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[The relationship between price and wage frequency changes for Sweden]

[Price rigidity and wage rigidity in Sweden]

by

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Abstract Nominal rigidity is a central question in the debates to address better models to predict the outcome of certain policies. However, there is little empirical evidence that gives a deeper understanding of the mechanism that transmits this friction into the economy. This paper aims to understand the relationship between price rigidity and wage rigidity in the Swedish economy. I found a positive relationship and some insights about the nature of that relation accounting for particular factors such as collective agreements in the labor market and labor intensity among industries.

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1

Introduction

1.1 Introduction

The importance of correctly calibrate and specify economic models to address better policies responses drives to heated discussions among economist about the validity of the assumptions made. Empirical analysis have an important role in this matter as if provides general or specific evidence for the conditions of a certain economy and take account for this particularities at the moment of construct models. One of the central questions in that requires more evidence and academic effort is the concept of price stickiness. In the actual circumstance of the economy this concept drives a key variable in the moment of modeling business cycle fluctuations or analysing possible consequences for monetary policy.

The current situation of the economy demands central banks and governments to implement monetary and fiscal responses that require a good understanding of the possible effects over key variables as output, employment, inflation, etc. Central banks only have direct control over nominal variables as interest rates or the nominal supply of money. In economics the control over nominal variables relates to the concept of money neutrality which states that controlling for monetary or nominal variables in the economy will not have a direct effect over the real variables. In other words, controlling how much money is the economy, will not control over how much is produced or how many jobs will be in the next period.

The majority of models like New Keynesian DSGE deal with the money neutrality through the concept of stickiness or "*nominal rigidity*". This means that it allows models to whatever the reason prices and wages will adjust with certain lag for policy changes or economic shocks, implying that changes in monetary policy affecting prices will result in changes to output. So that price stickiness are important since they are one main source of macroeconomic frictions is worth to understand the main determinants for this nominal rigidity and mitigate undesirable effects in the economy.

One way economist provide a solution to this frictions is the use of [Calvo \(1983\)](#) framework. This solution assumes a probability associated to price and wage for change in response of some changes in the economy. This framework require the analysis in periods so it allows for a progressive change and adjustments (time de-

pendent pricing models).

This paper aims to provide empirical evidence to understand the determinants and the magnitude of price rigidity. Specially the paper tries to understand the relationship between labor structure as labor cost and labor share for effects in the price setting behavior.

Following the framework from [Solórzano and Dixon \(2020\)](#) and using data from the department of Statistics from Sweden (SCB) I apply a panel data fixed effects model to estimate the causality and effects of wage rigidity over price rigidity for Sweden distinguishing industries. I account for specific characteristics in the Swedish labor market that differentiate from the benchmark framework. One of them is the high unionization level in the economy that differentiate two variables in the analysis. One that is highly influenced by collective bargain and other determined by law and policy changes.

I found that price rigidity is affected by wage rigidity and specially for the degree if changes in the labor agreements determined by law. On average p.p. increase in this variable that can be general payroll tax will lead to an increase in 0.425 p.p. in the frequency of price changes while 1 p.p. change in collective bargain variables like salary will affect on average 1.3 p.p. the frequency of price adjustment. Additionally, I take into consideration some industry characteristics as the share of labor cost and an easiness to adjust labor work index. I obtain an inverse relationship for the share of labor cost which is in line with previous work as [Peneva \(2011\)](#) and [Vermeulen et al. \(2007\)](#) that found a negative relationship between high level of labor cost and price frequency changes.

The structure of the paper is the following. Section 2 briefly presents previous work related to the empirical evidence for nominal rigidity. Section 3 focuses on descriptive work for the data collection and the standardization process among data sets and presents descriptive statistics. Section 4 describe the empirical method used and the specifications for the econometric framework and particular characteristics form the county taken into consideration for modeling. Section 5 concludes.

2

Literature review

2.1 Literature review

This section presents some previous work regarding different measures of price rigidity for different economies.

2.1.1 Previous research

The analysis of price setting behaviour has progressed but remained limited. Most studies in this area rely on the available statistical information on prices at individual level.

The characteristic of statistical information narrow the analysis to specific products or markets. For instance [Lach and Tsiddon \(1992\)](#) and [Eden \(2001\)](#) analyzed the correlation between inflation and price adjustment on the food industry, [Levy et al. \(1997\)](#) studies the process of price changes using store-level data for supermarket chains in the United States, and [Genesove \(2003\)](#) documented the rate of nominal rigidity for housing rents in the U.S.

Most recent studies in this area relied on surveys that contain large-scale data of prices and wages that combines statistical development in the construction of Consumer Price Index (CPI). [Bils and Klenow \(2004\)](#) used unpublished data from the U.S. Bureau of Labor Statistics to explore retail price rigidity. They record prices from 1995 to 1997 on a monthly frequency for 350 categories of consumer goods and services. The authors estimated the frequency of price changing responding to three measures of market structure: concentration ratio, wholesale mark-up and rate of non-comparable substitutions. They concluded that prices last less than 4.3 months and finding differences in price frequency changes across goods.

[Dhyne et al. \(2005\)](#) conduct an analysis to characterize basic features of price adjustment in the Euro area for 10 countries and compare it with U.S. evidence. The paper provides quantitative measures of the frequency and size of price adjustments over 50 products. Finding that the frequency of price changes in the euro area is 15.1 percent with a degree of heterogeneity across products (energy, industrial goods and services). Price decreases are not uncommon and the magnitude.

The work of [Fabiani et al. \(2005\)](#) conduct a study of pricing behaviour that covers 11,000 firms collected by nine European national central banks. They consider a range of factors that affect price changes as market structure, time frequency, consumer relationships (implicit or explicit contracts). They report that firms set prices according to mark-up rules and price discrimination, which suggest that models that incorporate monopolistic competition draw a better description on the price setting behavior. They highlight the existence of differences across sectors. Those who are exposed to severe competition review are more likely to adjust prices by structural factors as cost and demand changes.

One work that incorporates a broad range of data bases is [Álvarez et al. \(2005\)](#). The authors found evidence of price setting behaviour in the euro area based on three sources, consumer price index (10 countries), producer price index (5 countries) and qualitative information for surveys of firms (9 countries). The results are that prices in the euro area are sticky compared to the U.S., the non existence of downward price rigidity since 40 p.c. of price changes are decreases. The existence of heterogeneity and asymmetries among sectors and countries.

Expanding the analysis, the paper of [Altissimo et al. \(2006\)](#) incorporates the findings of the Inflation Persistence Network (IPN). The aim is to focus on the policy implications from the evidence of price setting behaviour and the determinants of inflation persistence. The IPN had recorded a large amount of information on macroeconomic and sectoral variables and on price-setting behaviour at the individual firm level. They highlight four main results: The estimated degree of inflation persistence in the euro area is moderate (it converges to medium-term objective for inflation announced by national central banks), stickiness in the retail sector is higher in euro area than in the U.S., significant sectoral heterogeneity in the degree of price stickiness and prices decreases are common.

Focusing in the producer side, [Vermeulen et al. \(2007\)](#) provided new evidence using producer price setting for 6 euro area countries. They found that each month around 21% of prices change. They also support the existence of substantial cross-sector heterogeneity in the frequency of price changes and no evidence of downward nominal rigidity. They recall important factors for producer price changes. First the degree of labor and non-energy and energy inputs decrease and increase respectively the frequency of price adjustments. The degree of competition in the market. Finally some seasonal patterns associated to retail levels.

In the paper of [Druant et al. \(2012\)](#) documented the evidence on the patterns of price and wage adjustment in European firms in 12 euro area countries. The uniqueness of this paper is that they used a survey developed by the Wage Dynamic Network (WDN) which captures heterogeneity of labour markets across European countries understanding of the effects of different labour market institutions and policies in price and wage setting practices. They took a multivariate framework in a probit estimation, taking into account variables as country differences, sector or firm size, and firm strategies that include a institutional setup covering wage indexation, collective bargaining at country and firm level. They also found the existence of heterogeneity across different sectors, however, they do not suggest strong patterns for

price frequency change in a country specific perspective. additionally, the authors also found that firm size and labor composition had an impact on price frequency changes.

In the case of México, [Solórzano and Dixon \(2020\)](#) used highly disaggregated price and wage microdata. They estimate a panel data fixed effects regression using the share of labor force that perceive a minimum wage as a instrumental variable to estimate the effects of the frequency of wage adjustment and further industry characteristics over the frequency of price changes. Their estimations showed a positive statistically significant impact the frequency of posted price adjustments increases by 1.219 p.p. after a 1 p.p. increase in the frequency of wage changes. Additionally, they create a parameter that measures the ability industries have to adjust their labor force, this results in a positive relationship interpreted as that industries exhibiting more volatile labor force are those changing more frequently their prices.

Focusing on wage rigidity [Babecký et al. \(2009\)](#) analyzed factors in firms characteristics and exogenous institutional factors associated with nominal and real wage rigidity for 14 countries in the European Union (EU). They employed a multinomial logit estimation to asses the relationship on a firm level. They found that both types of wage rigidity is quite substantial, approximately 10% of firms experienced wage freezes and 17% of firms applied wage indexation mechanisms. Among the factors that influence wage rigidity, collective bargaining affects positively real wage rigidity. The worker skills are also a institutional factor for wage rigidity, white-collar workers seem to had less wage cuts than blue-collar workers.

3

Data

3.1 Data

This section first presents the data used followed by an explanation of the cross-walk that allows comparison among different classification systems, then I address the measures and estimations for price and wage flexibility and the industry characteristics used as controls in the regression, followed by an explanation about the intuition behind this variables.

3.2 Data description

The data used for this paper is gathered from the Statistics Institute of Sweden (SCB) Statistics Sweden during the period from 2009 to 2019. In the case of prices I use product dis-aggregated data from the Consumer Price Index (CPI) and industry level data for wages. Additionally, I use industry level characteristics as the Multi Factor Productivity as the weights for production factor and Total Employment at industry level.

The data-set for CPI and wages is reported in a monthly frequency. The original dataset for CPI provides information of 357 products categorized by product grouped in The Classification of Individual Consumption by Purpose (COICOP) in a 4-digit level of aggregation.

For the labor side I use report of elements in the labor costs for workers in the private sector also provided by SCB. This measure is reported in Swedish korona per hour reported in a monthly frequency. This set of data includes the total wage for time worked and not worked, total employer contributions according to agreement, total employer contributions according to law, special payroll tax, general payroll tax and total labor cost as the sum of all this variables. The data is classified in the Swedish Standard Industrial Classification 2007 (SNI 2007).

To address the particular industry characteristics following previous framework in [Peneva \(2011\)](#), [Vermeulen et al. \(2007\)](#) and [Solórzano and Dixon \(2020\)](#) I consider the share of labor in the value of production per industry. This variable is extracted from Multifactor Productivity (MFP) also reported by SCB. The MFP is calculated as the weights for production factors (labor and capital) following the

industrial classification in the “statistical classification of economic activities in the European Community” (NACE Rev. 2). The value for labor share is taken as the weights for labour services in value added and is reported in a yearly frequency.

Finally, I estimate the ease to adjust labor force for each industry. This estimate is referred in the rest of the paper as easiness index. And is estimated in two steps. The first one accounting for the number of workers detrended and seasonally adjusted. Secondly, I estimate the standard deviation of the monthly observations of number of workers per industry. As a result the index consist on a industry level variable reported in a yearly frequency.

As a Summary the variables accounting for industry characteristics are integrated by the proxy of labor cost as the labor share for labour services in value added and the ease to adjust index taken as the ability of certain industries to replace labor force as a response to price or labor cost changes.

3.3 Data comparison

In order to compare the different datasets according to each classification system is necessary to create a cross walk benchmark that provides a valid transition to one classification to other. is difficult to identify previous studies that report a cross walk between CPI or micro-data for prices and wages by industry since is a relative not explored relationship.

In the research of [Bils and Klenow \(2004\)](#) the authors use unpublished data form the U.S. Bureau of Labor Statistics (BLS) in a micro-level and compared with the CPI also reported by the BLS. The products (or prices in this analysis) are divided into 388 entry-level items categories and geographically identified but there is no clear status at industry level classification. The work of [Dixon and Tian \(2017\)](#) studies the behaviour of price-setters using U.K. CPI data at the aggregate and sectoral level that allows for cross-sectional analysis by industry and inference about firm level behaviour. Further analysis that incorporates and as I recall the only that examines the relationship between prices and wages is presented by [Solórzano and Dixon \(2020\)](#), in this paper the cross-walk is made by two digit aggregation by industry level presented by the *Instituto Nacional de Estadística y Geografía (INEGI)* which is the national institute of statistics in México. The authors document the cross-walk comparison between the e North American Industry Classification System (NAICS) for products and the *Instituto Mexicano del Seguro Social (IMSS)*, Mexico’s Social Security Institute classification for wages. They compare four different directions to compare products and sectors finding that the most efficient was to break the NAICS classification for more than one product at IMSS.

The common benchmark for the data employed follows a the cross-walk between COICOP for prices and SNI 2007 for labor data into the NACE Rev.2. classification system. This classification was developed to provide industry definitions among European countries and was adopted in December 2006. The criteria used in this system follows activities grouped by the share of common technology used in process

of production of goods or services. The structure of NACE Rev.2 presents 4 levels of aggregation. It covers 21 sections which can be observed as sectors, 88 divisions of this sections, 272 groups and 615 classes.

Prices follow a 4-digit classification arranged by product group in which the first two digits represent the main groups and the last two complement for the under groups. I recognized two directions to compare this datasets. (1) following a cross-walk from CPI two digit aggregation to sections at NACE Rev.2 or (2) NACE Rev.2 to CPI. In the second case I identify that multiple price observations were grouped in the same sector and division losing some level of disaggregation. Because of that I decided to follow the first comparison that allows a division level of disaggregation for NACE Rev.2 resulting in a dataset that contains 283 products and 31 divisions of sections. As for the share of labor cost and total employment, both are presented according to the NACE Rev.2 classification system.

For labor variables that follow the SNI 2007 classification system the only cardinality identified is between two level aggregation from SNI 2007 to NACE Rev.2. This is because SNI 2007 do not possess a high level of dis-aggregation. This is a relevant issue that may arise some doubts in the result of this study. However, is the only free available data available from SCB with an open source entry.

3.4 Estimation of key variables

The variables of interest in this study are not prices and wages alone, is the frequency this variables change in a certain year for a specific industry. Following the framework from [Solórzano and Dixon \(2020\)](#) I estimate the frequency of price and wage changes in a two step process. The first step is to define a dummy variable for each product and wage that takes the value of one if there was a change or zero otherwise. A change is considered if and only if the observation in the current differ from the one observed in the immediate previous month. The changes are considered as the log variation above 0.1 percent points. The second step I estimate the average by industry of the dummy variables by price product and wage changes.

Formally the measures are:

$$PriceChange_{k,t} = \frac{\sum_{iek,met} 1_{if p_{i,m} \neq p_{i,m}}}{\sum_{iek,met} 1_{if p_{i,m} \& p_{i,m}}} \quad (3.1)$$

$$WageChange_{k,t} = \frac{\sum_{iek,met} 1_{if w_{i,m} \neq w_{i,m}}}{\sum_{iek,met} 1_{if w_{i,m} \& w_{i,m}}} \quad (3.2)$$

Additionally, one difference between the work of [Solórzano and Dixon \(2020\)](#) and this analysis arise from the particularities of the Swedish Labor Market. As mention in the previous section since the Swedish economy presents high level of workers belonging to a union. Is worth to distinguish from some variables that are influenced by a collective bargain as it could be the wage per hour and the contributions after collective agreement. This two variables can be seen as a result of an agreement between employers and employees, thus this aims to contribute the understanding

about the channels in which if changes in this variables have an impact on the frequency prices will adjust as a response. The second different variable accounts for the variables determined by law. This means belonging to a union will not have an impact if this variables change, thus they could be considered as an independent from collective agreements.

The equations of this variables are detailed in the Appendix 1.

3.5 Stylized Facts

The result data set considers 25 unique industries according to the NACE Rev.2. classification system. This industries are showed in detail in table 3.1 which reports the industry average for frequency changes for the price and labor cost variables across years. This is estimates as:

$$PriceChange_{j,k} = \frac{\sum_{t=1} FreqPriceChange_{k,t}}{T} \quad (3.3)$$

This estimate gives insight about the group variation also called the within variation. I find evidence for substantial heterogeneity across industries for price changes. This results are in line with previous research by [Dhyne et al. \(2005\)](#) which conduct an analysis to characterize basic features of price adjustment in the Euro area for 10 countries and compare it with U.S. evidence. Finding that the frequency of price changes in the euro area is 15.1 percent with a degree of heterogeneity across products (energy, industrial goods and services).

In the case of labor cost there is a huge similarity specially across manufacture industries about the frequency changes for the elements of labor cost particularly those who are settle down under law contracts. I suggest two explanations for this phenomenon. The fist one attributes the characteristics of the labor market in Sweden that are highly correlated from the unionization of workers and share of common benchmark for determine wage and labor cost. The second explanation comes form the limitations of the dataset, that present some deficiencies in the moment to disaggregate data for the vis a vis comparison as stated in the previous section.

Table 3.1 shows that for prices adjustments prices goes form 84% for Air transport to 9 % for human health activities and postal and courier activities. The standard deviation across industries for this period is 20% which reflects the relative high spread across industries. In the case of labor cost we can observe less heterogeneity across industries as the minimum frequency is 23% for Accommodation activities and 58% for Electricity, gas, steam and air conditioning supply. Additionally, is worth to mention that the behavior of the variables subject to common law as the total employer contributions according to law and payroll taxes differ form those determined by an collective agreement.

Additionally, table 3.2 shows the variations of frequency adjustment by years. This variation is also called as the between-variation. This table is estimated as for the fist row:

$$PriceChange_{j,k} = \frac{\sum_{k=1} FreqPriceChange_{k,t}}{K} \quad (3.4)$$

Table 3.2 needs to address some remarks. First, we can notice some deviations in years 2014 to 2016 for the frequency variation in the variables of contribution by law, special payroll tax and general payroll tax. Excluding this observations in general we can observe a less variation among the key indicators. In fact, the standard deviation for prices is 5.84% and on average the standard deviation for labor cost variables is around 8%.

3.6 Intuition

Remembering the aim of this paper. I try to estimate the effects frequency changes of wages or labor cost over the frequency of changes in prices for Sweden by industry. The underline reasoning of including this variables is that industries might experience different degrees of share of labor cost of labor intensity. This heterogeneity can be the cause for differences in the repos of price adjustments or the phenom of price rigidity. The nature if wages is that they show a huge downward rigidity. In other words, workers do not like to be pay less and will show resistance to cut wages and salaries. This fact arise the link between those industries that presumably rely on a more basis on their human capital or posses a high labor share than others. If an industry have a high share of labor cost, the response they will have to increase prices facing a change in the labor cost will be less quickly than those industries with low labor share. This is because since the last one can rely on other productivity factors as capital or adjust to this change only by modifying the level of labor force (easiness index).

3.6.1 Empirical Remarks

Economist often ask how stable prices are for the economy. In other worlds they ask how frequent the prices change in the economy. This question is answered by the concept of price stickiness which reflects how often or what is the *probability* of prices and wages to change in a certain moment of time for an economy. This question is important for monetary policy since it provides a clue of how would the economy and agents will react to certain shocks and address the correct response according to the transmission mechanism in the economy.

Economic theories state the existence of cost associated to price changing ans establish models with a time dependent horizon for prices to be adjusted. In this models the number of firms that change prices in any given period is specified exogenously. Two canonical models that set price setting behaviour as a time dependent and not synchronized are [Calvo \(1983\)](#) and [Taylor \(1998\)](#). The main question remains without a board consensus of how the nature of price and wage rigidities help to explain the dynamics between money, real output and inflation.

As [Taylor \(1998\)](#) state citing David Hume previous work, is useful to first review some general observations about wage and price setting since they constitute a fist

hand experience in our daily day basis in the economy.

Essentially wages are the result of the interaction between workers and firms. This negotiation is affected by exogenous changes as it is the inflation rate or tax reforms. In most of the market economies workers enjoy a set of benefits that are also part of the salary negotiations. Typically this negotiations are made once per year according to a performance and salary review, additionally is common to observe wages indexed to macroeconomic variables as inflation rate. There is no evidence of synchronization among firms to take changes in the nominal wage as it is common to occur throughout the year.

In the other hand, when focusing on price setting behaviour firms react mostly to changes of intermediate inputs and changes in demand. However, we also need to take into account the presence of some markup rules and competitive behaviour. Additionally, there is particularly empirical evidence of the heterogeneity of price changes across sectors.

3.7 Wage and Price Setting in Sweden

This section describes how wage and price behavior have been developing in Sweden.

3.7.1 Wage developing in Sweden

As it is well documented in [Edin and Holmlund \(1995\)](#) labor relations in Sweden are affected by their experience after the World War II. The *Basic Agreement* in 1938 between the LO (the Swedish trade union confederation) and the SAF (the Swedish employers federation) is considered the starting point of modern labor relations. It includes a set of rules for conflict resolutions and combined with previous law on collective agreements.

There are three major unions in Sweden which account for approximately 70% of the workers. The Swedish Trade Union Confederation (LO) was founded in 1898 and organizes blue-collar workers in the private and public sector. The Swedish Confederation of Employees (TCO) for salary employers or white-collar workers and The Swedish Confederation of Professional Associations (SACO) which is almost exclusively an organization for employees with a university education.

Among some particular features about the wage rigidity ? conducted a survey after special macroeconomic conditions. The first survey was conducted in 1991 after the most severe recession in Sweden after 1930s and the second survey took place in 1998. This survey gives useful insights about the behaviour of workers and wage settles in the labor market. They found that even in a situation of high unemployment and low inflation, wage cuts do not occur.

In fact, Swedish labor law states that employers are not able to cut nominal wages unilaterally. Wages are set in a two-tier system at industry level and local level negotiations. So that the *minimum* wage level specified at industry level specify a

floor which may not be undercut by a local wage agreement. The author concludes that these institutional agreements create higher hiring and firing cost. Additionally he remarks that managers are aware that employers care about relative wages for local bargain, this add more weight into the extent of nominal rigidity.

All this factors influence that the Swedish labor market present a certain degree of downward nominal wage rigidity caused by endogenous characteristics as the institutions that establish a floor for wages and also the collective bargain among unions and firms.

3.7.2 Price developing in Sweden

There is a relatively small work in this topic. [Apel et al. \(2001\)](#) analyzed the results from a survey answered by 600 random selected firms with more than 5 employers and excluding sectors whose price is decided by political means or do not have a price. They found that firms adjust the price of their main product once per year in 40.3% and 27.1% adjust less than once per year. They also asked the respondents to rank different reasons to change prices related to theories on price stickiness. The main responses were implicit contracts, sluggish cost and explicit contracts in that rank correspondingly. They conclude that the respondents are in line to change prices weighting more real changes rather than nominal changes. They remark that this could be due to the specific interaction in the economy where workers are aware of real wages due to collective worker organization.

In the next section I present the mythology and analyze one by one he expected effects of each variable over the frequency of price adjustments.

Table 3.1: Descriptive Statistics of Prices and Labor cost across years

Industries	Prices	Wages	Contributions agreement	Contributions law	General payroll tax	Special payroll tax	Total labor cost
Accommodation	23.78	23.33	29.16	30.83	35.00	30.83	24.16
Air transport	84.16	32.50	35.83	34.16	32.50	35.83	30.83
Electricity, gas, steam and air conditioning supply	28.75	58.33	59.16	59.16	58.33	60.83	59.16
Human health activities	9.16	49.16	51.66	50.83	49.16	52.50	49.16
Land transport and transport via pipelines	43.33	32.50	35.83	34.16	32.50	35.83	30.83
Manufacture of basic pharmaceutical products and pharmaceutical preparations	34.66	39.16	44.16	46.66	42.50	46.66	39.16
Manufacture of beverages	20.34	39.16	44.16	46.66	42.50	46.66	39.16
Manufacture of chemicals and chemical products	36.33	39.16	44.16	46.66	42.50	46.66	39.16
Manufacture of coke and refined petroleum products	50.27	39.16	44.16	46.66	42.50	46.66	39.16
Manufacture of computer, electronic and optical products	62.12	39.16	44.16	46.66	42.50	46.66	39.16
Manufacture of electrical equipment	57.50	39.16	44.16	46.66	42.50	46.66	39.16
Manufacture of fabricated metal products, except machinery and equipment	45.55	39.16	44.16	46.66	42.50	46.66	39.16
Manufacture of food products	37.19	39.16	44.16	46.66	42.50	46.66	39.16
Manufacture of furniture	34.27	39.16	44.16	46.66	42.50	46.66	39.16
Manufacture of motor vehicles, trailers and semi-trailers	9.37	39.16	44.16	46.66	42.50	46.66	39.16
Manufacture of other non-metallic mineral products	56.11	39.16	44.16	46.66	42.50	46.66	39.16
Manufacture of other transport equipment	27.77	39.16	44.16	46.66	42.50	46.66	39.16
Manufacture of paper and paper products	41.83	39.16	44.16	46.66	42.50	46.66	39.16
Manufacture of rubber and plastic products	39.44	39.16	44.16	46.66	42.50	46.66	39.16
Manufacture of textiles	73.18	39.16	44.16	46.66	42.50	46.66	39.16
Manufacture of tobacco products	8.33	39.16	44.16	46.66	42.50	46.66	39.16
Other manufacturing	35.15	39.16	44.16	46.66	42.50	46.66	39.16
Postal and courier activities	9.16	32.50	35.83	34.16	32.50	35.83	30.83
Real estate activities	33.05	44.16	47.50	46.66	48.33	47.50	45.00
Water transport	75.83	32.50	35.83	34.16	32.50	35.83	30.83
SD	20.86	6.18	5.68	6.3	5.67	6.11	6.55
median	36.33	39.16	44.16	46.66	42.50	46.66	39.16
mean	39.07	38.83	43.26	44.69	41.73	45.13	38.66

Table 3.2: Descriptive Statistics of Prices and Labor cost across Industries

Frequency of Adjustments	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	SD	mean
Prices	33.15	37.65	34.42	43.77	43.88	45.31	45.31	48.09	47.3	50.19	5.84	42.91
Wage	34.31	34.57	40.73	33.52	26.58	48.27	54.35	40.05	40.02	33	8.07	38.54
Contributions agreement	41.63	42.15	49.06	41.63	26.8	55.93	47.18	40.47	48.27	41.03	7.63	43.42
Contributions law	41.63	42.23	41.37	41.1	26.09	64.53	69.52	48.31	40.02	41.03	12.63	45.58
Special payroll tax	49.21	49.85	49.47	27.29	26.95	49.51	39.9	54.65	41.25	33.18	10.06	42.13
General payroll tax	41.63	41.82	41.85	41.4	26.16	64.38	70.12	48.31	40.24	41.03	12.69	45.69
total labor cost	33.37	34.57	40.95	34.16	26.16	48.39	54.77	40.05	40.02	33.07	8.27	38.55

4

Methods and Results

4.1 Empirical Method

This section explains the empirical method used in this work. I first describe the panel econometric specification for price and wage flexibility and then show the main results of this analysis.

4.1.1 Econometric Specification

I employ the empirical strategy following the framework from [Solórzano and Dixon \(2020\)](#) to explore the relationship and determinants of price adjustments at an industry level. The specification regresses the frequency of price adjustments on the frequency of wage adjustments and particular industry characteristics. Formally:

$$FPChange_{k,t} = \alpha + \beta_1 FWChange_{k,t} + \beta_2 FNoALChange_{k,t} + \beta_3 X_{k,t} + \gamma_k + \gamma_t + \xi_{k,t} \quad (4.1)$$

The subscript k represents industry and t stands for the year. The regression takes the frequency of price changes as $FPChange$ on the frequency of wage adjustments depending on collective agreement $FWChange$ and a labor variable cost non depending on collective agreement $FNoALChange$ and a variable for time-varying industry characteristics X that hold for the share of labor cost and a estimate of easiness of labor adjustment.

Finally, γ_k and γ_t address for industry fixed effects at industry level heterogeneity and possible shocks along time.

Some important remarks may arise at the moment of estimating equation (4.1) with a simple OLS. As stated in [Solórzano and Dixon \(2020\)](#) this specification may be biased due to reverse causality. This can be exemplified by thinking how the collective agreements take place before and after some price increasing. Additionally, I need to account for the possible omitted variable bias.

Since the nature of the question arise from a comparison within industries across time. Proposing a fixed effects specification will support strong evidence for the

causality effects that in this paper is determined by how frequency changes in labor cost affect frequency changes in prices. As long as the omitted variable bias or some eventual shocks are temporal, fixed effects estimators will result in the best estimates.

4.2 Results

Table 4.1 presents the main results of regressing the nominal price adjustments on the frequency of the chosen labor cost additionally with the industry characteristics fixed effects.

Each column present different regressions using different combinations for the explanation variables. The first column refer to the regression of frequency price adjustments over the frequency of wage adjustments for the complete period (2010-2019). This result suggests a positive relationship of 0.110 .This positive relationship is in line with previous studies as highlighted in [Solórzano and Dixon \(2020\)](#) for the case of the Mexican economy. The intuition behind this relationship is that industries with high labor intensity tend to be less flexible than those without a high share of labor. In this sense we can interpret the result as a 1 p.p. increase in the frequency of wage adjustment, price frequency changes will adjust by .110 p.p. in the case of Sweden.

As mention in the previous section, is worth to differentiate from those variables that are determined by a specific law contract and those influenced by union bargain. In this sense, the second column estimates the regression of frequency of price changes on the frequency of wage changes and the frequency of general payroll tax. The estimates show that the frequency of wage changes inverted to a negative relation, but statistically insignificant and very close to zero. However, including the frequency change of payroll tax results in a statistically significant estimator with a value of 0.124. This could be an insight result about the price setting behavior for the industries in this study whether they change prices more frequently depending on variables that are non negotiated.

The role of industry characteristics allow me to have a deeper examination of the mechanism and relevance of the variables of interest. As mention in the Literature review section, the framework of [Solórzano and Dixon \(2020\)](#) takes the intuition and combines the studies form [Álvarez et al. \(2005\)](#) and [Peneva \(2011\)](#) confirming the inverse relationship of labor cost and frequency of price adjustment.

An important variable that I take into consideration in the case of Sweden, comes form the developing estimator form [Solórzano and Dixon \(2020\)](#) where take account of how labor cost and prices are related through the employment level. What is more of interest is the number of workers and how easy it is for certain industries to adjust their labor force.

As described previously, the easiness index as I recall in the tables, is calculated as the detrended and seasonally adjusted number of workers per industry. Then

I take the standard deviation of the monthly observations of number of workers per industry. The interpretation about this estimator in the work of [Solórzano and Dixon \(2020\)](#) is the ability for industries to modify the labor force they employ. The intuition follows that the greater the volatility in the employment lever, the less that industry will relate their price setting behaviour to wage changes and labor cost.

Column 3 and 4 include this two characteristics to the first and second regression. Column 3 shows a almost similar estimation for wage frequencies as for the first regression around 0.013 value and statistically significant. One advantage of this specification is that the interpretation that the labor share per industry impacts price flexibility only through the measure of wage flexibility. Column 3 reflects a non significant and positive coefficient for labor share, this is a counter-intuitive result since some previous results like [Klenow and Malin \(2010\)](#) prove the negative relationship between this variable and price changes. The intuition behind is that a great dependence of labor share (greater wages relative in the cost by industry), prices tend to be more rigid. Further in the analysis I check for the validity of this result looking for extraordinary years that can affect the results of the regression.

Additionally, as expected from the previous work of [Solórzano and Dixon \(2020\)](#), the easiness index is a significant and strong coefficient to explain the frequencies of price changes. The estimator intuition follows that a huge value of easiness index represents a more volatile labor force for a determine industry, thus, it will follow a less price flexibility though the channel of wage flexibility. In this regression the coefficient for the easiness index is 1.51 which can be interpreted as how the index increase 1 p.p. it will follow an increase in the price volatility of 1.51 p.p.

Finally, column 4 incorporates the four variables used in the models 1,2 and 3. I found two important results. The first one is that non law based labor characteristic as wage changes and the frequency of price changes presents an inverse relationship but non significant. Adding to this point what is interesting is that the law based agreements in this case the general payroll tax is significant and with a positive relationship close to the previous estimates around 0.130 p.p. which implies a stable result among different specifications. The second result involves the industry characteristics where the expected inverse relationship between price changes and labor share shows but with a non significant value. However, the easiness index maintains the significant and strong value obtained in regression at column 3.

As we saw in the previous section, the data presents huge variations in the years 2014 to 2016 for the variables contributions specified by law and special and general payroll taxes. For this case I consider is worth to make some robustness checks to the previous specifications eliminating the years that present high volatility and might be the cause for bias estimators. In this sense, table 4.2 presents the same regressions as table 4.1 without the years with high variations. Column 1 presents a higher estimate for wage frequencies, but less precise as shown by the p value. Column 2 presents a significant estimator for the frequency of payroll changes of 0.387 p.p. but a non significant estimator for wage changes. Column 3 presents more relevant results, as the three estimators are significant and with the expected relationship direction. The frequency of wage changes is 0.235 p.p. and positive.

For the labor share the regression estimate an inverse relationship of -2.143 p.p. and finally a positive relationship for the easiness index of 1.860 p.p.

Finally, column 4 reports the regression with the 4 variables and without high volatility years. The results are intriguing as the only non significant estimator is the wage frequency change but the non bargain variable (general payroll tax) results with a higher precision of significance and a value of 0.533 p.p. with a positive relationship. The labor share presents a inverse relationship with value of -3.853 p.p. and the easiness index a positive relationship with 1.313 p.p.

Table 4.1: Frequency of price adjustments on the frequency of wage adjustments

	(1)	(2)	(3)	(4)
Wage	0.109593** (0.0114)	-0.0504959 (0.5823)	0.138713*** (0.0023)	-0.0244240 (0.7983)
General Payroll Tax		0.124034** (0.0455)		0.130053** (0.0413)
Labor Share			0.123340 (0.8449)	-0.324771 (0.6131)
Easiness Index			1.515661** (0.0106)	1.478037** (0.0112)
Constant	0.386817*** (0.0000)	0.391838*** (0.0000)	0.312946*** (0.0011)	0.382479*** (0.0001)
Observations	2220	2220	2220	2220
R^2	0.0040	0.0056	0.0078	0.0094

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The estimates take account for 25 industries and 222 products

4.2.1 Robustness Checks

In this section, the results are assessed through several specification tests. The tables for this specifications can be found in the Appendix II.

The first specification in table B.1 takes into consideration the total cost for labor. The idea behind this specification is that this variable is affected by both, collective and law agreements. In this sense the effects this will have over the frequency of price changes must be positive and higher than those obtained in the original specification. Columns 1 and 2 refer to the regression considering all the spectrum of years. Column 1 show the regression between frequency of price changes and frequency change of total labor cost. It follows the intuition reporting a significant and positive value of 0.115 p.p. Column 2 in the other hand gives an important result. Considering for industry characteristics the labor share do not follow the inverse relationship we expect but it is statistically insignificant. By contrast the frequency

Table 4.2: Frequency of price adjustments on the frequency of wage adjustments omitted years(2014 2015 and 2016)

	(1)	(2)	(3)	(4)
Wage	0.174610*	-0.0830034	0.235406**	-0.123396
	(0.0732)	(0.4307)	(0.0186)	(0.2688)
General Payroll Tax		0.387849***		0.533154***
		(0.0002)		(0.0002)
Labor Share			-2.143335***	-3.853182***
			(0.0064)	(0.0001)
Easiness Index			1.860268***	1.313298**
			(0.0020)	(0.0301)
Constant	0.356890***	0.287012***	0.584659***	0.751093***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Observations	1554	1554	1554	1554
R^2	0.0034	0.0101	0.0145	0.0244

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The estimates take account for 25 industries and 222 products

of total labor cost and easiness index follow a positive and significant relationship on line with the intuition stated before.

Continuing with table B.1. An additional result suggest in columns 3 and 4 where we drop high volatile years. For the relationship of total cost changes and price frequency changes the estimate is positive and significant in a 10% degree. Column 4 gives an important insight. In this specification all variables are significant and follow the expected relationship. Total labor cost frequency changes have an estimate of 0.218 p.p., labor share measure follows an inverse relationship of -1.988 p.p. and the easiness index a value of 1.808 p.p.

Table B.2 presents the same specification as equation 4.1 but with a different variable accounting for collective agreement as is the contributions of employer after agreement. Column 1 give results for wage frequency changes and collective agreement. It estimates a positive relationship for the first and a negative for the former. However, when omitting for wage in column 2 it tours to be positive but statically insignificant. Column 3 gives important insight as well. All variables are significant having an estimate for wage frequency positive and with value of 0.500 p.p. a negative value for contributions after agreement and labor share of -0.431 and -2.308 respectively and a positive value of 1.594 for the easiness index.

Again accounting for the high volatility years, column 4, 5 and 6 reports the regressions omitting those years. Column 4 suggest the same relationship as column 1 but with higher estimates. Column 5 reports significance only for the industry characteristics (labor share and easiness index) with negative and positive relationship.

Column 6 reports all estimates significant and with a higher estimate than other specifications. The relationship is maintained showing a positive relation between frequency price changes and wage frequency changes and easiness index and an inverse relation for contributions after agreement and labor share.

It is worth to notice how the relationship among explanatory variables varies as we omit wage in the specification. Finally, table B.3 reports the same regressions but when we omit this variable. Column 1 and 2 are as in the previous estimations considering all the years from the data while column 3 and 4 omit volatile years. The relevance of the findings of these specifications relies in the conclusion that omitting a measure of wage flexibility can lead to different directions when assessing the determinants of price flexibility. For a variable not subject to collective agreement it shows an inverse relationship as for the labor share. A positive relationship for an independent variable of collective bargains as it is total cost and for the easiness index.

4.2.2 Final Remarks

As we notice, the specification is very sensible depending on which variables we choose to include. However, there are some constant outputs that give certain insight for the relationship. First, the relationship for wage frequency changes and price frequency changes is positive when reported with a significant value. Second, when distinguishing between variables with some degree of dependence for collective agreements, price frequency changes tend to be less relevant and with smaller values. Third, it appears to hold that the relationship between labor share and price rigidity holds as from previous research showed. Fourth, the more easy an industry can adjust the labor force, the higher the frequency of price changes will occur.

5

Conclusion

5.1 Conclusion

The findings in this paper suggest that at evaluating the relationship between price frequency changes and wage frequency changes there exist a positive relationship around 0.130 p.p. on average. This means that an increase in 1 p.p. on the frequency of wage changes will imply an increase of 0.130 over the frequency of price changes.

One of the contributions of this paper is the gathering and standardization of price and wage data sets at industry level that are not so further explored in this topic. Additionally, the results of this paper confirm the heterogeneous behavior for price setting across industries. This is due to the labor intensity and easiness to adjust index.

Further, the previous knowledge about the Swedish economy can enrich the debate at allowing for differentiation for labor variables subject to collective agreements and those that act under the benchmark of law regulations.

However, the findings in this paper should be taken cautiously when considering for the magnitude of flexibility measures since the findings report a 40% change across industries. which are more than the double reported in previous works for other countries like México [Solórzano and Dixon \(2020\)](#)(20%) or U.S. (14%) and France (9%) [Barattieri and Gottschalk \(2014\)](#). I recall that this problem may arise because of the nature of the data that poses some limitations when trying to desegregate wage and labor cost reports by industry.

Nonetheless, this finding can support modeling for better estimations of business cycle and monetary policy in Sweden since it provides an analysis with industry aggregation. that gives empirical evidence of the behavior of price and wage settlers.

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Appendix A

Appendix

Data description

Equation for contributions after collective agreement:

$$ConAgreeChange_{k,t} = \frac{\sum_{iek,met} 1_{ifca_i,m \neq ca_i,m}}{\sum_{iek,met} 1_{ifca_i,m \& ca_i,m}} \quad (A.1)$$

Equation for contributions after law change:

$$ConLawChange_{k,t} = \frac{\sum_{iek,met} 1_{ifclaw_i,m \neq clwa_i,m}}{\sum_{iek,met} 1_{ifclwa_i,m \& clwa_i,m}} \quad (A.2)$$

Equation for special payroll tax:

$$SpTaxChange_{k,t} = \frac{\sum_{iek,met} 1_{ifspt_i,m \neq spt_i,m}}{\sum_{iek,met} 1_{ifspt_i,m \& spt_i,m}} \quad (A.3)$$

Equation for general payroll tax:

$$GnTaxChange_{k,t} = \frac{\sum_{iek,met} 1_{ifgnt_i,m \neq gnt_i,m}}{\sum_{iek,met} 1_{ifgnt_i,m \& gnt_i,m}} \quad (A.4)$$

Results

Table A.1: Robustness check with Total Labor Cost

	(1)	(2)	(3)	(4)
Total Labor Cost	0.115544*** (0.0072)	0.147408*** (0.0012)	0.175314* (0.0542)	0.218020** (0.0206)
Labor Share		0.146583 (0.8156)		-1.988663** (0.0113)
Easiness Index		1.571313*** (0.0086)		1.808818*** (0.0029)
Constant	0.384510*** (0.0000)	0.304564*** (0.0016)	0.356633*** (0.0000)	0.570480*** (0.0000)
Observations	2220	2220	1554	1554
R^2	0.0044	0.0085	0.0035	0.0139

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The estimates take account for 25 industries and 222 products

Table A.2: Robustness check with Contributions agreement

	(1)	(2)	(3)	(4)	(5)	(6)
Wage	0.334489*** (0.0000)		0.500230*** (0.0000)	0.758665*** (0.0000)		1.504222*** (0.0000)
Contributions agreement	-0.293587*** (0.0000)	0.0246747 (0.5411)	-0.431015*** (0.0000)	-0.727862*** (0.0000)	-0.108225 (0.2627)	-1.534589*** (0.0000)
Labor Share		0.710026 (0.2969)	-2.308954*** (0.0016)		-2.339248*** (0.0059)	-8.362340*** (0.0000)
Easiness index		1.106910** (0.0497)	1.594853*** (0.0069)		1.449467** (0.0135)	1.949602*** (0.0011)
Constant	0.427606*** (0.0000)	0.282696*** (0.0094)	0.711091*** (0.0000)	0.459482*** (0.0000)	0.758246*** (0.0000)	1.672996*** (0.0000)
Observations	2220	2220	2220	1554	1554	1554
R ²	0.0120	0.0023	0.0198	0.0206	0.0097	0.0616

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The estimates take account for 25 industries and 222 products

Table A.3: Robustness check without wages

	(1)	(2)	(3)	(4)
Contributions agreement	-0.293991*** (0.0000)	-0.411141*** (0.0000)	-0.807742*** (0.0000)	-1.432036*** (0.0000)
Total Cost	0.340755*** (0.0000)	0.490029*** (0.0000)	0.823197*** (0.0000)	1.369426*** (0.0000)
Labor share		-2.034468*** (0.0034)		-7.019439*** (0.0000)
Easiness index		1.699357*** (0.0041)		1.696468*** (0.0055)
Constant	0.425328*** (0.0000)	0.663451*** (0.0000)	0.470583*** (0.0000)	1.493558*** (0.0000)
Observations	2220	2220	1554	1554
R^2	0.0127	0.0204	0.0231	0.0562

p -values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The estimates take account for 25 industries and 222 products