Prices, Markups and Quality at the Firm-Product Level*

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Abstract

In this paper, we analyze price and markup dynamics at the firm-product level in Belgian manufacturing over more than a decade and relate these to firm-product productivity and quality dynamics. We use a detailed dataset that provides information about firms' product portfolio composition and the value and quantity sold for each product. We estimate a firm-product level marginal cost accounting for the multiproduct nature of production and compute a firm-product markup variable. We then estimate demand elasticity and product quality following Berry (1994). As a next step, we estimate a multi product production function (MPPF) using physical quantity as dependent variable and obtain a firm-product measure of TFP. We relate all these variables to better understand what is driving price and markup dynamics over a long time period. We find that our methodology generates sensible estimates in line with recent theoretical models of international economics with endogenous markups.

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1 Introduction

In today's globalized markets, firms' competitive advantage derives not only from their superiority in terms of technical efficiency but also in product quality. Until recently, the empirical literature in industrial organization and trade overemphasized the first dimension while, at the same time, some authors have stressed the existing limitations regarding the measurement of total factor productivity (TFP) and the link to quality.

In this paper, we analyze price and markup dynamics at the firm-product level in Belgian manufacturing over more than a decade and relate these to productivity dynamics. We use a detailed dataset covering a large sample of manufacturing firms over the period 1995-2009 that provides firm-product level information about values and quantities sold, together with standard accounting measures. We are therefore able to document pricing heterogeneity, estimate a firm-product level marginal cost accounting for the multiproduct nature of production, and to compute a firm-product markup variable. We then estimate a production function using physical quantity and obtaining a firm-product level of TFP. We also estimate demand elasticity and product quality. We can then relate all these variables and better understand what is driving price and markup dynamics over a long time period.

Our paper contributes to an emerging descriptive literature studying price behavior using similar datasets in the US, Colombia, Denmark and other countries (see e.g. Roberts and Supina, 1996, 2000; Foster, Haltiwanger and Syverson, 2008, 2010; Kugler and Verhoogen, 2012). A more recent literature introduces more structure following Berry (1994). These papers take advantage of the fact that we observe both revenue and physical quantities to estimate demand elasticity and product quality together with an estimation of cost and production function that takes into account the importance of multi-product firms (Petrin and Warzynski, 2011; Aw, Roberts and Lee, 2011). Our analysis combines these different approaches in a single framework. We start with some simple descriptive summary statistics and then gradually introduce more structure.

We find that our markup variables is positively related to firm productivity, while product price is positively related to TFPR, negatively related to TFPQ. The relationship between price, marginal cost and quality is more complex. Product quality is positively associated with marginal costs for some products, but negatively for others; in addition, prices are less sensitive to quality than marginal costs. This suggests that quality and efficiency can sometimes go hand in hand, but can also enter in conflict with each other.

We then use our framework to study an interesting policy experiment that took place in Belgium during the period that we analyze. In July 2004, the Belgian government liberalized the price of bread with the idea that it would lead to more competition and lower prices for consumers. We actually observe an increase in prices and markups, but also a dramatic increase in average product quality, together with a smaller productivity increase. Our analysis therefore offers a different perspective on the costs and benefits of price deregulation.

Section 2 focuses on demand estimation, while section 3 explains how we adapt our production function and cost estimation to a multi-product setting. Section 4 describes our dataset and provides some descriptive statistics. Section 5 presents our results. Section 6 concludes.

2 Demand

A critical aspect of our approach is that we want to be able to "back out" (or invert) from demand an estimate of product quality. This requires that there be a unique measure of product quality for every product given prices and market shares. If goods are weak substitutes in a random coefficients discrete choice demand setting then this uniqueness condition is satisfied for standard utility parameterizations (Berry, Levinsohn, and Pakes (1995)).

We let utility depend on individual characteristics ν_i, price (p_j), observed product characteristics (x_j), and unobserved characteristics (ξ_j):

$$U\left(\nu_i, p_j, x_j, \xi_j; \vartheta\right)$$

where ϑ is a vector of parameters to be estimated. A consumer will buy the good that provides the highest utility. Define A_j as the set of values of ν that induces the choice of j and let $P_0\left(d\nu\right)$ be the density of ν in the population. The market share of good j as a function of the characteristics of all goods competing in the market:

$$s_j\left(p, x, \xi; \vartheta\right) = \int_{\nu \in A_j} P_0\left(d\nu\right)$$

We start by considering a logit model. We write utility as:

$$u_{ij} = \beta x_j - \alpha p_j + \xi_j + \varepsilon_{ij} = \delta_j + \varepsilon_{ij}$$

with β the vector of taste parameters associated with characteristics x, α the marginal utility of income parameter, and ε_{ij} assumed to be distributed type 1 extreme value. We collect all of the terms in utility that are constant for good j in δ_j. Berry, Levinsohn, and Pakes (1995) show for random coefficients models that there exists a unique $\delta(\theta) = (\delta(\theta)_1, \ldots, \delta(\theta)_J)$ that matches observed to predicted markets shares. In the standard logit case the inversion is given by

$$lns_j - lns_0 = \delta_j = \beta x_j - \alpha p_j + \xi_j.$$

We will allow for price to be correlated with unobserved quality ξ, as in Berry (1994) and Berry, Levinsohn, and Pakes (1995).

A drawback of the logit IIA assumption is that the derivative of the inside share with respect to the number of goods is strictly positive. The nested logit specification, which follows Berry (1994), loosens the IIA assumption by allowing for the possibility that goods are closer substitutes for one another (relative to the simple logit). The utility function is now:

$$u_{ij} = \delta_j + \zeta_i + (1 - \sigma)\varepsilon_{ij}$$

where, following Berry (1994), for consumer i, ζ_i is common to all movies and has a distribution function that depends on σ such that if ε_{ij} is a random variable, then $\zeta_i + (1-\sigma)\varepsilon_{ij}$ is also extreme value. In this model the derivative of the inside share with respect to the number of goods approaches zero as σ approaches 1, so additional products simply cannibalize one another's share with no market expansion effect.

We implement this by including the product's share among inside goods - $ln(\frac{s_j}{1-s_0})$ - as an explanatory variable. Suppressing time subscripts, we estimate:

$$ln(s_j) - ln(s_0) = \beta_0 + \alpha p_j + \sigma ln(\frac{s_j}{1 - s_0}) + \xi_j$$

The coefficient on the variable is the parameter σ, which indicates the degree of substitutability. When $\sigma = 0$, the model resolves to the simple logit; when

$\sigma = 1$, inside products are perfect substitutes for another. $\frac{s_j}{1-s_0}$ is evidently endogenous and we instrument it in addition to prices.

One shortcoming of the nested logit specification is that it is not able to accommodate rotations in the demand curve due, for example, to unobserved (by the practitioner) advertising. A large empirical literature demonstrates that advertising can both shift and rotate the demand curve but the standard discrete choice demand specification cannot accommodate this flexibly.[1] If unobserved advertising does rotate the demand curve, then our standard IV approach is no longer consistent because the instrumented price is correlated with the demand error, which now includes an interaction term between price and the error. Gandhi, Kim, and Petrin (2011) show in the BLP automobile data that price elasticities increase by 60% when the demand framework is generalized to allow for non-separable errors.[2]

We explore this extension in our data by estimating a nested logit specification that allows price to interact with the demand error:

$$ln(s_j) - ln(s_0) = \beta_0 + \alpha p_j + \sigma ln(\frac{s_j}{1-s_0}) + \xi_j + \lambda p_j * \xi_j.$$

We follow the approach outlined in Gandhi, Kim, and Petrin (2011) who show how to consistently estimate demand parameters when price interacts with the error.

[1]See e.g. Pakes (1987) review of Mueller (1986) for evidence that advertising both shifts and rotates demand.

[2]They do not jointly estimate the supply side model so these results are not comparable to what BLP report.

3 Supply

In this section we develop an approach to estimating the variable cost function with multiple outputs and adjustment costs for quasi-fixed inputs. We allow for the production function shock to affect the cost function. We also allow this productivity shock to be correlated with both output quantities and quasi-fixed inputs, which are arguments of the cost function. Allowing for correlation between quantities and productivity is important because more productive firms will in equilibrium - holding quasi-fixed inputs constant - produce more output. Allowing for correlation between quasi-fixed inputs and productivity is also important because as more productive firms are the firms that are likely to survive and accumulate quasi-fixed inputs over time.

3.1 Production

Estimation of the productivity shock is important for controlling for simultaneity in the cost function and for recovering an estimate of technical efficiency the changes of which can be related to expenditures on process innovations. In the case of a firm that produces a single-product the exercise of recovering the firm-level productivity shock is straightforward. With production given as

$$q_{ijt} = \beta_0 + \beta l_{it} + \beta_k k_{it} + \beta_m m_{it} + \omega_{it} + \eta_{it}$$

where in logs labor is l_{it}, k_{it} is capital, m_{it} is materials, the productivity term ω_{it} is assumed to be first-order Markov and may be correlated input choices, and η_{it} is an i.i.d. shock to production. $\beta = (\beta_0, \beta_l, \beta_k, \beta_m)$ are the elasticities of output of good j with respect to the inputs holding the other output quantities at the firm fixed. We experiment with the different proxy approaches, using the Wooldridge (2009) versions of Levinsohn and Petrin (2003) and Olley and Pakes (1996) estimators to allow for correlation between the technical efficiency error and inputs. Once the production function is estimated it is straightforward to estimate ω_{it} and add it as a regressor in a (potentially non-separable) cost function specification.

Many of the firms in our data are multi-product firms. Data on inputs used in production are aggregated across all the products at a firm. There are two approaches in the literature when inputs are aggregated, the first being a special case of the second. The first treats the multi-product firm as a collection of single product firms by dividing inputs among the products by (e.g.) the revenue share of each good. The second approach is to treat the production function as multi-product, and to estimate the multi-product transformation function described below (see Mundlak and Razin (1971) or Diewert (1973)). In the case of single product firms both approaches reduce to the standard production function setup.

Diewert (1973) shows that under mild regularity conditions there will exist a transformation function that relates the output of any good j to all other goods the firm produces and to aggregate input use. We add to that setup a productivity term that we call ω_{it} which we assume follows a first-order Markov process and which may be correlated with both inputs and outputs. We write the production function for firm i producing good j as

$$q_{ijt} = \beta_0 + \beta l_{it} + \beta_k k_{it} + \beta_m m_{it} + \gamma' q_{it,-j} + \omega_{it} + \eta_{it}$$

where

$$q_{it,-j} = (q_{it1}, \ldots, q_{it,j-1}, q_{it,j+1}, q_{itJ})$$

$q_{it,-j}$ is the vector of quantities produced of other goods. Holding overall input use constant γ_k is the additional amount of output j that would result from reducing output k by one unit holding input use constant. We modify the Wooldridge (2009) versions of Levinsohn and Petrin (2003) and Olley and Pakes (1996) estimators to allow for correlation between the technical efficiency error and inputs and correlation between technical efficiency and $q_{it,-j}$.

3.2 Marginal Costs

We extend the settings of Lau (1967) and Berndt and Morrison (1981) who develop a variable cost function that accommodates both freely variable inputs ((m)aterials, (l)abor) and quasi-fixed inputs ((k)apital), where quasi-fixity is defined as having an adjustment cost function $c(\Delta k)$ such that

$$c(0) = 0, \;\; c(\Delta k) > 0 \, if \; \Delta k \neq 0$$

with Δ the first-difference operator. Under weak conditions they show that the variable cost (VC) function has as arguments the variable input prices ($P_I = (P_m, P_l)$), the quantity of output (q), and the levels and changes of the quasi-fixed inputs:

$$lnVC_{it} = f(P_{It}, k_{it}, \Delta k_{it}, q_{it}).$$

Including the levels and changes is sufficient for (locally) controlling for the discontinuity introduced by the adjustment costs into the adjustment-cost-free cost function (i.e. the cost function written only with arguments input prices and output quantities). This new VC function gives the minimum variable costs necessary to achieve output q_{it} when facing prices P_{It}, given the level and change of the quasi-fixed input (s).

We let J_i be an index of the number of different products produced by i and we define the productivity shock from i's production function as ω_{it} (see Section 4.1 for more detail). Our generalized variable cost function that accounts for multi-product production simultaneity induced by firm-specific productivity is written as:

$$lnVC_{it} = f(P_{It}, k_{it}, \Delta k_{it}, q_{i1t}, \ldots, q_{iJ_it}, \omega_{it}).$$

Allowing for multi-product production is straightforward in theory as we just extend the single-product variable cost function – which conditions on one output – to a setup that conditions on multiple outputs. The minimization problem then has firms solving for the minimum variable costs to produce the vector of outputs $(q_{i1t}, \ldots, q_{iJ_it})$ conditional on quasi-fixed inputs and their adjustments.

One issue with this estimation approach is that - in principle - each permutation of production product-tuples should be considered a separate production technology. This works to reduce the number of observations of any production product-tuple. A second issue for estimation is that there is a curse of dimensionality if each quantity is allowed to interact flexibly with all other arguments in the cost function. We revisit both of these issues in the Estimation section.

The problem of simultaneity is more difficult when working with the cost function because the productivity shock will not enter the cost function in a separable way. This invalidates the use of the proxy methods (e.g. Olley-

Pakes (1995), Levinsohn-Petrin (2003), Wooldridge (2010), ACF(?)) because they require that the estimated (production) function is separable in the productivity shock. In order to control for the simultaneity problem that is induced in the cost function by the simultaneity problem in the production setting we estimate the production function and recover the productivity shock and condition directly on it. In an environment with non-separable errors one must condition on both the realized values of all observed variables and the error in order to achieve consistency (i.e. instrumental variable methods are inconsistent for endogenous variables in non-linear settings).[3]

4 Data

We use the Belgian PRODCOM survey that every year samples all Belgian firms in the manufacturing sector with at least 10 employees[4]. It contains information about values and quantities sold by product (defined as a 8-digit code in the PRODCOM classification). We define a firm-product-level price (unit value) by dividing the value of the good by the quantity.

We match the PRODCOM survey with accounting information provided by the Central Balance Sheet, which covers the universe of Belgian firms. We use turnover, material costs, capital, depreciation, cost of employees and the number of employees.

Table 1 shows the number of firms observed every year. We see that the share of firms producing more than 5 goods has decreased over time (from 12% to 9%), while the share of single product firms has increased from 47.3%

[3]See e.g. Blundell and Powell (2003).

[4]See also Bernard, Van Beveren and Vandenbussche, 2011 for a paper that combines the PRODCOM data with an international trade transaction dataset.

to 50.6%. The relative share of firms producing between 2 and 5 products has remained constant.

Table 2 shows the evolution of the average number of products made by firms. We observe that the average drops by 10% over the period we study, from 3 to 2.7. These two tables appear to indicate that firms have reduced the scope of their product portfolio.

5 Results

5.1 Output Prices

Table 3 shows the average, median, standard deviation of price and coefficient of variation for a few selected products. We observe that dispersion increases for all our products. We also notice substantial heterogeneity in dispersion across products. There is initially more dispersion for beer and cartons, boxes and cases, compared to ready-mixed concrete and bread, but dispersion increases for all products during the period analyzed. This can also be seen in figure 1, that plots the distribution of the demeaned log price, as well as its evolution, for these products.

Table 4 also shows that the demeaned log price decreases with firm size on average for most products we investigate, with the exception of ready-mixed concrete.

Table 5 shows that there is a substantial amount of persistence in price, as those high price firms are likely to remain in the same category the following year for all our four products.

5.2 Marginal Cost

We then follow the procedure described in subsection 2.2 to compute our firm-product measure of marginal cost. Table 6 provides summary statistics for the same four products. We observe that, except for the last product, the coefficient of variation is larger than those of price, suggesting the presence of more heterogeneity on the cost side than on the pricing side. The coefficient of variation is much larger for ready-mixed concrete than for the other three products. Heterogeneity appears to increase for beer and bread, and decrease for ready-mixed concrete and cartons, boxes and cases. Figure 2 plots the distribution of marginal cost and its evolution.

Table 7 shows the correlation between marginal cost and firm size. We observe that marginal cost also decreases with firm size, although not always in a linear way.

5.3 Markup

Table 8 shows the average markup estimates for our subset of products. We obtain reasonable estimates, usually ranging between 1.1 and 1.6. Markups apparently decrease for all products, except for bread. We also observe the presence of substantial cyclicality. Figure 3 shows the evolution of the distribution of the log demeaned markup, which is simply a function of the price and marginal cost distribution.

Table 9 shows that the log demeaned markup increases with firm size for two of our products (ready-mixed concrete and bread), as the sensitivity of marginal cost with respect to size is larger than for price; but it decreases with firm size for the other two (beer and boxes) for the opposite reason.

Once again, we notice that the relationship is not always linear (only for the last two products).

5.4 Demand estimation and product quality

As discussed in section 2, we next estimate a demand function based on the Berry (1994) algorithm. Table 10 shows the coefficients and the average demand elasticity estimate that we compute. The average eslasticity is low for ready-mixed concrete, but larger for beer and bread. The average estimates are between -1 and -2 for three of our products.

This estimation also provides a measure of firm-product quality. Figure 4 shows the evolution of the distribution of quality over time. We observe even more heterogeneity than for our price and marginal costs estimates.

Marginal cost is positively related to quality for beer and cartons, boxes and cases; but negatively correlated for bread and ready-mixed concrete. Price is generally less sensitive to quality than marginal costs. As a consequence, the markup is positively related to quality for bread and ready-mixed concrete, but positively correlated for the other two goods.

5.5 Productivity

We then estimate a production function for one sector where most firms produce exactly two products: bread and cake. The appendix shows the estimates when we use physical quantity and deflated revenue as LHS variable,

Table 11 shows the evolution of the dispersion of productivity for that specific product. We observe that the standard deviations are increasing for both measures, and that there is apparently more heterogeneity in TFPQ than in TFPR.

Figures 5 and 6 show the evolution of the distribution of both variables. The graph confirms that TFPQ has a wider distribution.

Table 12 shows the correlation between our main variables of interests. We can see that: 1) price is positively correlated with marginal cost; 2) price is generally positively correlated with TFPR but negatively correlated with TFPQ; 3) marginal cost is negatively correlated with both measures of productivity, while the markup is positively correlated to both.

5.6 A simple policy question

As a last step of our analysis, we use our simple methodology to address a specific policy question: how does price deregulation affect our estimated variables? In 2004, bread prices were entirely liberalized, as requested by bakers and justified by a need to maintain product quality. Observers immediately noticed an increase in prices, as expected.

The facts presented above document an increase in the average price and markup after 2004, although declining in 2007. We also documented an increase in the coefficient of variation and the average marginal cost. But what happened to quality and efficiency? Figure 7 shows the evolution of the average quality index and TFPQ where 2004 is our base year. We observe a dramatic improvement in quality and a moderate increase in productivity as well.

6 Conclusion

In this paper, we proposed a simple methodology to estimate marginal cost, quality and productivity at the firm-product level. We applied our methodology on a rich firm-product level dataset covering a large subsample of Belgian manufacturing. The methodology yielded sensible estimates for the marginal cost and the markup. We document substantial heterogeneity in price, marginal cost, quality and productivity. Our results are in line with recent theoretical models of international economics with endogenous markups.

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Table 1: Number of firms by year

	Single Product Firms		Firms producing between 2 and 5 products		Firms producing between 6 and 10 products		Firms producing more than 10 products		Total	
	Number	Share	Number	Share	Number	Share	Number	Share	Number	Share
1995	2868	47.28%	2451	40.41%	493	8.13%	254	4.19%	6066	100%
1996	2903	47.75%	2428	39.93%	511	8.4%	238	3.91%	6080	100%
1997	3039	48.8%	2482	39.86%	496	7.97%	210	3.37%	6227	100%
1998	3121	49.59%	2517	40%	451	7.17%	204	3.24%	6293	100%
1999	3508	50.47%	2765	39.78%	477	6.86%	200	2.88%	6950	100%
2000	3523	51.59%	2638	38.63%	477	6.98%	191	2.8%	6829	100%
2001	3520	51.3%	2687	39.16%	457	6.66%	197	2.87%	6861	100%
2002	3462	51.26%	2652	39.27%	441	6.53%	199	2.95%	6754	100%
2003	3408	50.99%	2657	39.75%	407	6.09%	212	3.17%	6684	100%
2004	3216	50.78%	2512	39.67%	405	6.4%	200	3.16%	6333	100%
2005	3008	49.84%	2450	40.6%	380	6.3%	197	3.26%	6035	100%
2006	3123	50.18%	2524	40.56%	378	6.07%	198	3.18%	6223	100%
2007	3117	50.63%	2479	40.26%	379	6.16%	182	2.96%	6157	100%
2008	2177	49.48%	1782	40.5%	281	6.39%	160	3.64%	4400	100%
2009	2120	49.21%	1778	41.27%	262	6.08%	148	3.44%	4308	100%

Table 2: Evolution of the average number of products

	Number of Products	New	Dropped	Continuing
1996	3.01	0.63	0.67	2.07
1997	2.89	0.56	0.62	2.10
1998	2.81	0.42	0.48	2.12
1999	2.72	0.62	0.49	1.93
2000	2.69	0.35	0.42	2.10
2001	2.71	0.47	0.44	2.03
2002	2.71	0.35	0.38	2.11
2003	2.74	0.43	0.43	2.06
2004	2.78	0.34	0.43	2.15
2005	2.75	0.32	0.46	2.23
2006	2.73	0.37	0.32	2.12
2007	2.69	0.30	0.37	1.71

Table 3a: Summary Statistics for Beer Prices

	Average	Median	Std. dev.	Coeff. Var.
1996	1.018	1.008	0.335	0.329
1997	1.081	0.987	0.408	0.377
1998	1.066	0.977	0.438	0.411
1999	1.096	1.022	0.468	0.427
2000	1.124	1.023	0.503	0.447
2001	1.077	1.027	0.456	0.423
2002	1.131	1.055	0.480	0.424
2003	1.149	0.983	0.521	0.454
2004	1.211	1.114	0.601	0.497
2005	1.198	1.221	0.549	0.458
2006	1.200	1.244	0.553	0.461
2007	1.274	1.227	0.626	0.491

Table 3b: Summary Statistics for Ready-mixed Concrete Prices

	Average	Median	Std. dev.	Coeff. Var.
1996	0.0237	0.0241	0.0047	0.201
1997	0.0234	0.0238	0.0045	0.191
1998	0.0233	0.0231	0.0049	0.211
1999	0.0236	0.0239	0.0058	0.247
2000	0.0247	0.0248	0.0084	0.341
2001	0.0249	0.0251	0.0059	0.236
2002	0.0259	0.0260	0.0060	0.233
2003	0.0263	0.0265	0.0061	0.233
2004	0.0267	0.0267	0.0070	0.263
2005	0.0255	0.0260	0.0053	0.207
2006	0.0280	0.0275	0.0119	0.426
2007	0.0288	0.0278	0.0153	0.533

Table 3c: Summary Statistics for Fresh Bread Prices

	Average	Median	Std. dev.	Coeff. Var.
1996	1.422	1.487	0.401	0.282
1997	1.385	1.188	0.464	0.335
1998	1.435	1.186	0.494	0.344
1999	1.398	1.182	0.491	0.351
2000	1.438	1.185	0.492	0.342
2001	1.469	1.205	0.473	0.322
2002	1.485	1.167	0.629	0.424
2003	1.481	1.207	0.558	0.377
2004	1.467	1.190	0.519	0.353
2005	1.498	1.327	0.559	0.373
2006	1.568	1.313	0.627	0.400
2007	1.448	1.149	0.645	0.445

Table 3d: Summary Statistics for Cartons, Boxes, Cases etc. Prices

	Average	Median	Std. dev.	Coeff. Var.
1996	1.096	0.879	0.618	0.564
1997	1.159	0.830	0.825	0.712
1998	1.426	0.808	1.340	0.939
1999	1.345	0.791	1.309	0.974
2000	1.438	0.859	1.582	1.100
2001	1.266	0.883	1.008	0.796
2002	1.266	0.913	0.996	0.787
2003	1.234	0.920	0.977	0.791
2004	1.281	0.955	0.966	0.754
2005	1.217	0.872	0.991	0.815
2006	1.296	0.921	1.103	0.851
2007	1.387	1.030	1.010	0.728

Table 4: Output price differences by size quartile (robust regression)

	Constant	2nd Quartile	3rd Quartile	4th Quartile	# obs.
Beer	0.255*** (0.050)	-0.127*** (0.072)	-0.248*** (0.071)	-0.53*** (0.073)	287
Ready-mixed Concrete	0.022 (0.015)	0.048 (0.021)	0.015 (0.021)	-0.002 (0.021)	594
Bread	0.091*** (0.017)	-0.006 (0.024)	-0.109*** (0.024)	-0.314*** (0.024)	903
Cartons, Boxes and Cases	0.478*** (0.049)	-0.575*** (0.071)	-0.829*** (0.070)	-0.703*** (0.072)	233
Kitchen Furniture	1.31*** (0.118)	-0.739*** (0.165)	-1.655*** (0.164)	-2.816*** (0.166)	403

Table 5:

	HH_price	HM_price	HL_price	MH_price	MM_price	ML_price	LH_price	LM_price	LL_price
Beer	.897	.103	0	.024	.897	.079	0	.094	.906
Ready-Mixed Concrete	.829	.138	.033	.071	.842	.087	.015	.188	.797
Fresh Bread	.888	.106	.006	.081	.779	.140	.016	.270	.714
Cartons, Boxes, Cases, etc.	.933	.067	0	.049	.873	.078	0	.148	.852

Table 6a: Summary Statistics of Marginal Cost Estimates for Beer

	Average	Median	Std. dev.	Coeff. Var.
1996	0.667	0.603	0.300	0.450
1997	0.659	0.568	0.272	0.412
1998	0.643	0.537	0.294	0.458
1999	0.666	0.597	0.287	0.432
2000	0.681	0.615	0.321	0.471
2001	0.668	0.648	0.299	0.447
2002	0.705	0.655	0.335	0.475
2003	0.745	0.637	0.404	0.542
2004	0.761	0.706	0.400	0.526
2005	0.757	0.725	0.440	0.582
2006	0.730	0.718	0.396	0.543
2007	0.788	0.754	0.407	0.517

Table 6b: Summary Statistics of Marginal Cost Estimates for Ready-mixed Concrete

	Average	Median	Std. dev.	Coeff. Var.
1996	0.0304	0.0200	0.0296	0.9750
1997	0.0268	0.0191	0.0199	0.7435
1998	0.0285	0.0194	0.0218	0.7632
1999	0.0302	0.0221	0.0208	0.6895
2000	0.0297	0.0227	0.0201	0.6766
2001	0.0304	0.0221	0.0216	0.7120
2002	0.0306	0.0238	0.0213	0.6963
2003	0.0298	0.0237	0.0194	0.6500
2004	0.0314	0.0238	0.0221	0.7028
2005	0.0328	0.0239	0.0239	0.7293
2006	0.0361	0.0253	0.0266	0.7369
2007	0.0351	0.0245	0.0246	0.7009

Table 6c: Summary Statistics of Marginal Cost Estimates for Fresh Bread

	Average	Median	Std. dev.	Coeff. Var.
1996	1.305	1.148	0.563	0.432
1997	1.188	1.076	0.495	0.416
1998	1.371	1.158	0.794	0.580
1999	1.509	1.270	0.797	0.528
2000	1.418	1.239	0.808	0.570
2001	1.416	1.223	0.779	0.550
2002	1.421	1.236	0.844	0.594
2003	1.384	1.234	0.672	0.485
2004	1.421	1.220	1.066	0.750
2005	1.265	1.185	0.548	0.433
2006	1.325	1.235	0.609	0.460
2007	1.280	1.197	0.661	0.516

Table 6d: Summary Statistics of Marginal Cost Estimates for Cartons, Boxes, Cases etc.

	Average	Median	Std. dev.	Coeff. Var.
1996	0.714	0.667	0.343	0.481
1997	0.721	0.604	0.408	0.566
1998	0.838	0.645	0.562	0.670
1999	0.749	0.628	0.550	0.734
2000	0.780	0.686	0.476	0.610
2001	0.739	0.658	0.417	0.565
2002	0.764	0.677	0.436	0.570
2003	0.798	0.700	0.441	0.552
2004	0.831	0.697	0.438	0.526
2005	0.914	0.775	0.471	0.516
2006	0.884	0.778	0.380	0.430
2007	0.916	0.798	0.446	0.487

Table 7: Marginal Cost Differences by Size Quartile

	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile	# obs.
Beer	0.115*** (0.052)	-0.029 (0.075)	-0.092 (0.074)	-0.339*** (0.076)	287
Ready-mixed Concrete	0.379*** (0.049)	-0.428*** (0.071)	-0.612*** (0.071)	-0.405*** (0.071)	594
Bread	0.355*** (0.024)	-0.264*** (0.034)	-0.449*** (0.034)	-0.761*** (0.034)	903
Cartons, boxes and cases	0.195*** (0.045)	-0.297*** (0.065)	-0.452*** (0.064)	-0.134*** (0.066)	233

Table 8a: Average Markups for Beer

	Average	Median	Std. dev.
1996	1.523	1.385	0.475
1997	1.425	1.400	0.538
1998	1.567	1.413	0.748
1999	1.699	1.761	0.684
2000	1.575	1.481	0.775
2001	1.545	1.513	0.763
2002	1.546	1.463	0.806
2003	1.569	1.558	0.800
2004	1.561	1.620	0.727
2005	1.574	1.544	0.770
2006	1.537	1.424	0.783
2007	1.404	1.367	0.731

Table 8b: Average Markups for Ready-mixed Concrete

	Average	Median	Std. dev.
1996	1.384	1.210	1.042
1997	1.306	1.184	0.895
1998	1.327	1.201	0.982
1999	1.173	1.031	0.798
2000	1.217	1.234	0.825
2001	1.260	1.189	0.903
2002	1.275	1.145	0.889
2003	1.237	1.129	0.788
2004	1.285	1.146	0.893
2005	1.203	1.064	0.862
2006	1.469	1.025	1.811
2007	1.114	1.052	0.696

Table 8c: Average Markups for Fresh Bread

	Average	Median	Std. dev.
1996	1.160	1.191	0.245
1997	1.267	1.249	0.510
1998	1.210	1.171	0.510
1999	1.087	1.080	0.423
2000	1.175	1.151	0.480
2001	1.181	1.199	0.413
2002	1.191	1.179	0.514
2003	1.181	1.145	0.376
2004	1.208	1.175	0.405
2005	1.289	1.245	0.409
2006	1.289	1.211	0.400
2007	1.242	1.225	0.410

Table 8d: Average Markups for Cartons, Boxes, Cases, etc.

	Average	Median	Std. dev.
1996	1.555	1.630	0.429
1997	1.569	1.511	0.400
1998	1.694	1.503	0.997
1999	1.787	1.512	0.910
2000	1.738	1.408	0.966
2001	1.711	1.458	0.768
2002	1.657	1.531	0.718
2003	1.592	1.395	0.727
2004	1.570	1.464	0.626
2005	1.366	1.284	0.664
2006	1.397	1.234	0.644
2007	1.537	1.351	0.682

Table 9: Markup differences by size quartile

	1st quartile	2nd quartile	3rd quartile	4th quartile	# obs.
Beer	0.125** (0.021)	-0.084*** (0.030)	-0.258*** (0.029)	-0.167*** (0.030)	287
Ready-mixed Concrete	-0.382*** (0.056)	0.496*** (0.080)	0.621*** (0.080)	0.466*** (0.080)	594
Bread	-0.229*** (0.017)	0.231*** (0.024)	0.350*** (0.024)	0.415*** (0.024)	903
Cartons, Boxes, Cases, etc.	0.425*** (0.023)	-0.263*** (0.034)	-0.513*** (0.034)	-0.701*** (0.035)	233

Table 10: Demand Estimation

Dep. var.: lnsj-lns0	Beer	Ready-mix concrete	Bread	Cartons, Boxes, Cases, etc.
α	-1.54*** (0.18)	-11.51*** (4.97)	-1.20*** (0.09)	-0.94*** (0.08)
Average elasticity	-1.79	-0.3	-1.77	-1.2
Median elasticity	-1.59	-0.29	-1.59	-0.82
# obs.	287	594	903	233

Table 11: **Standard Deviations of TFPQ and TFPR Estimates (Bread)**

	TFPQ	TFPR
1996	0.270	0.169
1997	0.409	0.462
1998	0.519	0.483
1999	0.473	0.426
2000	0.502	0.460
2001	0.472	0.433
2002	0.476	0.487
2003	0.394	0.300
2004	0.418	0.312
2005	0.412	0.272
2006	0.428	0.263
2007	0.467	0.322

Table 12: Correlation Between Price, Marginal Cost, Markup and TFP Estimates - Bread

	p	mc	μ	TFPQ	TFPR
p	1				
mc	0.5797	1			
μ	0.0604	-0.5499	1		
TFPQ	-0.4695	-0.8679	0.7508	1	
TFPR	0.1223	-0.457	0.7644	0.6499	1

Figure 1a: Distribution of output price (beer made from malt)

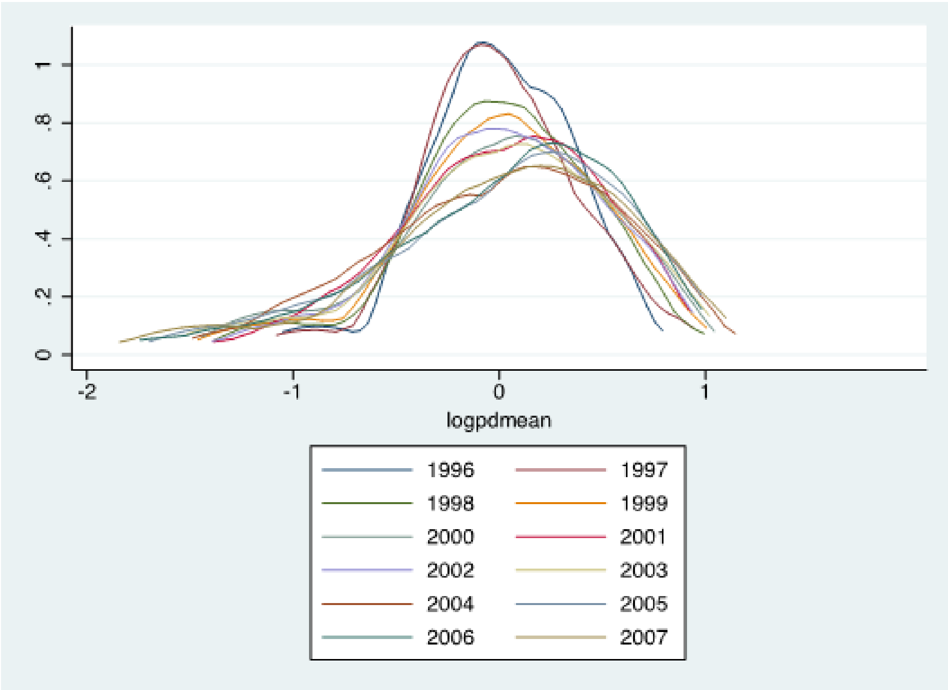

Figure 1b: Distribution of output price (ready-mix concrete)

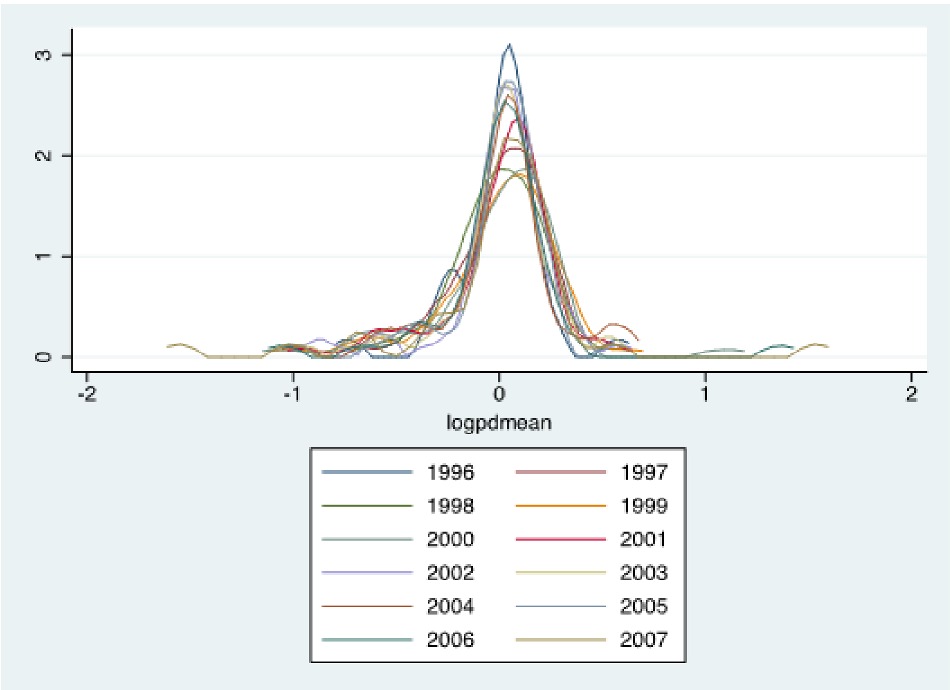

Figure 1c: Distribution of output price (bread)

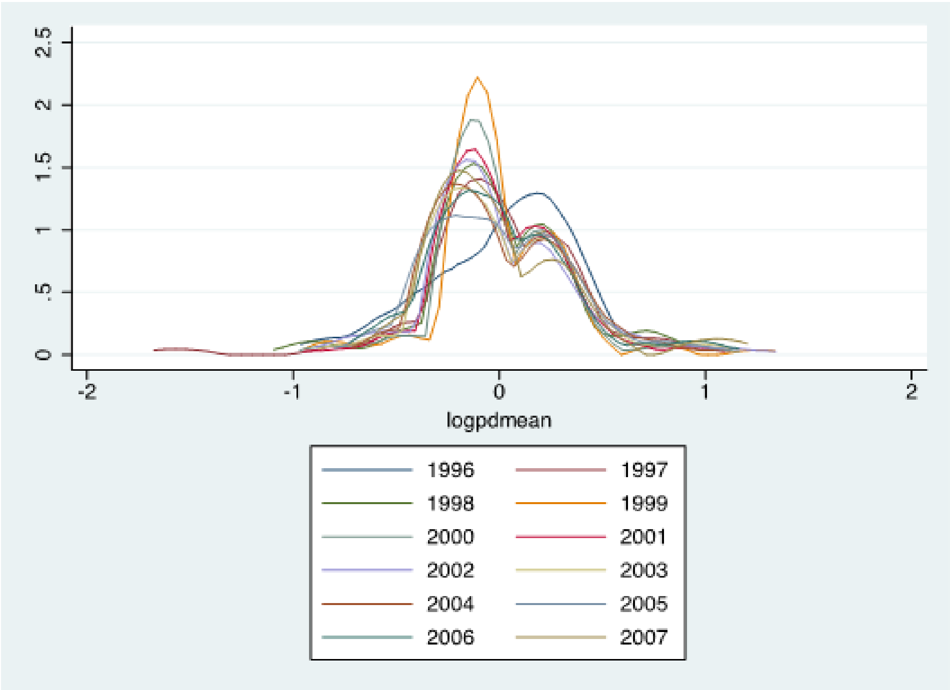

Figure 1d: Distribution of output price (Cartons, boxes and cases)

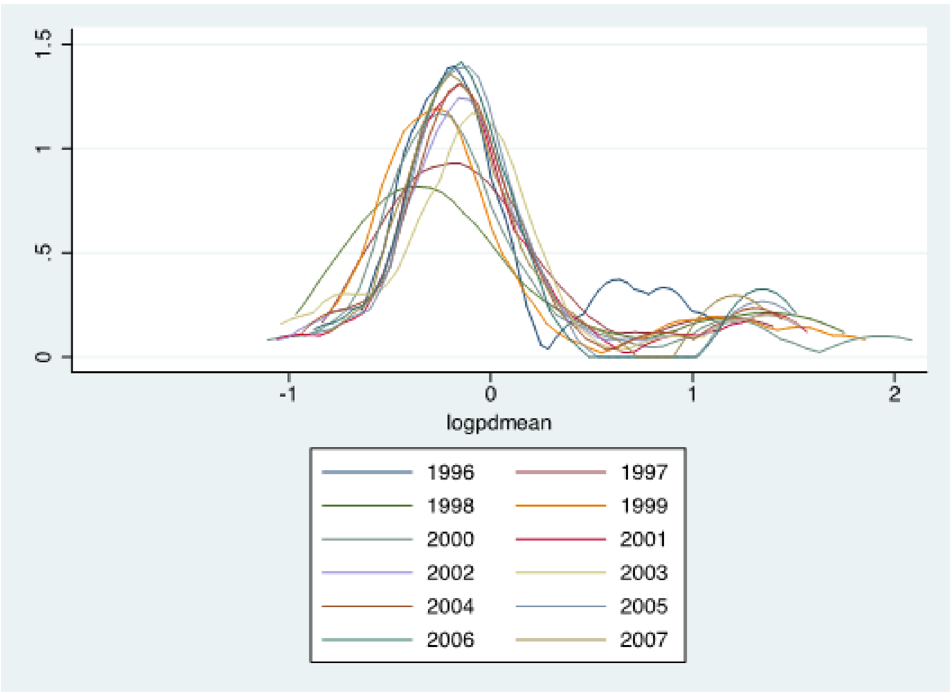

Figure 2a: Distribution of marginal cost (beer made from malt)

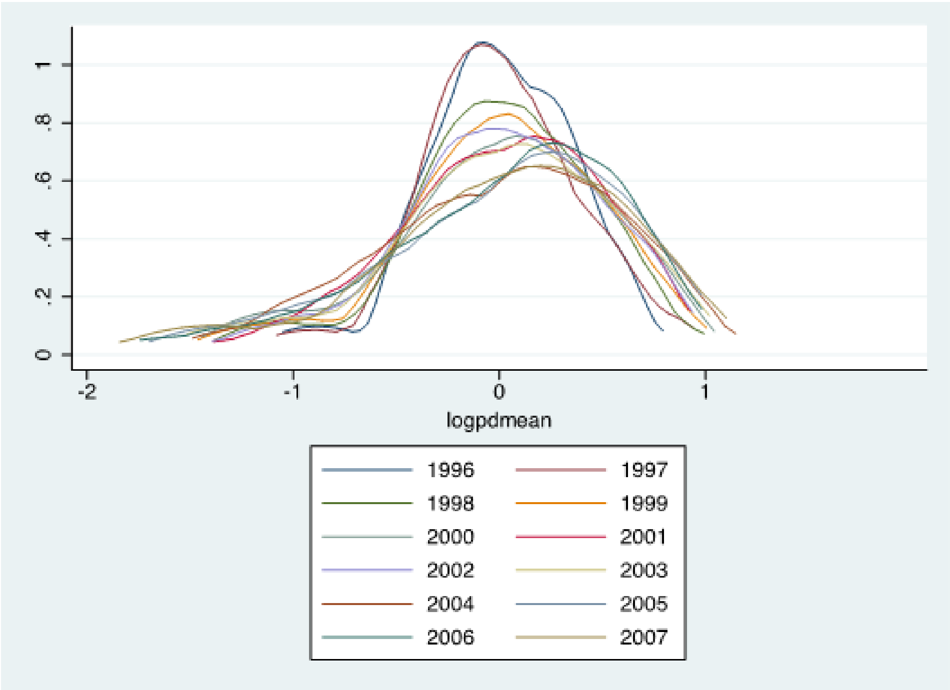

Figure 2b: Distribution of marginal cost (ready-mix concrete)

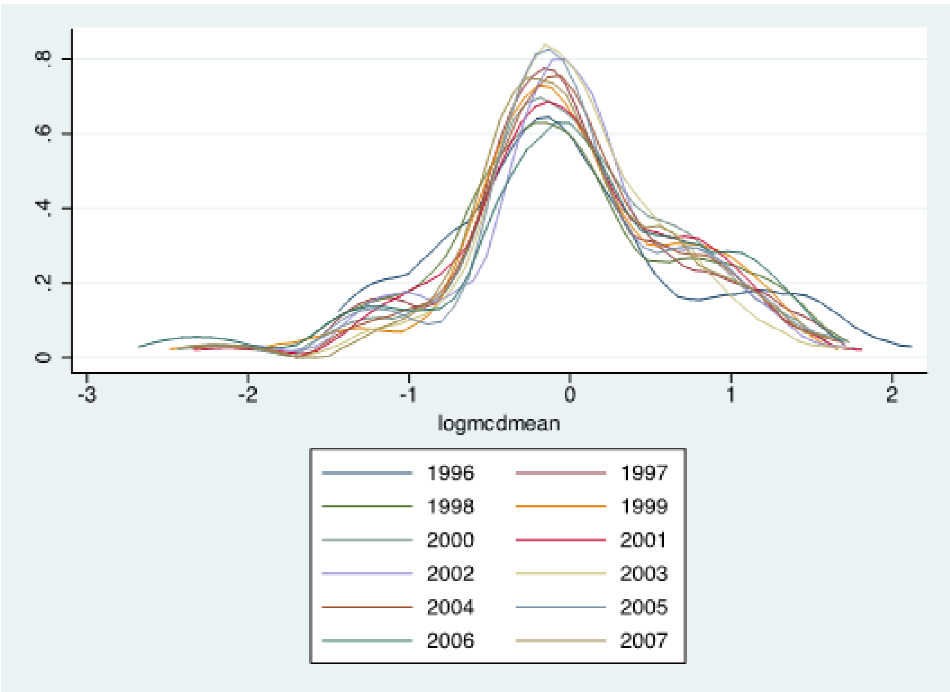

Figure 2c: Distribution of marginal cost (bread)

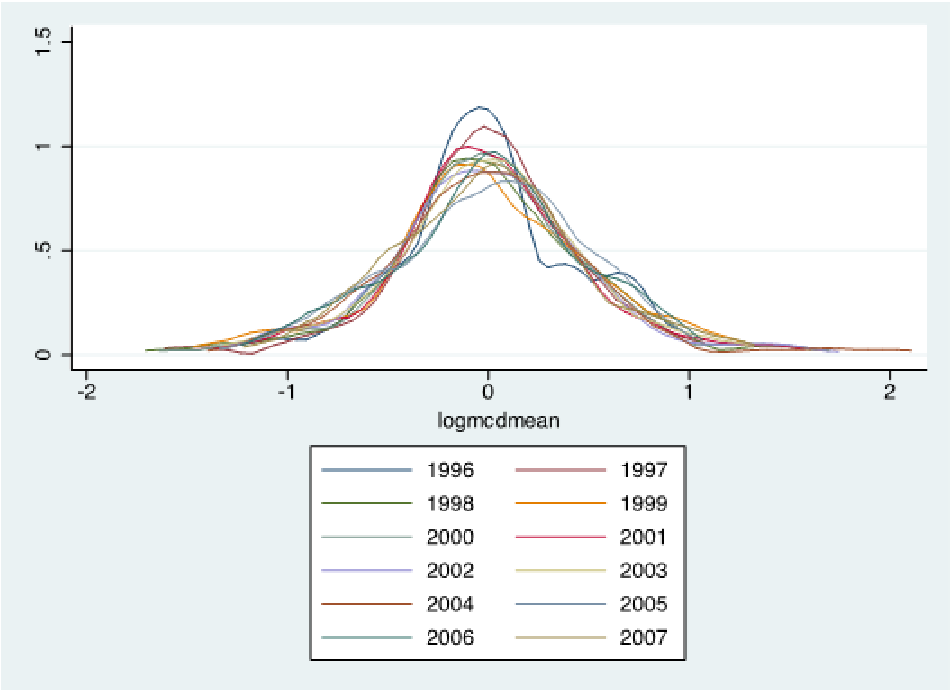

Figure 2d: Distribution of marginal cost (Cartons, boxes and cases)

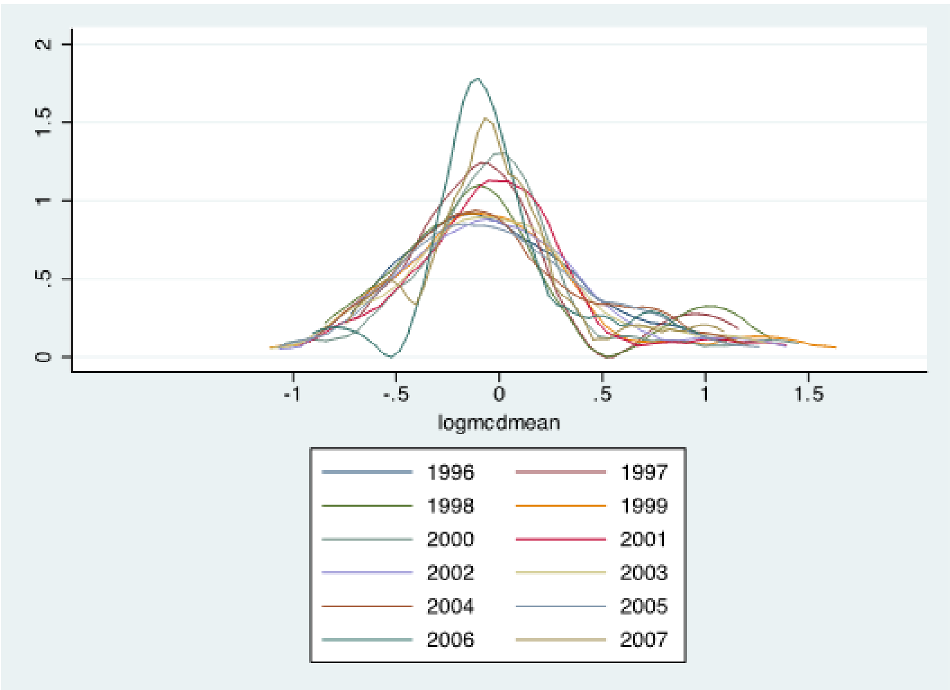

Figure 3a: Distribution of the markup (beer made from malt

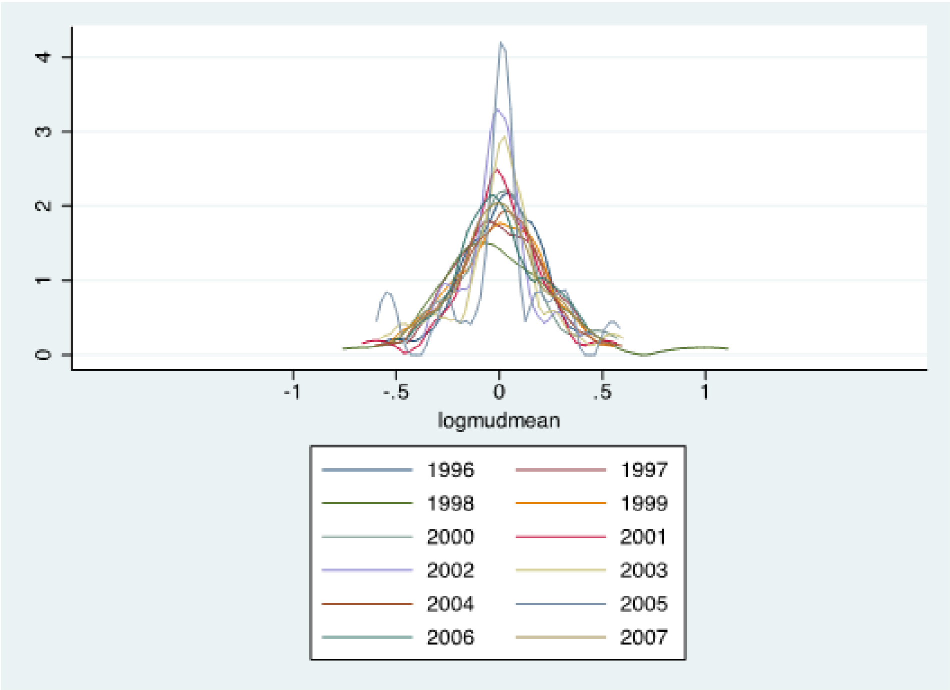

Figure 3b: Distribution of the markup (ready-mix concrete)

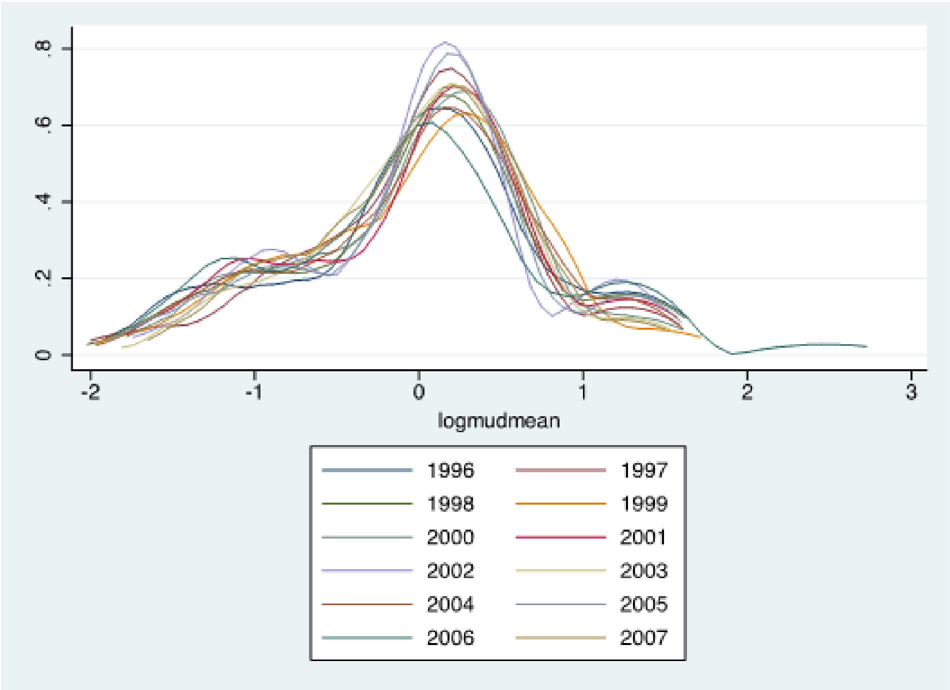

Figure 3c: Distribution of the markup (bread)

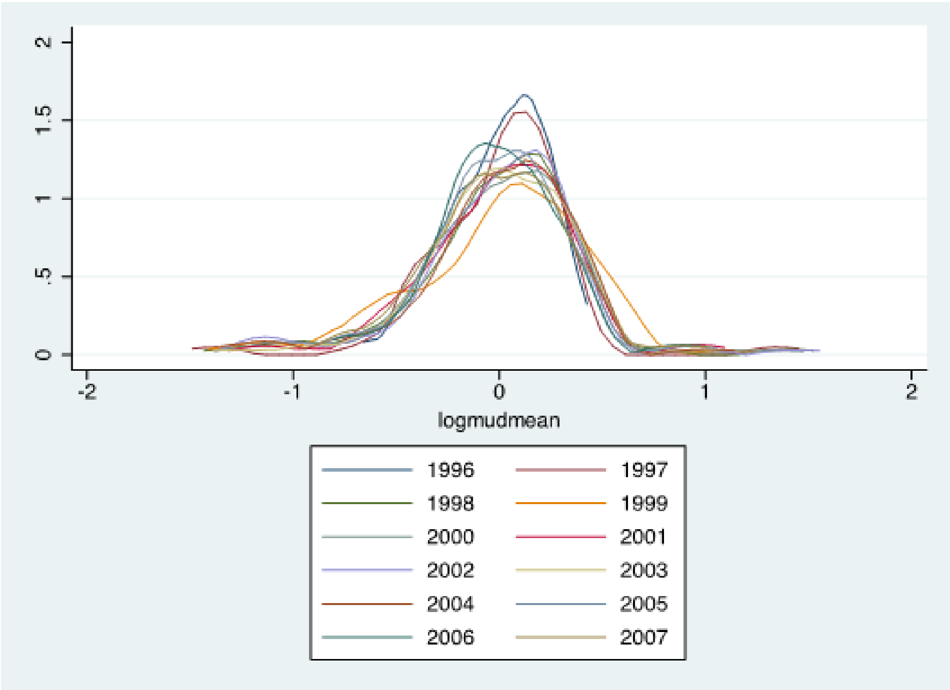

Figure 3d: Distribution of the markup (Cartons, boxes and cases)

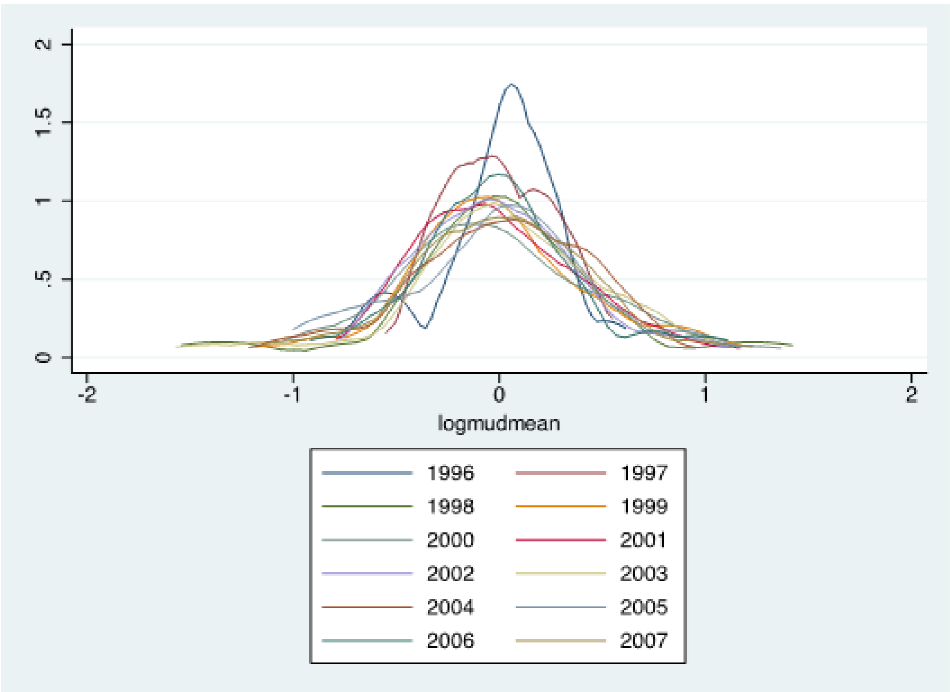

Figure 4: Evolution of the quality distribution

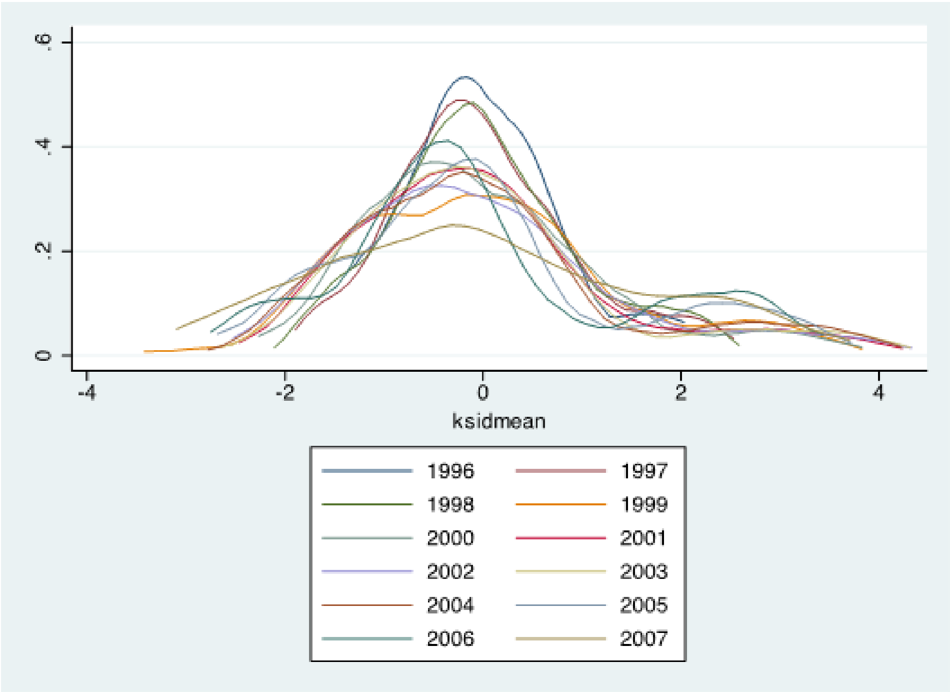

Figure 5: Distribution of revenue TFP (TFPR)

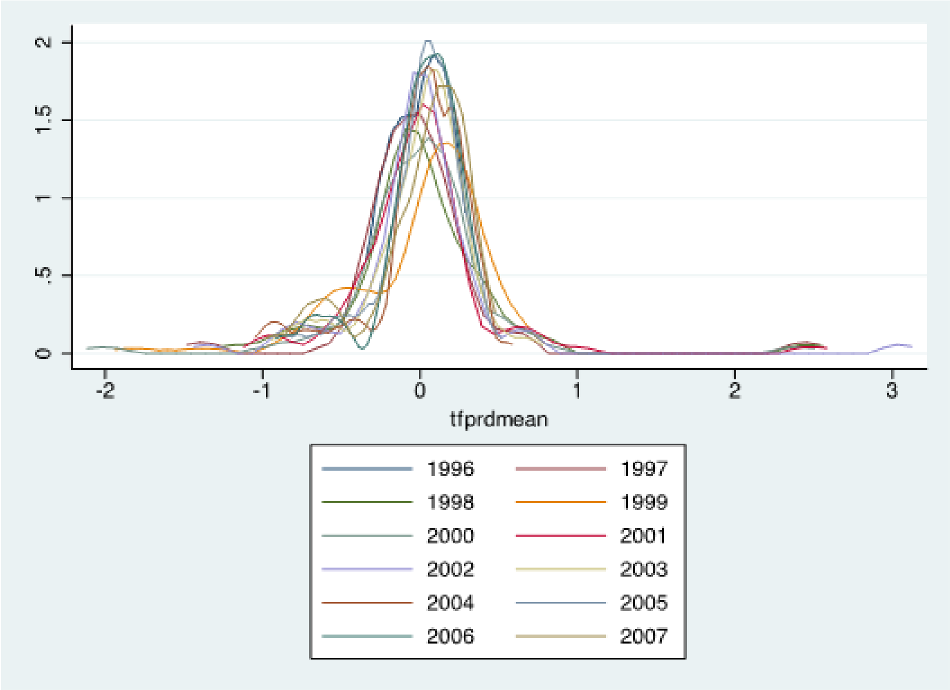

Figure 6: Distribution of physical TFP (TFPQ)

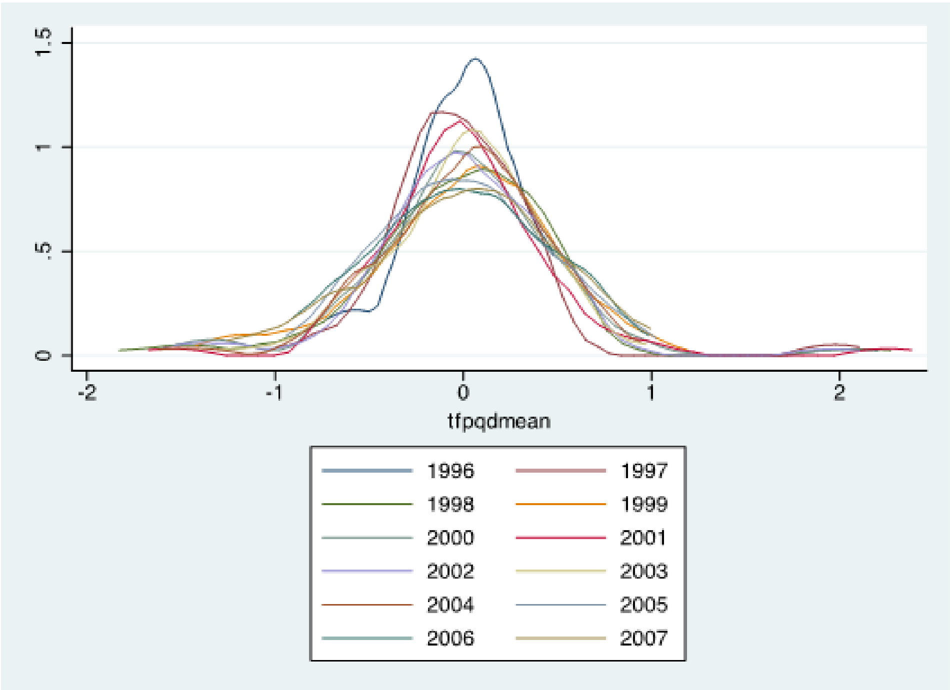

Figure 7: Evolution of average quality and efficiency: Bread