

Quantified Narrative Evidence on the Price-Setting Behavior of Publicly Traded Companies*

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Abstract

I quantify narrative evidence from 20 years of archived corporate reports to construct a novel dataset on the price-setting behavior of almost 1,000 publicly traded companies. This dataset allows me to investigate both the reasons why firms change their prices and the factors that prevent them from doing so. I find that the causes of price changes are highly asymmetric, and that strategic complementarities (real rigidities) are an important aspect of the reported pricing decisions. I also document that incomplete pass-through is common in the data, and that price durations alone do not necessarily reflect price rigidity. Finally, I show that the reported pricing decisions are closely related to the observable behavior of the US GDP deflator. I discuss my findings in the context of widely-used price-setting models.

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1 Introduction

Assumptions about price-setting behavior are at the heart of a large class of widely-used macroeconomic models. Among other things, they determine how well these models can fit aggregate fluctuations and whether or not they can reproduce the empirically observed delayed real effects of nominal shocks. In addition, the price-setting behavior of firms also has direct practical implications for central banks. Only if they have a good understanding of the price-setting process, can they be confident that their policy decisions will actually lead to the desired macroeconomic outcomes. Even with the wealth of micro-level price data that has driven much of the field’s recent progress, however, it has remained difficult to address some fundamentally important topics such as the main drivers of price changes and the mechanisms that can prevent firms from implementing them.

In an effort to better understand these aspects of the price-setting process, I use a type of data not previously considered by the related literature: narrative evidence contained in annual corporate reports. I exploit this evidence systematically, searching 20 years of archived documents for explicit discussions of price decisions and then quantifying their contents. The resulting dataset reflects 1,949 important pricing decisions taken by 983 different firms and encodes unique causal information that cannot be captured by realized prices alone. Some of my main findings include that the causes of price changes are highly asymmetric, that price-setting changes over the business cycle, and that real rigidities are an important feature of the reported pricing decisions.

The population of firms that I consider in this study includes all companies that are registered with the US Securities and Exchange Commission (SEC) and thus have to prepare the reports from which I construct the dataset. While the regulation that determines whether or not a company falls into this category is relatively complex, the general rule is that all firms whose securities are publicly traded in the US must register.¹ The firms that satisfy this criterion tend to be somewhat larger than the average US company, cover all major sectors, and account for a sizable fraction of US GDP.² They are also relatively international, with many of them selling their products both within and outside of the US.

The types of pricing decisions that these firms discuss in their corporate reports tend to be those that had a notable impact on their overall business results in the relevant fiscal periods. In fact, much of the narrative evidence on price setting occurs in sections where firms discuss the development of important summary measures such as total revenues, sales or net income. My results thus emphasize important pricing decisions

¹A good starting point for readers interested in more detailed information on these registration and reporting requirements is the SEC financial reporting manual available via <http://www.sec.gov/divisions/corpfin/cffinancialreportingmanual.shtml>

²Using Compustat data of public companies, Gabaix (2011) reports that the sales of the top 50 US non-oil firms alone account for approximately 24% of US GDP.

taken by relatively large firms. As I show below, these decisions are closely related to the US GDP deflator and therefore particularly informative for macroeconomists and policy makers interested in the development of the aggregate price level.

The first specific aspect of price setting behavior that I investigate are the reasons that cause firms to change the prices of their products. Based on all discussions in which firms explicitly state at least one such reason, I discover a strong asymmetry between price increases and price decreases. While the former mostly result from increases in costs, the latter are largely driven by competitive pressures and considerations about sales volumes. Furthermore, distinguishing between different types of costs, I document that fluctuations in raw-material and commodity prices played a much larger role than variations in wages or salaries over the 20-year sample horizon.

Next, I consider the reported factors that prevented the firms from changing their prices. Here, I first document that almost all of the reported price rigidities describe cases in which firms experienced cost increases and had to decide about the extent to which they would pass them on to their customers. My analysis suggests that the most important factor preventing them from doing so were competitive pricing pressures, followed by weak aggregate demand conditions and pre-existing contracts. I also find that other regularly considered factors such as menu costs and customer antagonization do not appear to play an important role for the reported pricing decisions.

Given the very frequent mentions of competitive pricing pressures in the context of both implemented price changes and rigidities, I argue that strategic complementarities appear to be an important feature of the price-setting process. To investigate this interpretation further, I search for evidence of incomplete pass-through, a phenomenon that has been considered evidence for real rigidities.³ This exercise reveals that approximately 51% of the reported cases of price rigidities do indeed describe situations in which firms adjusted their prices and yet describe these adjustments as incomplete relative to the increases in costs. Overall, the extracted discussions thus provide strong evidence for the presence of real rigidities.

Exploiting the fact that the SEC's digital archive of corporate reports covers more than 2 business cycles, I also provide a novel look at the time dimension of firms' price-setting behavior. Here, I first document that the number of implemented price changes is somewhat higher in the second half of the sample, and that the reported rigidities are almost entirely concentrated in that period. Based on the actual contents of the extracted discussions, I then illustrate that the main driver of this behavior was the late-2000 commodity price boom. In addition, I also document that the reported pricing decisions are closely related to the development of the US GDP deflator.

³For example, see Gopinath et al (2010) and Gopinath and Itskhoki (2011).

Jointly, the time-series evidence suggests that inflation between 2006 and 2010 would have been more volatile in a counterfactual world with weaker strategic complementarities, fewer fixed-price contracts, and fewer concerns about a weak demand environment. The fact that increased volatility in raw-material prices caused an increase in price changes can also generally be interpreted as evidence of state-dependent pricing behavior.⁴ Finally, the simultaneous increase in both reported price changes and reported price rigidities during the commodity-price boom suggests that price durations by themselves are not necessarily good measures of price rigidities or the degree to which they are binding.

This paper aims to contribute to a large empirical literature investigating the behavior of prices. Following the seminal work by Bils and Klenow (2004), one strand of this literature has used detailed micro-level pricing data to document important stylized facts such as the frequencies of price changes and their size distributions.⁵ Much of this micro-level evidence is now regularly used to calibrate macroeconomic models, and to assess which ones are most successful at generating realistic price behavior. At a qualitative level, some of the most important findings of this literature are that prices change frequently, that both small and large price changes are common, and that price decreases occur even when aggregate inflation is strictly positive.⁶

The main conceptual difference between these studies and mine is that I do not focus on providing precise measurements of the statistical behavior of prices. Instead, by exploiting the unique type of narrative information contained in the corporate reports, my emphasis is on understanding *why* prices behave the way they do. That is, by using corporate reports to studying the factors that cause firms to change prices or prevent them from doing so, I aim to allow for a better interpretation of the detailed stylized facts obtained from the micro-level price data. Of course, the narrative information contained in the corporate reports can also help better distinguish between competing price-setting models equally compatible with the raw price data.

A second strand of the empirical price setting literature that is also closely related to this paper has used surveys to directly ask firms about how they set prices. Following the influential study by Blinder (1991) and Blinder et al (1998) as well as some less formal earlier work, such surveys have now been carried out for many countries.⁷ Generally speaking, the fundamental motivation of these survey-based studies is

⁴A similar argument could also be made by just looking at the comovement of raw material costs and price durations over time. However, by considering the information contained in the corporate reports, my exercise actually establishes a causal link between the two.

⁵Other influential studies using US data include Nakamura and Steinsson (2008), Klenow and Kryvtsov (2008) and Bils et al (2012). For evidence from Europe, also see Dhyne et al (2006) and Vermeulen et al (2012). Some earlier work based on less representative data includes Cecchetti (1986), Kashyap (1995), Lach and Tsiddon (1992) and Levy et al (1997). Recently, Cavallo (2013) has also introduced price data scraped from supermarket websites as an alternative to that collected by government agencies.

⁶Maćkowiak and Smets (2008) and Nakamura and Steinsson (2013) review many of the stylized facts obtained from micro-level price data and also discuss their main implications for widely used macro models.

⁷Earlier survey-based studies on price-setting include Hall and Hitch (1939), Early (1956), Kaplan et al (1958), Lanzillotti

very similar to the one of this paper. Both recognize that some aspects of price-setting are difficult to assess from realized prices alone, and that verbal information may be a useful alternative in those cases.

Beyond this fundamental similarity in motivation, however, the quantified narrative evidence I construct from the corporate reports is quite different from the survey data. Instead of asking companies very general questions about how they typically set their prices, I consider only specific pricing decisions actually taken by the reporting firms. Thus, even though my dataset contains the type of verbal information previously available only from surveys, it retains the property of micro-level price data that each observation corresponds to one actual pricing decision. Furthermore, while survey responses are typically guided by pre-defined answer choices and research questions, the corporate reports reflect the perspective of the reporting firms, flexibly expressed in their own words. Finally, as opposed to one-off surveys conducted in a specific macroeconomic environment, the corporate report data covers more than two complete business cycles. It is therefore reflective of all business cycle stages and can even provide some insights into how price-setting behavior has varied over time.

Finally, given its results, this paper also contributes to the ongoing discussion of strategic pricing complementarities and their role in price-setting behavior. While it is widely recognized that such complementarities can help generate a realistic amount of non-neutrality in monetary models, actual evidence on their existence is mixed and often indirect.⁸ In particular, while some papers have argued that the empirically observed incomplete pass-through of cost shocks supports the role of real rigidities, a different group of papers has used calibrated models to argue that real rigidities reduce their ability to fit important aspects of the data.⁹

My findings contribute to this discussion by providing three types of evidence for the existence of strategic complementarities. First, they show that firms often explicitly mention the behavior of competitors as a factor that affected their price-setting decisions. Second, they also document that incomplete pass-through of cost

(1958), Fog (1960), Haynes (1962), Lanzillotti (1964), Novotny and Walther (1978) and Walther (1978). With the exception of Lanzillotti (1958) and Novotny and Walther (1978), all of these studies and their main results are briefly summarized in Blinder et al (1998). A large number of survey-based studies on price-setting were also carried out as part of the European Central Bank's Inflation Persistence Network (IPN). For these studies and corresponding discussions see Fabiani et al (2006, 2007). Recent country-specific survey evidence also exist for Australia (Park et al, 2010), Canada (Amirault et al, 2006), Iceland (Ólafsson et al, 2011), Japan (Nakagawa, 2000), Norway (Langbraaten et al, 2008), Sweden (Apel et al, 2005) and the UK (Hall et al, 2010 ; Greenslade and Parker, 2012). While Blinder (1991) and Blinder et al (1998) mostly focused on theories of price stickiness, many of these later studies have also investigated the *causes* of price changes.

⁸See Ball and Romer (1990), Kimball (1995) and Basu (1995) for early theoretical contributions. Gertler and Leahy (2008) show that strategic complementarities can cause a significant degree of non-neutrality even if price-setting is assumed to be state-dependent.

⁹The existing evidence on incomplete pass-through and the link to real rigidities is discussed, for example, by Gopinath and Itskhoki (2011) and Gopinath et al (2012). On the other hand, Klenow and Willis (2006) argue that empirically observed large individual price changes are inconsistent with strong real rigidities. Burstein and Hellwig (2007) use product-level market shares and prices to assess the role of strategic complementarities in price setting. They find evidence in favor of strategic complementarities, but also document that they do not lead to notably stronger monetary non-neutrality in their specific model. Bills, Klenow and Malin (2012) argue that reset price inflation should exhibit a positive autocorrelation and low variance if real rigidities are present. They find, however, that this behavior is not borne out by the data.

changes is an important feature of the data. Third, they actually establish a direct causal link between the two phenomena, documenting that firms explicitly mention competitive pressures as the main reason for most of the reported cases of incomplete pass-through.

The rest of this paper is organized as follows. Section 2 discusses the dataset and its construction, section 3 presents the main empirical results, section 4 discusses the findings and concludes.

2 The Dataset

As discussed above, all of the main results that I present in this study are based on narrative evidence provided in the annual corporate reports of firms that are publicly traded at US exchanges. Given that such data has not been used in previous studies on price setting behavior, this section discusses some important properties of corporate reports and then illustrates why they are useful for the price-setting literature.

2.1 Corporate Reports as a Source of Narrative Evidence on Price Setting Behavior

Annual corporate reports are one of the most important channels through which publicly listed firms inform financial market participants, researchers and other stakeholders about the states of their businesses.¹⁰ Combining quantitative elements such as balance sheets and income statements with additional verbal discussions and explanations, they provide insights about a variety of topics including the firms' profits, their financial situations, and important corporate decisions. Furthermore, given that annual reports are subject to external audits and detailed regulation by the US Securities and Exchange Commission (SEC), they can generally be thought of as very reliable.¹¹

Especially the quantitative elements of corporate reports have been widely used for research in economics, finance and accounting. Through commercial databases such as Compustat, they are readily available in an easy-to-use format that allows for detailed firm-level analyses and also facilitates combinations with other data sources. Some of the important economic concepts that are regularly assessed using this type of data include the reporting firms' capital structures, their financial constraints, their cash flows and their profitability. Recently, researchers have also started to exploit the additional narrative evidence contained in the reports. This development, however, is still relatively new and largely confined to the finance and

¹⁰See the discussion in Griffin (2003).

¹¹While cases of financial misreporting do occur, they typically result in punishment by both capital market participants and the SEC. Karpoff and Lou (2010) identify 454 cases between 1988 and 2005 in which the SEC disciplined firms for some sort of financial misrepresentation. On average, these firms lost 18.2% of their market value when their misrepresentation was revealed to the public. Furthermore, in direct support of the validity of the narrative information that I use in this paper, I document below that it is closely related to the actual development of the aggregate US price level.

accounting literatures.¹²

From the perspective of the empirical price setting literature, what makes the reports particularly attractive is the fact that they sometimes contain explicit verbal discussions of cases in which firms either changed prices or were unable to do so. Regularly covering topics like the reasons for price changes and the factors that prevented the firms from changing prices, these discussions can potentially shed light on various important issues the literature aims to understand.

Importantly, the type of information that can be extracted from the corporate reports is captured neither by realized price data nor by price-setting surveys. While prices by themselves do not reveal the causal links that explain why firms did or did not change prices, surveys tend to provide only general descriptions of pricing behavior as opposed to information about specific decisions firms have actually taken. Furthermore, surveys are typically guided by predefined answer choices and cover only short sample horizons.

2.2 Construction of the Dataset

To construct the dataset, I proceed through the following four basic steps: First, I download all annual corporate reports available in the EDGAR database maintained by the SEC.¹³ This yields just above 200,000 documents filed by almost 40,000 different firms over the past 20 years. Second, I separate out the text contained in each one of these reports and break it down into sentences using a disambiguation algorithm from the computational linguistics literature.¹⁴ Third, I identify a subset of sentences that actually contain information about either implemented price changes or cases of price rigidities. Finally, I translate that information into a number of quantitative variables suitable for the subsequent analysis.

Given the large number of reports and the amount of data each one of them contains, constructing the dataset is a computationally intensive task. At least conceptually, however, three of the four steps outlined above involve relatively little discretion. In particular, the electronic infrastructure maintained by the SEC allows users to download all approximately 200,000 relevant files, and the sentence disambiguation technique established by the computational linguistics literature mainly requires the choice of an appropriate training dataset.¹⁵ Finally, given that the sample size turns out not to be excessively large, the translation of the extracted sentences into statistical variables can be based entirely on manual readings. The step that

¹²For example, see Li(2008), You and Zhang (2009), Feldman et al (2010), Hoberg and Phillips (2010) and Li et al (2013).

¹³I consider all documents filed as 10-K and 10-K405, as well as the small business equivalents 10-KSB and 10-KSB40.

¹⁴Before the sentence boundary detection, I also automatically remove tables and other non-text contents such as HTML formatting instructions. The sentence disambiguation algorithm that I use is that of Kiss and Strunk (2006) as implemented in the Python Natural Language Toolkit (NLTK). An alternative method would have been to simply assume that sentences end whenever a full stop occurs. However, this can lead to mistakes given that full stops also have other functions such as indicating abbreviations and separating decimals from integers.

¹⁵The disambiguation algorithm that I use is trained on the Wall Street Journal data of the Penn Treebank. Its language is relatively similar to that used by firms in their corporate reports.

is significantly more elaborate than the other three is the one that considers the texts of all reports and separates out only those sentences that actually talk about price changes or price rigidities.

What makes this step of the data construction process particularly difficult is that the millions of sentences contained in the 200,000 reports are both too unstructured for a fully automatic classification and too numerous for a purely manual one. To tackle this challenge, I implement an approach that combines manual readings with an automatic pre-selection step. More precisely, I first search each one of the sentences contained in the annual reports for a number of verbal patterns likely to be associated with information about either price changes or price rigidities.¹⁶ Then, out of all sentences that pass this initial screen, I keep only those for which a manual reading confirms that they do indeed contain the desired type of information.

To set up the pre-selection step, I begin by manually reading several full reports as well as large amounts of sentences that contain important basic keywords. For example, I read large numbers of sentences containing a variant of the word “price” in order to understand the wording and grammatical structure firms typically use to describe price changes and price rigidities. Then, I write down a number of grammatical patterns that capture these types of expressions and can be used to identify all sentences that contain at least one of them.

To ensure that the pre-selection step does not cause a bias with respect to the information I am interested in, I do not search for specific reasons of price changes or price rigidities. Instead, I remain agnostic and use only very general grammatical structures that can accommodate all of them and do not favor any specific one. The exact patterns that I use for the pre-selection step are summarized in table 1, with round brackets indicating that an element is optional and square brackets denoting that only one of the words they contain must occur.

For those candidate sentences that are likely to contain information about implemented price changes, the patterns require that a variant of the word “price” as well as a verb referring to the concept of change occur. Furthermore, they impose that the word “we” or the expression “the company” must appear. This second condition is to ensure that the candidate sentences refer to price changes that the firms actively implemented as opposed to general market trends and pure price-taking behavior.¹⁷ Finally, the patterns also impose some conditions on the order of the required elements and the maximum distance between them.

The patterns used to pre-select candidate sentences about price rigidities are conceptually very similar. However, instead of a reference to the concept of change, they require an expression that denotes inability or a decision not to take a specific action. To illustrate the kind of information that the selected sentences

¹⁶The exact verbal patterns used for this step are discussed below.

¹⁷For example, firms who mainly sell commodities tend to have little freedom in their pricing decisions. Instead, they are largely bound to accept the development of market prices. See Amirault et al (2006).

Table 1: Verbal Patterns Used to Pre-Select Candidate Sentences About Implemented Price Changes or Price Rigidities

Pre-Selection Patterns for Price-Change Sentences

1. “we (have) [increased/decreased/raised/reduced/lowered/adjusted/changed]
(*word*)(*word*)(*word*)(*word*)(*word*) [price/prices/pricing]”
2. “the company (has) [increased/decreased/raised/reduced/lowered/adjusted/changed]
(*word*)(*word*)(*word*)(*word*)(*word*) [price/prices/pricing]”

Pre-Selection Patterns for Price-Rigidity Sentences

1. “we (were) [unable to/not able to/did not/could not/have not/had not]
(*word*)(*word*)(*word*)(*word*)(*word*) [price/prices/pricing]”
2. “the company (was) [unable to/not able to/did not/could not/has not/had not]
(*word*)(*word*)(*word*)(*word*)(*word*) [price/prices/pricing]”

Notes: The table shows verbal patterns used to pre-select candidate sentences that are likely to contain information about implemented price changes or cases of price rigidities. Round brackets indicate optional elements. Square brackets denote that only one of the elements they contain is required to occur. The element *word* is a placeholder satisfied by any single word.

contain, table 2 provides some examples for both cases of realized price changes and cases of price rigidities. All of these sentences match at least one of the patterns displayed in table 1 and also survived the manual reading step.

After the automatic pre-selection, the subsequent manual reading and removal of duplicates, the final dataset contains 1,708 sentences about implemented price changes and 241 sentences about price rigidities. These observations were reported by a total of 983 different firms. In terms of the number of different companies covered, the sample is thus notably larger than those of many survey studies on price-setting behavior.¹⁸

3 The Empirical Findings

Using the set of extracted corporate-report sentences described above, this section provides the main empirical results of the paper. It presents quantified narrative evidence on the causes of implemented price changes,

¹⁸For example, the survey of Blinder (1991) and Blinder et al (1998) was set up to obtain a sample size of approximately 200 firms.

Table 2: Sample Sentences About Implemented Price Changes and Price Rigidities

Sample Sentence	Category	Company Name	Fiscal Year
“This continued through the first half of 2003, and negatively impacted our gross margins, as we lowered our prices to meet competitor pricing.”	Price Change	Reliance Steel & Aluminum	2003
“Effective September 2003, we increased the suggested list price for the adult somasensor and the pediatric somasensor in the united states to \$11,000 and \$14,000, respectively.”	Price Change	Somanetics	2003
“In April 1993, the company reduced the average selling price of membership contracts even further in an attempt to increase unit volume.”	Price Change	Bally Manufacturing	1993
“Due to a very competitive environment, we were unable to increase selling prices during 2010 to compensate for the increased waste paper costs and as result our operating margins were reduced.”	Price Rigidity	Orchids Paper Products	2010
“The competition has put pressure on prices in the market, and we have not been able to increase the prices in some markets to the extent of our cost increases.”	Price Rigidity	Devcon International	2003
“Due to existing contractual obligations, we have not raised red cell prices to market levels.”	Price Rigidity	Hemacare	2002

Notes: The table shows extracted corporate report sentences about implemented price changes and price rigidities. The sentences were extracted from the corporate reports using the pre-selection patterns shown in table 1 and a subsequent manual reading step.

the causes of price rigidities and incomplete cost pass through. It also explores the time-variation of price changes and price rigidities over the 20-year sample horizon.

3.1 Reported Causes of Price Changes

The first specific aspect of price setting behavior that I assess are the reasons that drive firms' decisions or desires to change prices. Knowledge of these drivers is important for our understanding of inflation dynamics, and it has direct implications for policy makers who want to influence the development of the price level by targeting its fundamental determinants.

To provide a quantitative look at the reported reasons for price changes and their relative frequencies, I consider all sentences in which firms explicitly state at least one such reason. I then group these sentences using the seven categories described in table 3. These categories generally reflect the wording that firms use, but they also take into account economic similarity. For example, closely related concepts such as sales, revenues, volume and market share all fall into one common group denoted 'Sales / Market Share'. In cases where the reasons stated by firms correspond to more than one of the seven categories, I use multiple assignments. This causes the sample size to be slightly larger than the number of sentences that contain at least one reason for price changes.

Table 3: Categories of Reasons for Price Changes

Category	Short Name	Sample Expressions
Cost Changes	Costs	'product costs' , 'manufacturing costs' , 'material costs' , 'commodity costs'
Competitive Considerations	Competition	'price competition' , 'competition in the marketplace' , 'competitive advantage' , 'competitive pricing pressures'
Aggregate Demand / Market Conditions	Demand	'economic conditions' , 'market conditions', 'consumer demand' , 'customer demand'
Sales / Market Shares	Sales	'market share' , 'subscriber growth' , 'sales volume' , 'broader market'
Profitability and Margins	Profitability	'gross profit' , 'margin pressure' , 'gross margins' , 'profitability'
Product Features / Life Cycle	Product	'new product introductions' , 'added features' , 'feature functionality' , 'next generation'
Other	Other	-

Notes: The table shows the seven categories into which the reasons for price changes were grouped. For each one of these categories, the column 'Sample Expressions' displays a number of key-words that were used to assign specific sentences to that category. The sample expressions shown are not exhaustive. The sentences were assigned to multiple categories whenever that best reflected their content.

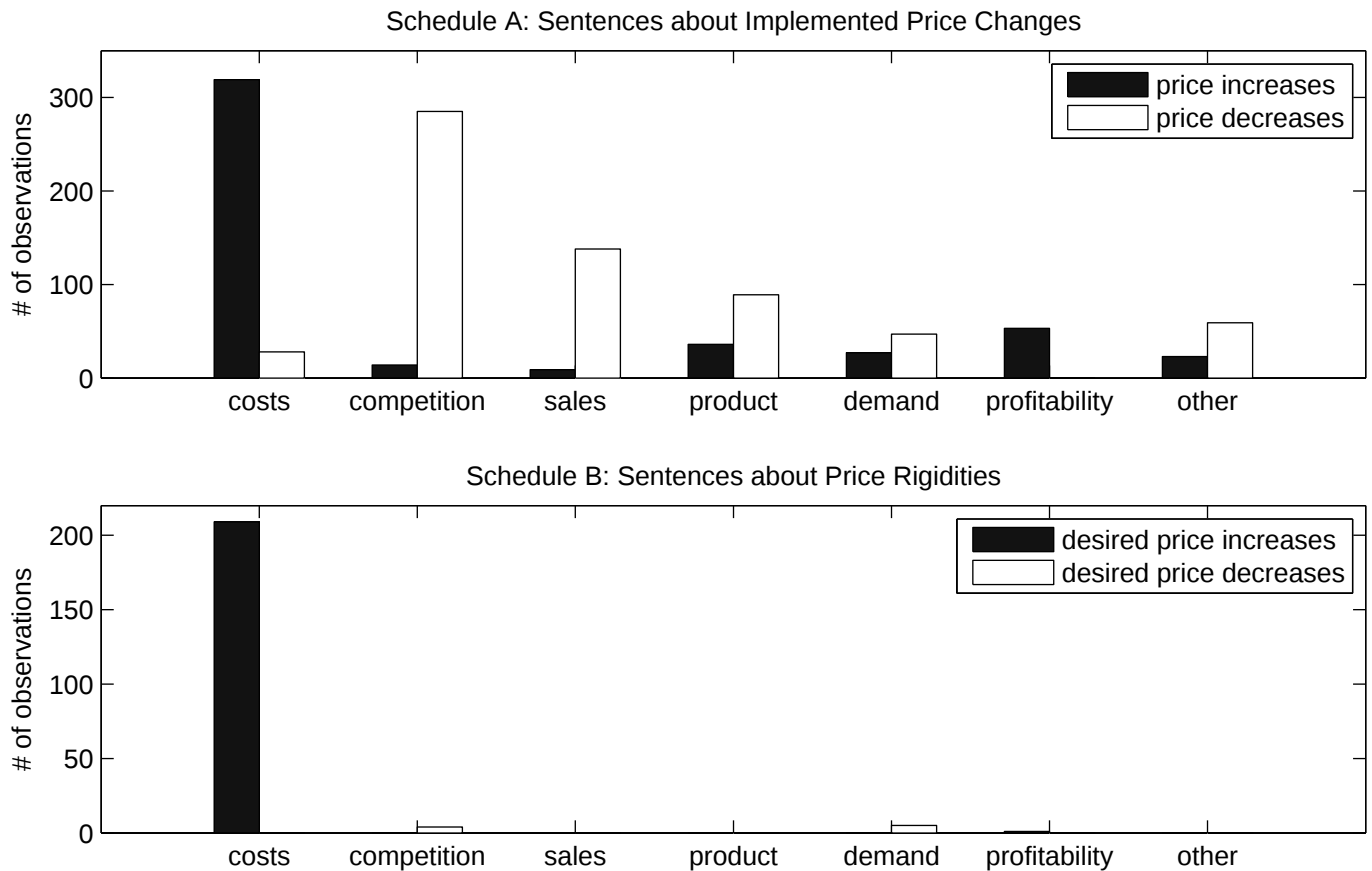
Figure 1 displays the results of this exercise, distinguishing between the price changes that were actually implemented and those that are discussed in the context of reported rigidities. Based on the former, schedule A shows that both competitive considerations and changes in costs are particularly important, followed by considerations about sales volumes and product features. Furthermore, the distinction between price increases and price decreases reveals a pronounced asymmetry: While cost shocks and profitability are almost entirely concentrated in the category of price increases, competitive considerations and sales only appear to play a role in driving prices down.

Repeating the exercise for the sample of price rigidity sentences, schedule B of figure 1 confirms that costs play a very important role in causing upward pressure for prices. In fact, it suggests that almost all of the extracted price rigidities reflect cases in which firms did not or not fully pass through rising costs. Of course, this also implies that they cannot offer further insights into the causes of desired price reductions.

To assess if the strong asymmetry between the causes of price increases and decreases is simply driven by a general upward trend in raw-material prices, I also perform a subsample analysis using only the years 1993-2001. Even though commodity prices did not exhibit an upward trend during this period, I obtain the same type of asymmetry.

Another potential non-fundamental reason for the observed asymmetry is that large companies may decide not to report decreasing levels of competition in order to avoid interventions by competition authorities. To tackle this concern, I repeat the analysis using subsamples that contain only small firms.¹⁹ In spite of the fact that these small firms are unlikely to be subject to competitive interventions, I find that their reported pricing decisions also exhibit the same type of asymmetry.

Figure 1: Reported Reasons of Price Changes



Notes: The figure illustrates the distribution of reported reasons for price changes. Schedule A reflects the cases of actually implemented price changes. Schedule B reflects the cases of desired price changes discussed in the context of price rigidities. Sample expressions and category definitions are shown in table 3. The sentences were assigned to multiple categories whenever that best reflected their content.

¹⁹The first sample of small firms that I use for this exercise are those that are exempt from the filing the full 10-K forms and instead are only required to file the shorter small-business (10-KSB) versions. The second sample of small firms contains only those that fall in the lowest quartile in terms total assets. I obtain the total asset measure for all firms that can be linked to Compustat.

Given the revealed importance of costs as a driver of price changes, I also investigate exactly what types of costs matter the most. In particular, based on keywords such as those provided in table 4, I distinguish between raw-material costs, labor costs and a third category containing less frequent items. As above, I also again allow for multiple assignment in cases where firms discuss more than just one type of cost in a given sentence.

Table 4: Types of Costs and Associated Keywords

Cost Category	Sample Expressions
Raw Materials	raw material, commodities, input, energy, fuel
Labor Costs	wage, employee, personnel, labor, labour, payroll
Other	operating, manufacturing, transportation, product

Notes: The table shows the three cost categories used to further distinguish the cases in which implemented or desired price changes were caused by changes in costs. For each one of these categories, the column 'Sample Expressions' displays a number of key-words that were used to assign specific sentences to that category. The sample expressions shown are not exhaustive. Sentences were assigned to multiple categories whenever that best reflected their contents.

The resulting break-down into the different cost-categories is shown in figure 2. It suggests that raw-material costs were by far the most frequent causes price changes, and that only a very small number of the reported observations were due to changes in labor costs. Furthermore, there appears to be no fundamental difference between the cost types relevant for the desired price changes discussed in the rigidity sentences and those that were actually implemented.

Figure 2: Types of Cost Shocks That Caused Price Changes



Notes: The figure illustrates the distribution of the different cost types that caused implemented or desired price changes. The different categories were manually assigned to each sentence. Sample expressions and category definitions are shown in table 4. The sentences were assigned to multiple categories whenever that best reflected their content.

Of course, this breakdown is conditional on the changes in the different cost categories that actually occurred over the sample horizon. The role of labor costs, for example, may have turned out to be larger had wages fluctuated more over the past 20 years. Nevertheless, there are two reasons to believe that at least the most salient features of the distributions shown in figure 2 also generalize to other periods. First, the sample horizon covers more than two complete business cycles and thus reflects many different macroeconomic environments. Second, wages were not unusually stable during the sample horizon. In fact, the period I consider contains 5 changes in the US Federal minimum wage and also exhibits a volatility of employee compensation that is very similar to that over its entire recorded history.²⁰

To complement the information obtained by grouping the reported reasons into categories, I also consider word clouds constructed directly from the extracted price-setting sentences. Based only on the word-frequencies of the explanations that firms provide, these graphical representations can serve as useful robustness checks because they do not involve any discretionary grouping decisions. As figure 3 shows, the message of the word clouds is well in line with the distribution of the groupings shown above. While the explanations for price increases mostly contain references to changes in costs, price decreases are mostly linked to competitive pressures. Thus, the word clouds confirm both the asymmetry between price increases and decreases, and the actual reasons for the changes.

²⁰While the annualized quarterly growth rate of employee compensation had a standard deviation of 1.09% over the sample horizon, the corresponding value over its entire recorded history back to 1947 is only marginally higher at 1.16%. The time series underlying these value was obtained from the Bureau of Economic Analysis, via the website of the Federal Reserve Bank of St. Louis. The corresponding BEA Account code is A576RC1. The history of changes in the US federal minimum wage was obtained from the US Department of Labor via <http://www.dol.gov/whd/minwage/chart.pdf>.

Figure 3: Word Clouds of the Reported Reasons For Price Changes



Notes: The word-clouds illustrate how often firms used specific words when describing the reasons for implemented or desired price changes. The size of each displayed word reflects the number of times it occurs in the sentence fragments that contain these reasons. Only sentences that actually contain at least one reason were used. A number of very common English language words not related to the information of interest are not displayed.

The findings shown here have a number of implications for theoretical work and conduct of monetary policy. First, they highlight that price-setting behavior of competing firms appears to be an important factor causing price changes. I interpret this as evidence for significant strategic pricing complementarities. Since such complementarities can help generate monetary non-neutrality, they are a popular ingredient of structural monetary models. However, as argued above, they are also difficult to identify using realized price data alone and have thus remained controversial from an empirical perspective.

The findings also highlight the need for theoretical mechanisms that can deliver asymmetries in price-setting behavior. Even though such asymmetries have also been documented in realized prices (e.g. Peltzman, 2000) and survey responses (e.g. Fabiani et al, 2006 ; Loupias and Sevestre, 2013), they are typically not considered to be one of the main stylized facts that workhorse price-setting models should be able to reproduce. Two theoretical mechanisms that may help improve the performance of models in this respect and have already been explored in existing work are positive trend inflation and consumer search. While the former achieves the desired effect by making negative cost shocks transitory and reinforcing positive ones, the latter can achieve it by making customer search after price increases more desirable than after price decreases.²¹

Finally, the dominant role of raw material costs in causing price increases has two different implications

²¹For the work on asymmetric price setting and customer search see Cabral and Fishman (2012) and the references therein. For the relationship between positive trend inflation and asymmetric pricing behavior see Ball and Mankiw (1994).

worth highlighting. On the one hand, it has been shown that prices of commodities are among the first to respond to monetary policy shocks.²² This suggests that they may be an important channel through which central banks can affect the prices of goods further down the production chain. On the other hand, however, commodity prices can also exhibit speculative behavior similar to that typically observed in financial markets. Thus, by allowing the speculative behavior to feed through to a much wider group of goods, the link documented here may also complicate the conduct of monetary policy.

3.2 Reported Causes of Price Rigidities

Next, apart from the factors that cause price changes, the extracted corporate report sentences also contain information about the opposing forces that prevent such changes from occurring. Having a correct understanding of these price rigidities is important, for example, because they are commonly believed to play a central role in the transmission of nominal shocks to real variables.²³ In order to quantify the different causes of price rigidities, I apply the same approach also used above and group the reasons reported by firms into a number of conceptually different categories. Summaries of these categories as well as some corresponding sample expressions are shown in table 5.

²²For example, see Uhlig (2005).

²³See Nakamura and Steinsson (2013) and the references therein.

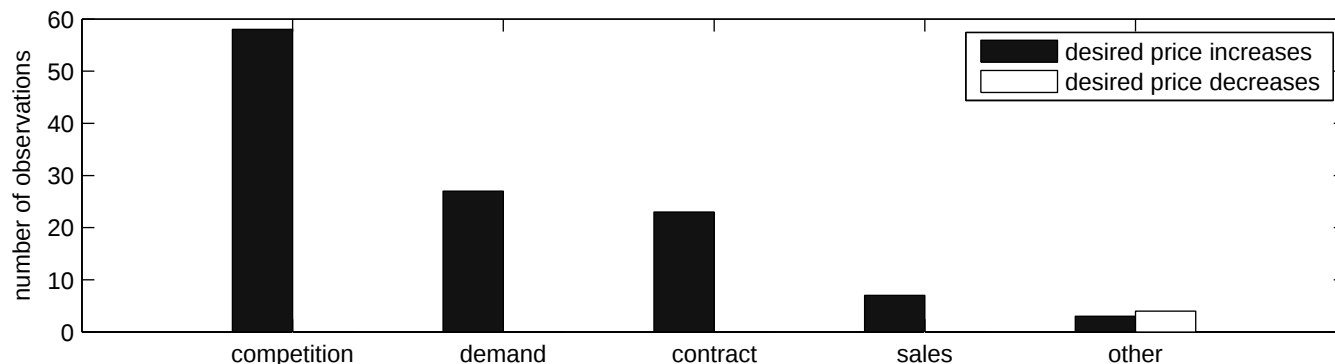
Table 5: Categories for Causes of Price Rigidities

Category	Short Name	Sample Expressions
Competitive Considerations	Competition	'intense competition' , 'competitive environment' , 'competitive pricing pressure' , 'competitive pressure'
Aggregate Demand / Market Conditions	Demand	'challenging economic times' , 'market conditions' , 'demand environment' , 'weak demand'
Sales / Market Shares	Sales	'market share' , 'subscriber growth' , 'sales volume' , 'broader market'
Existing Contracts	Contracts	'fixed price agreement' , 'sales order backlogs' , 'fixed price contracts' , 'signed sales contracts'
Other	Other	-

Notes: The table shows the five categories into which the causes of price rigidities were grouped. For each one of these categories, the column 'Sample Expressions' displays a number of key-words that were used to assign specific sentences to that category. The sample expressions shown are not exhaustive. The sentences were assigned to multiple categories whenever that best reflected their content.

Plotting the distribution of the causes of price rigidities that results from this grouping exercise, figure 4 reflects that almost all observations refer to cases in which firms wanted to *increase* their prices. In terms of the factors that prevented them from implementing these price increases, it illustrates that competitive considerations are mentioned most frequently, followed by demand conditions and pre-existing nominal contracts.

Figure 4: Reported Causes of Price Rigidities



Notes: The figure illustrates the distribution of reported causes of price rigidities. Sample expressions and category definitions are shown in table 5. The sentences were assigned to multiple categories whenever that best reflected their content.

Using the word-frequencies of the explanations given by firms, I also again obtain a corresponding graphical representation in the form of a word cloud. Since almost all of the desired price changes are increases, however, a breakup by direction as used above is not feasible here. As figure 5 shows, the general picture obtained from the grouping exercise is again confirmed by the word frequencies. That is, the most common terms used in the explanations are those related to competition, contracts and the general demand environment.

Figure 5: Word Cloud of the Reported Reasons of Price Rigidities



Notes: The word-cloud illustrates how often firms used specific words when describing the causes of price rigidities they experienced. The size of each displayed word reflects the number of times it occurs in the sentence fragments that contain these reasons. Only sentences that actually contain at least one reason were used. A number of very common English language words not related to the information of interest are not displayed.

The frequent mentions of competitive pressures as a reported cause of price rigidity are generally well in line with the findings from the previous section. They, too, can be interpreted as evidence in favor of strategic pricing complementarities between competing firms. This further validates the use of such complementarities as a mechanism that can increase the degree of monetary non-neutrality in structural models. In addition, the sentences shown here explicitly document that these complementarities work not only by inducing price decreases, but also by actually preventing firms from raising their prices.

Another interesting aspect of the reported rigidities is the fact that firms appear to be less able or willing to pass along cost increases when aggregate demand is weak. This suggests that they face a countercyclical elasticity of demand and thus have incentives to set markups in a procyclical fashion. However, such a behavior is at odds with a large number of macroeconomic models in which a countercyclical behavior of markups forms an essential part of the monetary transmission mechanism.²⁴

Finally, it is also worth noting that a number alternative causes of rigidities regularly considered in existing work are practically absent from the extracted narrative discussions. For example, the firms do not emphasize classical nominal frictions such as menu costs. Fixed-price contracts arguably come closest to such nominal frictions, but they are endogenous in the sense that they result from the interaction between the firms and their customers. A second notably absent force is fear of customer antagonization. This factor first emerged in an open question of the survey by Blinder (1991) and Blinder et al (1998), and it was also confirmed as very important in several of the subsequent survey studies. For example, in their review of the IPN evidence, Fabiani et al (2006) relate that “the fear of antagonizing customers with frequent price changes seems to be the most important explanation for price stickiness in the euro area” (page 6).²⁵

One potential explanation for the absence of these factors is based on the fact that the pricing decisions discussed in the corporate reports tend to be the relatively large and important ones. In principle, both menu costs and fear of customer antagonization may well be strong enough to prevent firms from implementing minor or temporary price changes. At the same time, however, they may not be sufficient to deter firms from implementing those price changes large enough to have notable effects on their overall business results.²⁶

²⁴See Nekarda and Ramey (2013) for a recent discussion and empirical results that also support a procyclical behavior of markups.

²⁵Also see Rotemberg (2005), who explores the role of customer antagonization in a theoretical setting.

²⁶For example, if these costs are independent of the size of the nominal adjustment, only relatively large shocks would cause firms to leave the inaction region and actually change their prices.

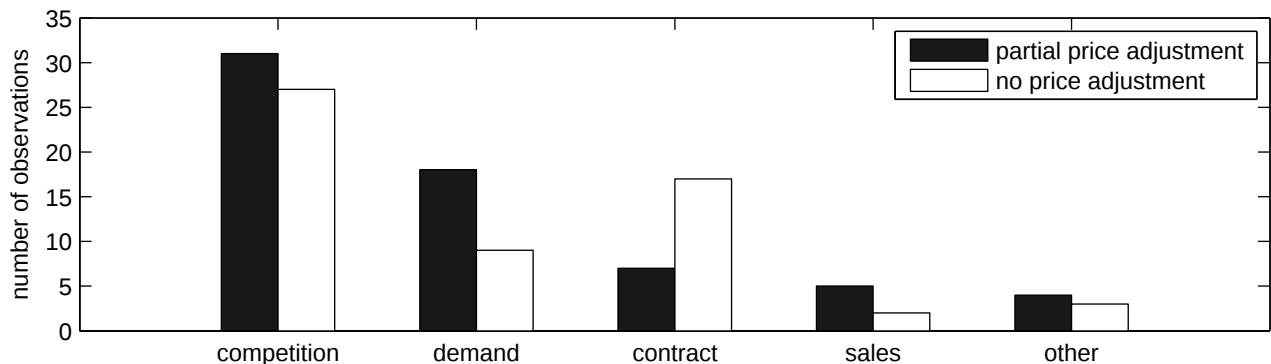
3.3 Incomplete Cost Pass-Through

Another important aspect of price-setting behavior concerns the extent to which firms pass along changes in costs to prices. If this pass-through is incomplete, nominal prices can be thought of as rigid even if they change very often. This can invalidate approaches that infer and calibrate price rigidity based only on price durations. Cases of incomplete pass-through can also be interpreted as evidence for rigidities other than fixed adjustment costs, given that they condition on nominal prices changing. Finally, the extent to which changes in costs translate to changes in product prices has implications for the behavior of markups.

To allow for a quantitative assessment of incomplete pass-through, I consider all extracted rigidity sentences and manually code a new dummy variable. This variable identifies all observations in which firms explicitly state that the reported rigidity only caused them to limit the size of a price adjustment instead of entirely preventing it. Given the causes of upward pressures as documented above, we know that almost all of these cases describe situations in which firms experienced increased costs but passed on only a fraction of these increases to their customers.

Overall, I find that incomplete pass-through is very frequent, accounting for slightly more than half of the extracted rigidity sentences. Breaking the observations down according to their causes as shown in figure 6, I also find that those rigidities that led to incomplete adjustment do not appear to be fundamentally different from the ones that fully prevented price changes. Both types are mainly driven by competitive considerations and aggregate demand conditions.²⁷

Figure 6: Causes of Price Rigidities: Incomplete Adjustment vs. No Adjustment



Notes: The figure illustrates the distribution of reported causes of price rigidities. It distinguishes between those rigidities that caused the desired price adjustment to be incomplete, and those that fully prevented it from occurring. Sample expressions and category definitions are shown in table 5. The sentences were assigned to multiple categories whenever that best reflected their content.

²⁷One exception to this is the fact that the order of demand conditions and pre-existing contracts is reversed. However, given the small sample size, it is difficult to assess if this is indeed due to fundamental differences between the two groups.

The frequent occurrences of incomplete adjustment imply that the rigidities firms report should not simply be thought of as fixed costs of nominal adjustment. This is generally well in line with the above interpretation that price-setting is affected by real rigidities. Interestingly, though, the behavior documented here is not just driven by the strategic pricing complementarities and can instead also arise because of weak aggregate demand conditions and to some extent even because of binding nominal contracts.

Given that firms' desired price levels are not observable in realized price data, the existing price-setting literature has mainly assessed incomplete adjustment by examining the extent to which real and nominal exchange rates comove.²⁸ My findings generally corroborate the ones of that literature at the firm-level and without relying on the same assumptions, but they also establish a more direct link between incomplete adjustment and its underlying causes.²⁹ In the future, surveys may provide further evidence on the issue, but existing studies have not emphasized it.

3.4 Time Variation Between 1993 and 2013

The results shown so far were based on the entire sample of price-setting sentences, extracted from all 20 years of archived corporate reports. However, since each one of the extracted sentences in my database corresponds to a specific year, I am also able to explore how the rigidities and price changes have evolved over time. Survey studies can generally not provide this type of information because their interview periods tend to be much shorter.

To actually provide a look at the time-dimension of firms' price-setting behavior, figure 7 plots the total numbers of corporate reports, implemented price changes, and reported rigidities for each of the sample years. Furthermore, to illustrate the cost-environment faced by the reporting firms, it also displays the evolution of raw-material prices over the sample horizon. Knowing from above that input costs play an important role in causing the reported price changes, especially the late-2000 commodity boom appears to be an interesting historical premise worth investigating.

Looking first at the sample of implemented price changes as displayed in schedule A, we see a relatively low number of observations between 1994 and 1996, the period during which the EDGAR database was initially phased in by the SEC.³⁰ After that, the number of price changes is consistently higher, exhibiting

²⁸See Gopinath et al (2011).

²⁹One of the main assumptions under which incomplete exchange rate pass-through can be interpreted as evidence of real rigidities is that exchange rate fluctuations are exogenous. See Golosov (2011) for a discussion.

³⁰See Asthana and Balsam (2001) and Griffin (2003) for more information on the introduction of the EDGAR database.

some growth over time as well as a peak in 2004 and 2005. Furthermore, while the overall break-down is approximately balanced, the 2004/2005 peak is largely driven by a higher number of price *increases*.

Next, turning to the distribution of the rigidity sentences as plotted in schedule B, the observed behavior over time looks very different. Unlike the implemented price changes, the number of rigidity observations remains low well beyond the initial phase-in of the EDGAR database between 1993 and 1996. Indeed, it only starts to pick up in 2003 and then shows a pronounced peak in the years 2008 and 2009. In terms of the directions of the desired price changes, the few cases of reported downward rigidities are not concentrated in a specific period, making desired increases dominant in every single sample year.

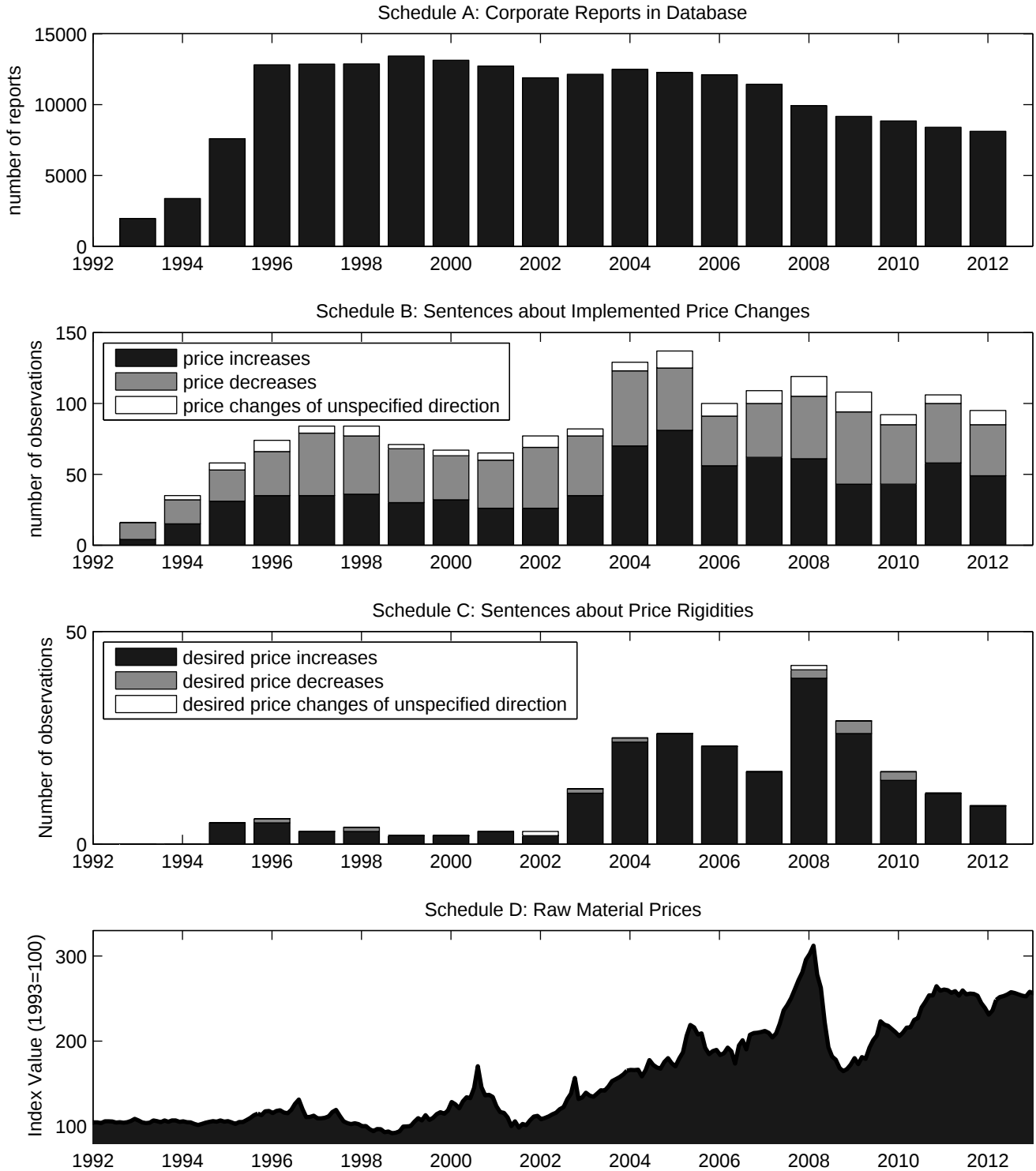
How do these observations relate to the development of commodity prices as plotted in schedule D? In line with the findings from above, the comovements suggest that raw-material costs played an important role in firms' price-setting decisions over the sample horizon. In particular, it appears that firms were generally able to change their prices by the desired amounts until approximately 2002. However, when raw material prices started to rise at a faster rate, upward-rigidities in the form of existing contracts, competitive pressures and weak demand began to bind. At that point, at least some of the reporting firms could no longer pass along all cost changes by raising their prices.

From a macroeconomic perspective, this narrative suggests that the reported upward rigidities may have played an important role in keeping inflation relatively stable during the late-2000 commodity price boom. Especially when considering that the reported rigidities often refer to cases in which the desired price changes were large enough to have a noticeable impact on the firms' overall financial results, they may have also mattered for the economy as a whole.³¹

Finally, the observed evolution of price changes and rigidities also illustrates that price change frequencies by themselves are problematic as measures of price flexibility. While an isolated look at the increasing number of price changes over the sample horizon might have suggested that rigidities became less important, the interpretation changes once we condition on the arrival of cost shocks. Indeed, an alternative story is consistent with state-dependent pricing and suggests that it was an increase in cost shocks that caused an increase in the number of price changes, while also bringing firms closer to a situation in which the upward rigidities began to bind.

³¹Such a relationship would also be qualitatively in line with the results presented in Cecioni (2010). Based on an estimated New Keynesian model with endogenous firm entry, they suggest that a 10% increase in the number of firms in the US economy would reduce inflation by 1.4% in the short run. Also see Gust et al (2010), who argue that the empirically observed decline in exchange rate pass-through over the last two decades may be driven by increased trade integration and a correspondingly higher responsiveness to competitors' pricing choices.

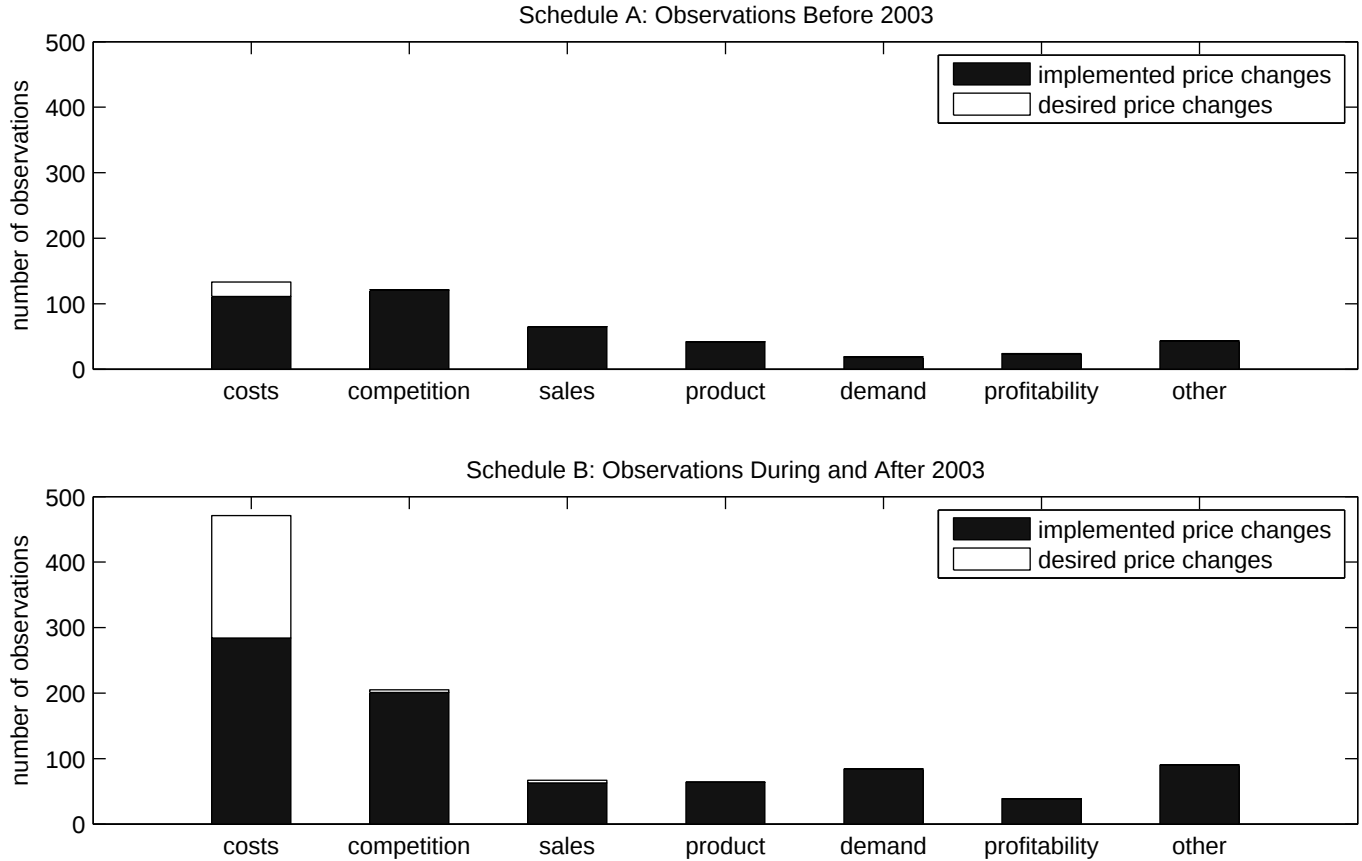
Figure 7: Price-Setting Behavior Over Time



Notes: The figure illustrates the reporting firms' price setting behavior over time. For each year, Schedule A shows the number of annual corporate reports in the database, Schedule B plots the number of extracted price change sentences, and Schedule C plots the number of extracted price rigidity sentences. Reports filed in year t are assigned to calendar year $t - 1$. Schedule D plots raw material prices as measured by the Crude Materials for Further Processing Producer Price Index (PPICRM). This series was obtained from the Federal Reserve Bank of St. Louis and normalized to set its value for January 1 1993 equal to 100.

This alternative story is also supported by figure 8. Distinguishing between observations that occurred before and after 2003, it highlights that firms would have implemented approximately 50% more cost-motivated price changes during the later part of the sample had they not faced the reported rigidities.³²

Figure 8: Causes of Implemented and Desired Price Changes Before and After 2003



Notes: The figure shows the distribution of the causes of implemented and desired price changes. Schedule A shows only observations reported before 2003. Schedule B shows only observations corresponding to the years 2003 and after. Implemented price changes are those reported in the extracted price-change sentences, and desired price changes are those reported in the extracted rigidity-sentences. Reports filed in year t are assigned to calendar year $t - 1$. Sample expressions and category definitions are shown in table 3. The sentences were assigned to multiple categories whenever that best reflected their content.

³²My choice of 2003 as the break-point is motivated by the fact that it marks the beginnings of the commodity-price boom, as well as the observed increase in reported price rigidities.

3.5 Observed Inflation and Reported Price Changes

As discussed above, the pricing decisions extracted from the corporate reports are likely to have notable aggregate effects for two different reasons. First, the publicly traded firms that file the reports with the SEC are relatively large and account for a sizable fraction of US GDP. Second, the price decisions they discuss in their reports are likely to be those that were important enough to be important for their overall business results in the respective reporting periods.

Here, I provide some direct evidence for the relationship between changes in the aggregate price level and the price changes discussed in the corporate reports. Since firms typically do not disclose the exact size of the price changes they implement, I cannot calculate a quantitative measure of reported inflation. However, I can exploit that changes in the aggregate price level P_t must be proportional to the net fraction of price increases in the economy, assuming that price increases have the same average size as price decreases and that all goods contribute to GDP with equal weights.

To see that this is true, first assume that the GDP contributions of all goods in the economy are equal. This implies that changes in the aggregate price level can be expressed as the simple average of all individual price changes:

$$\Delta P_t = \tilde{\Delta p}_t \quad (1)$$

Next, let N_t^+ and N_t^- be the total numbers of individual price increases and decreases, respectively. The fraction of price increases is then given by $\alpha = \frac{N_t^+}{N_t^+ + N_t^-}$ and can be used to rewrite (1) as

$$\Delta P_t = \alpha \Delta \tilde{p}_{t,+} + (1 - \alpha) \Delta \tilde{p}_{t,-} \quad (2)$$

Here, $\Delta \tilde{p}_{t,+}$ and $\Delta \tilde{p}_{t,-}$ denote the average sizes of individual price increases and decreases, respectively. Finally, assuming that $\Delta \tilde{p}_{t,+} = -\Delta \tilde{p}_{t,-}$ equation (2) simplifies to

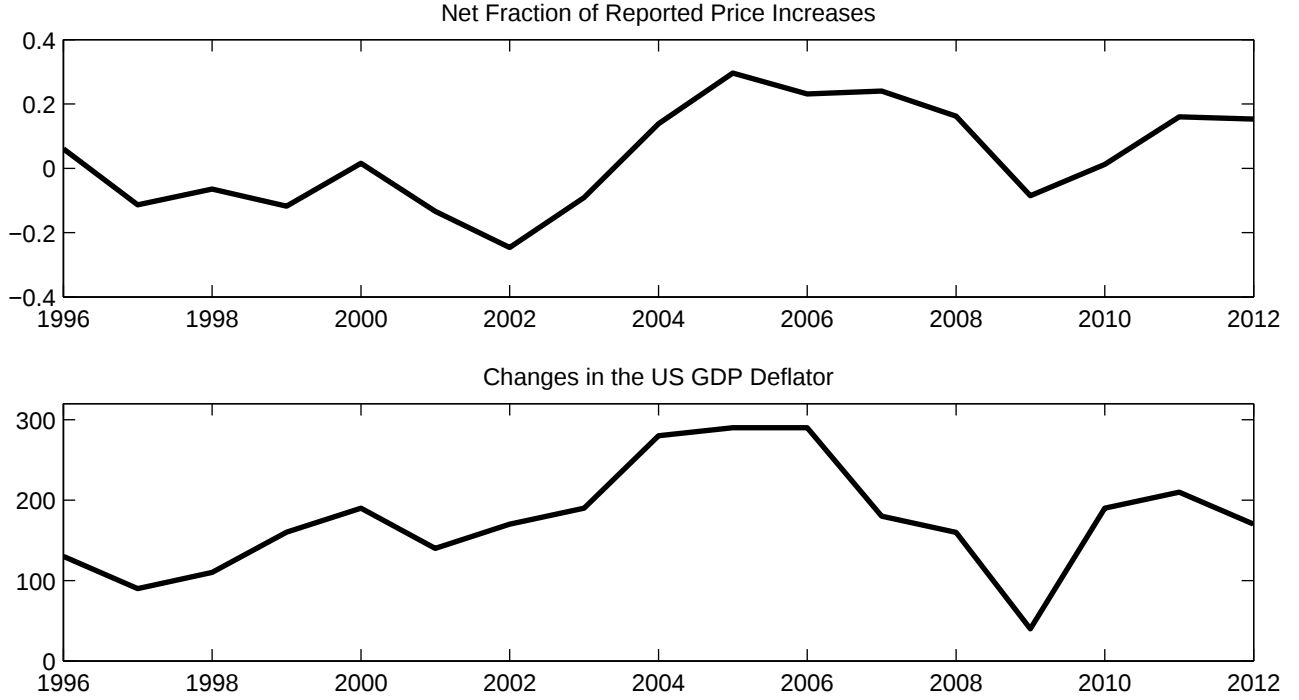
$$\Delta P_t = (2\alpha - 1) \Delta \tilde{p}_{t,+} \quad (3)$$

Using the above definition of α , this implies that the change in the aggregate price level is proportional to the net fraction of price increases in the economy:

$$\Delta P_t \propto \frac{N_t^+ - N_t^-}{N_t^+ + N_t^-} \quad (4)$$

Motivated by this relationship, figure 9 plots data equivalents of both sides of equation (4). While I define ΔP_t as the change in the US GDP deflator, I measure N_t^+ and N_t^- as the numbers of price increases and decreases extracted from the corporate reports. The plots illustrate that the two measures are indeed positively correlated as suggested by equation (4). This finding supports the above argument that the pricing decisions extracted from the corporate reports are informative for central bankers who aim to understand and possibly influence those types of pricing decisions important for the development of aggregate inflation.

Figure 9: Reported Price Changes and Changes in the GDP Deflator



Notes: The figure shows changes in the net fraction of reported price increases and changes in the us GDP deflator. The net fraction of price changes is calculated as $\frac{N_t^+ - N_t^-}{N_t^+ + N_t^-}$, where N_t^+ and N_t^- are measured as the numbers of price increases and price decreases extracted from the corporate reports. Reports filed in year t are assigned to calendar year $t - 1$. The US GDP deflator series (gdpdef) was obtained from the Federal Reserve Bank of St. Louis.

4 Conclusion

In this paper, I have quantified narrative evidence from 20 years of archived corporate reports to construct a novel dataset on the price setting behavior of publicly traded companies. This dataset reflects the properties of 1,949 important pricing decisions taken by 983 different firms and encodes unique causal information that cannot be inferred from realized prices alone. The information it contains also differs from that used in

survey studies because it avoids the use of pre-defined questions, because each observation can be interpreted as reflecting one specific pricing decision, and because it covers a sample period of approximately 20 years instead of a specific business cycle stage.

Using the dataset, I have then explored a number of important aspects of the price setting behavior of publicly traded firms. In particular, I have investigated the causes of price changes, the causes of price rigidities, cases of incomplete cost pass-through, and time-variation in price-setting behavior. Furthermore, to illustrate the relevance of the dataset for our understanding of aggregate inflation, I have documented that the reported price changes are closely related to the development of the US GDP deflator.

My main findings can be summarized in terms of four results. First, the causes of price changes are highly asymmetric. While price increases are mainly driven by increases in raw-material costs, price decreases mainly result from competitive pricing pressures. Second, pressures resulting from the pricing behavior of competitors are also the most important factor preventing firms from raising their prices, followed by considerations about weak aggregate demand and existing contracts. Third, the presence of real rigidities is not just born out by frequent references to the behavior of competitors, but also by a large number of cases in which firms adjust prices but explicitly describe these price changes as incomplete. Fourth, as evident from the late-2000 commodity price boom, a larger number of price changes does not necessarily imply that rigidities are weaker or less binding.

These results highlight that monetary models should generally be able to reproduce asymmetric behavior between price increases and decreases, as well as variation in price setting over the business cycle. They also lend support to state-dependent pricing and suggest that the degree of price rigidity should not be calibrated based only on observed price durations. Instead, measures of price rigidity should take both the realized price durations and the properties of their underlying shocks into account. Finally, the various types of evidence in favor of strategic pricing complementarities suggest that real rigidities may indeed be a valid mechanism of generating monetary non-neutrality in structural models.

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