digital intensity based on Calligaris, Criscuolo, and Marcolin (2018).

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[2] While the markups presented in Annex Figure 2.2.1 are derived from a production function where capital only includes tangible fixed assets, qualitatively similar results are obtained when intangible assets are also included in the measure of capital.

Annex 2.3. Assessing the Macroeconomic Implications of Rising Market Power: Methodological Details and Results

This annex provides additional details on the analysis of the macroeconomic implications of changes in markups for: innovation (Section A); investment (Section B); inflation, interest rates, the effects of the 2008 global financial crisis and the slope of the Phillips curve (Section C); labor income shares (Section D); and international spillovers (Section E).

A. Innovation

Patent Data

The measure used for innovation is the number of patents per firm-year. Data on patents come from PATSTAT, a database maintained by the European Patent Office that contains information of firm patenting around the world. Bureau van Dijk provides a link between Orbis' firm identifier and every patent application filing available in PATSTAT; this link is used to construct firm-level patent stocks.

Following the literature, the analysis takes into account patent quality by weighing each individual patent by the number of citations it received.[1] Further, the analysis typically focuses on the so-called triadic patents, that is, those patents registered in the world's three main patent offices, namely the European Union, Japan and the United States. Triadic patents are generally considered to be of comparatively higher quality.

Regression Analysis

The empirical analysis is conducted at two levels, country-industry and firm. In both cases, a quadratic specification is considered.

At the country-industry level, the average number of citation-weighted patents is regressed on the lagged value of a measure of market power, the lagged value of the square of that measure, as well as country-year and country-sector fixed effects. Two alternative measures of market power are considered, namely the Lerner index and the markup. Following Aghion and others (2005), among other studies, patents are assumed to follow a Poisson process. Therefore, the following Poisson regression is estimated:

$$E[P_{jct}|mp_{jct-1}] = \exp\{\beta_1 * mp_{jct-1} + \beta_2 * mp_{jct-1}^2 + \gamma_{ct} + \gamma_{cj}\}, \tag{2.4}$$

where j indexes industries, c countries, and t years. The dependent variable P denotes average citation-weighted patents; the main explanatory variable of interest mp is the market power measure (either the logarithm of the average markup or the average Lerner index), and γ_{ct} and γ_{cj} represent country-year and country-industry fixed effects, respectively.

[1] More precisely, each patent's weight is the number of citations received from outside the so-called patent family.

The results are presented in Annex Table 2.3.1, where the first two columns present regressions on the full sample of patents—those that have been filed anywhere in the world—while the last two columns show results only for the sample of "triadic" patents mentioned above. Column (4) provides the baseline regression used to generate the hump-shaped relationship shown in the chapter. Indeed, the regression results in the Table support the hump-shaped hypothesis for both measures of market power and both sets of patents considered; the coefficients on market power and its square are positive and negative, respectively, and statistically significant at conventional confidence levels.

Similar analysis is carried out at the firm level, with comparable findings (Annex Table 2.3.2). The specification features a stricter set of fixed effects as it always includes firm fixed effects and, in some specifications, country-industry-year fixed effects (using the 4-digit industry classification) as well. The regressions also include lagged firm size (the logarithm of real operating revenue) as an additional control. Columns (1) and (3) present the Ordinary Least Squares (OLS) results while columns (2) and (4) present the Poisson findings. The OLS specifications yield very similar results, despite the difference in the sets of fixed effects considered—country-year and industry-year in column (1) or the strictest set of fixed effects, country-industry-year, in column (3). Column (2), the Poisson specification with the strict set of fixed effects, is the baseline specification used to analyze the implications of markup increases for innovation in the chapter. The last column uses a control function approach to control for potential endogeneity—reverse causality in particular. The instrument for a firm's (logarithm of the) markup is the logarithm of the median markup across all other firms in the same country-industry-year, other than the one being instrumented. Given the instrument choice, the regression has country-year and industry-year fixed effects rather than country-industry-year

Annex Table 2.3.1. Market Power and Innovation: Sector-Level Analysis

	(1) Citation Weighted Patents	(2) Citation Weighted Patents	(3) Citation Weighted Patents in Triadic	(4) Citation Weighted Patents in Triadic
1-year Lagged Lerner	6.373***		7.977***	
	(1.384)		(1.859)	
1-year Lagged Lerner Squared	-43.196***		-51.832***	
	(10.925)		(14.221)	
1-year Lagged Log Markup		4.016**		4.629**
		(1.713)		(1.890)
1-year Lagged Log Markup Squared		-3.123**		-4.665**
		(1.428)		(1.902)
Country-Year Fixed Effects	Yes	Yes	Yes	Yes
Country-Industry[1] Fixed Effects	Yes	Yes	Yes	Yes
Number of Observations	11,735	11,735	11,735	11,735

Source: IMF staff calculations.

Note: Poisson estimation. The dependent variable in columns (1) and (2) is the average number of citation-weighted patents in the country-industry-year. The dependent variable in columns (3) and (4) is the average number of citation-weighted patents jointly filed in the European Union, Japan, and the United States in the country-industry-year. Lerner is the average EBIT-to-turnover ratio in the country-industry-year. Sample is of annual

Standard errors in parentheses. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

[1]Industries are NACE revision 2 4-digit sectors.

Annex Table 2.3.2. Market Power and Innovation: Firm-Level Analysis

	(1) log (Citation Weighted+1)	(2) Citation Weighted	(3) log (Citation Weighted+1)	(4) Citation Weighted
	OLS	Poisson	OLS	Poisson CF[1]
1-year Lagged Log Markup	0.0019**	0.7304**	0.0022***	0.732***
	(0.0006)	(0.2340)	(0.0006)	(0.199)
1-year Lagged Log Markup Squared	-0.0005*	-0.5987***	-0.0005*	-0.488**
	(0.0003)	(0.1774)	(0.0003)	(0.151)
1-year Lagged Log Operating Revenue	0.0006***	0.1242***	0.0007***	0.120***
	(0.0001)	(0.0227)	(0.0001)	(0.018)
1-year Lagged Residual				-0.047
				(0.083)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Country-Industry[2]-Year Fixed Effects	Yes	Yes	No	No
Country-Year Fixed Effects	No	No	Yes	Yes
Industry[2]-Year Fixed Effects	No	No	Yes	Yes
First-Stage F-statistics above 10				Yes
Number of Observations	4,723,475	4,723,475	4,723,475	4,723,475

Source: IMF staff calculations.

Note: The dependent variable in columns (1) and (3) is one plus the logarithm of the number of citation-weighted patents filed jointly in the European Union, Japan, and United States. In columns (2) and (4) the dependent variable is the number of citation-weighted patents filed jointly in the European Union, Japan, and the United States. The instrumental variable for lagged logarithm markup is the lag of the logarithm median markup in a firm's country-industry[2]-year, while excluding that firm. Sample is of annual frequency from 2000 to 2015. See Annex Table 2.1.2 for countries in sample. Standard errors clustered at the firm level.

Standard errors in parentheses. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

[1]The instrumental variable for lagged markups is the lag of median markups in a firm's country-sector-year, while excluding that firm.

[2]Industries are NACE revision 2 4-digit sectors.

fixed effects; as the first two columns show, however, results vary very little depending on which of these sets of fixed effects is used. The control function procedure consists of two stages. In the first stage, the logarithm of the markup is regressed on the instrument, firm size, and the two sets of fixed effects; the F-statistic indicates that these first-stage (OLS) estimates are strong. The second stage consists of a Poisson regression as before, but now including the residuals from the first-stage regression as an additional regressor. Overall, while the point estimates change slightly between columns, the results provide further support to the hump-shaped relationship between market power and innovation.

B. Investment

Regression Analysis

The regression underlying the estimation of the effects of markups on investment is the following firm-level OLS specification:

$$I/Y_{ijct} = \beta_1 + \beta_2 * markups_{ijct-1} + \beta_3 * \ln size_{ijct-1} + \theta_i + \gamma_{cjt} + \varepsilon_{ijct}, \qquad (2.5)$$

where i indexes firms, j industries (4-digit NACE Rev. 2 classification), c countries, and t years. The dependent variable, I/Y, is net tangible investment divided by value added, which is (tangible assets$_t$ – tangible assets$_{t-1}$). This definition of the net investment rate has the advantage of being consistent with the theoretical prediction that it should be permanently lower if the markup is permanently higher; by contrast, the ratio of net tangible investment to tangible assets should be affected only temporarily (see the DSGE model presented in Section C below, for example). The main explanatory variable is the (first lag of the) firm's markup—the same measure employed in the innovation analysis. The regression also controls for firm size, measured by (the logarithm of) real operating revenue, as well as firm and country-industry-year fixed effects. While the rich set of fixed effects goes a long way toward addressing potential endogeneity issues, instrumental variable techniques are also employed. The instrument considered is the same as in the innovation analysis, namely the median markup across all other firms in the same country, industry (4-digit NACE) and year.[2] OLS and IV results are statistically and quantitatively comparable, as shown in Annex Table 2.3.3. Column (1) provides the estimates used in the calculations of the investment

Annex Table 2.3.3. Markups and the Ratio of Investment to Value Added

	(1) OLS	(2) OLS	(3) IV[1]
1-year Lagged Markup	-0.062***	-0.059***	-0.093***
	(0.003)	(0.003)	(0.021)
1-year Lagged Log Operating Revenue	-0.029***	-0.027***	-0.033***
	(0.001)	(0.001)	(0.004)
Firm Fixed Effects	Yes	Yes	Yes
Country-Industry[2]-Year Fixed Effects	Yes	No	No
Country-Year Fixed Effects	No	Yes	Yes
Industry[2]-Year Fixed Effects	No	Yes	Yes
First Stage F-statistic			101.7
Number of Observations	2,510,177	2,530,445	2,520,465
R^2	0.347	0.310	0.002

Source: IMF staff calculations.
Note: Dependent variable = net investment in tangible assets / value added. IV = instrumental variable. OLS = ordinary least squares. Sample is of annual frequency from 2000 to 2015. See Annex Table 2.1.2 for countries in sample.
Robust standard errors in parentheses. * p < 0.10; ** p < 0.05; *** p < 0.01.
[1]The instrumental variable for lagged markups is the lag of median markups in a firm's country-industry[2]-year, while excluding that firm.
[2]Industries are NACE revision 2 4-digit sectors.

[2] Robustness checks were performed using 5-year lags as well and the results are qualitatively the same.

effects of markup increases in the chapter. As in the innovation analysis, given the instrument choice, the IV regression in column (3) has country-year and industry-year fixed effects rather than country-industry-year fixed effects; as the first two columns show, however, results vary very little depending on which of these sets of fixed effects are used. Annex Table 2.3.4 presents the first stage IV regression. The F-test is well above 10, which confirms the strength of the instrument.

Annex Table 2.3.4. Markups and Ratio of Investment to Value Added IV Results: First and Second Stages

	(1) IV[1] First Stage	(2) IV[1] Second Stage
1-year Lagged Median Markup	0.156***	
	(0.015)	
1-year Lagged Log Operating Revenue	-0.180***	-0.033***
	(0.002)	(0.004)
1-year Lagged Markup		-0.093***
		(0.021)
Firm Fixed Effects	Yes	Yes
Country-Year Fixed Effects	Yes	Yes
Industry[2]-Year Fixed Effects	Yes	Yes
First Stage F-statistic		101.7
Number of Observations	2,520,465	2,520,465
R^2		0.002

Source: IMF staff calculations.

Note: In first stage, dependent variable is markups. Second stage dependent variable is net investment in tangible assets / value added. IV = instrumental variable. Sample is of annual frequency from 2000 to 2015. See Annex Table 2.1.2 for countries in sample.

Robust standard errors in parentheses. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

[1]The instrumental variable for lagged markups is the lag of median markups in a firm's country-industry[2]-year, while excluding that firm.

[2]Industries are NACE revision 2 4-digit sectors.

Within versus Between Effects of Markups on Investment

The main analysis of investment relies on within-firm estimation. While this specification implies a stronger identification strategy, it discards by design any changes in the aggregate investment from the possible reallocation of investment away from low-markup high-investment rate firms to high-markup low-investment rate ones. As a quick check for the presence of such between-firm reallocation effect in the sample of firms used in the chapter, the OLS regression above is re-run with alternative sets of fixed effects. In particular, a comparison of regressions with and without firm fixed effects can shed some light on the relative importance of the within and between components of the overall relationship between markups and investment. The regressions (Annex Table 2.3.5) without firm fixed effects yield a (negative) coefficient on the markup variable that is several times smaller in magnitude than the coefficient obtained when estimating the same regression with firm fixed effects; this tentatively suggests that the within component plays a larger role in explaining the overall relationship between markups and investment.

Annex Table 2.3.5. Markups and Ratio of Investment to Value Added: Fixed Effects Decomposition

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS
1-year Lagged Markup	-0.000	0.002***	-0.000	0.001	0.002***	-0.074***	-0.062***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)
1-year Lagged Log Operating Revenue	-0.002***	0.001***	-0.004***	0.000	0.000	-0.041***	-0.029***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Firm Fixed Effects	No	No	No	No	No	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	No	No	No
Country Fixed Effects	No	Yes	No	No	No	No	No
Industry[1] Fixed Effects	No	No	Yes	No	No	No	No
Country-Year Fixed Effects	No	No	No	No	No	No	No
Country-Industry[1] Fixed Effects	No	No	No	Yes	No	No	No
Industry[1]-Year Fixed Effects	No	No	No	No	No	No	No
Country-Industry[1]-Year Fixed Effects	No	No	No	No	Yes	No	Yes
Number of Observations	2,598,549	2,598,549	2,598,539	2,598,035	2,578,439	2,530,960	2,510,177
R^2	0.063	0.075	0.068	0.089	0.188	0.194	0.347

Source: IMF staff calculations.

Note: Dependent variable = net investment in tangible assets / value added. OLS = ordinary least squares. Sample is of annual frequency from 2000 to 2015. See Annex Table 2.1.2 for countries in sample.

Robust standard errors in parentheses. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

[1]Industries are NACE revision 2 4-digit sectors.

Robustness Exercises and Extensions

Results are robust to controlling for cash flows (scaled by total assets), and leverage (debt by total asset) in addition to firm size (Annex Table 2.3.6). While cash flows have a positive and statistically significant effect on investment, high leverage has a negative impact.

Instead of the ratio of investment to value added (I/Y), an alternative approach is to focus on the change in tangible assets relative to previous year's stock of tangible assets (I/K). The results from these regressions, which are presented in Annex Table 2.3.7, are qualitatively similar to those obtained when using I/Y.

Annex Table 2.3.6. Markups and Ratio of Investment to Value Added: Extra Control Variables

	(1) OLS	(2) OLS	(3) IV[1]
1-year Lagged Markup	-0.060***	-0.057***	-0.105***
	(0.003)	(0.003)	(0.023)
1-year Lagged Log Operating Revenue	-0.032***	-0.030***	-0.038***
	(0.001)	(0.001)	(0.004)
1-year Lagged Cash Flow / Total Assets	0.056***	0.056***	0.058***
	(0.010)	(0.012)	(0.012)
1-year Lagged Leverage	-0.137***	-0.136***	-0.130***
	(0.002)	(0.002)	(0.004)
Firm Fixed Effects	Yes	Yes	Yes
Country-Industry[2]-Year Fixed Effects	Yes	No	No
Country-Year Fixed Effects	No	Yes	Yes
Industry[2]-Year Fixed Effects	No	Yes	Yes
First Stage F-statistic			84
Number of Observations	2,282,040	2,302,313	2,293,587
R^2	0.359	0.321	0.004

Source: IMF staff calculations.

Note: Dependent variable = net investment in tangible assets / value added. IV = instrumental variable. OLS = ordinary least squares. Sample is of annual frequency from 2000 to 2015. See Annex Table 2.1.2 for countries in sample.

Robust standard errors in parentheses. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

[1]The instrumental variable for lagged markups is the lag of median markups in a firm's country-industry[2]-year, while excluding that firm.

[2]Industries are NACE revision 2 4-digit sectors.

Annex Table 2.3.7. Markups and Net Investment

	(1) OLS	(2) OLS	(3) IV[1]
1-year Lagged Markup	-0.118***	-0.114***	-0.101***
	(0.003)	(0.003)	(0.025)
1-year Lagged Log Operating Revenue	-0.131***	-0.129***	-0.126***
	(0.001)	(0.001)	(0.005)
Firm Fixed Effects	Yes	Yes	Yes
Country-Industry[2]-Year Fixed Effects	Yes	No	No
Country-Year Fixed Effects	No	Yes	Yes
Industry[2]-Year Fixed Effects	No	Yes	Yes
First-Stage F-statistic			115.8
Number of Observations	4,627,278	4,653,935	4,633,017
R^2	0.258	0.240	0.005

Source: IMF staff calculations.

Note: Dependent variable = net investment in tangible assets / tangible assets in previous period. IV = instrumental variable. OLS = ordinary least squares. Sample is of annual frequency from 2000 to 2015. See Annex Table 2.1.2 for countries in sample.

Robust standard errors in parentheses. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

[1]The instrumental variable for lagged markups is the lag of median markups in a firm's country-industry[2]-year, while excluding that firm.

[2]Industries are NACE revision 2 4-digit sectors.

C. Implications for Interest Rates, Inflation and Economic Slack Post-2008 Financial Crisis

This section describes the model used in the analysis of the macroeconomic effects of the rise in markups. The implications of rising markups for the slope of the Phillips curve, and the sensitivity of those results to alternative modeling assumptions, are also discussed.

Model

The model used is a New Keynesian dynamic stochastic general equilibrium (DSGE) framework with capital adjustment costs (see Jones and Philippon 2016, and Galí 2008). In this section, the set of log-linear equations is presented. Variables are expressed in log deviations from steady-state while terms without a time subscript are steady-state values.

Households

The representative household's consumption choice gives:

$$\mathrm{E}_t\lambda_{t+1} = \gamma(c_t + \mathrm{E}_t c_{t+1}) - \xi_{dt}, \tag{2.6}$$

where λ_{t+1} denotes the relative shadow value of wealth between periods *t* and *t+1*, c_t denotes consumption, γ denotes the household's intertemporal elasticity of substitution, and E_t denotes the conditional expectation operator. The term ξ_{dt} denotes an autoregressive process augmenting the household's discount factor:

$$\xi_{dt} = \rho_d \xi_{d,t-1} + \sigma_d \epsilon_{dt}. \tag{2.7}$$

A negative shock to ϵ_{dt} causes households to become more patient and the relative shadow value of future wealth increase, leading them to reduce current consumption.

The representative household's optimal choice of labor supply implies the marginal rate of substitution between labor supply and consumption is:

$$mrs_t = \phi n_t + \gamma c_t, \tag{2.8}$$

where mrs_t denotes the marginal rate of substitution, n_t denotes labor supplied, and ϕ denotes the inverse of the household's elasticity of labor supply.

The representative household's optimal choice of one-period bonds gives rise to the Euler equation:

$$\mathrm{E}_t\lambda_{t+1} + r_t - \mathrm{E}_t\pi_{t+1} = 0, \tag{2.9}$$

where r_t is the nominal interest rate on one-period bonds, and π_t is the rate of inflation.

The representative household accumulates capital k_t and lends it to goods-producing firms for use in production. Net investment x_t is:

$$x_t = \frac{i}{k}(i_t - k_t), \tag{2.10}$$

where i_t is gross investment.

From the representative household's problem, the shadow value of a unit of installed capital–Tobin's Q–satisfies:

$$q_t = \mathrm{E}_t\lambda_{t+1} + \frac{r_k}{r_k+q-\delta}\mathrm{E}_t r_{k,t+1} + \frac{q}{r_k+q-\delta}\mathrm{E}_t q_{t+1} + \xi_{qt}. \tag{2.11}$$

The term ξ_{qt} is an autoregressive process that temporarily affects the value of installed capital:

$$\xi_{qt} = \rho_q \xi_{q,t-1} + \sigma_q \epsilon_{qt}. \tag{2.12}$$

Equation (2.11) says that the shadow value of installed capital, and therefore the investment incentives of households, is high if the future shadow value of wealth is high, the expected return on capital is high, or the expected value of installed capital is high.

In log-linear terms, net investment satisfies:

$$x_t = \frac{q}{\phi_k} q_t, \tag{2.13}$$

where ϕ_k parameterizes the quadratic capital adjustment cost. The higher is the cost of capital adjustment, the less sensitive is net investment to changes in Tobin's Q.

The definition of net investment in log-linear terms is:

$$x_t = k_{t+1} - k_t. \tag{2.14}$$

The economy's log-linearized resource constraint is:

$$y_t = \frac{c}{y}c_t + \frac{i}{y}i_t. \tag{2.15}$$

Firms

Firms hire capital and labor from households to produce intermediate goods which are aggregated into final goods. Firms access a Cobb-Douglas production function:

$$y_t = \alpha k_t + (1-\alpha)n_t + \xi_{at}, \tag{2.16}$$

where α is the weight on capital in production and ξ_{at} is an autoregressive productivity process subject to an exogenous shock ϵ_{at}:

$$\xi_{at} = \rho_a \xi_{a,t-1} + \sigma_a \epsilon_{at}. \tag{2.17}$$

Firms set the return on capital $r_{k,t}$ equal to the marginal product of capital, and the real wage w_t to the marginal product of labor, which are related to the labor-capital ratio by:

$$r_{k,t} = w_t + n_t - k_t. \tag{2.18}$$

Firms' marginal costs are a weighted sum of its input costs:

$$mc_t = (1-\alpha)w_t + \alpha r_{k,t} - \xi_{at}. \tag{2.19}$$

Monetary Policy and Nominal Rigidities

Nominal rigidities arise because firms cannot freely set prices, and instead face the Calvo (1983) pricing protocol, whereby they face a probability chance of being able to reset prices. In log-linear terms, this gives rise to a standard Phillips curve in inflation π_t^p:

$$\pi_t^p = \beta \mathrm{E}_t \pi_{t+1}^p + \kappa_p mc_t + \xi_{et}. \tag{2.20}$$

The term ξ_{et} is an autoregressive process subject to an exogenous shock, which helps to account for the behavior of observed inflation:

$$\xi_{et} = \rho_e \xi_{e,t-1} + \sigma_e \epsilon_{et}. \tag{2.21}$$

As discussed below, the slope of the Phillips curve, κ_p, is an increasing function of the parameter governing the Calvo (1983) probability of price adjustment, denoted by $1-\theta_p$.

Firms also face sticky nominal wages, which gives rise to a Phillips curve in wage inflation:

$$\pi_t^w = \beta E_t \pi_{t+1}^w + \kappa_w (mrs_t - w_t), \tag{2.22}$$

where wage inflation π_t^w is defined as:

$$\pi_t^w = w_t - w_{t-1} + \pi_t. \tag{2.23}$$

The term κ_w is a function of households' labor supply elasticity, denoted by φ, the elasticity of substitution between labor varieties, denoted by μ_w, the elasticity of the parameter governing the Calvo probability of nominal wage adjustment, denoted by $1 - \theta_w$, and the discount factor β. See Gali (2008) for details of the derivation.

Monetary policy follows a standard Taylor rule:

$$r_t = \rho_r r_{t-1} + (1 - \rho_r)\left(\rho_\pi \pi_t^p + \rho_y (y_t - y_t^F)\right) + \rho_g g_t + \sigma_i \epsilon_{it}, \tag{2.24}$$

where y_t^F is the flexible price level of output, and g_t is output growth. The flexible price level of output is determined by a system of equations analogous to the ones above, but where there are no wage or price frictions. The monetary policy rule is subject to an exogenous shock ϵ_{it}.

Solution and Estimation

Solution

Equations (2.6) through (2.24) constitute a system of equations in the following 19 variables: $y_t, k_t, n_t, w_t, r_{k,t}, \pi_t^p, \pi_t^w, c_t, i_t, \lambda_t, mc_t, mrs_t, x_t, q_t, r_t, \xi_{at}, \xi_{dt}, \xi_{et}, \xi_{qt}$, together with the equations of the flexible price economy and the definition of output growth $g_t = y_t - y_{t-1}$.

To simulate the economy under a rise in markups, the model's solution is approximated subject to an unanticipated trend in the elasticity of substitution between intermediate goods-producing firms' output. The nominal interest rate is also subject to the zero lower bound, $i_t \geq 0$. The solution methodology is described in Jones and Philippon (2016).

A number of parameters are calibrated to standard values used in the literature. The parameters of the shock processes and the parameters of the monetary policy rule are estimated on aggregate data using Bayesian likelihood methods.

Estimation

The calibrated parameters are presented in Annex Table 2.3.8 and are set to standard values. The robustness of the results to higher capital adjustment costs is explored below.

Bayesian methods are used to estimate the remaining parameters of the model. Data on the policy interest rate, consumption growth, output growth, inflation, and employment, are used for both the United States and the euro area. For the United States, the observables are drawn from the Federal Reserve Economic Database, over the time period 1986Q1 to 2008Q4. For the euro area, the observables are drawn from the European Central Bank's Area-wide Model database, over the time period 1997Q2 to 2008Q4.[3]

Annex Table 2.3.8. Calibrated Parameters

Parameter	Value	Description
β	0.9926	3% annual real interest rate
γ	1	Log utility
φ	2	Frisch labor supply elasticity of 1/2
α	1/3	Capital share of income of 33%
φ_k	10	Quadratic capital adjustment cost
δ	0.025	10% annual depreciation rate
μ_p	5	Initial price markup of 25%
μ_w	6	Initial wage markup of 20%
θ_p	2/3	Gali (2008). Average price duration of 3Q
θ_w	3/4	Gali (2008). Average price duration of 4Q

Source: IMF staff compilations.

Moments of the prior and posterior distributions of the parameters of the shock processes and the monetary policy rule are given in Annex Table 2.3.9. Wide priors are used. The estimates are consistent with estimates from the literature.

Annex Table 2.3.9. Prior and Posterior Distributions of Estimated Parameters

		Prior			Posterior					
					US			Euro Area		
Parameter	Type	50%	25%	75%	50%	25%	75%	50%	25%	75%
ρ_a	B	0.5	0.4	0.6	0.921	0.905	0.936	0.872	0.84	0.901
ρ_d	B	0.5	0.4	0.6	0.922	0.91	0.932	0.787	0.752	0.819
ρ_e	B	0.5	0.4	0.6	0.79	0.759	0.819	0.513	0.443	0.58
ρ_q	B	0.5	0.4	0.6	0.867	0.849	0.883	0.813	0.786	0.837
σ_a	IG	0.6	0.4	1	0.493	0.469	0.52	0.485	0.451	0.523
σ_d	IG	0.6	0.4	1	0.118	0.108	0.13	0.11	0.097	0.125
σ_e	IG	0.6	0.4	1	0.103	0.095	0.112	0.109	0.097	0.121
σ_q	IG	0.6	0.4	1	0.212	0.192	0.234	0.18	0.158	0.206
σ_i	IG	0.6	0.4	1	0.147	0.136	0.159	0.121	0.11	0.134
ρ_r	B	0.75	0.7	0.82	0.801	0.783	0.817	0.792	0.766	0.815
ρ_p	N	2	1.8	2.2	2.135	1.996	2.275	1.809	1.618	1.994
ρ_g	N	0.13	0.09	0.16	0.209	0.189	0.229	0.209	0.187	0.232
ρ_y	N	0.13	0.09	0.16	0.163	0.142	0.185	0.204	0.175	0.233

Source: IMF staff calculations.

Note: Prior distributions are B (beta), IG (inverse-gamma), N (normal).

An Unanticipated Rise in Markups

This section describes the main model simulation exercise.

Steady-State

In the long-run, the steady-state of the model implies that the markup over marginal costs is a function of the elasticity of demand for the output of intermediate goods-producers:

[3] All data series, except the nominal interest rate, are demeaned prior to estimation.

$$\frac{1}{\text{markup}} = mc = \frac{\mu_p - 1}{\mu_p}. \tag{2.25}$$

The lower the demand elasticity of substitution, the lower is steady-state marginal costs, and the higher is the markup. As demand becomes more inelastic, firms cut production and charge higher markups, so that the amount of labor and capital hired falls. The steady-state capital-output ratio is:

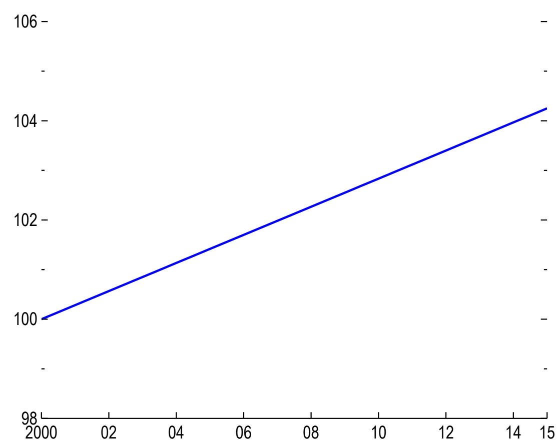
$$\frac{k}{y} = \frac{1}{\text{markup}} \frac{\alpha}{r_k}, \tag{2.26}$$

which says that the higher is the steady-state markup, the lower the capital-output ratio, given a steady-state r_k, which is a function of the household's discount factor. The investment-to-output ratio in the steady state is $\delta \frac{k}{y}$. This ratio also declines when steady-state markups are higher.

Transition Dynamics

In the main simulation, the model economy is subject each period to an unanticipated and exogenous decrease in the elasticity of substitution between intermediate goods, which is chosen to match the average granular increase in the within-incumbent firm component of markups for the euro area and the United States (Annex Figure 2.3.1). In the transition to the steady-state with lower capital, net investment is negative. Other key simulation results are discussed in the chapter.

Annex Figure 2.3.1. Calibrated Rise in Markups, Average of United States and Euro Area
(Index, 2000=100)



Source: IMF staff calculations.
Note: Rise in markups only captures within-firm component of markups.

Robustness

The sensitivity of the posterior distributions of the estimated parameters to a higher capital adjustment cost parameter is checked, as it is not well identified in our baseline estimation. When the capital adjustment cost parameter is doubled relative to its baseline value (calibrated to $\phi_k = 20$), the estimated standard deviation of the investment shocks, σ_q, increases from around 0.2 to about 0.3 for both the United States and the euro area. The simulated impact of the trend rise in markups on investment and the natural interest rate remains qualitatively unchanged, being only marginally smaller under higher capital adjustment costs, which makes investment more sluggish in response to shocks.

Rising Markups and the Slope of the Phillips Curve Under Different Assumptions

Baseline Calvo Pricing

In the baseline specification of the model, the slope of the Phillips curve depends positively on a firm's markup. This is ultimately because firms are assumed to set prices using a Calvo (1983) pricing specification, whereby there is uncertainty about when they can adjust prices. In that framework, the linearized Phillips curve is (see for example Galí 2008):

$$\pi_t^p = \beta \mathrm{E}_t \pi_{t+1}^p + \left(\frac{(1-\theta_p)(1-\beta\theta_p)}{\theta_p}\right)\left(\frac{1}{1+\mu_p\frac{\alpha}{(1-\alpha)}}\right) mc_t + \xi_{et}, \tag{2.27}$$

This formulation follows when firms have decreasing returns to scale production, so that their marginal costs rise relatively more when they produce more, incentivizing them to keep their prices close to those of their competitors. This incentive is weaker when the elasticity of demand μ_p is lower—and therefore when the firm's markup is higher—because a lower demand elasticity leads firms to cut output, which in turn reduces steady-state marginal costs, and thereby also dampens the response of marginal costs when the firm's relative price changes.

Rotemberg Pricing

An alternative pricing assumption is the Rotemberg (1982) specification, whereby firms face quadratic resource costs of adjusting prices but are free to do so at any time. Under Rotemberg pricing, the linearized Phillips curve is:

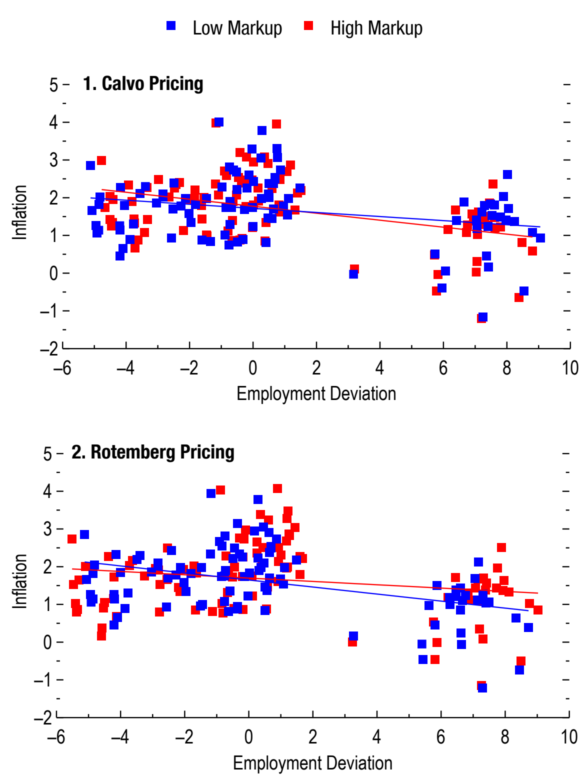
$$\pi_t^p = \beta \mathrm{E}_t \pi_{t+1}^p + \left(\frac{\mu_p - 1}{\phi_p}\right) mc_t + \xi_{et}, \tag{2.28}$$

where ϕ_p parameterizes the size of the quadratic price adjustment. If a value of ϕ_p which implies the same slope of the Phillips curve as under the baseline Calvo pricing model is chosen, then the aggregate dynamics of the model are identical.

In contrast to the implications under the baseline framework, when markups are higher, the slope of the Phillips curve declines under Rotemberg pricing. Intuitively, faced with a less elastic demand curve—a lower μ_p—a firm's revenue is less sensitive to shocks. This makes firms less willing to incur a resource cost to change their price, so that prices and inflation become less responsive to shocks.

To study the quantitative implications for the slope of the Phillips curve under the different pricing protocols in the baseline model, in Annex Figure 2.3.2, the estimated shocks that generate the aggregate United States data are extracted and two counterfactual simulations are conducted: one assumes markups to be set at their 2000 level for the entire sample, while the

Annex Figure 2.3.2. Simulated Phillips Curve



Source: IMF staff calculations.

other assumes constant markups at a level that is 8 percent above their 2000 level for the entire sample. The Phillips curve—the relationship between inflation and employment relative to trend—is then plotted for both simulations. This exercise is performed under Calvo pricing, and then under Rotemberg pricing. As illustrated in the figure, under Calvo pricing the Phillips curve is steeper when markups are higher, while under Rotemberg pricing it is flatter when markups are higher.

Annex Table 2.3.10. Markups and Labor Share

	(1) OLS	(2) OLS	(3) IV[1]
1-year Lagged Markup	-0.032***	-0.031***	-0.018*
	(0.001)	(0.001)	(0.011)
1-year Lagged Log Operating Revenue	-0.033***	-0.034***	-0.031***
	(0.000)	(0.000)	(0.002)
Firm Fixed Effects	Yes	Yes	Yes
Country-Industry[2]-Year Fixed Effects	Yes	No	No
Country-Year Fixed Effects	No	Yes	Yes
Industry[2]-Year Fixed Effects	No	Yes	Yes
First Stage F-statistic			87.02
Number of Observations	2,515,925	2,535,858	2,526,009
R^2	0.735	0.721	0.008

Source: IMF staff calculations.

Note: Dependent variable = wage bill / value added. IV = instrumental variable. OLS = ordinary least squares. Sample is of annual frequency from 2000 to 2015. See Annex Table 2.1.2 for countries in sample.

Robust standard errors in parentheses. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

[1]The instrumental variable for lagged markups is the lag of median markups in a firm's country-industry[2]-year, while excluding that firm.

[2]Industries are NACE revision 2 4-digit sectors.

D. Labor Share

Regressions Analysis

The regression underlying the estimation of the effects of markups on labor share follows the same OLS and IV specifications as the analysis of the effect of markups on investment rate (Equation 2.5 in section B above), with the labor income share now being the dependent variable. The labor share is measured as the ratio of the firm's wage bill to value added. The detailed OLS and IV regression results are shown in Annex Table 2.3.10 and the first stage of the IV regression is presented in Annex Table 2.3.11. Column (1) presents the baseline OLS results that underpin the figure and calculations in the corresponding section of the chapter. Column (2) shows that results are quantitatively robust to considering two pairs of country-year and country-industry fixed effects instead of the country-industry-year fixed effects used in the baseline regression. Column (3) shows that results remain qualitatively robust, but are a bit weaker statistically and quantitatively, when the markup is instrumented to address potential endogeneity issues.

Annex Table 2.3.11. Markups and Labor Share IV Results: First and Second Stages

	(1) IV[1] First Stage	(2) IV[1] Second Stage
1-year Lagged Median Markup	0.124***	
	(0.013)	
1-year Lagged Log Operating Revenue	-0.183***	-0.031***
	(0.001)	(0.002)
1-year Lagged Markup		-0.018*
		(0.011)
Firm Fixed Effects	Yes	Yes
Country-Year Fixed Effects	Yes	Yes
Industry[2]-Year Fixed Effects	Yes	Yes
First Stage F-statistic		87.02
Number of Observations	2,526,009	2,526,009
R^2		0.008

Source: IMF staff calculations.

Note: In first stage, dependent variable is markups. Second stage dependent variable = wage bill / value added. IV = instrumental variable. Sample is of annual frequency from 2000 to 2015. See Annex Table 2.1.2 for countries in sample.

Robust standard errors in parentheses. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

[1]The instrumental variable for lagged markups is the lag of median markups in a firm's country-industry[2]-year, while excluding that firm.

[2]Industries are NACE revision 2 4-digit sectors.

Within versus Between Effects of Markups on Labor Income Shares

Similar to the estimation of markups on investment rates, the main analysis of labor share effects relies on within-firm estimation. While this specification implies a stronger identification strategy, it discards by design any changes in the aggregate labor share from the possible reallocation of labor away from low-markup high-labor-share firms to high-markup low-labor-share ones. Yet resource reallocation from high-labor-share to low-labor-share firms has been found to be an important factor behind the fall in the aggregate labor share in the United States (Autor et al. 2017a and 2017b; Kehrig and Vincent 2018). As a quick check for the presence of such between-firm reallocation effect in the sample of firms used in the chapter, the OLS regression (Annex Table 2.3.12) is re-run with alternative sets of fixed effects. In particular, a comparison of regressions with and without firm fixed effects can shed some light on the relative importance of the within and between components of the overall relationship between markups and labor shares. The regressions without firm fixed effects yield a (negative) coefficient on the markup variable that is up to twice as large in magnitude than the coefficient obtained when estimating the same regression with firm fixed effects; this hints at a sizeable between component in the overall relationship between markups and labor shares, in line with recent literature.

Annex Table 2.3.12. Markups and Labor Share: Fixed Effects Decomposition

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS
1-year Lagged Markup	-0.045***	-0.048***	-0.044***	-0.055***	-0.056***	-0.023***	-0.032***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
1-year Lagged Log Operating Revenue	-0.028***	-0.045***	-0.020***	-0.039***	-0.038***	-0.026***	-0.033***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Firm Fixed Effects	No	No	No	No	No	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	No	No	No
Country Fixed Effects	No	Yes	No	No	No	No	No
Industry[1] Fixed Effects	No	No	Yes	No	No	No	No
Country-Year Fixed Effects	No	No	No	No	No	No	No
Country-Industry[1] Fixed Effects	No	No	No	Yes	No	No	No
Industry[1]-Year Fixed Effects	No	No	No	No	No	No	No
Country-Industry[1]-Year Fixed Effects	No	No	No	No	Yes	No	Yes
Number of Observations	2,603,627	2,603,627	2,603,616	2,603,110	2,583,835	2,536,364	2,515,925
R^2	0.045	0.215	0.139	0.316	0.346	0.694	0.735

Source: IMF staff calculations.

Note: Dependent variable = wage bill / value added. OLS = ordinary least squares. Sample is of annual frequency from 2000 to 2015. See Annex Table 2.1.2 for countries in sample.

Robust standard errors in parentheses. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

[1]Industries are NACE revision 2 4-digit sectors.

International Spillovers

A priori, there can be international spillovers of markups through both input and demand channels. To capture these different spillover channels, the specification below contains the following terms: the first term captures the input channel by including a weighted sum of each foreign supplier's markups, where the weights are imports relative to the total value added of the importing country; the second term captures the demand channel by including the sum of each foreign buyer's markups, weighted by exports relative to the total value added of the exporting country. Additional controls include the domestic linkages and their associated markups as well as country-year, sector-year, and country-sector fixed effects.

$$\log VA_{ijt} = \alpha + \beta_1 \sum_d^D \sum_k^K \frac{VAM_{ijdk2005}}{VA_{ij2005}} * \mu_{dkt} + \beta_2 \sum_d^D \sum_k^K \frac{VAX_{ijdk2005}}{VA_{ij2005}} * \mu_{dkt} + \beta_3 \sum_i^I \sum_j^J \frac{VA_{ijij2005}}{VA_{ij2005}} \mu_{ijt} + \theta_{it} + \delta_{jt} + \sigma_{ij} + \varepsilon_{ijt}, \text{ where country i and d, sector j and k, d} \neq \text{i, and k} \neq \text{j.} \quad (2.28)$$

The regression results in Annex Table 2.3.13 show that there are international spillovers from higher markups through the input channel (first term, column 1) for emerging markets. For a hypothetical industry in an emerging market country that imports 40 percent of its value added from abroad, a hypothetical 10 percentage point increase in markups across all foreign suppliers is associated with a 0.3 percent decrease in value added, all else equal.

Annex Table 2.3.13. International Spillovers from Markups

	EMs
Foreign Import-Share-Weighted Markup[1]	-0.075***
	(0.010)
Foreign Export-Share-Weighted Markup[2]	-0.533
	(0.379)
Number of Observations	3,424
R^2	0.998

Sources: OECD Inter-Country Input-Output Tables; and IMF staff calculations.
Note: The dependent variable is logorithm of value added in country i, sector j. Regression includes controls for domestic demand and input channels, country-sector, country-year, and sector-year fixed effects. EMs = emerging markets.
Robust standard errors in parentheses. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.
[1]Import-share-weights are constructed as intermediate imports from country d and sector k to country i, sector j, divided by the total intermediate inputs in country i, sector j.
[2]Export-share-weights are constructed as intermediate exports to country d and sector k from country i, sector j, divided by the total intermediate inputs in country i, sector j.