Price Dynamics in Japan (1981-2001): A Structural Analysis of Mechanisms in the Goods and Labor Markets

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Abstract

This paper aims to provide an alternative framework to previous studies of deflation in Japan. We focus on the real dimension of the price dynamics and propose an imperfect competition model, which describes a rent economy, where the formation of prices can be separated into the markup (level of the rent in the goods market) and the unit labor cost (distribution of the rent in the labor market). We use a panel industry dataset to analyze the impact of institutional and structural factors on the heterogeneous price dynamics of 10 manufacturing sectors. Although the evolution of unit labor costs seems to be the driving force of price dynamics in the manufacturing industry, our structural analysis leads to consider the importance of the increasingly competitive environment, as captured by rising import penetration. Along with the decline of bargaining power of the workforce, this is at the origin of the deflationary pressures that characterized the Japanese economy during the Lost Decade.

Keywords : Deflation, Japanese Economy, Wage Bargaining, Markup, Deregulation, Panel Threshold Regression.

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1 Introduction

From the mid-1990s to 2005, Japan experienced a period of deflation. If one excludes the controversial debate on the appropriate monetary policy, it is possible to say that research on deflation in Japan has essentially focused on the assessment of the respective contribution of supply and demand mechanisms, eventually based on an AS/AD framework. However, it has been particularly difficult to quantify: the best-known identification problem in econometrics is certainly the disentangling of supply and demand curve shifts to determine the source of price change (Saxonhouse, 2005). That is why one should be very modest regarding our understanding of deflation, which has not improved very much since the controversy over the causes and nature of the Great Depression in the US.

The aim of this paper is to provide an alternative framework to analyze price dynamics in Japan. It has the following characteristics. First, our contribution is strictly delineated by the fact that we are focusing on the real dimension of deflation. However, this does not mean that we consider it as an exclusive theoretical story: monetary and banking mechanisms are obviously important and have to be considered in complementary studies. Second, instead of using the concepts of demand-led and supply-led deflations, we try to disentangle what is related to the goods market and labor market dynamics respectively. More precisely - and this is the third characteristic of our perspective - we adopt an imperfect competition theoretical framework: price formation in Japan, as in other economies, takes place in a monopolistic competition environment; the present contribution tries to take this fact into account in the analysis of deflation. In our model, whose main inspiration comes from Blanchard and Giavazzi (2003) and which describes a "rent economy", the decrease of prices can be alternatively or simultaneously explained by a decrease of the level of the rents (determined in the goods market) or by a change in their distribution (determined in the labor market). Fourth, although monetary policy mismanagement may have contributed to the emergence of deflation, to its deepening and its duration, the basic hypothesis of our study is that the causes of this deflation were structural. That is why a major part of this paper is dedicated to the analysis of the impact of institutional and structural changes in the labor and goods markets on the price dynamics. It also means that our aim is to detect the existence of a regime change. Fifth, it has been shown that the deflation in Japan was more severe from the point of view of the GDP deflator than from the CPI (consumer price index) perspective. This seems to indicate that the basis of the deflation is large and does not concern only a few specific industries (Baig, 2003). However, at the same time, non negligible differences have been observed across industries. Not surprisingly, deflation is more pronounced in the manufacturing industries rather than the non manufacturing industries; furthermore, within the manufacturing industries, one also observes an important heterogeneity (see appendix 1). In the empirical part of this paper, we focus on the manufacturing industries and we use this heterogeneity to try to understand the impact of institutional and structural factors in a panel framework. In doing so, we do not study deflation by itself, which is by definition a macro phenomenon, but rather investigate the driving force of the price dynamics in the industry, which expe-

rienced the more pronounced price decrease. Generalization of our results is left to further studies.

The expected originality of this perspective is to contribute to a better theoretical understanding of price formation as well as to a deeper knowledge of the structural transformation of the Japanese economy since the mid 1980s, which may have facilitated the emergence of deflation. First, we revisit an old tradition on the link between wages and prices, in taking into account more recent papers, theoretical and empirical, on the relationship between market structure and markup formation (Banerjee & Russell, 2005; Martins et al., 1996). This tradition has recently been promisingly applied to explain the evolution of prices in the cases of national economies, like Hong-Kong, Australia and Belgium (Genberg & Pauwels, 2004; Cockerell & Russell, 1995; Dobbeleare, 2004). Second, in applying - for the first time, to our knowledge - this framework to the analysis of deflation in Japan, we consider mechanisms which are usually studied separately - the impact of tension in the labor market (as measured by the vacancy rate), of labor disputes, of the change of the labor status composition of the workforce, of deregulation of the goods market, of increasing openness to foreign imports, and of market dynamics at the industry level, through the evolution of the number of firms. Third, using the heterogeneity of price dynamics across sectors to analyze the impact of institutional and structural factors and trying to detect a regime change lead us to use a threshold approach in a panel framework, in following the Hansen's procedure (1999). Here again, to our knowledge, this is the first time that this framework has been applied to this kind of analysis of price dynamics.

Although previous statistical decompositions of price dynamics have shown that the evolution of unit labor costs was apparently the driving force of the price dynamics in the Japanese manufacturing industry (Canry & Lechevalier, 2007) our structural analysis leads us to reconsider the importance of the increasingly competitive environment in the goods market. More precisely, we demonstrate that rising import penetration has significantly affected the price dynamics, directly as a explanatory variable and indirectly as a threshold variable at the origin of regime changes in these price dynamics. The differences of regulation across sectors is another factor to explain the heterogeneity of price dynamics. However, a simple statistical analysis shows that regulation has not evolved over time, when one considers the manufacturing sector as a whole. Therefore, this variable cannot explain the trend toward deflation. That is why it is possible to conclude that, along with the decline of the bargaining power of the workforce (as captured by the decreases of the vacancy rate, of the number of disputes, and of the share of regular employees), the increasing openness of the Japanese economy is at the origin of the deflationary pressures, which characterized the Lost Decade.

The structure of this paper is as follows. We first present the theoretical framework, in which we analyze the relations between prices, wages and markup ratios, in characterizing the equilibrium in the goods market and the labor market. Second, we introduce structural variables of the labor and goods markets to characterize the Japanese economy since the

1980s from institutional and structural points of view, and describe their evolution. Finally, we propose a panel econometric analysis of the price dynamics in the manufacturing industry (decomposed into 10 sub-sectors) between 1981 and 2001 on an annual basis, using some structural characteristics of the labor and goods markets as explanatory variables.

2 The theoretical framework: monopolistic competition and wage bargaining

Some recent papers proposed an analysis of the interactions between goods and labor markets in a imperfect competition framework, to explain some stylized facts characterizing the non inflationist context of the European and American economies since the mid-1980s. This is the case of the contribution by Blanchard & Giavazzi (2003), who study the impact of deregulation within a model of imperfect competition in the goods market and of wage bargaining in the labor market. We modify this model to study deflation in Japan. This approach allows us to introduce some important parameters - the degree of monopolistic competition in the goods market and the bargaining power of the workers - and to study their impact on prices.

2.1 Goods market: monopolistic competition

The productive sphere is composed of n firms, each producing one good q_i, $i = 1, 2, ...n$, entering in the utility function of the consumers. Taking into account the demand function of goods (not specified here), firms can differentiate their production in comparison to the production of the other firms. Considering that each firm produces only one good, it makes the good produced by firm i imperfectly substitutable with that produced by firm j ($i \neq j$). This differentiation of goods is the fundamental reason for the existence of monopolistic rents in the economy.

The production function of firm i is simply :

$$q_i = al_i \qquad \forall i = 1, 2, ...n \tag{1}$$

This is a production function with constant returns to scale. At this stage, the only production factor is labor. But, in fact, production also requires a preliminary fixed investment (or cost) in capital, K.

The demand function that firm i faces can be written as:

$$q_i^d = \frac{q}{n}\left(\frac{p_i}{p}\right)^{-\frac{1}{\eta}} \qquad \forall i = 1, 2, ...n \tag{2}$$

where q is the aggregate demand, η an indicator of the degree of competition in the economy (the degree of product differentiation) and p, the price index is given by the equation:

$$p = \left(\frac{1}{n} \sum_{i=1}^{n} p_i^{\frac{\eta-1}{\eta}} \right)^{\frac{1-\eta}{\eta}} \tag{3}$$

2.2 Labor market : "right to manage" type of wage bargaining

The workers try to get a part of the monopolistic rent determined in the goods market, through wage bargaining conducted in a decentralized way within each firm. Here the framework is a "right to manage model", in which workers and firms negotiate only on the wage, and workers let the firms determine the level of employment. Therefore, contrary to the "optimal control" model, in which bargaining simultaneously determines the wage and employment, this model leads to non Pareto-optimal results. However, we prefer this framework for empirical and theoretical reasons. As for the former, this choice of model could appear surprising at first sight, since Aoki (1988) has convincingly described the bargaining game in the J-firm as characterized by a "wide range of bargainable subjects". However, Aoki's theoretical perspective is broad and does not concern specifically the so-called "shunto" ("Spring offensive"), for which the object of bargaining is mainly - if not exclusively - the annual wage increase, especially during the 1980s and the 1990s (Koshiro, 2000). As for theoretical reasons, they can be summarized as follows: in the case of the right to manage model, and contrary to the optimal control model, the key parameters - the degree of differentiation of goods (that is the more or less competitive nature of the market) and the bargaining power of the workers - have an impact on prices. This case exactly corresponds to what we want to capture in this paper.

In the frame of the "right to manage" model, wage bargaining in the firm i classically takes the form of a game between the union and the firm. The joint maximization program in firm i can be written as :

$$\max_{w_i} \mathcal{N} = (w_i - w_u)^{\gamma} l^{\gamma} \left(p_i q_i - w_i l_i\right)^{1-\gamma} \tag{4}$$

where w_u is the (exogenous) reservation wage in the economy. γ stands for the bargaining power of the union. In this program, the rent is shared between wages and profits. Employment is determined by the firms, which adjust their labor demand to the wage rate resulting from the wage bargaining. As the agents think by backward induction, this rule of employment determination is of course taken into account by the agents during wage bargaining.

2.3 Equilibrium

The easiest way to characterize the equilibrium is to proceed in two steps, starting with partial equilibrium and then turning to general equilibrium.

Partial equilibrium. In the partial equilibrium, each firm is taken separately and the agents within each firm consider that the price determined in their firm has only a marginal influence on the general price level. Solving the program at the partial equilibrium determines at the same time the (nominal and real) wage (the workers consider that the price level is given at the macroeconomic level), employment and the production of each firm (not specified here). We focus here on the result regarding the wage:

$$w_i^* = \left[1 + \frac{\eta\gamma}{1-\eta}\right] w_u \tag{5}$$

At the partial equilibrium, the real wage $\frac{w_i^*}{p}$ bargained by the workers is indexed on the reservation wage expressed in real terms ($\frac{w_u}{p}$). This bargained real wage is a increasing function in γ (bargaining power of the workers) and in η (measuring the level of rent in the goods market): $\frac{w_i^*}{p}\underset{+\ +}{\left(\gamma, \eta\right)}$. In fact, one can consider the bargained real wage as "indexed" on the firm's rent. That is why these two variables are evolving jointly.

Moreover, each firm determines its price by applying a markup ratio μ to the unit labor cost. The markup ratio depends positively on the degree of differentiation of goods (negatively on the degree of competition): $\mu = \frac{1}{1-\eta} > 1$. The unit labor cost paid by the firm is defined as the nominal wage corrected by the average labor productivity, a. The price p_i^* set by the firm i is therefore equal to :

$$p_i^* = \frac{1}{(1-\eta)}\frac{w_i^*}{a} \tag{6}$$

$$= \left[\frac{1-\eta+\eta\gamma}{(1-\eta)^2}\right]\frac{w_u}{a} \tag{7}$$

It is then possible to calculate the "real" wage paid by the firm i :

$$\frac{w_i^*}{p_i^*} = (1-\eta)a \tag{8}$$

This "real" wage depends only, positively, on the labor productivity and, negatively, on the degree of imperfect competition on the goods market: $\frac{w^*}{p*}\underset{+\ -}{\left(a, \eta\right)}$.

General equilibrium. Turning now to the general equilibrium, we have $p = p_i^*$ because all the firms are identical. The same applies to the wage: $w^* = w_i^*$. The equilibrium can therefore been described as follows. The real wage in the economy is the same as the one in any firm:

$$\frac{w^*}{p^*} = (1 - \eta)a \tag{9}$$

Finally, the number of firms n^* is determined by an entry condition. The firms enter the market until their profit allows them to pay the fixed cost K.

A few general remarks can be made about this solution:

1. This model describes a rent economy, in which the level of rent is determined by the degree of competition in the goods market and its distribution between firms and workers is determined by the bargaining power of union in the labor market. It is important to notice that, in this model, the rents depend only on the parameter η, which measures the imperfect substitutability between the different goods in the demand function of consumers. Therefore, the entry condition in the goods market (existence of a fixed capital cost or, more generally, of an entry cost in the market) determines the number of firms n^* at the equilibrium. But, it has no impact on the markup ratio (and therefore on prices) applied by each firm. This surprising result can be explained easily: from a theoretical point of view, an increase of the number of firms n^* (following a decrease of the entry cost) affects the quantity of the good q_i^* produced by firm i (which decreases if n^* increases), but not its price, which is still determined by the relation (7), not depending on n^*. Putting it differently, the more numerous are the firms, the less is the quantity produced by each firm, with the price being unaffected by these changes. In this article however, we assume that η (which has a positive impact on p) is a very general indicator of imperfection in the goods market: η measures not only the degree of substitutability between the goods but also the whole set of conditions (entry cost, institutional regulations), which make this market imperfectly competitive. It means that we assume, like Blanchard and Giavazzi (2003), that the parameter η is itself a function of n : $\eta = \eta\left(\underset{-}{n}\right)$. This hypothesis allows us to restore a negative relation between the price level and the number of firms : as $p = p\left(\underset{+}{\eta}\right)$ and $\eta = \eta\left(\underset{-}{n}\right)$, we finally get that $p = p\left(\underset{-}{n}\right)$.

2. In this model, the markup ratio depends only on η. However, the price level depends on the markup ratio and on the unit labor cost, therefore also on γ. This is the fundamental relationship on which our empirical analysis depends.

3. We do not introduce any monetary policy variables. Our focus is indeed the impact of the imperfect competition in the labor and goods markets on price dynamics. However, in the empirical part of this paper, we will introduce the money supply (M2) as a determinant of the price level. This gap between our model and our empirical analysis can be justified as follows. On the one hand, a basic way to introduce monetary policy in an imperfect competition framework is to follow the line of Blanchard & Kiyotaki (1987). However, in this case, monetary policy has an effect on price through aggregate demand. As this is not the core of our perspective and as this way of introducing the money supply is rather *ad hoc* in our framework, we decided not to consider explicitly money in our model. On the other hand, in this New Keynesian framework, monetary policy becomes effective both in the short run and in the long run, as shown by Baba (1997). This is why it was important to introduce it in the econometric estimation. Moreover, as it will be seen below, controlling for the money supply in the estimation allows us to introduce a macro temporal term.

4. We can summarize as follows the expected effects from a change of the parameters η and γ in a "right to manage" type of wage bargaining model.

Table 1: **Expected effects from a change of the parameters η and γ in a "right to manage" type of wage bargaining model**

Effect of an increase of... on	Nominal Wage	Price	"Real Wage"	markup
γ	Positive	Positive	None	None
η	Positive	Positive	Negative	Positive

5. The rent-sharing models (such as our model) can easily be used to found a wage-curve equation, relating the level of the nominal wage to the unemployment rate (by supposing that the reservation wage depends on unemployment rate). From this perspective, our theoretical framework implicitly leads to a wage-curve equation rather than to a Phillips curve, relating nominal wage growth to unemployment (Blanchard & Katz, 1997).

Based on this framework, the rest of this article gives an empirical analysis of the real side of price dynamics in Japan, by focusing on the manufacturing industry.

3 Analyzing the structural and institutional determinants of price dynamics in Japan

Blanchard & Giavazzi (2003) propose a typology of the OECD countries, in which the

classification criteria are the regulation intensities in the goods and labor markets (level of employment protection in this last case). In this typology, in the second part of the 1990s, Japan is at an intermediate level between two extremes, the Anglo-Saxon countries on one side, and the Mediterranean countries like Italy and Greece on the other side. The aims of this part are twofold. First, we introduce structural determinants of the rent level and distribution, which will be used in the next part to estimate econometrically the price dynamics in manufacturing industries. Second, we specify the evolution of these structural variables from the early 1980s to the beginning of the 2000s, at the macro level and more specifically in the case of manufacturing industries.

In doing so, we are not focusing only on deregulation. We also consider other institutional and structural determinants of price dynamics. For at least two decades, deregulation has certainly been the key structural change in Japan from an institutional point of view. However, its intensity and its effectiveness should be carefully evaluated (OECD, 2000, 2004; Carlile & Tilton, 1998). Furthermore, at the same time, other factors related to short-term cycles and to other institutional dynamics may have played a role in a reverse direction. For example, the increasing number of bankruptcies or the rising heterogeneity of firms' performances may have reinforced the monopolistic nature of some markets[1].

3.1 Measuring the respective contributions of the unit labor cost and of markup to price dynamics in the manufacturing industries in Japan: A stylized fact.

A previous analysis has shown that price dynamics in the manufacturing industry between 1981 and 2001 is better explained by the evolution of unit labor costs than by the evolution of markups (Canry & Lechevalier, 2007). We recall here this stylized fact. We first rewrite the equation (9) into an equation relating the equilibrium price to the markup and the unit labor cost:

$$p^* = \mu \frac{w^*}{a} \tag{10}$$

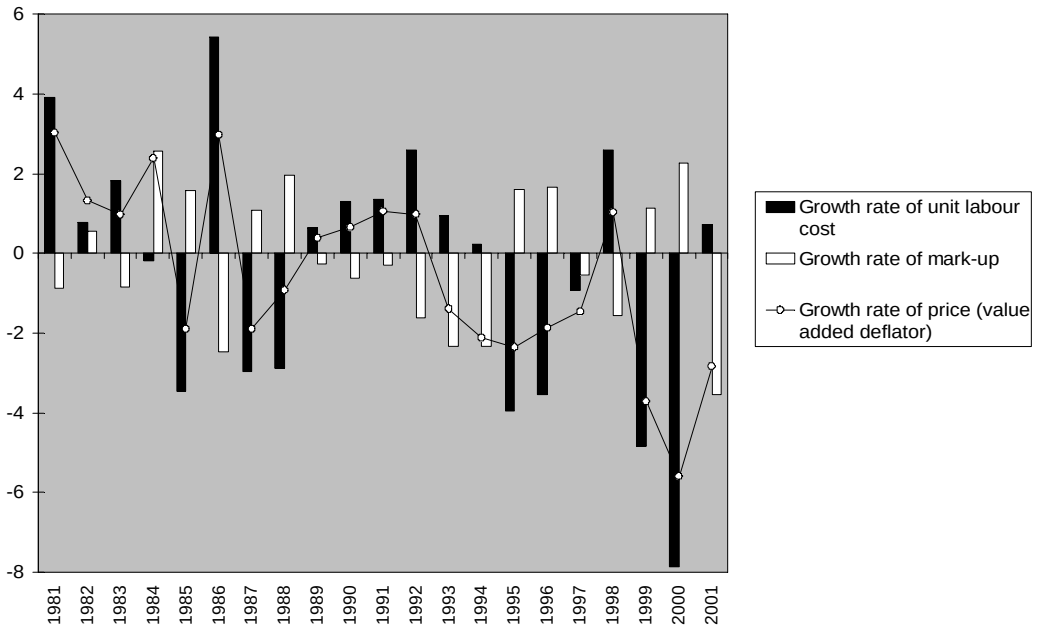
where $\mu = \frac{1}{(1-\eta)} > 1$ is the markup set by firms on their unit labor cost ($ULC = \frac{w^*}{a}$). By differentiating equation (10), we get:

$$\frac{\Delta p}{p} = \frac{\Delta \mu}{\mu} + \frac{\Delta ULC}{ULC} \tag{11}$$

[1] A well-known case is the car industry, dominated today more than ever by Toyota: this sector may be considered to be more monopolistic than ever, although the level of its regulation is not particularly high in comparison to other sectors.

Based on this formula, figure 1 describes the decomposition of the inflation rate into the markup and unit labor cost growth rates for the Japanese manufacturing industry between 1981 and 2001. For the 1981-91 period, the average annual growth rate of inflation was 0.73%. One third of this growth (0.22 point) stems from markup growth, and the two remaining thirds come from unit labor cost growth (0.52 point). For the 1992-2001 period, the average inflation rate was -1.93 % . A little more than one quarter is explained by the markup decrease (-0.53 point) and almost three quarters stem from the unit labor cost decrease (-1.41 points). If we assume that markup variations are a good proxy of deregulation in the goods market and that unit labor cost variations capture evolutions of the bargaining power of workers in the labor market, this very crude statistical analysis suggests that evolutions in the labor market played an important role in price deflation in the manufacturing sector during the 1990s - without saying any more about causality between labor costs and prices. To a lesser extent, increasing competitiveness in the goods markets is also a part of the story to explain the price evolutions in the manufacturing sector. Based on this stylized fact and on our model, we expect that structural analysis

Figure 1: **Decomposition of the price growth rate (deflator of the gross value added) into growth of the markup and growth of unit labor cost, Japan, Total manufacturing, 1981-2001**



will lead to emphasis of the variables affecting the bargaining power of the workforce in understanding price dynamics.

3.2 From the theoretical variables to the empirical variables: capturing the institutional and structural changes in the goods & labor markets

In the model developed in the preceding part of this paper, we have extracted the following key variables: in the goods market, any measure of the degree of competition affecting the level of rent in the economy; in the labor market, the bargaining power of workers. Deregulation negatively affects these variables and should therefore lead to a price decrease. We introduce supplementary variables to capture other institutional or structural changes affecting the level and distribution of rents, and thus to generalize Blanchard & Giavazzi's model. The whole set of variables effectively used in this paper is summarized in table 2. In what follows, we also discuss the pertinence of other variables, which have not been used or were rejected during the estimation phase.

Table 2: **Description of the structural variables**

data	symbol	description of the data	source
i		Industry index (1-10)	
t		Time index (1981-2001)	
Price	P	Price index (of value added)	STAN (OECD)
Productivity	prodty	Labor productivity index, by sector	STAN (OECD)
R&D Intensity	RD	Ratio of R&D expenditures to the value added, by sector	STAN (OECD)
Regulation index	Regu	Regulation index (Regulated industries are those where some relevant categories are subject to regulation); This index takes a value between 0 (no regulation) and 1 (complete regulation)	JIP (ESRI & RIETI)
Import penetration	mpen	Share of imports in total domestic demand; total domestic demand being estimated as production plus imports less exports, by sector	STAN (OECD)
Number of firms	firms	Number of firms with more than 20 employees, by sector	Census of manufacturers (METI)
Average size of firms	av_size	Average firm size (by sector)	Census of manufacturers (METI)
Vacancy rate	vac_rate	Vacancy rate by sector	Survey of employement trends (MHWL)
Disputes by establishment	disputes	Percentage of disputes cases relative to the number of establishments by sector	Survey of labor disputes (MHWL)
Part-time workers	ptw	Share of part-time workers in total employment by sector	Employment Status Survey (MHWL)
Money Supply	M2	Money supply (as measured by M2)	Statistics Bureau (MIC)
Exchange rate	ERYD	Exchange rate between dollar and yen (value of one dollar in terms of yens)	Statistics Bureau (MIC)

3.2.1 Structure of the goods market

Regarding the structure of the goods market, it seems first of all relevant to use the **intensity of R&D expenses** (measured by the ratio between R&D expenses and the value added), available in the STAN database. This indicator is classically considered as a proxy for product differentiation, the basic mechanism at the root of the existence of monopolistic rents. However, the most important problem - leaving aside the question of data accuracy - is that this indicator does not distinguish between product innovations and production

process innovations. In these conditions, we assume that industries with the highest R&D intensity are characterized by the most differentiated products and therefore by the least competitive environment. It is expected that a high differentiation of products, as captured by a high intensity of R&D expenses, leads to high markup rates and therefore to a higher level of prices. Unfortunately, because the two dimensions of innovation mentioned above are not separated, there is a risk that the estimation would be polluted by another effect. Production process innovations are expected to have a positive impact on productivity, which in turn leads to lower prices. The overall effect is therefore undetermined, which may limit the use of this indicator.

The next variable to be considered is any **index of regulation** by sector. More precisely, one should consider, on the one hand, tariff barriers and any standardization measures limiting the import of foreign products; on the other hand, any entry barrier by regulation, which prevent the access of new firms to the market. These two indicators can be found in some OECD studies as well in the annual reports by the European and American chambers of commerce, but there is very little continuity in these indicators and they are calculated for too narrow definition of products or sectors. Fortunately, the JIP (Japan Industry Productivity) database (provided by ESRI and RIETI) has been updated recently and includes two indicators of regulation by sectors between 1970 and 2002. We do not enter into the details of the construction of these indices but it is worth noting that their construction is partly *ad hoc*. Both take values between 0 and 1 (from the less regulated to the most regulated) and they are expected to have a positive impact on prices. In one of these indices, regulated industries are those where *all* relevant categories are subject to regulation; in the other one, regulated industries are those where *some* relevant categories are subject to regulation. The latter is expected to be more relevant for our analysis, as will be confirmed by the econometric estimation.

The third variable related to the goods market, taken from the STAN database, aims to capture the degree of openness of the market through **import penetration**, which is of course related to regulation but goes beyond as it is affected by the strategies of the firms. The impact of this variable on prices is straightforward: the more open is the market, the lower should be the markup rates and therefore the prices.

Finally, following Martins & al. (1996), we use other indicators to describe the monopolistic structure of a given market, as the result of a full set of mechanisms, which cannot be reduced to the deregulation. More precisely, we will use three main indicators. First of all, instead of the variable "relative size of the firms in the sector" used by Martins & al. (1996) - as a proxy for the existence of a scale advantage - we resort to two other indicators (found in the Census on manufacturing industries by METI): the **number of firms** (respect. establishments) in the sector, alternatively in level or in growth rate, and the **average size of the firms** (respect. establishments) - measured by the number of employees. We also add an indicator of the **share of large companies** (for example more than 300 employees) in the total employment of the sector: the bigger this share is, the

more monopolistic this sector should be. Implicitly, we refer to the typology proposed by Martins & al. (1996) concerning the market structure: a market is considered as "fragmented" when the average size is small and when the number of firms increases with the market size; it is considered as "segmented" in the symmetric case. Of course, the limit between these two cases is arbitrary. In their study, Martins & al. (1996) show that the markup ratio is higher in segmented markets, as it is the opposite of the theoretical competitive case. In doing so, they capture a negative monopoly effect of the number of the firms on prices. For example, mergers in a given industry will reduce the number of firms and are likely to increase the "monopoly power" of the remaining firms, which then set higher prices, through higher markups. However, some other mechanisms may lead to an opposite and positive correlation between these two variables. For example, when a sector experiences a positive demand shock, prices increase; it may be a signal for new firms to enter the market. More generally, the evolution of prices might be a good indicator of the profitability of a sector and then have an impact on entry/exit behaviors by firms. Even in being not exhaustive and in considering only these two effects, it appears that the sign of the correlation between the number of firms and price is not clearly determined[2]. This has been probably all the more the case in Japan during the Lost Decade, since it has been recognized that the firms dynamics could hardly be characterized as "Schumpeterian": the exiting firms were far from being the least productive, the bankruptcies being more related to their financial structure than to their productive performance, in relation with the non competitive lending attitude of some banking institutions (Nishimura et al., 2005)[3]

[2]That is certainly why Martins & alii (1996) propose their typology in considering two variables, the number of firms and the average size.

[3]Let us mention briefly some other potentially accurate indicators, which have not been used in this study because of data availability, but which could be useful in further research. One particularly attractive structural variable is **market share by sector**, which gives a direct measure of the market structure, partly independent of the regulation and more sensitive to market dynamics. This indicator can be found in the Yano database, but for a very different sectorial decomposition. According to Sutton (2007), it allows distinction between two types of sectorial dynamics, the Schumpeterian one (in which the competition frequently changes the hierarchy among companies at the industry level) and the Chandlerian one (in which the advantages relative to the size or the initial presence in the market lead to very "conservative" hierarchies). In the first case, markups as well as prices tend to be reduced, while in the second case, high markup rates can be maintained in the middle or long term. Other variables may be found the JIP database (by ESRI and RIETI) but suffer from data continuity for the period under study (and therefore could not be used): these are the **degree of penetration of the FDI**, which is an alternative measure of the market openness is supposed to have a negative impact on markups and prices (exactly like the import penetration); **advertising expenses intensity**, which is an alternative measure of product differentiation, with the advantage of not affecting productivity, and which is expected to have a positive impact on markups and prices.

3.2.2 Structure of the labor market

As for the structure of the labor market, the bargaining power of unions is very often captured through the number of strikes per year. We use data from the Ministry of Labour (currently the MHLW, Ministry of Health, Labor and Welfare), more precisely the *Survey on Labor Disputes*. However, we cannot restrict the indicator to the number of strikes, which is not the main way of expression of the workforce in Japan, at least for the last fifty years (Koshiro, 2000). Our indicator is called **"labor disputes"**, taking into account not only strikes but also any "conflict" between a given firm and its employees.

Another very classical variable is the **union rate**. We did not use this indicator in our regressions for the following reasons. First, unionization in Japan should be understood at the firm level rather than at the industry level, as industry unions are often only "weak" umbrella organization; that is why it is very difficult if not impossible to find accurate data at this semi-aggregated level. Second, the interpretation of the union rate is very difficult because the conditions of unionization vary greatly from one firm to another: membership in the enterprise union is mandatory in some firms, while it is *de facto* prohibited in some others.

These two "classical" indicators are completed by two others, available in surveys by the Ministry of Labour, relative to labor market dynamics, affecting the balance of power. We first consider the **vacancy rate** (the ratio between the number of vacant positions and the number of persons looking for a job)[4]. It affects positively the bargaining power of the workforce and therefore the prices. More precisely, the lower is the vacancy rate (more job applicants for less vacant positions), the tighter is the labor market, the weaker is the bargaining power of the workforce and the lower are the prices. This indicator is not without problems as it is endogenous to the model and as its structural interpretation is at least questionable. However, its use in the literature as an advanced indicator of the bargaining power of the workforce has been very convincing in our opinion, especially from a historical perspective; it gives it the "flavour" of a structural indicator (Minami, 1994)[5].

Another type of indicator is the **share of non regular workers in the total workforce**. If the impact of an increasing share of less well-paid workers on the unit labor cost is obvious, the impact on the bargaining power of the workforce is more complicated and

[4]This indicator has been preferred to another one, the **unemployment rate**, which has been often used to capture a "reserve army" effect as well as to measure the trade-off between inflation and output. As this trade-off is a matter of theoretical and empirical debate, and as the unemployment rate is a macro indicator, we prefer using the **vacancy rate**, which has the great advantage of being available at the industry level.

[5]The post-war evolution experienced by the vacancy rate can be summarized as follows: from the end of the war to the 1960s, there was a surplus of workforce; in the 1960s, Japan entered into a period of labor shortage, which increased the bargaining power of the workforce. This situation came to an end in the 1990s.

has been the object of contradictory evaluations. For some authors, this is the sign that the Japanese labor market is following more and more an Insiders/Outsiders type of logic, in a similar way as has been shown in the case of European labor markets (Lindbeck & Snower, 1988). In this context, the decrease of bargaining power may have affected only one category of workers, the most fragile, mainly female and younger workers. As for incumbent workers, they may keep their positions as well as their associated advantages, which is in the interest of the firms from an incentive point of view. According to some other authors, the impact on the incumbent workforce fundamentally depends on the specific employment policy by the firm, which can opt for a separation strategy between these two types of workers (which does not negatively affect the security of the regular workers) or for a homogenous policy, negatively affecting the security of the regular workers (Feuille & Morishima, 2000). Although the impact on bargaining power is unclear, it is possible to assume that an increase of the share of non regular workers in the total workforce negatively affects the average wage and therefore prices. Besides, we should mention data problems. This essentially concerns the measurement of the number and share of non regular workers. In Japan, as in other countries, there are various definitions. To simplify, we focus on part-time workers, whose growth has been the most important evolution in the Japanese labor market since the mid 1980s. The data are available in the *Employment status survey*, which has been preferred to other surveys (like the *Labor force survey* and the *Monthly labor survey*). However, this survey is conducted only every five years (1982, 1987, 1992, 1997, 2002), and we had to extrapolate the data between two dates. This important data limitation should be recalled when we will interpret the results of the estimations.

3.2.3 Financial and monetary variables

Finally, we introduce some financial and monetary variables, which are not present in our theoretical model. Therefore, we are going beyond the strict boundaries of our initial framework. Our concern here is twofold. On one hand, from an empirical point of view, it would be mistaken to analyze the impact on prices of the structural and institutional changes having affected the Japanese economy since the beginning of the 1980s without even considering financial and monetary variables. On the other hand, the strict prediction of our model is that these variables should not affect the price dynamics we are studying at the industry level: "real" variables should remain significant once monetary variables have been introduced. That is why the introduction of these variables is a good test for the robustness of our theoretical model.

As mentioned at the end of the theoretical part, we consider a monetary policy variable, namely the money supply, M2, which should have a positive impact on prices[6]. Following the discussion by McKinnon & Ohno (2001), we also introduce the exchange rate between the US dollar and the yen, although a "basket" type - taking into account the yen value

[6]Regarding the interest rate, it appeared to be clearly non significant during the estimation phase and is not mentioned here.

relative to a set of currencies - may have been considered as more appropriate. A revaluation of the yen in comparison to the dollar is expected to have a negative impact on prices, according to McKinnon & Ohno's story.

3.3 Basic features of our dataset

The evolution of the significant variables for the whole manufacturing sector as well as for the 10 sub-sectors is summarized in table 3. The boundaries of each subsector are specified in table 4. We had to merge some of the 23 manufacturing industries, as classified by the MITI/METI, because of availability problems for some of the data at the most disaggregated level. After merging, we end up with 10 sectors, which are characterized by unequal weight: the sector "machinery and equipment" represents 27.9% of the total manufacturing value added (on average for the period 1981-2001), whereas the "wood" industry represents only 1.2%.

A few comments can be made. First, a break clearly appears in the evolution of the prices between the "1980s" and the "1990s": if one considers the whole manufacturing sector, it experienced deflation in the 1990s (-2.32% per year), whereas the inflation rate was almost zero but still positive in the 1980s (0.46%). For all the sub-sectors, one observes a decrease of the inflation rate, which turns negative in some cases. Only two sectors ("machinery equipment" and "transport equipment", which define the core of the manufacturing capabilities of Japan) were characterized by a negative growth rate of the price in the 1980s; on the contrary, in the 1990s, only three sectors ("textiles", "wood" and "pulp and paper", that is three "traditional" sectors) did not experience deflation.

This decrease of the inflation rate is hardly explained by an increase in labor productivity growth[7]. As a whole, the manufacturing sector experienced a slowdown of productivity growth in the 1990s by comparison to the 1980s (respectively 3.18% and 4% per annum). All the manufacturing industries are included, except the "food" industry; however, in some cases, this slowdown is particularly impressive: for example, in the case of the "wood" industry productivity growth was 2.68% per annum in the 1980s and became -2.32% per annum in the 1990s; as for the "pulp and paper" industry, productivity growth has been divided by 7 between the two decades. As for "machinery and equipment", the decrease of productivity growth rate has been "only" 30%. This slowdown of productivity growth has not been stopped by the increase of the R&D ratio, from 5.4% to 6% if one considers manufacturing as a whole, and concerning all the sub-sectors (at the exception of "other non metallic mineral products" and "basic metals").

[7]Labor productivity is measured as the value-added per employee. We have tried to modify this variable by taking into account the number of hours by employee at the sector level, but the results are not significant.

Table 3: **Descriptive statistics of the main explanatory variables**

	Inflation rate (%)		Productivity growth (%)		R & D Intensity (% of VA)		Index of regulation of the market	
Sector	1981-1991	1992-2001	1981-1991	1992-2001	1987-1991	1992-2001	1981-1991	1992-2001
TOTAL	0,46	-2,32	4	3,18	5,42	6,05	0,22	0,22
1	3,01	-0,01	-0,62	-0,25	1,86	1,98	0,93	0,9
2	2,77	0,65	1,96	-0,7	1,47	1,82	0,01	0,00
3	3,25	2,06	2,68	-2,32	1,7	2,4	0,00	0,00
4	1,66	0,92	3,04	0,44	NA	NA	0	0
5	0,89	-0,56	3,45	2,65	11,01	11,33	0,58	0,64
6	1,02	-1,77	3,44	1,6	5,11	4,69	0,05	0,07
7	0,75	-2,23	3,28	0,91	3,44	3,31	0,07	0,07
8	-3,31	-5,62	8,71	6,29	12,54	15,61	0,3	0,24
9	-1,04	-1,17	4,39	2,64	10,76	12	0,14	0,13
10	0,83	-2,48	3,53	1,6	0,91	1,29	0,11	0,17

	Import penetration rate (%)		Growth rate of the number of firms (%)		Average size of firms (%)	
Sector	1981-1991	1992-2001	1981-1991	1992-2001	1981-1991	1992-2001
TOTAL	6,14	10,07	0,96	-2,54	114,2	114,3
1	7,64	10,26	1,29	-0,45	102,18	104,24
2	10,6	24,79	-0,15	-7,36	93,72	90,1
3	12,11	21,26	-2,1	-4,69	103,04	102,45
4	2,51	2,67	1,17	-1,61	105,59	105,14
5	9,27	9,3	2,16	-0,44	132,62	130,22
6	1,81	3,4	-0,57	-3,81	91,67	91
7	4,8	5,03	0,83	-1,73	122,08	116,03
8	4,61	11,32	2,12	-2,66	143,22	147,6
9	3,36	5,19	0,78	-1,5	61,06	50,02
10	4,72	7,52	0,92	-3,5	110,69	114,64

	Vacancy rate (%)		Disputes by establishment (%)		Share of part-time workers (%)	
Sector	1981-1991	1992-2001	1981-1991	1992-2001	1981-1991	1992-2001
TOTAL	3,28	1,66	0,94	0,51	15,6	18,6
1	3,01	1,88	0,08	0,03	29,73	37,84
2	5,29	2,85	0,14	0,2	22,66	26,58
3	3,39	2,32	0,04	0,05	13,52	14,29
4	2,64	1,64	0,33	0,24	13,96	16,3
5	2,24	1,18	0,25	0,07	10,95	14,73
6	2,98	1,22	0,17	0,07	10,6	12,32
7	4	1,89	0,1	0,04	10,08	11,99
8	3,42	1,41	0,22	0,08	14,05	14,36
9	2,47	1	0,26	0,11	8,48	11,63
10	3,37	1,23	0,06	0,03	22,33	24,4

Table 4: **Decomposition of the manufacturing industry into 10 sub-sectors**

Classification in the paper	Name of the industry	Classification METI (1985-2001)	Share of the value-added of the total manufacturing (1981-2001)
1	FOOD PRODUCTS, BEVERAGES AND TOBACCO	**12 & 13**	**11.2**
2	TEXTILES, TEXTILE PRODUCTS, LEATHER AND FOOTWEAR	**14&15**	**4.5**
3	WOOD AND PRODUCTS OF WOOD AND CORK	**16 & 17**	**1.2**
4	PULP, PAPER, PAPER PRODUCTS, PRINTING AND PUBLISHING	**18&19**	**7.8**
5	CHEMICAL, RUBBER, PLASTICS AND FUEL PRODUCTS	**20, 21,22 & 23**	**14.2**
6	OTHER NON-METALLIC MINERAL PRODUCTS	**24&25**	**3.8**
7	BASIC METALS AND FABRICATED METAL PRODUCTS	**26, 27 & 28**	**13.2**
8	MACHINERY AND EQUIPMENT	**29; 30 & 32**	**27.9**
9	TRANSPORT EQUIPMENT	**31**	**10.0**
10	MANUFACTURING NEC; RECYCLING	**33&34**	**6.2**

However, as it has already been stated, the other aspect of R&D spending is a higher differentiation of goods, that is a less competitive environment. From this point of view, it is important to notice the (rather stable over time) heterogeneity across industries, three sectors - "chemicals", "machinery and equipment", "transport equipment" - being characterized by a ratio higher than 10%.

As for regulation, the results are very clear. On the one hand, surprisingly, there is almost no evolution between the 1980s and the 1990s. This is true if one considers the manufacturing sector as a whole or the specific sectors. Only two sectors have been a little deregulated ("food" and "machinery") and three sectors have been a little regulated ("chemicals", "transport equipment", and "manufacturing nec"). On the other hand, the differences across sectors are striking: 5 sectors are completely deregulated ("textiles", "wood", "pulp & paper", "other non metallic mineral products" and "basic metals"), one sector is completely regulated ("food"), two are very regulated ("chemical" and "machinery") and two are a little regulated ("transport equipment" and "manufacturing nec").

Concerning import penetration, the increasing openness of the manufacturing industry is striking. This ratio has increased by 40% if one looks at the manufacturing industry as a whole. All the manufacturing sectors experienced an increase in import penetration. In two cases ("textiles" and "machinery and equipment"), it more than doubled. Moreover, the heterogeneity of import penetration across sectors has increased, as appears when one calculates the standard deviation, which increased from 3.7 in the 1980s to 7.9 in the 1990s.

The firms' dynamics is characterized by a decline in the number of firms in the 1990s, which concerns all the manufacturing sectors: whereas the annual growth rate of the number of firms was 0.96 in the 1980s, it is -2.54 in the 1990s. To explain this evolution, one should refer to the conditions of entry and exit of firms. The former is affected by deregulation but also by market conditions, which were particularly depressed in the 1990s for some sectors and which may have more than counterbalanced the positive effects of deregulation. The latter one is essentially determined by the number of bankruptcies, which

experienced an increase, in relation with the financial and banking crisis (Peng, 2004). As for the average size of firms, it was very stable if one considers manufacturing as a whole (114.2 employees per firm on average in 1981-1991 against 114.3 in 1992-2001) but the situation is contrasted across industries: in three of them ("food", "machinery and equipment", "manufacturing nec"), the firms experienced an increase of their average size, whereas it was the opposite in the other seven cases.

Finally, the following comments can be made about the labor market related variables. A preliminary remark is necessary at this stage. Japan shares with most of the European countries a type of labor market whose mechanisms are far from the theoretical competitive model. The call for deregulation of labor markets can be understood in this context. But Japan distinguishes itself from Europe by the importance of implicit contracts at the level of the firms in comparison to regulations imposed by the government. For example the relatively high level of employment security the Japanese employees enjoy on average in comparison to their American counterparts is not the result of an employment regulation but rather of an implicit agreement between employees and employers. That is why it is particularly misleading to study the Japanese labor market from a comparative perspective by adopting a common framework and the same categories as the ones used for Europe or the US. In this context, it is very difficult, in the Japanese case, to follow the same reasoning as Blanchard & Giavazzi (2003) about the impact of deregulation of employment protection on the bargaining power of unions. Therefore, it is necessary to analyze the evolution of other characteristics of the labor market to capture the nonetheless increasing fluidity of labor relations. This is explained by the changing strategy of some firms (and very little by the desire of a part of the workforce, be female or young, to "enjoy" a more flexible of working life). In this context, the major evolutions that the Japanese labor market experienced since the beginning of the 1990s are rather *de facto*. They converged to negatively effect the bargaining power of the workforce and are potential candidates to explain the evolution of unit labor costs (figure 1). A plurality of evolutions are noticed[8].

First, the vacancy rate halved between the 1980s and the 1990s for the manufacturing sector as a whole (from 3.28 to 1.66); moreover, this evolution is more or less common to all sectors. The bargaining power of workers is negatively affected by this evolution, as they have less choices (less offered positions by candidates). Second, the labor disputes ratio was also almost halved between the 1980s and the 1990s, from 0.94% to 0.51%, if one considers the manufacturing industry as a whole. Without any doubt, this trend led to a decrease of the bargaining power of the workforce. This evolution concerns all the manufacturing sectors, which are characterized by a very low rate of labor disputes in the 1990s. The only exception is the "pulp & paper" sector characterized by a ratio six times higher than the average in the 1990s. Third, the increase of the non regular workforce, in

[8]We do not even consider unionization, because differences across sectors are difficult to interpret, as noted above. However, it is worth mentioning that the union rate dropped from 30,8% in 1981 to 24,5% in 1991 and to 20,2% in 2002, the decrease therefore being continuous since the beginning of the 1980s.

the absolute and as a share of the total workforce, is also striking. If one considers the manufacturing sector as a whole, part-time employment (which is the main component of the non regular employment) represents on average 15.6% of the total employment in the 1980s and 18.6% in the 1990s[9]. This increase concerns all the sectors, but here again, the differences across sectors are striking: this figure varies from 37.8% in the "food" industry to 11.6% in the "transport equipment" industry. This increase of the share of the non regular employment, associated with a stable wage differential between regular and non regular employees - the latter earning on average 35% less than the former - mechanically leads to a decrease of the unit labor cost at the aggregate level. This impact is confirmed as one of the main motivation of the firms in hiring non regular workers in surveys conducted by the Ministry of Health, Labor and Welfare.

4 An econometric analysis of the structural factors of deflation in Japan

4.1 Objective and approach

We consider a balanced panel of 10 sectors over the period 1981-2001 (21 years). Except the regulation variable (which can take values equal to zero), all the variables are in logarithm to facilitate the interpretation of estimated coefficients. As stated by Hsiao (2003), the advantages of using panel data are associated to some problems: they are deeply linked to the issue of heterogeneity and stability of the economic relations which are estimated. Ignoring heterogeneity among cross-sectional or time-series parameters could lead to inconsistent or meaningless estimates of interesting parameters.

The simplest method in order to introduce parameter heterogeneity consists of assuming that the constants of the model are different across individuals[10]. This specification - known as the individual effects model - allows us to capture the timeless (or structural) dimension of the heterogeneity:

$$P_{i,t} = \mu_i + \beta X_{it} + \epsilon_{it} \tag{12}$$

Where $P_{i,t}$ is the price for the sector i and the period t and X_{it} is the regressors matrix. The individual effect μ_i can be fixed or random. Our choice between these two specifications will be determined by a standard Hausman test. However, this model has two major drawbacks. Firstly, it implies that the impact of the variables on the price is constant during the 21 year period. This hypothesis is highly improbable if one considers the price dynamics as analyzed in the preceding sections. Second, it implicitly assumes that the prices in all sectors are characterized by the same dynamics, which is obviously unrealistic.

[9]This evolution is much more impressive in the case of non-manufacturing industries. Consequently, part-time workers represented more than 20% of the total workers by the end of the 1990s.

[10]The results of this specification are presented in section 4.2

One solution to circumvent both issues consists of introducing threshold effects in a linear panel. More precisely, we use a Panel Threshold regression (PTR) model (Hansen, 1999). In this case, the transition mechanism between extreme regimes is very simple: at each date, if the threshold variable observed for a given sector is smaller than a given value, called the threshold parameter, the price relation is defined by a particular regime, which is different from the regime used if the threshold variable is larger than the threshold parameter. We develop this methodology and give the results in section 5.3.

Finally, it is worth mentioning two other issues related to our estimation procedure. First, we do not investigate the problem of non stationarity. This choice is motivated by the fact that the consequences of non stationarity in linear panel models are not equivalent to those generally pointed out in a time series context[11]. Second, the key issue of causality between prices and wages has not been considered, as no solution is available in panel econometrics to our knowledge.

4.2 Estimation without threshold effect

The objectives of this section are twofold. First, we want to identify which structural variables have a significant impact on prices dynamics and whether this conforms to the theoretical relations. Second, the estimated coefficients obtained will be used as benchmark for the threshold approach (section 4.3). The estimated equation is as follows:

$$\begin{aligned} P_{i,t} = \mu_i &+ \alpha_1 prodty_{i,t} + \alpha_2 RD_{i,t} + \alpha_3 regu_{i,t} + \alpha_4 mpen_{i,t} \\ &+ \alpha_5 firms_{i,t} + \alpha_6 av\_size_{i,t} + \alpha_7 vac\_rat_{i,t} + \alpha_8 disputes_{i,t} \\ &+ \alpha_9 ptw_{i,t} + \alpha_{10} m2_{i,t} + \alpha_{11} M2_{i,t} + \alpha_{12} ERDY_{i,t} + \epsilon_{it} \end{aligned} \tag{13}$$

Our approach is as follows: we first introduce all the variables and then remove the non significant variables one by one until we get the best model. Because of the lack of space, we report here only three alternative linear specifications. We do not introduce any temporal term (temporal dummies) as we expect that the money supply (M2) captures the temporal trend common to all the sectors. The results are reported in table 5.

According to the results of the Hausman test, the first specification has to be estimated with fixed effects, while random effects lead to a better estimation for the second and the third specifications. In the model 1, we include all the variables. Not surprisingly, the results are not good, basically because of the correlation between some variables. Only

[11] More precisely, if the noise can be characterized as independent across individuals then "by pooling the cross section and time series observations, we may attenuate the strong effect of the residuals in the regression while retaining the strength of the signal given by the explanatory variables. In such a case we can expect a panel-pooled regression to provide a consistent estimate of some long run regression coefficient" (Phillips and Moon, 1999).

Table 5: **Results of the linear estimation**

Price Index of value added	Model 1	Model 2	Model 3
Productivity	$-0,784^{***}$	$-0,61^{***}$	$-0,648^{***}$
	$(-15,2)$	$(-15,2)$	$(-17,2)$
R&D	$-0,055$	–	–
	$(-1,48)$		
Regulation	$0,382^{*}$	$0,439^{***}$	$0,46^{***}$
	(1,95)	(2,87)	(3,07)
Import	$0,015$	$-0,112^{***}$	$-0,092^{***}$
	(0,44)	$(-4,11)$	$(-3,51)$
Number of firms	$0,054$	$-0,271^{***}$	$-0,204^{***}$
	(0,75)	$(-4,06)$	$(-3,08)$
Average size	$-0,119$	$-0,063$	–
	$(-1,32)$	$(-0,63)$	
Vacancy rate	$0,005$	$0,036^{***}$	$0,032^{***}$
	(0,76)	(5,07)	(4,91)
Disputes	$0,0169$	$0,037^{***}$	$0,039^{***}$
	(1,09)	(2,5)	(2,82)
Part-time	$-0,358$	$-0,091$	$-0,091^{*}$
	$(-5,3)$	$(-1,5)$	$(-1,78)$
M2	$0,439^{***}$	$0,426^{***}$	$0,438^{***}$
	(8)	(13,04)	(14,3)
Exchange rate	$-0,006$	–	–
	$(-0,18)$		
Hausman Test	25^{***}	0	0
	(0,01)	(1,00)	(1,00)

Notes: Model 1 is estimated with fixed effects; models 2 and 3 are estimated with random effects. $t-statistics$ are in parentheses. ***: significance level at 1%, **: significance level at 5%,*: significance level at 10%. For the Hausman Test, the χ^2 and the p-value are reported (p-value in parentheses).

productivity, the regulation index, the share of part-time workers, and the money supply are significant with the expected signs. The vacancy rate has the expected sign (positive) but is not significant. As for the other variables (R&D intensity, import penetration, number of firms, average size of the firms, number of disputes, and exchange rate), they are all not significant with an unexpected sign. Then, we remove successively the exchange rate and the R&D ratio. The second model presented here has therefore 9 variables. The results are much better: all the variables are significant with the expected sign, with the exception of the average size of the firms (not significant and unexpected sign).

Therefore, we remove this last variable and estimate model 3 with 8 explanatory variables. All the variables are now significant with the expected sign. We remark that, as expected, labour productivity and the money supply have a very strong impact on the price level. A 1 % increase of labour productivity brings about a 0.65 % decrease of prices and a 1 % increase of M2 increases prices by 0.44 %. The three variables capturing the

bargaining power of unions (the vacancy rate, the number of disputes, and the share of part-time workers) are all significant (at the 1 % level for the two first and at the 10% for the share of part-time workers): their respective estimated elasticities are 0.03%, 0.04% and -0.09%. The three variables (regulation index, import penetration and number of firms) capturing the degree of competition are significant at the 1% level: their elasticities are respectively 0.46%, -0.09% and -0.2%. To sum-up, this simple estimation leads us to qualify the stylized fact of section 3.1: the labor market variables (vacancy rate, number of labor disputes, and part-time workers) have a significant impact on price dynamics; but this is also the case for the goods market variables (regulation, import penetration, and number of firms), which have globally higher elasticities. Therefore, they should be taken into account carefully in analysis of price dynamics in Japan since the 1980s.

Finally, a few comments can be made about the three variables that were removed. The possible insignificance of R&D intensity has been already explained. As for the average size of firms, the insignificant results could be for two different reasons: first, this variable is correlated (weakly) with the number of firms; second, the average size of firms is probably correlated (more than the number of firms) to business cycles (during booms, firms increase both prices and production, which increases in turn their average size). As for the rejection of the exchange rate as an explanatory variable of price dynamics in the manufacturing sector between 1981-2001, it does not lead us to conclude that the story by McKinnon and Ohno is invalid. Their approach is fundamentally at the macro level and does not fit well with ours. Finally, it is worth noting that our results are weakened by the fact that potential explanatory variables are certainly missing. This means that the unexplained variance is far from being negligible.

As noted above, the preceding approach has a major drawback as it assumes that the relation between prices and explanatory variables is the same over time and for all individuals or sectors. This strong assumption is removed in the next section by the introduction of threshold effects.

4.3 Threshold approach

4.3.1 Specification and estimation

In this section, we follow Hansen's procedure (1999) in order to identify potential threshold effects in price dynamics in Japan between 1981 and 2001 (equation 14). More precisely, we test whether an exogenous variable has contributed to the fact that this dynamics turned into deflation in the 1990s. This issue clearly corresponds to the definition of a threshold regression model in non-dynamic panels (PTR) [12]. To illustrate our approach, we consider

[12] "Threshold regression models specify that individual observations can be divided into classes based on the value of an observed variable." (Hansen, 1999)

a first specification with two regimes:

$$P_{i,t} = \begin{cases} \mu_i + \alpha_{1,1} prodty_{i,t} + \alpha_{1,2} regu_{i,t} + \alpha_{1,3} mpen_{i,t} + \alpha_{1,4} firms_{i,t} + \alpha_{1,5} vac\_rat_{i,t} \\ \quad + \alpha_{1,6} disputes_{i,t} + \alpha_{1,7} ptw_{i,t} + \alpha_{1,8} M2_{i,t} + \epsilon_{it} \ if \ q_{i,t} \leq \gamma \\ \mu_i + \alpha_{2,1} prodty_{i,t} + \alpha_{2,2} regu_{i,t} + \alpha_{2,3} mpen_{i,t} + \alpha_{2,4} firms_{i,t} + \alpha_{2,5} vac\_rat_{i,t} \\ \quad + \alpha_{2,6} disputes_{i,t} + \alpha_{2,7} ptw_{i,t} + \alpha_{2,8} M2_{i,t} + \epsilon_{it} \ if \ q_{i,t} > \gamma \end{cases} \tag{14}$$

where q_{it} is threshold variable and γ a threshold. This model can be written in a single equation form:

$$price_{it} = \mu_i + \alpha_1 X_{it} \, \mathbb{I}(q_{it} \leq \gamma) + \alpha_2 X_{it} \, \mathbb{I}(q_{it} > \gamma) + \epsilon_{it} \tag{15}$$

Where X is the vector of explanatory variables and $\mathbb{I}(.)$ is an indicator function which takes the value of 1 when the threshold condition in the brackets is satisfied and 0 otherwise. The errors ϵ_{it} are assumed to be independent and identically distributed with mean zero and finite variance σ^2. In this model, the observations are divided into two regimes depending on whether the threshold variable q_{it} is smaller or larger than the threshold parameter γ. The regimes are distinguished by different regression slopes, α_1 and α_2. A first advantage of this model is that no constraints are imposed on the choice of the threshold variable, except the facts that it cannot be a contemporaneous endogenous variable and it cannot be time dependent[13]. For our specific purpose, the PTR model has a second great advantage: conditionally on the number of regimes, it allows parameters to vary across individuals (heterogeneity issue), but also with time (stability issue).

There is no reason to limit our analysis to only two regimes. The estimation approach proposed by Hansen allows a more general specification with r thresholds (*i.e.* $r+1$ regimes), which take the form:

$$\begin{aligned} price_{it} = \mu_i \quad &+ \quad \alpha_1 \ X_{it} \, \mathbb{I}(q_{it} \leq c_1) + \alpha_2 \ X_{it} \, \mathbb{I}(c_1 < q_{it} \leq c_2) \\ &+ \quad \alpha_3 \ X_{it} \, \mathbb{I}(c_2 < q_{it} \leq c_3) + ... + \alpha_r \ X_{it} \, \mathbb{I}(c_r < q_{it}) + \epsilon_{it} \end{aligned} \tag{16}$$

where the threshold parameters c_j are sorted, $c_1 < ... < c_r$.

The estimation procedure is as follows. First, the parameters α_i for $i = 1, ..., r$ are estimated according to the least squares sequential procedure. For example, if we consider a single threshold model, for a given value of the threshold parameter c, the slope coefficients α_1 and α_2 can be estimated by OLS. Then, we can compute the sum of squared errors,

[13]The choice of this threshold variable is discussed further below.

denoted $S_1(c)$:

$$S_1(c) = \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\epsilon}_{it}^2 \tag{17}$$

The threshold parameter c is then estimated by minimizing $S_1(c)$.

$$\hat{c} = ArgMin_c \; S_1(\hat{c}) \tag{18}$$

As stressed by Hansen (1999), the minimization problem can be reduced to searching over values of c equalling the distinct values of q_{it} in the sample. However, it is undesirable to select a threshold c, which leads to too few observations in one or other regime. For this reason, we impose a supplementary constraint : there should be at least $T/2$ observations in a given regime[14].

The next step is to determine whether the threshold effect is statistically significant relative to a linear specification. The null hypothesis in this case describes the simple linear specification and can be expressed as: $H_0 : \alpha_1 = \alpha_2$. This hypothesis could be tested by a standard test. The likelihood ratio test of H_0 is based on:

$$F_1 = \frac{S_0 - S_1(\hat{c})}{\hat{\sigma}^2} \tag{19}$$

where S_0 is the sum of the squared residuals of the linear model, S_1 the sum of the squared residuals of the one threshold model and $\hat{\sigma}^2 = \frac{S_1(\hat{c})}{n(T-1)}$. Unfortunately, c is not defined under H_0, so classical tests have non-standard distributions (no chi-squared distribution). One solution consists of simulating by Bootstrap the asymptotic distribution of the statistic F_1.

When the threshold effect is proved, the same kind of procedure can be applied to general models (equations 16) in order to determine the number of thresholds required to capture the whole non-linearity or, equivalently, the heterogeneity across sectors and the time instability. The new null hypothesis consists in testing a specification with r regimes versus a specification with r+1 regimes. For example, we start the procedure by testing one threshold versus two, and then two versus three, etc. We stop the procedure when the null hypothesis is not rejected. The likelihood ratio test associated is:

$$F_r = \frac{S_r - S_{r+1}(\hat{c})}{\hat{\sigma}_r^2} \tag{20}$$

where $\hat{\sigma}_r^2 = \frac{S_{r+1}(\hat{c})}{n(T-1)}$. The asymptotic distribution is again simulated by bootstrap.

[14]The choice of this constraint is a guarantee that the influence of a given sector in the search of c is not neglected.

4.3.2 Results

In the estimation phase, we successively consider two potential "candidates" for the threshold variable: the import penetration ratio and the vacancy rate. These variables are selected for three reasons. First, they are two of the structural variables, respectively on the goods and on the labor markets, which have been introduced as potential candidates to determine the level of the rent in the economy and its sharing. Second, the estimation without threshold showed that these two variables are very significant. Finally, the impact of their evolution has been particularly emphasized by previous studies. As for the increasing import penetration, it has been analyzed as a potential source of disequilibrium by some institutionalist analyses (e.g. Boyer & Yamada, 2000). As for the vacancy rate, this is by definition a very cyclical variable; but its evolution has been analyzed by some authors as the origin of the turning point of the Japanese economy in the 1960s (Minami, 1994), as noted above. Japan may have experienced an equivalent turning point in the 1980s and the 1990s[15].

For each threshold variable, the first step consists of testing the linear specification and, eventually, determining the number of thresholds. The results of the linearity test and the determination of the number of thresholds are reported in table 6.

The linearity tests clearly lead to the rejection of the null hypothesis of linearity of price dynamics in Japan, whatever the threshold variable we consider. The test for a single threshold F_1 is highly significant, with a bootstrap p-value smaller than 0.01. This first result confirms the non-linearity of price dynamics in Japan. More originally, it shows the presence of strong threshold effects detected in the cases of the two selected threshold variables. The lowest value of F_1 statistic is obtained for the vacancy rate; however, even

[15]Productivity, the regulation index, the number of disputes by establishment, the share of part-time workers, and the money supply (M2) may have been other candidates. Productivity experienced a slowdown, which has been studied intensively and could be interpreted in terms of a change of the growth regime from the point of view of the dynamics of the firms (Nishimura et al., 2005). However, our perspective focuses on institutional and structural variables in the goods and labor markets; the productivity trend may have contributed to a regime change but this is not the focus of our theoretical story, as it has nothing to do with the level and the distribution of the rents in the economy. As for the regulation index, it has been used as a threshold variable and leads to similar results as the estimations with the import penetration as the threshold variable. However, there is an important difference: as seen above, the regulation index does not capture any temporal evolution but only cross-sectional heterogeneity. This is the main reason, it has not been chosen as the threshold variable. The increasing share of the part-time workers is considered by many authors as the most important evolution in the Japanese labor market for the last 25 years (Sako & Sato, 1997); however, we did not use it as a threshold variable because of data problems explained above. The number of disputes by establishment has not been selected, as it is less significant than the vacancy rate and the share of part-time workers; it has also been recognized that the number of disputes may not be the best proxy for the bargaining power of workers in Japan. Finally, M2 has not been selected because it is fundamentally a monetary policy variable.

Table 6: **Tests of linearity and determination of the number of regimes**

	Threshold Variable	
	Import Penetration	Vacancy Rate
One Threshold		
RSS	0.357	0.420
F_1	65.9	22.8
$p-value$	0	0
Two Thresholds		
RSS	0.293	0.354
F_2	47.2	33.3
$p-value$	0.08	0.05
Three Thresholds		
RSS	0.269	0.329
F_3	51.7	22.8
$p-value$	0.00	0.09

Note: $p-values$ are obtained with 300 simulations.

in this case, the value of the test is largely below the critical values at standard levels. The likelihood ratio tests F_2 and F_3 are also significant at a level of 10% for the two variables. Thus, there are at least four regimes. According to Hansen's procedure, it would be necessary to estimate and test four thresholds, five thresholds and so on, until the corresponding F-test is statistically not significant. However, we limit our analysis to a model with at most three threshold parameters (*i.e.* four regimes). This choice can be justified by two arguments (Hurlin, 2006). Firstly, the computational costs of the estimation are very important for panel models with more than four regimes. Secondly, when a supplementary regime is introduced, it does not affect (or only slightly affects) the estimates of the other threshold parameters and the estimates of the slope parameters in the existing regimes.

Looking at table 6, we can also determine the optimal threshold variable among the two "candidates". Our choice is justified by two criteria: we select the threshold variable which minimizes the sum of squared residuals (Hansen, 1999) and which leads to the strongest rejection of the linearity hypothesis[16]. According to these two criteria, the model with import penetration as the threshold variable is the optimal one ($F_1 = 65.9$ and $RSS = 0.269$). To check the robustness of our results, it is however useful to analyze not only the results when the import penetration is the threshold variable but also when the vacancy rate is

[16]As suggested by Gonzàlez et al. (2005), the "optimal" threshold variable in a panel smooth transition model corresponds to the variable which leads to the strongest rejection of the linearity hypothesis. We extend here this result to the PTR class of model.

used.

Results when import penetration is the threshold variable. The estimates of the parameters of the PTR models with four regimes and the corresponding t-statistics based on standard errors corrected for heteroskedasticity are reported in Table 7, together with the thresholds' values. These parameters are important because they show when the transition between two regimes occured. For instance, if the logarithm of the import penetration is more than 1.27 (value of the first threshold, corresponding to an import penetration rate of 3,56 %), the concerned sector switches to the second regime. According to these values, we can deduce the distribution of the sectors among the different regimes (table 8). We also plot this transition with respect to time and sector (figure 2).

Table 7: **Four Regimes Panel Model: Estimated Parameters**

Dependent variable: price	Transition: Import Penetration			
Regime	Low	Middle Low	Middle High	High
Productivity	-0.601^{***} (-16.5)	-0.652^{***} (-20.3)	-0.608^{***} (-16.8)	-0.745^{***} (-10.3)
Regulation	0.980^{***} (4.52)	0.319^{***} (2.50)	0.291^{***} (2.41)	-2.18^{***} (-3.7355)
Import	0.031 (1.26)	-0.046 (-1.35)	-0.158^{***} (-3.29)	-0.103^{***} (-2.40)
Vacancy rate	-0.016^{***} (-2.84)	0.045^{***} (6.10)	0.001 (0.12)	-0.0160^{**} (-2.04)
Disputes	-0.004 (-0.36)	0.016 (1.06)	0.012 (0.91)	0.197^{***} (3.69)
Part-Time	-0.139^{***} (-2.51)	0.035 (0.60)	-0.040 (-0.67)	-0.840^{***} (-8.40)
M2	0.3535^{***} (12.2)	0.322^{***} (11.05)	0.366^{***} (11.3)	0.562^{***} (15.8)
Threshold		1.27	1.82	2.43

Note: $t-statistics$ are in parentheses.***: significance level at 1%, **: significance level at 5%,*: significance level at 10%.

Before going into details of the results, three preliminary comments should be made. First, the variable "number of firms", when included in our estimations, is either insignificant or significant with unexpected sign (positive). As this variable did not capture the monopoly power effect we expected and also generated astonishing and incoherent results in the estimation of the other variables, we have decided to remove it. Second, one observes that the import penetration variable regularly increases for all the sectors. This result implies that the sector can move to the next regime but will not return to the former one. Therefore, this variable allows us to capture the evolution over time: indeed, 60 % of the observations of the first regime (28 of 47 observations) are concentrated in the 1981-89

Table 8: **Distribution of Observations by Regimes (Transition: Import Penetration)**

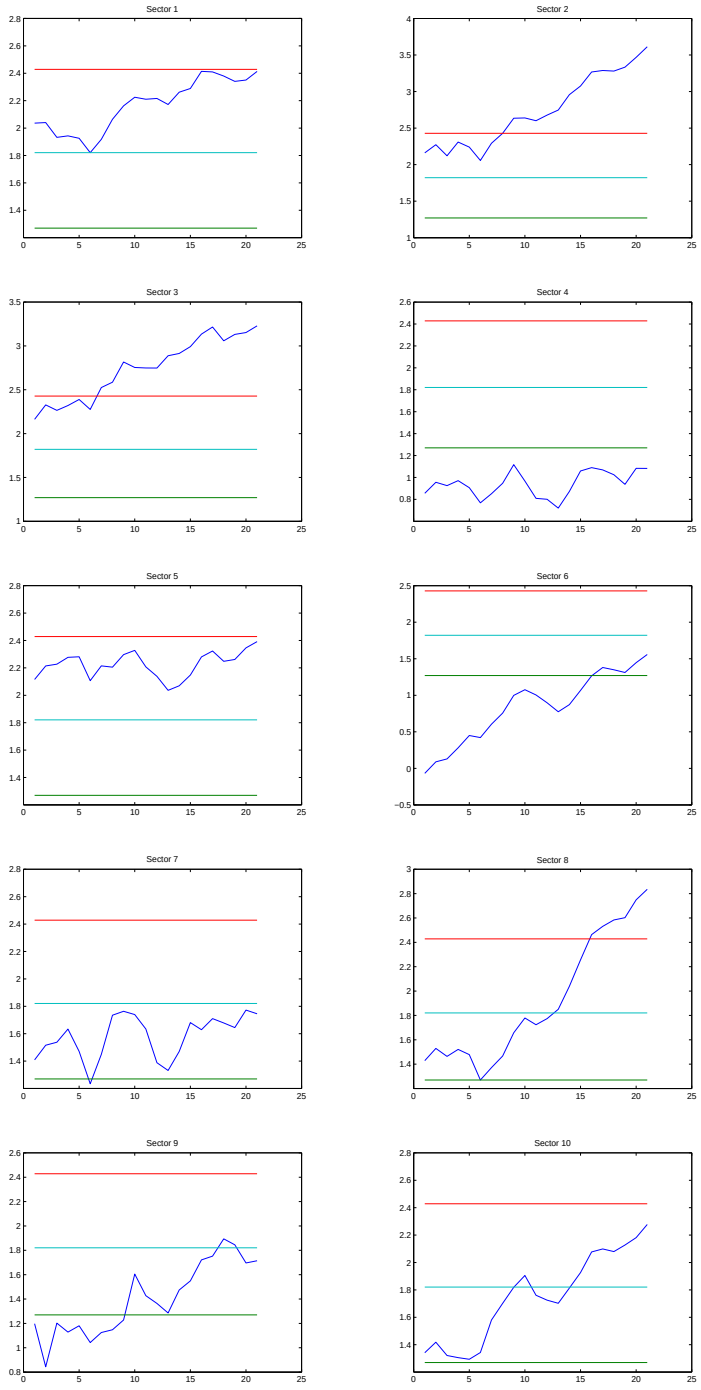
Regime	Low	Middle Low	Middle High	High
Sector 1	0	0	21	0
Sector 2	0	0	8	13
Sector 3	0	0	6	15
Sector 4	21	0	0	0
Sector 5	0	0	21	0
Sector 6	16	5	0	0
Sector 7	1	20	0	0
Sector 8	0	12	3	6
Sector 9	9	10	2	0
Sector 10	0	13	8	0
Total	47	60	69	34

period and 53 % of the observations of the fourth regime (18 of 34 observations) are concentrated in the 1996-2001 period. However, this does not mean that all the sectors are converging towards the last regime, as only three sectors are concerned. Our framework also allows us to capture the cross-sectional heterogeneity in clustering all the sectors with the same import penetration (Figure 2).

The distribution of the observations by regimes can be summarized as follows. The first regime contains 47 observations shared out among four sectors (sector 4 - "paper products, printing and publishing" - is integrally included in this regime, and sector 6 - "nonmetallic mineral products" - is included until 1996). The second regime (middle inferior) contains 60 observations and five sectors cross it; sector 7 - "Basic metals" - is included in this regime from 1982 to 2001. The third regime contains 69 observations: only three sectors do not cross it, while sectors 1 and 5 - "food" and "chemical" - are integrally included in this regime. Finally, the fourth regime contains 34 observations (including only sectors 2, 3 and 8, "textiles", "woods" and "machinery and equipment"). As it can be seen from this brief description, it is difficult to draw any strong conclusions from the distribution of sectors across regimes. For example, very different sectors like "food" and "chemical" coexist in the same regime. We can nonetheless recognize that the second regime is populated mainly by the core of the Japanese manufacturing industries ("basic metals", "machinery and equipment", and "transport equipment") while two traditional industries ("textiles" and "wood") are dominant in the fourth regime.

All the 7 variables we analyze (after having removed the number of firms, by comparison to the best model of estimation without threshold) are significant in at least one

Figure 2: **Representation of Transition with Import Penetration**



Note: The horizontal lines represent the threshold values.

regime (in only the fourth regime in the case of labor disputes) and have the expected sign when they are significant, but their significance varies depending on the regime. However, there are two problems concerning two significant variables with an unexpected sign, for which we could not find any solution or explanation at this stage: these are the vacancy rate in the first and the fourth regimes (negative signs) and the regulation index in the fourth regime (negative sign)[17]. However, these two problems are relatively minor, if one considers the fact that we have the estimation for seven variables in four regimes and that these variables are significant with the expected sign otherwise (in the second regime only in the case of the vacancy rate).

In the four regimes, the impacts of labour productivity and the money supply (M2) on prices remain important, very significant (at 1 % level), and close to those obtained with the linear specification. As for import penetration, it becomes significant (with the expected negative sign) in the third and fourth regimes. It can be interpreted as follows: an increase of import penetration has no effect on prices when the degree of openness of the sector remains low (import penetration lower than 6,2 % according to the value of the second threshold). As for the regulation index, its impact is very strong in the first regime (0.98, that is more than double in comparison to the estimation without threshold), then still significant but much less strong in the second and third regimes (approximately 0.3) and finally significant with an unexpected sign in the fourth regime, as emphasized above. One possible explanation of this last result is that the fourth regime includes two sectors, for which the regulation index is zero ("textile" and "wood"), beside the sector "machinery".

Results when the threshold variables is the vacancy rate The results when the vacancy rate is the threshold variable - which are reported in appendix 2 - are a useful complement to the former ones, when import penetration is the threshold variable. As in the former exercise, the observations are not equally distributed across sectors and over time. Nevertheless, there are some differences. In the case of the vacancy rate as the threshold variable, there is no sector entirely in any one given regime, while the evolution of the distribution over time is even more pronounced than in the case when the import penetration is the threshold variable: all the sectors indeed cross the four regimes, with the exception of "textiles" and "basic metals", which do not cross the first regime. As the vacancy rate experienced a decline over time, it means that this exercise helps us to better capture the evolution over time of price dynamics than the cross-sectional heterogeneity.

If we turn our attention to the coefficients, we note that they all have the expected sign, when they are significant. As a whole, they are similar to the ones obtained in the estimations without threshold effects and with the threshold effect captured by import penetration, especially in the cases of productivity and money supply. However, some

[17]One explanation is provided below regarding the regulation index.

differences have to be highlighted. As for import penetration, this estimation leads to a significant result only in the second regime and with an elasticity which is three to four times less than in the preceding estimation. Regarding the regulation index, one observes a significant impact, which is increasing over time (from 0.36 in the fourth regime to 0.65 in the first regime). Among the labor-market related variables, the ratio of labor disputes is now the most significant variable (with the expected positive sign), followed by the share of part-time workers. As for the vacancy rate, it is significant with the expected sign in only the third regime. As a whole, the driving forces of price dynamics in Japan seem to have changed over time. In the 1980s (essentially the fourth and the third regimes), the labor market related variables are dominant (2 to 3 significant variables), while in the 1990s (second and first regimes),price dynamics are more driven by the goods market related variables: import penetration and the regulation index are both significant in the second regime, and the coefficient of this last variable in the fourth regime is almost double its value in the fourth regime.

Therefore, these results are coherent with the preceding ones, and allow us to partly explain the Japanese deflation in the 1990s, as Japan experienced at once a higher international openness in most industries and a global erosion of workers' bargaining power.

5 Conclusion

In this article, we have proposed an alternative theoretical and empirical framework to analyze price dynamics in Japan. Rather than disentangling the demand-side and the supply-side underlying mechanisms of price dynamics, we adopt a model of imperfect competition in the labor and goods markets. In this framework, the price level directly depends on the level of rents (determined by the degree of competition on goods market) and their distribution (depending on the bargaining power of workers). Focusing on the real dimension of price dynamics, we use this model to empirically investigate, in a panel framework, the determinants of price dynamics in the manufacturing industry decomposed into 10 sectors between 1981 and 2001.

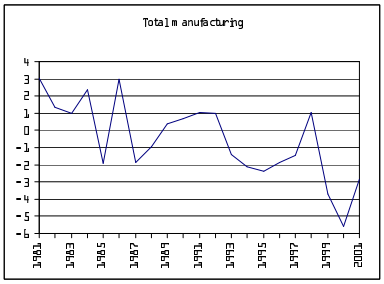
We use the heterogeneity across sectors and over time to estimate the impact of institutional and structural factors in the labor and good markets on price dynamics. Moreover, by using - for the first time for this specific issue, to our knowledge - a threshold approach in panel, we are able to detect a regime change. As a whole, our results lead to qualify previous decompositions of price dynamics into the respective dynamics of unit labor costs and the markup ratio, concluding that the dominant impact of the former is dominant. Our structural analysis indeed shows the important impact of increasing import penetration in Japan on prices, directly as a explanatory variable and indirectly as a threshold variable at the origin of regime changes in price dynamics. However, at the same time, the three labor market related variables we have selected - the vacancy rate, labor disputes, and the share of part-time workers - have also a more or less significant impact

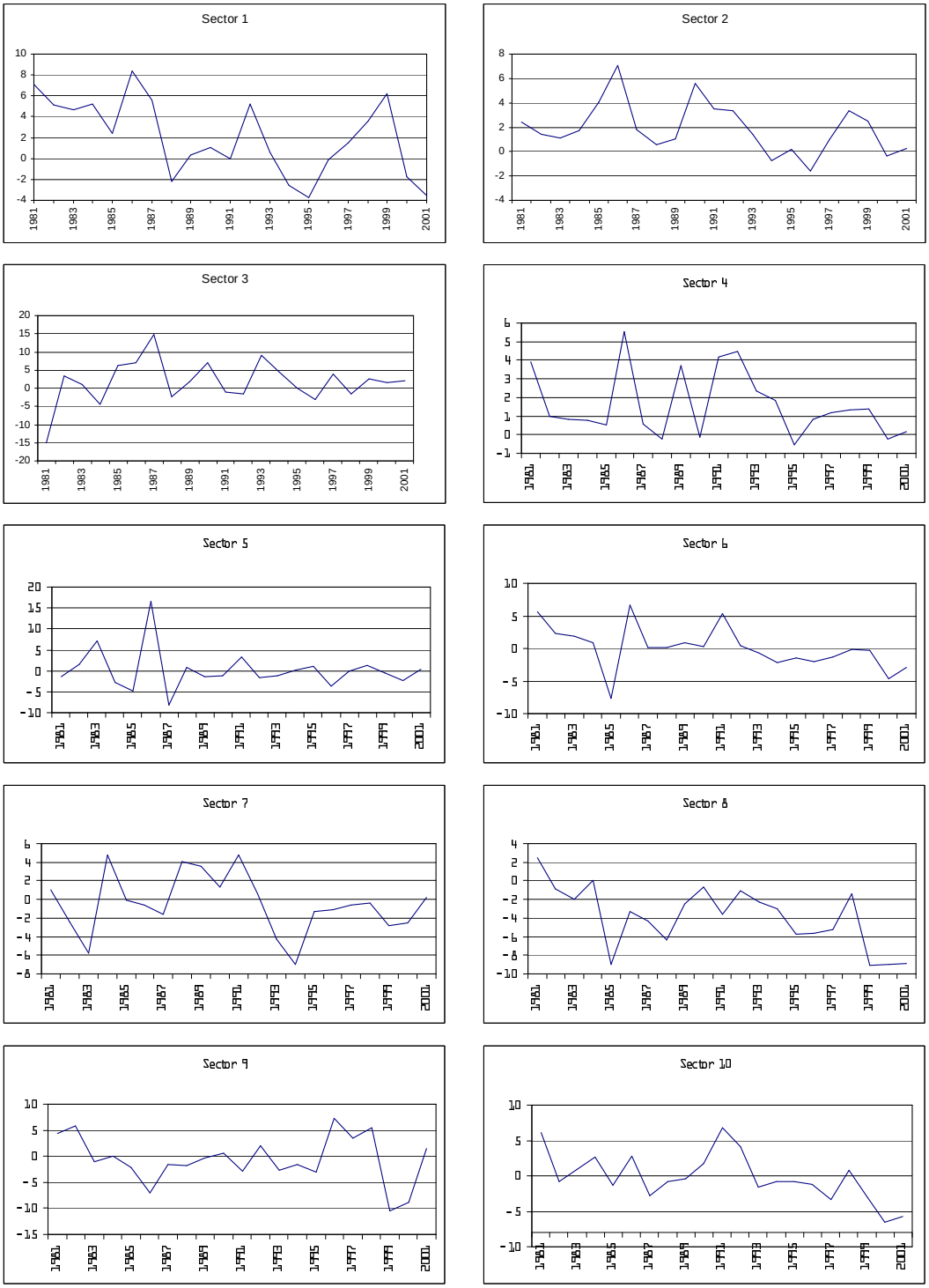
and show the importance of the decline of employees' bargaining power during this period. As for deregulation of the goods market, it explains the heterogeneity of price dynamics across sectors but not the deflationary pressures, as the deregulation index we are using in our estimation did not evolve over time.

Finally, if we leave aside the fact that our analysis is probably affected by some missing variables that we could not collect, our framework could be improved in at least two directions. First, to allow a more comprehensive understanding of deflation in Japan, this econometric estimation could be extended to non-manufacturing industries. Second, it is necessary to fill the gap between the results based on a statistical decomposition of the prices into unit labor costs and markups (Canry & Lechevalier, 2007) and the present econometric analysis of the structural determinants of the level and the distribution of rents. One possible route is to explore the existence of complementarities between the labor and the good markets, following the seminal paper by Dobbelaere (2004). For example, the increasing degree of openness of the good market may directly affect the bargaining power of employees and therefore explain the trend of unit labor costs.

Appendix 1: Inflation rate (1981-2001) in manufacturing industries

Figure 3: **Inflation rate (1981-2001) in manufacturing industries**





Note: Refer to the table 4 for the content of the 10 subsectors

Appendix 2: Results of estimation when the vacancy rate is the threshold variable

Table 9: **Four Regimes Panel Model: Estimated Parameters**

Dependent variable: price	Transition: Vacancy Rate			
Regime	Low	Middle Low	Middle High	High
Productivity	-0.673^{***} (-16.5)	-0.652^{***} (-16.1)	-0.731^{***} (-20.1)	-0.736^{***} (-19.1)
Regulation	0.646^{***} (4.24)	0.484^{***} (3.32)	0.397^{***} (2.61)	0.36^{**} (2.28)
Import	-0.001 (-0.02)	-0.036^{*} (-1.68)	-0.018 (-1.08)	-0.008 (-0.43)
Vacancy rate	-0.006 (-0.17)	-0.024 (-0.86)	0.044^{*} (1.94)	-0.016 (-1.36)
Dispute	0.041 (1.45)	0.068^{***} (5.02)	0.057^{***} (5.14)	0.025^{***} (2.32)
Part-Time	-0.300^{***} (-3.50)	-0.120^{*} (-1.72)	-0.143^{***} (-2.41)	-0.207^{***} (-3.20)
M2	0.488^{***} (15.7)	0.471^{***} (16.1)	0.457^{***} (16.0)	0.469^{***} (16.5)
Treshold		-0.586	0.151	0.917

Note: $t-statistics$ are in parentheses.***: significance level at 1%, **: significance level at 5%,*: significance level at 10%.

Table 10: **Distribution of the Observations by Regimes (Transition: Vacancy Rate)**

Regime	Low	Middle Low	Middle High	High
Sector 1	2	3	8	8
Sector 2	0	1	4	16
Sector 3	1	3	9	8
Sector 4	0	7	7	7
Sector 5	2	8	7	4
Sector 6	4	3	9	5
Sector 7	2	1	11	7
Sector 8	3	1	10	7
Sector 9	2	8	8	3
Sector 10	3	3	7	8
Total	19	38	80	73

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