DIFFERENTIAL MERGER EFFECTS:

The Case of the Personal Computer Industry

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Contents:

Discussion paper
No. EI/37 December 2004

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* I am indebted to my supervisor Prof. Paul Geroski for his constructive comments and continuous support. I also wish to thank Peter Davis, Wouter Denhaan, Konstantinos Metaxoglou, Marco Ottaviani, Mario Pagliero, Elias Papaioannou, Mark Schankerman, Gregorios Siourounis and John VanReenen for constructive discussions and suggestions. I am also grateful to James O'Brien from IDC for his help with the data. Financial support from the LBS and ESRC is gratefully acknowledged. All remaining errors are my own.

Abstract

This paper examines how information on the purchasing patterns of different customer segments can be used to more accurately evaluate the economic impact of mergers. Using a detailed dataset for the leading manufacturers in the US during the late nineties, I evaluate the welfare effects of the biggest ($25 billion) merger in the history of the PC industry between Hewlett-Packard and Compaq. I follow a two-step empirical strategy. In the first step, I estimate a demand system employing a random coefficients discrete choice model. In the second step, I simulate the postmerger oligopolistic equilibrium and compute the welfare effects. I extend previous research by analysing the merger effects not only for the whole market but also for three customer segments (home, small business and large business). Results from the demand estimation and merger analysis reveal that: (i) the random coefficients model provides a more realistic market picture than simpler models, (ii) despite being the world's second and third largest PC manufacturers, the merged HP-Compaq entity would not raise postmerger prices significantly, (iii) there is considerable heterogeneity in preferences across segments that persists over time, and (iv) the merger effects differ considerably across segments.

JEL Classification: D12, G34, L41, L63

Keywords: Computer industry, discrete choice models, merger analysis, product differentiation, random coefficients.

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1 Introduction

Merger activity has witnessed an unprecedented increase over the last decade, both in terms of monetary value and number of deals involved.[1] The number of mergers reviewed by US regulators in 1998, for example, was 4,728 (compared to 3,702 in 1997 and 1,451 in 1991) with a total merger value that exceeded $1 trillion.[2] Theory suggests that a merger between competitors increases firms' market power (both for the merged entity and its competitors), thereby leading to higher prices and lower output (absent any offsetting efficiency gain).[3] Antitrust authorities, therefore, actively seek to prevent mergers that could threaten competition. The extent to which prices rise, however, is an empirical question. Moreover, the effect on total welfare is ambiguous and theoretical work cannot, by itself, answer this question. The purpose of this paper is to examine how information on the purchasing patterns of different customer segments can be used to more accurately evaluate the economic impact of mergers.

I evaluate the welfare effects of the biggest ($25 billion) merger in the history of the personal computer (PC) industry between Hewlett-Packard (HP) and Compaq. I also examine a second hypothetical merger between the two largest firms in the industry, Dell and Compaq. Using a detailed dataset for the leading PC manufacturers in the US during the late nineties, I extend previous research by analysing the merger effects not only for the whole market but also for three customer segments (home, small business and large business). The existence of customer groups with different purchasing patterns, although recognised in other markets (e.g., tourist vs. business travelers in the airline industry; Berry, Carnall and Spiller, 1997), has never been incorporated in a merger analysis.

Merger evaluation is based on a two-step empirical strategy, first proposed by Baker and Bresnahan (1985) and developed further by Berry and Pakes (1993), Hausman, Leonard and Zona (1994) and Nevo (2000a). First, I estimate a structural demand system employing a random coefficients discrete choice model (McFadden, 1973; Boyd and Mellman (1980); Cardell and Dunbar (1980); Berry, 1994; Berry, Levinsohn and Pakes, 1995 (henceforth BLP); Nevo, 2001). Demand is estimated both for the whole market and for each of the three customer segments. The resulting estimates, in conjuction with a Nash-Bertrand equilibrium assumption, are used to recover estimates of the profit margins and marginal costs for each PC producer. Second, I simulate the postmerger equilibrium prices under various assumptions at three points in time. I compare the welfare effects of these mergers across time and segments.

Results from the demand estimation and merger analysis reveal that: (i) the random coefficients model provides a more realistic picture of the market than simpler models, (ii) the demand specification is found to be robust to various perturbations. This sample counters recent criticisms that a random coefficients model either over-estimates (Goeree, 2004) or under-estimates (Ackerberg and Rysman, 2004) elasticities. (iii) despite being the world's second and third largest PC manufacturers, the merged HP-Compaq entity would not raise postmerger prices significantly, (iv) there is considerable heterogeneity in preferences across segments that persists over time, and (v) the merger effects vary con-

[1] For a recent review on merger activity, see Andrade, Mitchell and Stafford (2001).

[2] *Business Week*, March 23, 1998, p.35 and Romeo (1999).

[3] For a recent review on the theory of unilateral effects, see Ivaldi, Jullien, Rey, Seabright and Tirole (2003).

siderably across segments. Evidence from the HP-Compaq merger in 2001, for example, suggests that an attempt from the merged entity to take advantage of its full product line would result in negative profits in the home and small business segments, with more than compensating gains from the large business segment. Moreover, the merger would harm home consumers more than business buyers. Hence, this cross-sectional analysis not only provides firms with a more accurate picture of the merger, but also allows competition authorities to evaluate the merger more effectively given the knowledge of its differential welfare implications.

This paper contributes to a growing empirical literature on structural demand estimation and horizontal merger analysis. Traditional methods of horizontal merger analysis, that rely on concentration measures, provide a standard to evaluate the competitive effects of the merger only under strong assumptions. The nature of competition and the large number of brands in differentiated oligopolistic product markets render these concentration measures difficult to use easily for policy recommendation.[4] Recent advances in structural methods that combine demand estimation with a game theoretic model of the competitive market structure make merger simulations feasible for many industries.[5] Structural empirical analysis of this market, however, poses many challenges due to the large number of PCs available and the frequent introduction of new products and characteristics.

Merger evaluation requires an accurate assessment of substitution possibilities. The random coefficients model has several advantages over alternative demand specifications. First, it allows for flexible own-price elasticities to be driven by the price sensitivity of different consumers and not by functional form assumptions as in the case of the logit model. Second, it permits cross-price elasticities to depend on how close products are in the characteristics space without imposing a priori product segmentation (Nested Logit, Principles of Differentiation Generalized Extreme Value) or a priori parameter restrictions (market level linear or log-linear demand systems). Moreover, McFadden and Train (2000) show such a model can approximate arbitrarily close any choice model.

The structural demand model results match market reality closely. Reported profit margins for the top manufacturers vary from 10 to 20 percent, while estimated margins for the whole market vary from 10.4 to 18.8 percent. Additionally, the demand specification is robust to various perturbations. Goeree (2004) presents an empirical discrete choice model where consumers have limited information with respect to available products. She argues that models assuming full consumer awareness will be biased towards being too elastic. In contrast, Ackerberg and Rysman (2004) argue that standard discrete choice models under-predict elasticities. They suggest that this is due to these models' failure to correct for the crowding of the unobserved characteristic space when new products are introduced in the market. I find no evidence in this sample that a random coefficients model either over-estimates or under-estimates elasticities. These results contribute to

[4] For example, the Hirshman/Herfindal index (HHI) of concentration is a less reliable measure of market power in an industry with differentiated products. Markups can be high, when products are not close substitutes, even in unconcentrated industries. Hence, merger effects depend more on the substitution pattern among products, than on their market shares.

[5] Examples include beer (Baker and Bresnahan, 1985; Hausman, Leonard and Zona, 1994; Pinkse and Slade, 2004), automobiles (Berry and Pakes, 1993; Ivaldi and Verboven, 2004), long distance telecommunications (Werden and Froeb, 1994), ready-to-eat cereals (Nevo, 2000a), carbonated soft drinks (Dube, 2004) and airlines (Peters, 2001).

our knowledge for the performance of these models in differentiated oligopolistic markets.

According to the merger simulations, absent any cost efficiencies, the HP-Compaq deal would result in a $1.06 million loss in consumer surplus in 2001 and a $11.7 million overall welfare gain. This is empirical support for the merger approval by both the US Federal Trade Commission and the European Competition Commission. Stiff price competition and the high degree of substitutability among PC manufacturers meant that the merged entity's transitory market power was not significant to threaten competition in the late nineties. Competitors such as Dell, Gateway and IBM would benefit the most if HP-Compaq were to raise postmerger prices.

The demand estimation also reveals considerable and persistant preference heterogeneity across the three segments. The European Competition Commission's report for the HP-Compaq merger explicitly recognises that "*because, among other elements, individual consumers show different purchasing patterns,..., the market for PCs could be broken down between consumers and commercial customers.*"[6] The results not only validate the view expressed by the European Competition Commission, but also indicate the differential responses of segments to any merger.[7]

Although results from the whole market for the HP-Compaq merger in 2001 indicate that the combined firm's profitability would be positive, segment examination reveals that: the merger would be unprofitable for the home (-$0.5 million) and small business (-$0.26 million) segments, with all the gains coming from the large business segment ($1.80 million). This illustrates the differences in each segment's underlying demand and it seems to be close to reality. Hence, this cross-sectional analysis provides firms with a more comprehensive picture of the merger that can also be used for strategic purposes.

This detailed analysis can also be valuable from the public policy perspective. Consumer loss from the HP-Compaq merger is much higher for home than for business buyers. This is not the case, however, for all mergers across time. The hypothetical Dell-Compaq merger in 1998, for example, yields a negative consumer surplus, which is larger for the large business than the other two segments. Overall welfare though is significantly smaller in the home than in the small or large business sectors. Knowledge of these differential effects can provide regulators with valuable information for the assessment of the overall impact of the proposed merger.

The rest of the paper is organized as follows: Section 2 describes those aspects of the personal computer industry most relevant to the demand analysis. Section 3 discusses the empirical framework to estimate demand, simulate the mergers and calculate the welfare effects. Section 4 describes the data and estimation details. Section 5 presents results. The first subsection analyses the demand estimates. The second subsection examines the sensitivity of the demand specification and the third subsection presents the merger analysis. The final section concludes.

[6] Case No COMP/M. 2609-HP/COMPAQ, Office for Official Publications of the European Communities.

[7] Further consequences of this finding, related to the interaction between the PC and server markets are explored in Genakos, Kühn and Van Reenen (2004).

2 The Personal Computer Industry

Technical change in personal computing has occurred at an extremely fast pace throughout its history. Competition, however, has changed radically in the late nineties from the period when the first IBM PC was introduced.[8] Three important aspects of the personal computer industry's evolution are relevant to the demand analysis and the HP-Compaq merger: the fast rate of technical innovation, the reduction in R&D expenditures of PC manufacturers and the proliferation of differentiated products.

The early emergence of the IBM PC platform[9] played a prominent evolutionary role. It served as a coordinating mechanism due to IBM's decision to use other firms' technology in key functions (most notably, Intel for the microprocessor and Microsoft for the operating system) and to have an open architecture (i.e. any user could add non-IBM hardware and software). This open architecture meant that platform components were interchangeable. Consequently, all market participants could benefit from the technological progress and all had a focal point for their innovative efforts. In addition, this new architecture led to the transition from the vertically integrated suppliers to an horizontal market structure of vertically disintegrated specialized firms.[10]

Under the new horizontal structure, although various firms have dominant positions in different layers, no single firm controls the platform's direction. This creates both fierce competition and continuous innovation at every layer. *Figure 1* documents how quickly the microprocessor's[11] quality evolved. Specifically, the "benchmark"[12] value of the best available processor more than doubled within a year and increased more than sixteenfold within six years. Similar patterns hold for the other essential PC components, such as the RAM or hard disk.

At the same time, due to the vertical disintegration, PC manufacturers reduced their R&D expenditures[13] and concentrated on collecting the various parts of the final product from companies in different layers of the platform. Technical knowledge was not the critical advantage anymore. Assembly simplicity and ease of component purchasing, lowered the entry barriers for potential new assemblers. As seen in *Figure 2*, this caused both a surge of small producers (denoted as "Others") and the rise of the "Dell phenomenon". Firms such as Dell or Gateway quickly established a strong market position by taking advantage of the new industry structure.

[8] Langlois (1992) and Steffens (1994) provide excellent historical reviews of the personal computer industry and Breshnahan and Greenstein (1999) present an integrated analysis of the whole computer industry's evolution.

[9] Following Bresnahan and Greenstein (1999), a computer platform can be defined as a "bundle of standard components around which buyers and sellers coordinate efforts".

[10] That is what Bresnahan and Greenstein (1999) called "divided technical leadership", i.e. the supply of key platform components by multiple firms.

[11] I will use the words microprocessor, processor or CPU interchangeably.

[12] CPU benchmarks were obtained from *The CPU Scorecard* (www.cpuscorecard.com). They are numbers assigned to each processor-speed combination based on technical and performance characteristics. Bajari and Benkard (2004) were the first to use this variable.

[13] "R&D spending by most PC manufaturers has declined over the past four years from an industry average of just 4% of sales to about 2% of sales. In sharp contrast, Intel, the dominant supplier of microprocessors to the PC industry, ploughed 8% of revenues, or $1.3bn, into R&D last year. Microsoft, the leading PC software supplier, spent $890m on R&D last year, or 15% of its sales", *Financial Times* (10/2/1996).

PC variety also increased during the late nineties. First, the range of available quality widened, as is evident from the increased difference over time between the upper and lower bound of "benchmark" values in *Figure 1.* Processor manufacturers, such as Intel, looked for greater market segmentation through a larger range of vertically differentiated processors and a shortened average life cycle of each processor.[14] Personal computer manufacturers, in turn, amplified this phenomenon by offering an ever increasing number of products that were not only different in their "basic" characteristics (such as the microprocessor, RAM or speed) but also in other dimensions (CD-ROM, modem, DVD, monitor size etc). Finally, the combination of fast technical innovation, numerous successful entrants and increased product proliferation led to a continuous fall in PC prices. *Figure 3* illustrates both the increased product options and the decreasing prices. These trends are not only important for the demand specification, but they also portray the competitive environment in which HP and Compaq consolidate their forces.

3 The Empirical Framework

I follow a two-step empirical strategy to evaluate the merger's competitive effects. In the first step, I estimate a structural model that describes the demand and supply conditions in the personal computer industry. In the second step, I simulate the postmerger oligopolistic equilibrium and compute the welfare effects. The demand system[15] is estimated employing a random coefficient discrete choice model similar to that of BLP. I then use the resulting elasticities in combination with a Nash-Bertrand equilibrium assumption to recover estimates of marginal costs and to simulate the merger.

3.1 Demand

The empirical model of demand is obtained by aggregating a discrete choice model of individual consumer behavior. Each consumer is endowed with preferences over product characteristics, rather than the products themselves (Lancaster (1971)). This solves the dimensionality problem faced in a classical demand system, like that of Deaton and Muellbauer (1980). Individual heterogeneity is modeled in a way that does not restrict substitution patterns a priori, but allows elasticities between products to be driven by how similar the products are in the characteristics space. This not only makes the model more realistic, but also affects subsequent calculations for the merger simulation.

The conditional indirect utility, $u_{ij}(\theta)$, of each consumer $i = 1, ..., I$ for every product $j = 1, ..., J$ is assumed to be a function of observed and unobserved product characteristics, individual characteristics and unknown parameters $\theta = (\theta_1, \theta_2)$. It takes the following form:

$$u_{ij}(\theta) = \delta_j(\theta_1) + \mu_{ij}(\theta_2) + \epsilon_{ij} \equiv V_{ij} + \epsilon_{ij}. \quad (1)$$

[14] Song (2003) documents the shortening of processor life cycles in the late nineties and Genakos (2004) presents evidence of the same phenomenon in the PC market.

[15] For a recent review of the literature on demand models for differentiated products, see Davis (2000).

The first term, δ_j, is the mean utility derived from consuming good j, which is common to all consumers. It is given by

$$\delta_j = x_j\beta - \alpha p_j + \xi_j, \tag{2}$$

where x_j and β are vectors of the observed product characteristics and the associated taste parameters respectively, α is the marginal utility of income, p_j is the price of product j and ξ_j denotes utility derived from characteristics observed by the consumers and the firms, but not the econometrician. Unobserved product characteristics include unquantifiable variables such as firm or brand reputation for reliability, prestige effects or after-sales service quality. Since these characteristics are observed by market participants, they will be correlated with the equilibrium prices making the price coefficient biased towards zero. Instrumental variable techniques can not straighforwardly be applied, given that both p_j and ξ_j enter the market share equation in a nonlinear way. Berry (1994) develops a general method that allows the use of instrumental variables to a large class of discrete choice models.

The second term in (1), μ_{ij}, represents a deviation from the mean utility. This is individual specific and can be written as

$$\mu_{ij} = \sum_k \sigma_k x_{jk} \nu_{ik} + \sigma_p p_j \nu_{ip} \tag{3}$$

where x_{jk} is the kth characteristic of product j, for $k = 1, ..., K$ and σ_k, σ_p are unknown coefficients. The vector $\nu_i = (\nu_{i1}, ..., \nu_{iK}, \nu_{ip})$ represents each consumer's $K + 1$ idiosyncratic tastes for the K observed characteristics and the associated price. It is drawn from a multivariate normal distribution with zero mean and an identity covariance matrix.[16] Finally, ϵ_{ij} denotes shocks that are identically and independently distributed across products and consumers with a Type I extreme value distribution.[17] Notice that μ_{ij} depends on the interaction of consumer specific preferences and product characteristics. More precisely, each consumer i derives $(\beta_k + \sigma_k \nu_{ik})\, x_k$ utility from every kth product characteristic. BLP show that allowing for substitution patterns to depend on consumer's heterogeneous tastes (i.e. $\mu_{ij} \neq 0$) is crucial for realistic demand elasticities.[18] For example, consumers who attach a higher utility to laptop computers would more likely substitute towards other laptops rather than desktops.

[16] The choice of this distribution is ad hoc. Although the multivariate normal is the most popular choice (e.g., BLP; Nevo, 2000a, 2001), other possibilities have also been explored (e.g., Petrin, 2002). There is no evidence that the choice of this assumption affects the estimated coefficients in any fundamental way.

[17] While this particular assumption facilitates estimation by insuring nonzero purchase probabilities and smooth derivatives for the market share equation, it has recently been criticized. Petrin (2002), for example, shows that welfare changes from the introduction of new products are overstated due to the presence of this idiosyncatic error term. Alternative models, like the probit model of Goolsbee and Petrin (2004), are prohibited for the current application given the large number of products in each period. Finally, recent work by Berry and Pakes (2002) and Bajari and Benkard (2004) that remove the logit error entirely, although promising, is still under development.

[18] When μ_{ij} is zero, the only source of heterogeneity among consumers is based on the i.i.d. ϵ_{ij}'s. In terms of elasticities, that implies that all the consumers have the same expected ranking over products. In other words, consumers would substitute more towards the most popular products independently of their characteristics and the characteristics of the products they bought previously.

Introducing an "outside good" completes the demand specification. Consumers are allowed to not purchase any of the personal computers offered by these firms. Otherwise, a uniform price increase would not change the quantities purchased. The indirect utility of the outside option is

$$u_{i0} = \xi_0 + \sigma_0 \nu_{i0} + \epsilon_{i0}. \tag{4}$$

where the price of the outside good is normalized to zero. Since relative levels of utility cannot be identified, the mean utility of one good has to be normalized to zero. As is customary, I normalize ξ_0 to zero. The term ν_{i0} accounts for the outside alternatives' unobserved variance. It implies that a random coefficient exists on the constant term for the inside goods' utility.

Each consumer is assumed to purchase one good per period[19] from the available choice set, which provides him with the highest utility. Given the assumption on the distribution of ϵ_{ij}, the probability that consumer i purchases good j is given by the multinomial logit choice probability (McFadden, 1973)

$$\Pr(j \mid x, i) = \frac{\exp\left(\delta_j + \sum_{k=1}^{K} \sigma_k x_{jk} \nu_{ik} + \sigma_p p_j \nu_{ip}\right)}{1 + \sum_{j=1}^{J} \exp\left(\delta_j + \sum_{k=1}^{K} \sigma_k x_{jk} \nu_{ik} + \sigma_p p_j \nu_{ip}\right)} \tag{5}$$

Market shares for each product, s_j, are obtained by aggregating over consumers and their vectors of unobservable tastes. This integral is solved numerically via aggregation by simulation, using a technique introduced by Pakes (1986).

3.2 Supply and equilibrium

The supply side is structured in a way that approximates competition in the PC market. Each of the F multiproduct firms has a portfolio, Γ_f, of the $j = 1, ..., J$ different products in the PC market. The profit function of firm f can be expressed as

$$\Pi_f = \sum_{j \in \Gamma_f} (p_j - mc_j) \, M s_j(p), \tag{6}$$

where $s_j(p)$ is the predicted market share of brand j, which depends on the prices of all other brands, M is the market size and mc_j is the constant marginal cost of production. Assuming that there exists a pure-strategy Bertrand-Nash equilibrium in prices[20] and that

[19] Although this assumption seems reasonable for home or small business users, it might not be applicable to the large business segment. Hendell (1999), for example, observes PC purchases of large firms and models explicitly the choice of multiple products. However, without more dissagregate information his techniques cannot be applied to the current data. Hence, if this phenomenon is widespread this model can be seen as a first approximation to the true choice model.

[20] Caplin and Nalebuff (1991) have shown that a pure strategy Nash equilibrium exists under fairly general conditions, assuming single product firms. There are no theoretical papers that generalize their results for multiproduct firms. I follow the empirical literature and assume its existence and uniqueness.

all prices that support it are strictly positive, then the price p_j of any product produced by firm f must satisfy the first-order condition

$$s_j(p) + \sum_{r \in \Gamma_f} (p_r - mc_r) \frac{\partial s_r(p)}{\partial p_j} = 0 \tag{7}$$

This system of J equations can be inverted to solve for the marginal costs. Define $S_{jr} = -\partial s_j(p)/\partial p_r$, $j, r = 1, ..., J$,

$$\Omega^*_{jr} = \begin{cases} 1, & \text{if } j \text{ and } r \text{ are produced by the same firm,} \\ 0, & \text{otherwise,} \end{cases}$$

and Ω a $J \times J$ matrix with $\Omega_{jr} = \Omega^*_{jr} * S_{jr}$. Then, given the product ownership structure before the merger (Ω^{bm}), marginal costs (in vector notation) are given by

$$mc = p - \Omega^{bm}(p)^{-1} s(p). \tag{8}$$

The markup vector in (8) depends only on the parameters of the demand system and the equilibrium price vector. Therefore, by using the estimated demand parameters we can compute estimates of price-cost margins and marginal costs without using actual cost information. These calculations are based upon the demand coefficients' consistency and the equilibrium assumption. For the merger simulation, I use the same equilibrium assumption and the new (after merger) industry structure matrix Ω^{am}. The postmerger equilibrium price vector, p^*, solves

$$p^* = \widehat{mc} + \Omega^{am}(p^*)^{-1} s(p^*), \tag{9}$$

where $\widehat{mc}$ are the estimated marginal costs, based on the demand coefficients and the premerger ownership structure of the industry.

The estimated postmerger prices rely on several assumptions: First, the equilibrium assumption remains the same before and after the merger. While, this needs to be questioned for every possible merger, there are no reasons to doubt its validity for the HP-Compaq merger. Second, the marginal costs and the number of products are held constant at their premerger level. However, this framework allows me to quantify claims that a merger will have cost efficiencies. As a counterfactual exercise, I calculate the necessary cost efficiencies that would leave the postmerger equilibrium prices unchanged and assess their plausibility. Third, the postmerger elasticities are calculated based on premerger data, which implicity assumes that consumer preferences and the outside good's value remain constant after the merger. This assumption can be challenged since changes in firms' strategy within the industry or changes outside the industry could affect both the price sensitivity and the overall PC demand. Therefore, this analysis is more indicative of the short rather than the long run response to the merger.

3.3 Consumer Welfare

The structural model's results are also used to calculate consumer welfare changes due to the merger. I use compensating variation to calculate the dollar amount that would leave a consumer indifferent before and after the merger. Assuming that the marginal utility of income is fixed, McFadden (1981) and Small and Rosen (1981) show that the compensating variation of individual i is given by

$$CV_i = \frac{\ln\left[\sum_{j=0}^{J} \exp\left(V_{ij}^{am}\right)\right] - \ln\left[\sum_{j=0}^{J} \exp\left(V_{ij}^{bm}\right)\right]}{\alpha_i} \tag{10}$$

where $\alpha_i = \alpha + \sigma_p \nu_{ip}$ is the price coefficient for each individual and V_{ij}^{bm} and V_{ij}^{am}, as defined in (1), are computed using the premerger prices and postmerger predicted prices, respectively. Aggregating over i and multiplying by the market size gives the mean compensating variation. These calculations assume that both the value of the each product's unobserved characteristic, ξ_j, and the utility from the outside good remain constant after the merger.

4 Data and Estimation

4.1 Data

The personal computer tracker (PC Tracker) is an industry census conducted by the International Data Corporation (IDC). The PC Tracker gathers information from the major vendors, component manufacturers and various channel distributors.[21] It is one of the best available datasources for the PC industry.[22] I use quarterly information on quantities and prices from 1995Q1 to 2001Q2 (i.e. just before the HP-Compaq merger announcement). I concentrate on the top nine producers in the US market to match each observation with more detailed product characteristics.[23] The unit of observation is defined as a manufacturer (e.g. Dell), brand (e.g. Optiplex), form factor (e.g. desktop), processor type (e.g. Pentium II) and processor speed (e.g. 266 MHZ) combination. More detailed information on the data construction can be found in the Appendix.

This dataset also provides unique information on the PC buyers' identity at an aggregate level, distinguishing among the following segments: small office, small, medium and large business, government, education and home.[24] This allows me to examine the Euro-

[21] IDC claims that it covers more than 80% of the US market.

[22] Various datasets from the IDC have been used both in economics (Foncel and Ivaldi, 2001; Van Reenen, 2003; Pakes, 2003) and in management (Bayus, 1998; Bayus and Putsis, 1999, 2001).

[23] These manufacturers are: Acer, Compaq, Dell, Gateway, Hewlett-Packard, IBM, NEC, Sony and Toshiba. Apple is excluded because IDC records its processors in a way that I was unable to match more detail characteristics.

[24] According to IDC definitions a small office is a non-residential business site with less than 10 employees. A small business is a business site with 10 to 99 employees, medium business with 100 to 499 employees and large business with 500 or more employees. The government includes city, county, state, provincial, regional, military and federal governmental agencies. Education covers institutions such as K-12, colleges, universities and trade schools. Finally, the home segment includes all home purchases, regardless of usage (home office, work-at-home or consumer applications).

pean Competition Commission's claim that the various customer segments have different purchasing patterns and whether the merger would affect certain segments differentially. Hence, in my analysis I estimate the demand model both for the whole market and for each of the three following segments: home, small business (including the small business, small office and medium business segments)[25] and large business. These three segments account for the majority (average 89%) of all PC sales. The largest is the home segment (37%), followed by the small business (34%) and then the large business (17%).[26]

Despite the large number of small producers, the PC industry is rather concentrated with the top five firms accounting for 52% and the top ten firms for 72% of the aggregate sales. *Table 1* presents the average percentage shares of the nine firms included in the sample. They account for 65% of total sales, 60% and 65% for the home and small business segments respectively, reaching 80% for the large business segment. *Tables 2–5* provide sales weighted means of the variables used in the specifications, both for the overall market and different segments. These variables include quantity (in units of 1,000), price (in $1,000 units), "benchmark" (in units of 1,000), RAM (in units of 100MB), monitor size and dummies for CD-ROM (1 if standard, 0 otherwise), internet (1 if modem or ethernet included as standard, 0 otherwise) and desktop. The variable choice is based on two criteria: first, to capture technological innovation (i.e. the "benchmark" and RAM) and trends in related markets (i.e. the modem/ethernet for internet and CD-ROM for multimedia). Second, to be relevant both for the overall market and for the three individual segments.

These tables reveal the remarkable pace of innovation and competition in this industry. The quantity of products rises from 88 in 1995Q1 to 277 in 2001Q2, along an upward trend. The core computer characteristics, "benchmark" and RAM, follow an amazing average quarterly growth of 13% and 11% respectively. New components at the start of the sample period, such as the CD-ROM and internet peripherals, that are installed in 68% and 51% of new PCs respectively, diffuse quickly and are virtually standard by the end of the sample period. Even more spectacularly, this fast technological progress is accompanied by rapidly falling prices. In real terms, the sales-weighted average price of PCs fell by 45% in the late ninenties.[27] This combination of forces allowed portable computers to become affordable for more consumers, which can be seen by the negative trend of the desktop market share. Finally, the tables reveal some interesting differences among the various segments. Large businesses, for example, buy more expensive PCs on average, with better core characteristics and a stronger preference for portable computers. They are slightly behind, however, in adopting peripherals.

[25] I calculate aggregate elasticities for each of these segments based on IV logit regressions. Small office, small business and medium business have very similar elasticities and for that reason, I combine them in a single segment. I also experimented separating the medium business segment from the combined small office-small business segment. Results from either the IV logit or the random coefficients model confirmed their similarity.

[26] I exclude the government and education segments both because of their small market share and because I could not find reliable information regading their market sizes.

[27] There is an extensive empirical literature using hedonic regressions that documents the dramatic declines in the quality adjusted price of personal computers. See, for example, Dulberger (1989), Gordon (1989), Triplett (1989), Berndt, Griliches and Rappaport (1995) and Pakes (2003).

4.2 Estimation

Demand model estimation closely follows Berry (1994) and BLP. The algorithm minimizes a nonlinear GMM function that is the product of instrumental variables and a structural error term. This error term is defined as the unobserved product characteristics, ξ_j, that enter the mean utility. In order to compute these unobserved characteristics, I solve for the mean utility levels, δ, by solving the implicit system of equations

$$s\left(x, p, \delta; \theta_2\right) = S \tag{11}$$

where $s\left(.\right)$ is the vector of calculated market shares and S is the vector of observed market shares. This finds the vector δ, given the nonlinear parameters θ_2, that matches the predicted to the observed market shares. Berry (1994) shows that this vector exists and is unique under mild regularity conditions on the distribution of consumer tastes. It is numerically calculated using BLP's contraction mapping algorithm. Once this inversion has been computed, the error term is calculated as $\xi_j = \delta_j\left(x, p, S; \theta_2\right) - \left(x_j\beta + \alpha p_j\right)$.

Given a set of instruments, $Z = [z_1, ..., z_M]$, a population moment condition can be written as $E[Z'\xi(\theta^*)] = 0$, where $\xi(\theta^*)$ is the above defined structural error term evaluated at the true value parameters. Then, following Hansen (1982), an optimal GMM estimator takes the form

$$\widehat{\theta} = \arg\min_{\theta} \widehat{\xi}(\theta)' Z A^{-1} Z' \widehat{\xi}(\theta), \tag{12}$$

where $\widehat{\xi}(\cdot)$ is the sample analog to $\xi\left(\cdot\right)$ and A is a consistent estimate of the $E\left[Z'\xi\xi'Z\right]$.

The intuition behind this procedure is straighforward. The structural residuals, defined above, are the difference between the mean utility and that predicted by the linear parameters, $\theta_1 = (\alpha, \beta)$. The GMM estimator serves to minimize this difference. At the true parameter value θ^*, the population moment condition is equal to zero, so the estimates would set the sample analog of the moments, i.e. $Z'\widehat{\xi}$, equal to zero. If there are more independent moment equations than parameters, the sample analogs can not be set exactly to zero, but as close to zero as possible. By using the inverse of the variance-covariance matrix of the moments, less weight is given to those moments with higher variance. I calculate the weight matrix using the usual two-step procedure, starting with an initial matrix given by $Z'Z$. To minimize the GMM function I used both the Nelder-Mead nonderivative search method and the faster Quasi-Newton gradient method based on an analytic gradient.[28]

Finally, using the results in Berry, Linton and Pakes (2004), I increased the number of simulation draws (more than ten times larger than the average number of products in my sample) to obtain consistent and asymptotically normal estimators for the parameters. I compute standard errors for the estimates using the asymptotic variance of $\sqrt{n}\left(\widehat{\theta} - \theta^*\right)$ given by

$$\left(\Gamma'\Gamma\right)^{-1}\Gamma'\left(\sum_{i=1}^{3} V_i\right)\Gamma\left(\Gamma'\Gamma\right)^{-1} \tag{13}$$

[28] For more details see the appendix in Nevo (2000b).

where Γ is the gradient of the moments with respect to the parameters, evaluated at the true parameter values and approximated by its sampling analog. Three possible sources of variance include: the process generating the product characteristics, V_1, the consumer sampling process, V_2, and the simulation process, V_3. V_1 is given by the variance of the moment conditions and approximated using its sampling analog. V_2 is assumed to be negligible given that the sample size is the US household population. Finally, to account for the variance introduced by the simulation, I calculate V_3 by bootstrapping fifty times the moment conditions to obtain an estimate of their variance across different sets of simulation draws. As a result of the large number of initial draws, the error due to simulation is minimal.[29]

4.3 Instruments

Identification of the population moment condition in (12) is based on an assumption and a vector of instrumental variables. I assume that the unobserved product level errors are uncorrelated with the observed product characteristics. In other words, that the location of products in the characteristics space is exogenous.[30] This is actually close to reality since most R&D and most components built in PCs are produced by other firms, not the PC manufacturers.

With respect to the instrumental variables, I experimented with various types that have been suggested in recent literature. First, in the spirit of Hausman, Leonard and Zona (1994), Hausman (1996), Nevo (2000a, 2001) and Hausman and Leonard (2002), I used prices of the same PC models in Canada[31] as instruments for US prices. Their proximity and close trade relationships, implies that Canadian PC prices have the same cost components as US PC prices and only demand factors would be different. Moreover, such an instrument could be partially immune to the Bresnahan (1996) critique, since aggregate shocks (such as a national advertising campaigns) that affect the US demand would be uncorrelated with the Canadian demand. The disadvantage of this instrument, however, is the small cross-sectional variation (i.e. only one instrument for each price).

The second set of instruments directly follows the BLP approach. They used the sum of the same observed characteristics of own-firm products and that of competing firms. Given the previous exogeneity assumption, characteristics of other products will be correlated with price, since the markup for each model will depend on the distance from its nearest competitors. These instruments have been used successfully to study many industries.

Lastly, I modify the previous instruments in the spirit of Bresnahan, Stern and Trajtenberg (1997). They used as instruments functions of the observed characteristics,

[29] I do not correct for correlation in the distrurbances of a given model across time for two reasons: First, because firm and processor generation fixed effects are included in the estimation. Second, because there is a high turnover of products. The average PC life in my data is three quarters (see also Pakes, 2003, p. 1586).

[30] Endogenizing each firm's decision of which products to produce conditional on its beliefs about what other firms will produce and the state of future demand in a multidimensional differentiated products oligopoly is still an open research question and beyond the scope of this paper.

[31] Given that I examine only these top nine manufacturers, I was able to match each model with the same model sold in Canada over the same period. The dataset on the Canadian models and prices is also from the IDC. The prices were deflated using the Canadian price index.

segmented according to their proposed clustering of the PC market during the late eighties. My modification is simpler and closer to the competitive enviroment during the late nineties: I calculate the sum of the observed characteristics of products offered by each firm and its rivals, conditional on the form factor of each computer. The intuition underlying this modification is that the price of a desktop PC would be more constrained by the proximity of other desktops rather than a laptop, given their fundamental differences in functionality and technical characteristics.

5 Results

I turn now on the results from the demand estimation and their implications in terms of markups and profit margins. I then assess the robustness of the specification used to various pertrubations. Next, I simulate the effects of the HP-Compaq merger and a second, hypothetical, merger between Dell and Compaq. I analyze the mergers' effects not only for the whole market, but also for the three customer segments individually. The choice of the second merger is intended to demonstrate the variation in the differential segment effects.

5.1 Demand Estimates

I use the logit model (i.e. $\mu_{ij} = 0$) to examine the importance of instrumenting the price and test the different sets of instrumental variables. *Table 6* reports the results obtained from regressing $\ln(S_j) - \ln(S_0)$ on prices, characteristics and time fixed effect variables. Columns 1 and 2 report ordinary least squares results. While column 2's firm fixed effects inclusion is an improvement on column 1 (both the price coefficient and the model fit increase), the majority of products are predicted to have inelastic demands (88.4% for column 1 and 58.4% for column 2). This clearly counters reality.

To correct for the price endogeneity, I experiment with different instrumental variables in the last five columns. In column 3, I use Canadian prices of the same models. The price coefficient increases, as expected, but almost a quarter of all the products still have inelastic demand. Columns 4 and 5 use the BLP instruments and my modified instruments respectively, in conjuction with Canadian prices. Both the price coefficient and the proportion of inelastic demands remain unaffected. When I use only the BLP instruments in column 6, the coefficient on price rises significantly (leaving only 16.45% of products with inelastic demands), but fails to correct for the negative RAM coefficent (implying that, *ceteris paribus*, consumers prefer lower to higher RAM) and the positive desktop dummy coefficient (implying that, *ceteris paribus*, consumers prefer a desktop to a laptop). Moreover, the Hansen-Sargan overidentification test is rejected, suggesting that the identifying assumptions are not valid.

The modified instruments alone seem to control the endogenous prices more effectively, as seen from the last column. The price coefficient rises further, leaving no products with inelastic demands. Moreover, the test of overidentified restrictions cannot be rejected at the 1% level of significance, despite the large number of observations. All other coefficients are statistically significant with their expected signs. The "benchmark" is valued more highly than RAM and the CD-ROM availability more highly than internet peripherals.

The desktop dummy indicates that consumers attach greater value to laptop computers. The only surprising result is the small negative coefficient for monitor size.[32] Finally, the processor generation dummies[33] indicate that each new CPU generation contributes significantly over the fourth generation, with the sixth generation contributing most. This is probably due to the significant improvements to PC hardware and software during the sixth generation and the relatively short period since the introduction of the seventh generation (the first model appears in 2000Q1). Similar results regarding the instrumental variable validity hold for each of the three market segments, but for brevity are not reported here.

Table 7 reports the random coefficient model results for the whole market. Column 1 replicates column 7 from the previous table to ease comparisons. Due to the difficulty of the full model estimation and uniqueness of the PC market, a parsimonious list of random coefficients has been selected. As Bresnahan, Stern and Trajtenberg (1997) suggested, because of the modularity of personal computers and the ease with which consumers can re-configure their machines, not all characteristics carry the same weight. For example, consumers might choose a computer without a modem or CD-ROM as standard, not because they do not value it, but because they can buy it later and possibly arbitrage any price differences. To the extent that consumers can easily re-configure PCs, I would not be able to capture consumers heterogeneous preferences along these dimensions. Hence, I focus here on random coefficents for the "benchmark" and desktop variables. These are essential characteristics for every computer and cannot be altered as easily as other core characteristics (such as RAM or hard disk) or peripherals (such as the modem or CD-ROM).

Full model results are in column 2. The random coefficients are identified by observing multiple markets with different distributions of the observed characteristics. Although the sample period is short (only six and a half years), the pace of the PC industry's evolution provides confidence that I can identify these parameters. For the whole market, three out of four coefficients have Z-statistics greater than one. For the segment estimations (*Table 10*), this is eight out of twelve. Moreover, each characteristic is estimated to have a significantly positive effect either on the mean or standard deviation of the taste distribution, with the constant the only exception. The magnitudes of the standard deviations relative to their means suggest that there is significant heterogeneity on price and on the preferences for desktop computers. Most of the remaining coefficients retain their signs and significance, as in the IV regressions.

The advantage of using the random coefficients model stems from the more realistic substitution patterns among PCs, which is important for the merger simulation. A small sample of those elasticities is given in *Table 8*. In the top panel I present five models marketed by Acer in the first quarter of 1995 along with their main characteristics. Markups (in the last column) rise almost monotonically with price. This is in contrast to the logit

[32] This most likely stems from the introduction of more advanced and thinner monitors of the same size in the last 2-3 years of the data. These are not recorded separately.

[33] In dynamic markets with frequent changes in the processor's underlying technology, such as the PC market, competition among products of the same CPU generation differs significantly from competition with products of other generations. Applications of this idea in a standard hedonic framework can be found in Pakes (2003) and Chwelos, Berndt and Cockburn (2004), where they use indicator variables for CPU generations to estimate "piece-wise" stable coefficients for the PC characteristics.

model, which would predict a higher markup for the lower priced model. The bottom panel reports, semi-elasticities (percentage change in market share for model i from a \$500 change in the price of j) of these five models from the random coefficents and IV logit models. Most fundamentally, cross price elasticities are now driven by how close models are in the characteristics space, rather than being equal as in the logit model.

One way to test the overall model implications is to compare the estimated percentage profit margins with observed values. Most of these multiproduct firms do not report separate accounting measures for their PC operations. Even if they did, however, accounting estimates of profit margins are known to be problematic.[34] For that reason, I rely on two surveys from the *Financial Times* that put gross profit margins of the top PC manufacturers at 20% in 1996 and 10% in 1998.[35] *Table 9* summarizes the estimated markups and margins for the different models. Markups derived from the OLS regression are too high and imply that most brands have negative marginal costs. The IV regression results predict a median markup of 19 percent, reaching 33 percent at the 90th percentile. However, profit margins are more realistic in the random coefficients model. The median is 13.4 percent ranging well within the reported values from 10.36 in the 10th percentile to 18.75 in the 90th percentile.[36]

Table 10 reports the demand analysis broken down by segments. The first three columns contain results for the home segment, the next three for the small business segment and the final three for the large business segment. Turning to the home segment first, a qualitatively similar pattern of results emerges to that for the whole market. The coefficient on price is biased towards zero in OLS (column (1)) compared to the IV logit in column (2) by a large factor. This is true across all three segments. There is also evidence in columns (3), (6) and (9) of random coefficients on price and key characteristics that are significantly different from zero, leading Wald tests to reject OLS and IV regressions in favour of the more flexible model.

There is substantial variation in the estimated coefficients between the three segments. Businesses seem to consistently have price coefficients closer to zero (i.e. less elastic demands) than households, whatever estimation method is used. The degree of heterogeneity in the price coefficient also seems greater among large businesses (1.79) than small businesses (1.04) and households (0.88). Furthermore, businesses seem to place a higher mean valuation on quality than do households (e.g. in the random coefficients specification the mean value of "benchmark" is over 2 for large and small businesses and under 1.4 for home).

The differences among the segments, however, become more meaningful, when looking at the aggregate demand elasticities. Using the standard method of simulating a 1%

[34] See, for example, Fisher and McGowan (1983).

[35] "When profits switch off-line from performance: Despite record sales, PC manufacturers are struggling on slim margins", *Financial Times* (10/2/1996). "The world PC market: Big name suppliers tighten their grip", *Financial Times* (4/3/1998).

[36] My estimates fall between the other two papers that estimate a structural demand model for the PC industry. Foncel and Ivaldi (2001), using quarterly data from IDC (without the additional product characteristics) for the home segment from various industrialized countries during the period 1995-1999, estimate a nested logit model and report a mean margin of 2.7% for the US in 1999. Goeree (2004) using quarterly data from Gartner for the US home segment between 1996-1998 reports a median margin of 19% from her preferred model (see the discussion in the sensitivity analysis). Based on my estimates, the mean and median margins for the home segment are 12.6 and 11.5 percent respectively.

increase in the price of all models, I calculate aggregate elasticities for the whole market and the three segments in *Table 11*. The upper panel presents the mean elasticities and the lower panel the median elasticities from the IV logit and random coefficients model. Demand is overall more inelastic based on the random coefficients model results. This is due to random coefficients' more flexible substitution patterns both for the inside products and the outside good. A very consistent pattern of results emerges from both methods, however: the home segment has the most elastic demand and the large business segment the least elastic. For the random coefficients model the difference is about 1.8 to 1, whereas for the IV logit it is 2.5 to 1. The small business' elasticity falls somewhere in between the other two segments. This heterogeneity validates the European Competition Commission's view about the differences between home and business buyers. It also indicates that personal computers were a necessity for businesses in the late nineties. The rapid diffusion of the internet together with developments in software and peripherals made the PC an indispensable part of business life. In contast, households responded more slowly to these changes and started to mimic businesses buying behaviour only when PC prices had fallen dramatically. These findings have direct implications of the merger's effects on different segments.

5.2 Sensitivity Analysis

Table 12 presents the estimated markups and margins as a way to summarize the implications from three alternative specifications. In the first two columns, I replace the RAM with the hard disk variable, leaving everything else unchanged. These variables (together with speed) followed the same upward trend and so are highly collinear. Substituting between the two characteristics hardly changes the previous results, with the mean and median margin slightly lower at 13 and 12.4 percent respectively.

The second specification relates to Goeree's (2004) model. She estimates a structural model of PC demand for the US home segment using various data sources that cover the top 10 manufacturers between 1996-98. She argues that due to the large number of models, consumers have limited information with respect to available products. Therefore, she emphasizes that models assuming full consumer awareness will generate inconsistent estimates of product specific demand curves that are biased towards being too elastic. She provides different predictions for the median profit margin across firms, with her preferred specification at 19% and a baseline random coefficients model at 5%.

Three comments are in order. First, compared to the market reality and given that the home segment is more elastic than the other two segments, a 19% median margin is more likely an upper bound. It is definitely not more realistic than the profit margin distribution for the whole market described previously. Second, Goeree uses a sophisticated methodology, incorporating aggregate advertising information into an individual maximisation framework. Her dataset, however, contains a restricted number of observable PC characteristics,[37] making the explanatory variables insufficient to capture the observed variation in market shares. That leaves a lot of variability for the advertising variables to explain. Third, it is not clear how her instrumental variables perform in overidentification

[37] She does not use information related to the different processors, nor does she account for the different CPU generations. Moreover, she lacks information on other core characteristics (such as RAM or hard disk) and on important peripherals (like CD-ROM, monitor size, modem etc).

tests and how they change in each model specification.

I lack the advertising data to test for Goeree's "limited information" story. Columns 3 and 4 of *Table 12*, however, present results from a specification similar to her baseline random coefficients model.[38] The limited set of explanatory variables produced a higher value for product's unobserved characteristics, ξ_j, and a higher aggregate elasticity, which translated to lower estimated margins. The profit margin distribution, however, is close to that obtained from my baseline model, even though parameter identification is worse (only one in four random coefficients was significant). Therefore, this questions whether Goeree's model, despite its methodological contribution, provides any significant improvement over a basic random coefficients model in terms of bringing the estimated profit margins closer to reality.

The last specification of the table addresses recent criticism by Ackerberg and Rysman (2004). They point out that standard discrete choice models (logit, nested logit, random coefficients logit etc) assume that one extra dimension is added to the "symmetric unobserved product differentiation" (SUPD) space with each new product in the market. They argue, however, that in markets with more products, the unobserved characteristic space should "fill up" in some sense and that standard models place strong restrictions on how this occurs. Their calibration and empirical evidence suggest that failure to correct for this lack of crowding, results in under-predicting elasticities and over-predicting gains from new products. They propose ways to make standard models more flexible, by introducing different functions of the number of products into the discrete choice estimating equation.

In columns 5 and 6, I follow one of their proposed modifications and include the logarithm of the number of products in the market as an additional exogenous variable (their "additive model") to my baseline model. The additional coefficient is negative and significant in the basic IV logit, but insignificant in the random coefficients model. More importantly, the mean (17.3%) and median (16.3%) margins are slightly higher, implying a more inelastic aggregate demand than the baseline model. Consequently, there is no evidence that my baseline model under-predicts elasticities.

Note that Ackerberg and Rysman base their proposed correction on the assumption that the unobserved characteristics space remains constant as the number of products in the market changes. I believe that this assumption does not hold for the PC market in the late nineties for two reasons: First, the increased variety in observed core characteristics and the improved modularity offered by PC manufacturers meant that computers were differentiated along important dimensions. This differentiation was valuable to consumers because they could find more easily a PC to match their preferences. Second, the continuous development of processors and the technological innovations in peripherals introduced differentiation along new dimensions. Hence, even though Ackerberg and Rysman's critisism remains useful, their proposed modification needs to be assessed at every application.

[38] Observable characteristics include: price, speed, Pentium dummy, Desktop dummy, firm and time fixed effects and random coefficients on the first four variables. As instruments I used my modified IVs, based on speed, number of rival models and number of models with a Pentium processor.

5.3 Merger Analysis

Using the structural demand parameters and the estimated marginal costs, I simulate the postmerger equilibrium for the whole PC market. The upper panel of *Table 13* presents price and quantity changes[39] both for the merger between HP and Compaq and the hypothetical merger between Dell and Compaq, at three different periods. In line with theoretical research on unilateral effects, both mergers result in higher prices for all products in the market, smaller sales for the merging entity and larger sales for the non-merging firms. Note also that any merger would raise prices more in 2001 than in 1998 or 1995. In the HP-Compaq case, for example, the mean percentage price increase would be 0.58 in the first period, 1.00 in the second and 1.11 in the third. The same effect across time is also true for the hypothetical merger between Dell and Compaq, with overall higher induced mean price increases, reaching 1.87 percent in 2001.

The effect of a merger on prices is a combination of the relevant strategic position of the firms involved (portfolio of products, degree of differentiation and market power) and the aggregate demand elasticity. The impact on prices is higher in the second merger, because the joint market power of Dell and Compaq is higher than that of HP and Compaq at any point in time. Both mergers, however, raise prices more in 2001 than in 1995, because aggregate PC demand had become more inelastic. During the last decade, the personal computer developed from an awkward and unfriendly tool for specialists into an indispensable part of every day life. The HP-Compaq merger would have caused less concern, in terms of its effect on competition and consumer welfare, at the beggining rather than at the end of the sample. Therefore, examining the differential effects of a merger at various points in time, provides competition authorities with a sense of the market dynamics that can be useful for any merger evaluation.

The equilibrium price and quantity changes assume that (marginal) cost conditions remain the same before and after the merger. However, firms often advocate, both to their shareholders and competition authorities, that cost efficiencies can be achieved after the merger. Since it is difficult to predict the actual cost reductions, the lower panel of *Table 13* presents statistics on the following counterfactual: what would be the necessary cost reductions such that the merger would have no effect on prices? For the HP-Compaq merger in 2001, for example, the average required cost efficiency is 1.5 percent with the maximum being 6.3 percent. Both are realistic. In fact, Ms C. Fiorina, the CEO of HP, targeted an overall 5-7 percent cost reduction.[40]

The hypothetical merger between Dell and Compaq in 2001 would need a much higher level of cost savings (2.5 percent on average, with a maximum of 10.3). The emerging picture is similar: larger cost decreases would be required over time to offset any postmerger price increases. These results are complementary to those on prices and quantities and provide another perspective on which a merger can be assessed.

The price and quantity results, although indicative, do not provide any criteria on

[39] It is worth noting, as Berry and Pakes (1993) mention, that the random coefficient model is flexible enough that even though a price setting behavior is assumed, pairs of prices are allowed to act as strategic complements or as strategic substitutes. In other words, what I find is that when a merger raises the prices of the merging firms, prices of the rivals went either way (although the majority of them, and hence the mean and median, were positive).

[40] "HP lays the ground for $3bn savings", *Financial Times* (5/6/2002). "HP to hit cost cuts target a year early", *Financial Times* (4/12/2002).

which to judge the magnitude of these effects. A structural model, however, can translate these price movements into consumer welfare changes. *Table 14* provides changes in the consumer surplus, firm's revenues and profits as a result of the various mergers. Still focusing on 2001, two results regarding the HP-Compaq merger stand out: First, the merger raises their combined profitability ($1.86 million), despite a fall in revenues. Second, the companies that benefit most are Dell (with a $6.15 million increase in profits), Gateway ($2.00 million) and IBM ($1.42 million). That matches reality well, where the merger's critics, such as Mr. Hewlett, insisted that competitors like IBM and Dell stand to gain the most from the merger: "*HP's rivals raised almost no objections to the merger. We are not surprised. We believe Dell, Sun and IBM must be delighted at the prospect of a merger...*".[41] These results provide a clear explanation as to why the major competitors did not complain about the merger: if the merged companies were to raise prices, these firms would benefit the most from such a strategy.

According to the estimates, the 2001 HP-Compaq merger would result in a $1.06 million loss in consumer surplus, but on a positive $11.67 million overall welfare gain. These results are empirical support for the merger approval by both the US Federal Trade Commission and the European Competition Commission. Stiff price competition and the high degree of substitutability among PC manufacturers meant that the merged entity's market power was not a significant threat to competition. Finally, in line with the previous results, a merger between Dell and Compaq would have been more harmful to consumer welfare at any point in time.

Using the predicted postmerger prices for the whole market and the estimated demand parameters for each sector, I calculate the merger effects on each segment separately. *Table 15* summarizes the predicted percentage changes in prices and quantities for the three segments. Due to differences in the underlying demand, the most striking phenomenon is the wide variation on quantity responces among segments. For example, a similar increase in prices from a 1995 merger between HP and Compaq (average percentage increase 0.61 for home, 0.58 for small and 0.55 for large), would have resulted in average percentage quantity decreases of 7.26 for home, 4.61 for small business and 2.53 for large business. The same is true for the Dell-Compaq merger, with amplified results. To a large extent this phenomenon persists over time, indicating the heterogeneity in preferences among the three sectors.

This price and quantity variation becomes more meaningful, when looking at the predicted changes in consumer surplus and firms' variable profits. *Tables 16, 17* and *18* present these results for the home, small business and large business segments respectively. The value of this cross-sectional analysis can be seen most clearly in the HP-Compaq merger in 2001. Although results from the whole market indicated that the combined firm's profitability would be positive, segment examination draws a more detailed picture: the merger would be unprofitable for the home (-$0.5 million) and the small business (-$0.26 million) segments, with all of the gains coming from the large business segment ($1.80 million). This supports the view that the merger was a "defensive move"[42] targeted directly at the large business segment,[43] rather than an attempt to monopolise the PC

[41] "Titanic failures", *Red Herring* (8/5/2002).

[42] "The HP-Compaq deal, which would consolidate the world's second and third largest PC makers, is thus best seen as a defensive move in a shrinking industry" *The Economist* (29/9/2001).

[43] "Fiorina (CEO of HP) and other HP executives insist that they must sell PCs to compete for lucra-

market. Hence, from the firm's point of view, this cross-sectional analysis provides a more comprehensive picture of the strengths and weaknesses of a possible merger.

Segment analysis is also valuable from a public policy perspective. Consumer loss from the HP-Compaq merger in 2001, for example, is much higher for the home segment than for the other segments. This is not the case for all mergers across time. In the hypothetical Dell-Compaq merger in 1998, the large Business segment has a negative consumer surplus, which is larger than that of the other two segments. Total welfare (consumer plus producer profits), however, is significantly smaller in the home than in the small or large business sectors. Given the size of the PC industry, these effects across segments would probably not change antitrust authorities' overall decision regarding the HP-Compaq merger. In merger cases, however, where households are believed to be more vulnerable than business buyers, knowledge of these differential effects can provide regulators with valuable information on overall merger assessment.

6 Conclusion

Evaluating the effects of a proposed merger has taken centre stage in debates on competition policy. This paper contributes to this debate by examining how information on the purchasing patterns of different customer segments can be used to more accurately evaluate the economic impact of mergers. Using a detailed dataset that covers the leading PC manufacturers in the US during the late nineties, I evaluate the welfare effects of the largest merger in the history of the PC industry, that between Hewlett-Packard and Compaq, along with a second hypothetical merger. I use a flexible structural model to estimate demand both for the whole market and for each of the three segments (home, small business and large business). The postmerger oligopolistic equilibrium is then simulated under various assumptions. The differential welfare implications of these mergers are computed both across time and across segments.

Results from the demand estimation and merger analysis reveal that: (i) the random coefficients model provides a more realistic picture of the market than simpler models. This advances our knowledge for the performance of these models in differentiated oligopolistic markets with a large number of products. (ii) the demand specification is found to be robust to various perturbations. This sample counters recent criticisms that a random coefficient model either over-estimates (Goeree, 2004) or under-estimates (Ackerberg and Rysman, 2004) elasticities. (iii) despite being the world's second and third largest PC manufacturers, the merged HP-Compaq entity would not raise postmerger prices significantly in 2001. Ease of entry, strong price competition and the high degree of substitutability among PCs meant that the merged entity's market power was not significant to threaten competition. (iv) there is considerable heterogeneity in preferences across segments that persists over time, and (v) the merger effects vary significantly across segments.

Although consumer groups with different purchasing patterns have been recognised in other industries as well, this is the first study to systematically integrate them into

tive corporate customers" (*The Boston Globe*, 9/7/2003). Although personal computers provided lower margins, they were perceived as a complimentary good to other products (such as servers or printers) and thus formed an integral part of HP's strategy to compete for large business customers.

a merger analysis. Analysing the differential merger effects by segments has important implications for both firms and competition authorities. In the HP-Compaq case, for example, an attempt from the merged entity to take advantage of its full product line would result in negative profits in the home and small business segments, with more than compensating gains from the large business segment. Hence, this analysis provides firms with a more accurate picture of the merger, which can also be used for strategic purposes. For example, firms can alter their product portfolio after the merger to match the segments' preferences more closely. The HP-Compaq evaluation also reveals that the merger would harm home consumers more than business buyers. The magnitude of consumer losses in this particular case would probably not change regulators' overall decision. In mergers, however, where the welfare impact is stronger and households are believed to be more vulnerable than businesses, knowledge of these differential effects becomes very important for antitrust authorities. More research is required to examine consumer segment heterogeneity and its consequences in other industries as well.

Future research also needs to address other dimensions related to postmerger equilibrium. Firms can affect postmerger competition using a variety of non-price strategies, such as advertising, R&D, new product development and brand life cycles. In addition, a merger can trigger firm entry or exit decisions that can counterbalance changes in concentration. The empirical method used in this paper is not suitable to incorporate such decisions. The dynamic framework of firm behavior developed by Ericson and Pakes (1995) and its applications on mergers (Gowrisankaran and Town, 1997; Gowrisankaran, 1999) provides a basis to incorporate such dimensions and is promising for future research.

7 Appendix - Data Construction

Quarterly data on quantities and prices[44] between 1995Q1 and 2001Q2 was taken from the PC Tracker census conducted by the International Data Corporation's (IDC). The available dataset provided disaggregation by manufacturer, brand name, form factor,[45] chip type (e.g. 5th Generation) and processor speed bandwidth (e.g. 200-300 MHz). However, during the late nineties, there was a surge in the number and variety of new processors, with Intel trying to achieve greater market segmentation by selling a broader range of vertically differentiated processors. In addition, the internet and the proliferation of multimedia meant that PCs were differentiated in a variety of dimensions that would be essential to control for. For that purpose, I concentrated on the top nine manufacturers in the US market (i.e. those who represented the majority of sales and for whom reliable additional information could be collected).

Each observation in the IDC dataset was matched with more detailed product characteristics from various PC magazines.[46] To be consistent with the IDC definition of price,

[44] Prices are defined by the IDC as "the average end-user (street) price paid for a typical system configured with chassis, motherboard, memory, storage, video display and any other components that are part of an "average" configuration for the specific model, vendor, channel or segment". Prices were deflated using the Consumer Price Index from the Bureau of Labor Statistics.

[45] Form factor means whether the PC is a desktop, notebook or ultra portable. The last two categories were merged into one.

[46] The characteristics data was taken from PC magazines (PC Magazine, PC Week, PC World, Computer Retail Week, Byte.com, Computer User, NetworkWorld, Computer World, Computer Reseller

I assign the characteristics of the median model per IDC observation if more than two models were available. The justification for this choice is that I preferred to keep the IDC transaction prices, rather than substitute them with the list prices published in the magazines. An alternative approach followed by Pakes (2003) would be to list all the available products by IDC observation with their prices taken from the magazines and their sales computed by splitting the IDC quantity equally among the observations. While, both approaches adopt ad hoc assumptions, qualitatively the results would be the same. Both list and transaction prices experienced a dramatic fall over this period and the increase in the number and variety of PCs offered would have been even more amplified with the latter approach. Finally, instead of using the seventeen processor type dummies and the speed of each chip as separate characteristics, I merge them using CPU "benchmarks" for each computer. Hence, my final unit of observation is defined as a manufacturer (e.g. Dell), brand (e.g. Optiplex), form factor (e.g. desktop), processor type (e.g. Pentium II), processor speed (e.g. 266 MHZ) combination with additional information on other characteristics such as the RAM, hard disk, modem/ethernet, CD-ROM and monitor size.

The potential market size for the home segment is assumed to be the number of US households (taken from the Current Population Survey). The small and large business market sizes are the total number of employees as reported respectivelly in the Statistics of US Businesses. I performed various robustness checks by reducing the market sizes or by fitting different diffusion curves (not reported here). The results do not change in any fundamental way.

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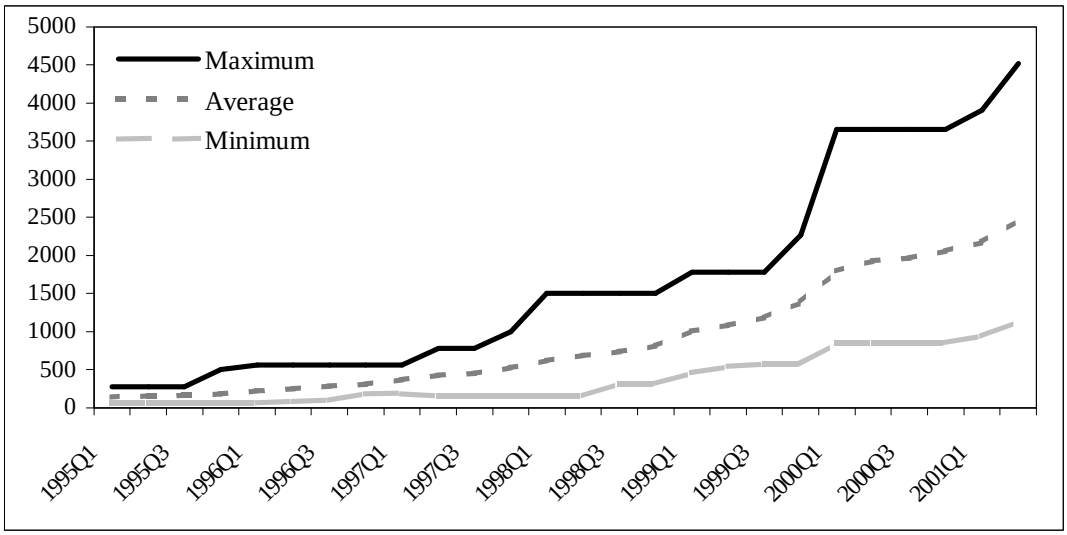
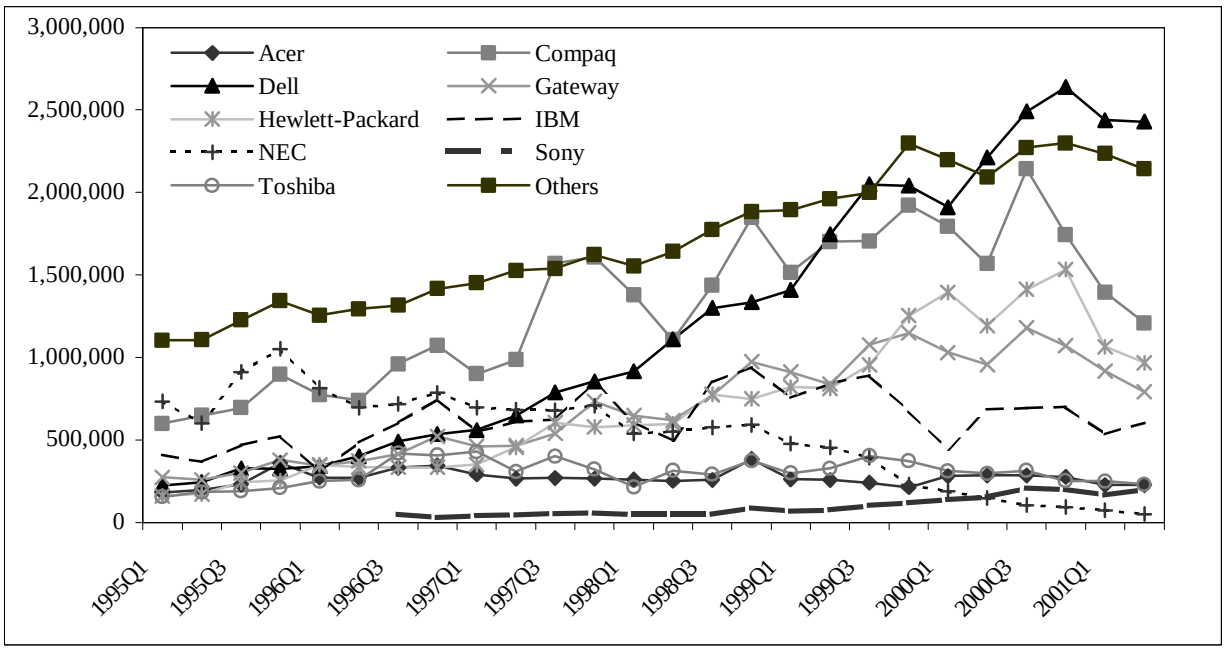
FIGURE 1 - EVOLUTION OF PC QUALITY (CPU BENCHMARK)



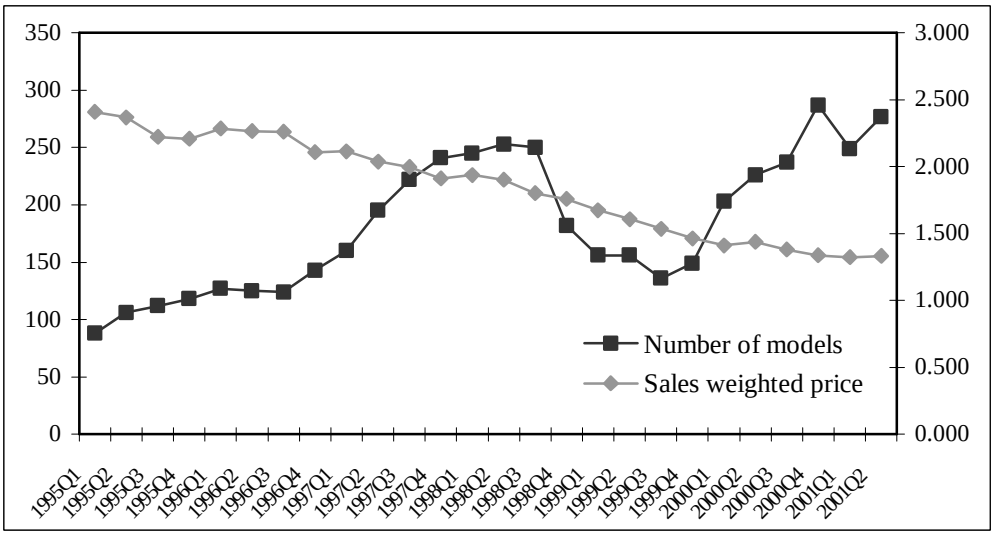
Notes: CPU benchmarks were obtained from The *CPU Scorecard* (www.cpuscorecard.com). They are numbers assigned to each processor-speed combination based on technical and performance characteristics.

FIGURE 2 – MARKET SHARES



Notes: Aggregate sales of PCs in the US market between 1995Q1 and 2001Q2. "Others" is a code given by IDC to small non-branded PC manufacturers.

FIGURE 3 – NUMBER OF PC MODELS AND AVERAGE PRICES



Notes: Number of models (left axis) and average sales-weighted price (right axis) for the top nine PC manufacturers. Prices are deflated using the US Consumer Price Index.

TABLE 1 – SAMPLE MARKET COVERAGE

Firm	Average Percentage Unit Share			
	Whole Market	Home Segment	Small Business Segment	Large Business Segment
Acer	3.31	2.16	5.32	2.89
Compaq	14.75	13.67	13.02	20.51
Dell	12.65	3.96	15.81	22.71
Gateway	7.61	10.52	5.28	3.92
Hewlett-Packard	7.46	9.25	5.84	9.40
IBM	7.37	4.51	9.49	10.80
NEC	7.18	12.98	4.07	3.29
Sony	0.74	1.23	0.67	0.18
Toshiba	3.60	1.46	5.04	5.89
Overall	64.66	59.74	64.53	79.58

Notes: Numbers are average percentage firm market shares during 1995Q1-2001Q2 for the whole market and for each segment.

TABLE 2 – DESCRIPTIVE STATISTICS FOR THE WHOLE MARKET

Period	No. of models	Quantity	Price	Benchmark	RAM	CD-ROM	Internet	Monitor size	Desktop
1995Q1	88	28.701	2.410	0.140	0.103	0.678	0.513	12.050	0.815
1995Q2	106	23.083	2.370	0.155	0.114	0.690	0.516	11.636	0.799
1995Q3	112	27.673	2.222	0.176	0.130	0.784	0.578	12.390	0.839
1995Q4	118	31.433	2.208	0.192	0.133	0.796	0.597	12.212	0.834
1996Q1	127	25.287	2.285	0.221	0.142	0.847	0.604	12.376	0.813
1996Q2	125	26.559	2.264	0.237	0.150	0.879	0.617	12.367	0.791
1996Q3	124	32.358	2.260	0.264	0.158	0.931	0.665	12.930	0.786
1996Q4	143	31.272	2.108	0.293	0.177	0.933	0.670	13.421	0.780
1997Q1	160	24.719	2.116	0.363	0.219	0.931	0.643	12.169	0.773
1997Q2	195	20.984	2.038	0.413	0.245	0.943	0.659	12.069	0.781
1997Q3	222	22.629	1.998	0.476	0.277	0.977	0.711	11.336	0.792
1997Q4	241	22.572	1.912	0.525	0.313	0.962	0.731	11.672	0.816
1998Q1	245	19.502	1.939	0.609	0.375	0.941	0.783	12.189	0.817
1998Q2	253	18.217	1.903	0.708	0.434	0.961	0.749	12.414	0.795
1998Q3	250	22.883	1.801	0.792	0.489	0.968	0.770	12.898	0.802
1998Q4	182	36.279	1.758	0.915	0.600	0.939	0.845	13.313	0.808
1999Q1	156	37.409	1.674	1.051	0.724	0.944	0.812	15.058	0.811
1999Q2	156	39.256	1.607	1.119	0.771	0.931	0.835	15.822	0.790
1999Q3	136	48.581	1.536	1.259	0.857	0.941	0.889	16.083	0.791
1999Q4	149	48.340	1.465	1.447	0.946	0.944	0.879	15.980	0.795
2000Q1	203	33.184	1.411	1.753	0.958	0.982	0.869	14.060	0.797
2000Q2	226	28.448	1.437	1.933	1.018	0.977	0.855	14.234	0.753
2000Q3	237	32.061	1.381	1.995	1.016	0.978	0.875	14.267	0.752
2000Q4	287	26.080	1.337	2.171	1.056	0.978	0.887	14.868	0.775
2000Q1	249	24.715	1.324	2.390	1.103	0.980	0.871	15.069	0.765
2000Q2	277	19.326	1.331	2.725	1.231	0.975	0.886	15.225	0.730
ALL	4767	27.804	1.752	1.114	0.624	0.934	0.777	13.706	0.789

Note: All entries in the last seven columns are sales weighted means.

TABLE 3 – DESCRIPTIVE STATISTICS FOR THE HOME SEGMENT

Period	No. of models	Quantity	Price	Benchmark	RAM	CD-ROM	Modem	Monitor size	Desktop
1995Q1	67	16.206	2.065	0.147	0.105	0.735	0.673	14.139	0.917
1995Q2	78	11.614	1.992	0.161	0.113	0.765	0.681	13.995	0.891
1995Q3	85	15.477	1.916	0.181	0.129	0.859	0.767	14.263	0.927
1995Q4	87	19.069	1.929	0.197	0.134	0.867	0.787	14.196	0.926
1996Q1	76	16.962	2.032	0.223	0.147	0.928	0.842	14.689	0.946
1996Q2	82	12.720	1.996	0.231	0.148	0.929	0.808	14.545	0.920
1996Q3	83	18.474	2.036	0.264	0.160	0.974	0.856	14.635	0.924
1996Q4	92	19.611	1.729	0.291	0.174	0.988	0.892	15.040	0.955
1997Q1	101	15.157	1.747	0.364	0.228	0.986	0.875	12.607	0.956
1997Q2	125	10.517	1.641	0.393	0.238	0.991	0.900	13.265	0.944
1997Q3	141	12.655	1.665	0.460	0.263	0.998	0.919	11.561	0.950
1997Q4	153	13.882	1.663	0.521	0.306	0.997	0.908	12.971	0.967
1998Q1	150	11.551	1.730	0.620	0.366	0.999	0.901	13.852	0.965
1998Q2	163	8.674	1.702	0.731	0.443	0.999	0.867	13.703	0.961
1998Q3	167	11.356	1.660	0.824	0.514	0.999	0.873	13.423	0.955
1998Q4	134	18.841	1.575	0.933	0.623	0.998	0.849	13.132	0.930
1999Q1	117	19.906	1.485	1.030	0.798	0.983	0.888	15.059	0.922
1999Q2	119	17.462	1.395	1.125	0.886	0.941	0.914	15.538	0.887
1999Q3	107	23.779	1.325	1.243	0.940	0.924	0.949	16.041	0.904
1999Q4	114	29.071	1.278	1.425	0.978	0.923	0.914	16.231	0.902
2000Q1	167	19.321	1.229	1.755	0.876	0.988	0.874	14.147	0.900
2000Q2	169	14.631	1.226	1.891	0.938	0.981	0.860	14.674	0.857
2000Q3	179	17.442	1.151	1.906	0.904	0.976	0.878	14.701	0.863
2000Q4	199	16.198	1.112	2.112	0.988	0.973	0.861	15.688	0.886
2000Q1	167	13.873	1.097	2.361	1.059	0.971	0.806	16.739	0.874
2000Q2	195	9.285	1.122	2.727	1.221	0.959	0.798	16.799	0.828
ALL	3317	15.494	1.504	1.118	0.627	0.957	0.863	14.602	0.913

Note: All entries in the last seven columns are sales weighted means.

TABLE 4 – DESCRIPTIVE STATISTICS FOR THE SMALL BUSINESS SEGMENT

Period	No. of models	Quantity	Price	Benchmark	RAM	CD-ROM	Ethernet	Monitor size	Desktop
1995Q1	88	11.010	2.576	0.135	0.100	0.643	0.085	10.737	0.754
1995Q2	106	9.487	2.528	0.151	0.112	0.655	0.109	10.592	0.755
1995Q3	112	10.543	2.400	0.172	0.128	0.741	0.115	11.312	0.783
1995Q4	118	11.642	2.398	0.190	0.132	0.752	0.112	10.948	0.770
1996Q1	127	9.864	2.389	0.218	0.139	0.789	0.131	11.060	0.736
1996Q2	123	11.960	2.345	0.240	0.151	0.852	0.196	11.524	0.746
1996Q3	119	13.389	2.374	0.263	0.157	0.905	0.204	12.125	0.714
1996Q4	137	12.787	2.328	0.294	0.179	0.899	0.167	12.577	0.678
1997Q1	153	9.844	2.312	0.361	0.214	0.898	0.068	12.072	0.669
1997Q2	189	9.076	2.203	0.422	0.248	0.922	0.108	11.685	0.711
1997Q3	214	9.235	2.143	0.482	0.282	0.966	0.158	11.326	0.709
1997Q4	229	9.013	2.049	0.527	0.315	0.946	0.197	10.971	0.726
1998Q1	231	8.185	2.031	0.598	0.375	0.918	0.319	11.454	0.739
1998Q2	242	8.268	1.975	0.698	0.429	0.949	0.296	11.926	0.730
1998Q3	242	10.091	1.864	0.776	0.473	0.956	0.349	12.783	0.721
1998Q4	172	15.181	1.856	0.897	0.581	0.913	0.335	13.412	0.722
1999Q1	154	13.706	1.791	1.062	0.677	0.922	0.321	15.011	0.727
1999Q2	153	15.047	1.723	1.109	0.719	0.926	0.329	15.840	0.721
1999Q3	136	17.252	1.672	1.263	0.811	0.950	0.297	16.033	0.704
1999Q4	146	15.667	1.628	1.452	0.904	0.952	0.308	15.771	0.686
2000Q1	200	10.536	1.571	1.722	1.008	0.986	0.323	14.325	0.683
2000Q2	223	10.480	1.559	1.929	1.051	0.977	0.367	14.291	0.667
2000Q3	233	11.496	1.535	2.040	1.086	0.980	0.390	14.354	0.657
2000Q4	281	9.058	1.476	2.223	1.106	0.978	0.380	14.783	0.682
2000Q1	241	9.045	1.436	2.399	1.137	0.980	0.415	14.757	0.681
2000Q2	267	7.782	1.415	2.720	1.225	0.974	0.489	14.762	0.644
ALL	4636	10.737	1.902	1.077	0.604	0.918	0.277	13.279	0.707

Note: All entries in the last seven columns are sales weighted means.

TABLE 5 – DESCRIPTIVE STATISTICS FOR THE LARGE BUSINESS SEGMENT

Period	No. of models	Quantity	Price	Benchmark	RAM	CD-ROM	Ethernet	Monitor size	Desktop
1995Q1	74	6.365	2.839	0.133	0.105	0.616	0.127	9.936	0.708
1995Q2	88	6.083	2.697	0.152	0.117	0.626	0.150	9.605	0.726
1995Q3	93	6.484	2.541	0.172	0.133	0.705	0.155	10.416	0.757
1995Q4	98	6.901	2.510	0.187	0.132	0.712	0.154	9.915	0.735
1996Q1	104	6.439	2.550	0.221	0.138	0.799	0.187	10.388	0.703
1996Q2	103	7.823	2.437	0.240	0.151	0.863	0.254	11.089	0.706
1996Q3	99	8.946	2.441	0.266	0.157	0.905	0.279	11.426	0.674
1996Q4	114	8.034	2.437	0.294	0.178	0.889	0.236	11.845	0.628
1997Q1	129	7.116	2.409	0.363	0.213	0.896	0.091	11.596	0.637
1997Q2	156	6.807	2.255	0.424	0.248	0.919	0.127	11.209	0.692
1997Q3	181	6.979	2.210	0.489	0.287	0.963	0.177	11.035	0.698
1997Q4	193	6.486	2.123	0.531	0.321	0.931	0.217	10.626	0.709
1998Q1	204	5.660	2.101	0.609	0.388	0.892	0.378	10.898	0.723
1998Q2	219	5.453	2.019	0.695	0.430	0.936	0.335	11.705	0.708
1998Q3	215	6.428	1.885	0.775	0.483	0.947	0.417	12.382	0.734
1998Q4	143	10.259	1.896	0.914	0.595	0.884	0.453	13.447	0.749
1999Q1	131	10.657	1.810	1.069	0.670	0.914	0.436	15.128	0.755
1999Q2	124	14.063	1.705	1.124	0.701	0.926	0.454	16.137	0.763
1999Q3	113	15.190	1.663	1.279	0.796	0.955	0.446	16.213	0.741
1999Q4	122	13.124	1.619	1.487	0.938	0.973	0.401	15.757	0.727
2000Q1	152	9.228	1.592	1.792	1.073	0.963	0.384	13.461	0.731
2000Q2	179	9.047	1.585	2.001	1.091	0.972	0.418	13.481	0.719
2000Q3	194	9.266	1.554	2.085	1.109	0.977	0.440	13.385	0.703
2000Q4	233	7.366	1.555	2.206	1.110	0.986	0.513	13.453	0.707
2000Q1	197	8.413	1.493	2.417	1.120	0.993	0.517	13.143	0.721
2000Q2	222	6.598	1.472	2.730	1.252	0.995	0.623	13.936	0.732
ALL	3880	8.085	1.919	1.165	0.651	0.920	0.363	12.917	0.718

Note: All entries in the last seven columns are sales weighted means.

TABLE 6 – RESULTS FROM LOGIT DEMAND FOR THE WHOLE MARKET

	OLS		IV				
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Price	-0.33**	-0.47**	-0.69**	-0.68**	-0.70**	-0.78**	-2.74**
	(0.030)	(0.031)	(0.048)	(0.049)	(0.048)	(0.267)	(0.505)
Constant	-9.22**	-9.49**	-8.89**	-8.91**	-8.87**	-8.64**	-3.08**
	(0.177)	(0.187)	(0.220)	(0.233)	(0.221)	(0.772)	(1.456)
Benchmark	0.32**	0.32**	0.44**	0.44**	0.45**	0.49**	1.61**
	(0.088)	(0.084)	(0.086)	(0.082)	(0.086)	(0.176)	(0.308)
RAM	-0.35**	-0.31**	-0.16*	-0.16*	-0.15*	-0.09	1.28**
	(0.090)	(0.089)	(0.095)	(0.096)	(0.095)	(0.207)	(0.377)
CD-ROM	0.09**	0.13**	0.15*	0.15*	0.15*	0.16*	0.29**
	(0.076)	(0.077)	(0.079)	(0.081)	(0.079)	(0.082)	(0.120)
Internet	0.22*	0.34*	0.32**	0.32**	0.32**	0.31**	0.16*
	(0.058)	(0.055)	(0.055)	(0.055)	(0.055)	(0.060)	(0.088)
Monitor Size	-0.02**	-0.02**	-0.02**	-0.02**	-0.02**	-0.02**	-0.05**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.010)
Desktop	0.62**	0.57**	0.41**	0.41**	0.40**	0.34*	-1.12**
	(0.057)	(0.056)	(0.062)	(0.063)	(0.062)	(0.203)	(0.384)
5^{th} Generation	0.36**	0.33**	0.38**	0.38**	0.38**	0.40**	0.89**
	(0.111)	(0.117)	(0.122)	(0.131)	(0.122)	(0.139)	(0.222)
6^{th} Generation	0.26*	0.27*	0.47**	0.46**	0.48**	0.55*	2.35**
	(0.149)	(0.150)	(0.156)	(0.161)	(0.156)	(0.285)	(0.512)
7^{th} Generation	1.00**	0.97**	1.05**	1.05**	1.05**	1.08**	1.79**
	(0.263)	(0.262)	(0.262)	(0.286)	(0.262)	(0.274)	(0.442)
Firm Dummies	no	yes	yes	yes	yes	yes	yes
Fit/Test of Over	0.130	0.229	-	31.39	63.61	31.24	18.064
Identification			-	(16.81)	(20.09)	(15.08)	(18.47)
1^{st} Stage R^2			0.461	0.4628	0.464	0.0166	0.0084
1^{st} Stage F-test			4043.8	777.2	452.68	210.2	5.02
Instruments							
Canada prices			X	X	X		
BLP IV				X		X	
"Modified" IV					X		X
Own price elasticity							
Mean	-0.68	-0.99	-1.43	-1.42	-1.45	-1.61	-5.69
Standard	0.29	0.42	0.61	0.60	0.62	0.69	2.42
Median	-0.64	-0.92	-1.33	-1.32	-1.35	-1.51	-5.32
% of inelastic demands	88.44	58.38	23.79	24.29	22.74	16.45	0

Notes: The dependent variable is $\ln(S_{jt})-\ln(S_{0t})$. Based on 4,767 observations for the whole market. All regressions include time dummy variables. Asymptotically robust standard errors are reported in parentheses. * Z-statistic>1. ** Z-statistic>2. Adjusted R^2 for the OLS regressions and the Hansen-Sargan test of overidentification for the IV regressions with the 1% critical values in parentheses. Canada prices are the prices of the same PC models in Canada; BLP IV are the sum of the values of the same characteristics of other products offered by the same firm, the sum of values of the same characteristics of all products offered by rival firms, the number of own-firm products and the number of rival firm products; "Modified" IV are the same as BLP IV, except that I condition on the form factor (see text for details).

TABLE 7 – RESULTS FROM THE RANDOM COEFFICIENTS MODEL FOR THE WHOLE MARKET

	IV	Random coefficients
Variables	(1)	(2)
Means		
Price	-2.74**	-5.94**
	(0.505)	(1.386)
Constant	-3.08**	-1.24
	(1.456)	(4.190)
Benchmark	1.61**	2.59**
	(0.308)	(0.967)
RAM	1.28**	1.71**
	(0.377)	(0.732)
CD-ROM	0.29**	0.32**
	(0.120)	(0.156)
Internet	0.16*	0.11*
	(0.088)	(0.112)
Monitor Size	-0.05**	-0.06**
	(0.010)	(0.023)
Desktop	-1.12**	-5.14*
	(0.384)	(3.990)
5^{th} Generation	0.89**	1.35**
	(0.222)	(0.339)
6^{th} Generation	2.35**	3.84**
	(0.512)	(0.907)
7^{th} Generation	1.79**	2.25**
	(0.442)	(0.735)
Standard Deviations		
Price		1.26**
		(0.604)
Constant		2.50*
		(2.143)
Benchmark		0.13
		(3.122)
Desktop		3.88*
		(2.954)
GMM Objective (df)		3.52 (3)

Notes: Based on 4,767 observations for the whole market. All regressions include firm and time dummy variables. Asymptotically robust standard errors are reported in parentheses. * Z-statistic>1. ** Z-statistic>2. The first column is the same as column (7) in table 6. The second column presents parameters estimated via the two-step GMM algorithm described in the estimation subsection. The standard errors reported for the random coefficients take into account the variance introduced through the simulation by bootstrapping fifty times the relevant component of the variance in the moment conditions.

TABLE 8 – SAMPLE OF ESTIMATED SEMI-ELASTICITIES

Model	Form	Brand	Price	Benchmark	Sales	Markup
Acer	Desk	AcerPower	2,476	97	28,783	246.900
Acer	Desk	AcerPower	3,382	272	7,196	323.280
Acer	Desk	AcerPower	2,775	142	23,986	270.600
Acer	Desk	Acros	2,506	97	25,154	249.180
Acer	Desk	Acros	2,785	217	4,791	271.180
	-210.097	0.449	1.519	1.543	0.303	
	[-136.836]	*[0.005]*	*[0.016]*	*[0.017]*	*[0.003]*	
	1.794	-162.145	1.895	1.609	0.380	
	[0.020]	*[-136.851]*	*[0.016]*	*[0.017]*	*[0.003]*	
	1.822	0.568	-192.317	1.612	0.338	
	[0.020]	*[0.005]*	*[-136.840]*	*[0.017]*	*[0.003]*	
	1.765	0.460	1.538	-208.454	0.307	
	[0.020]	*[0.005]*	*[0.016]*	*[-136.838]*	*[0.003]*	
	1.824	0.571	1.695	1.615	-193.264	
	[0.020]	*[0.005]*	*[0.016]*	*[0.017]*	*[-136.852]*	

Notes: The upper panel of the table gives the sample of Acer models in 1995Q1 for which the semi-elasticities are calculated in the lower panel. Cell entries in the lower panel are indexed *i,j*, where *i* indexes row and *j* column. Semi-elasticities are defined here as the percentage change in market share of *i* from a $500 change in the price of *j*. The first number in each cell provides the semi-elasticity calculated from the random coefficient model, whereas the second number is calculated from the IV logit model.

TABLE 9 – ESTIMATED MARKUPS AND MARGINS FOR THE WHOLE MARKET

	OLS Logit	Instrumental Variable Logit		Random Coefficient Logit	
Statistic	(1)	(2)	(3)	(4)	(5)
Median	2113.20	366.38	18.86%	250.38	13.39%
Mean	2114.30	366.56	20.95%	269.59	14.11%
10%	2109.40	365.70	11.61%	201.91	10.36%
90%	2121.80	367.86	33.24%	355.46	18.75%
Standard Deviation	4.64	0.80	9.39%	85.80	3.89%

Notes: Columns (1), (2) and (4) give statistics for the estimated distribution of markups over the whole period 1995Q1-2001Q2. Columns (3) and (5) provide statistics for the estimated distribution of margins. Margins are defined as markups divided by observed prices. All prices have been deflated using the US Consumer Price Index.

TABLE 10 – RESULTS OF THE DEMAND ESTIMATION FOR THE DIFFERENT SEGMENTS

	Home Segment			Small Business Segment			Large Business Segment		
	OLS	IV	Random Coefficients	OLS	IV	Random Coefficients	OLS	IV	Random Coefficients
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Means									
Price	-0.76**	-5.07**	-6.410**	-0.36**	-3.09**	-5.831**	-0.30**	-1.58**	-5.771**
	(0.071)	(0.534)	(1.123)	(0.033)	(0.498)	(2.002)	(0.034)	(0.313)	(1.566)
Constant	-10.64**	1.28	1.284	-8.56**	-0.71	1.138	-9.56**	-5.83**	-6.008
	(0.327)	(1.529)	(1.944)	(0.199)	(1.469)	(4.001)	(0.202)	(0.939)	(6.654)
Benchmark	0.27**	2.73**	1.372	0.26**	1.71**	2.714**	0.38**	1.12**	2.263**
	(0.130)	(0.346)	(1.523)	(0.095)	(0.294)	(0.781)	(0.097)	(0.213)	(0.799)
RAM	-0.08	0.83**	0.755**	-0.34**	1.47**	2.083**	-0.42**	0.48*	0.615*
	(0.156)	(0.255)	(0.270)	(0.091)	(0.392)	(0.696)	(0.093)	(0.254)	(0.387)
CD-ROM	0.04	0.46**	0.377*	0.27**	0.28**	0.234*	0.28**	0.35**	0.340**
	(0.136)	(0.184)	(0.214)	(0.076)	(0.127)	(0.170)	(0.080)	(0.100)	(0.128)
Internet	1.20**	0.83**	0.761**	0.14**	0.96**	1.314**	0.08*	0.32**	0.365**
	(0.079)	(0.120)	(0.125)	(0.065)	(0.195)	(0.386)	(0.070)	(0.102)	(0.182)
Monitor Size	-0.01*	0.02*	0.026**	-0.03**	-0.07**	-0.085**	-0.06**	-0.08**	-0.082**
	(0.008)	(0.013)	(0.013)	(0.007)	(0.012)	(0.019)	(0.007)	(0.009)	(0.018)
Desktop	1.30**	-2.57**	-7.115*	0.24**	-1.96**	-8.568*	0.40**	-0.53**	-2.597*
	(0.101)	(0.493)	(4.159)	(0.058)	(0.407)	(5.587)	(0.064)	(0.233)	(1.500)
5^{th} Generation	0.34*	1.66**	1.808**	0.37**	1.05**	1.510**	0.29**	0.63**	1.207**
	(0.184)	(0.321)	(0.418)	(0.118)	(0.250)	(0.481)	(0.121)	(0.182)	(0.424)
6^{th} Generation	0.76**	4.69**	5.101**	0.30**	2.81**	4.433**	0.04	1.22**	2.673**
	(0.238)	(0.589)	(0.745)	(0.154)	(0.523)	(1.418)	(0.162)	(0.342)	(0.899)
7^{th} Generation	1.79**	3.53**	3.609**	0.58**	1.90**	2.511**	0.02	0.58*	1.025**
	(0.363)	(0.614)	(0.648)	(0.279)	(0.499)	(0.863)	(0.291)	(0.361)	(0.511)
Standard Deviations									
Price			0.882**			1.042*			1.792**
			(0.444)			(0.609)			(0.712)
Constant			0.759			2.377			4.399*
			(1.179)			(2.652)			(3.810)
Benchmark			1.377**			0.051			0.102
			(0.647)			(1.885)			(5.285)
Desktop			4.374*			5.370*			2.555*
			(2.327)			(4.003)			(2.043)

Notes: All regressions include firm and time dummy variables. Asymptotically robust standard errors are reported in parentheses. * Z-statistic>1. ** Z-statistic>2. Parameters for the random coefficients model are estimated via the two-step GMM algorithm described in the estimation subsection. The standard errors reported take into account the variance introduced through the simulation by bootstrapping fifty times the relevant component of the variance in the moment conditions. The internet dummy equals one if the PC includes as standard a modem (for the home segment) or an ethernet card (for the small and large business segments).

TABLE 11 – ESTIMATED AGGREGATE ELASTICITIES

	Whole Market	Home Segment	Small Business Segment	Large Business Segment
Mean	(1)	(2)	(3)	(4)
IV Logit	4.95	7.94	5.93	3.17
Random Coefficients	3.94	4.70	4.17	2.62
Median				
IV Logit	5.10	8.26	5.97	3.18
Random Coefficients	3.94	4.84	4.20	2.49

Notes: Aggregate demand elasticity is calculated as the percentage change in total market share from a one percent increase in the price of all products in the market. Results for the overall market and each segment separately are based on the estimated coefficients in Tables 7 and 10.

TABLE 12 – ESTIMATED MARKUPS AND MARGINS FROM ALTERNATIVE SPECIFICATIONS

	Use Hard Disk instead of RAM		Specification similar to Goeree's random coefficients model		Include ln(number of products)	
Statistic	(1)	(2)	(3)	(4)	(5)	(6)
Median	233.73	12.37%	242.22	12.71%	293.71	16.28%
Mean	244.77	13.05%	255.59	13.51%	356.56	17.28%
10%	194.33	9.23%	197.07	9.81%	207.11	12.68%
90%	304.79	17.78%	328.77	18.29%	541.89	22.28%
Standard Deviation	54.09	3.82%	64.18	3.85%	380.15	7.87%
Number of significant random coefficients variables	3 out of 4		1 out of 4		2 out of 4	

Notes: Columns (1), (3) and (5) give statistics for the estimated distribution of markups from the various specifications. Columns (2), (4) and (6) present statistics for the estimated distribution of margins. A random coefficients variable is considered significant if either its mean or standard deviation of the taste distribution is significant (see text for details).

TABLE 13 – PREDICTED CHANGES DUE TO MERGERS IN PRICES, QUANTITIES AND MARGINAL COSTS

		1995Q2				1998Q2				2001Q2			
		HP and Compaq		Dell and Compaq		HP and Compaq		Dell and Compaq		HP and Compaq		Dell and Compaq	
		%p	%q	%p	%q	%p	%q	%p	%q	%p	%q	%p	%q
Merging	Mean	0.58	-4.80	0.84	-6.72	1.00	-6.95	1.31	-8.67	1.11	-5.37	1.87	-9.00
	Median	0.48	-4.07	0.76	-5.54	1.06	-7.31	1.26	-8.66	0.60	-3.29	1.63	-7.59
Non-Merging	Mean	0.02	0.73	0.03	1.26	0.02	1.31	0.03	0.93	0.01	0.73	0.04	0.63
	Median	0.02	0.27	0.02	0.42	0.01	0.49	0.02	0.18	0.00	0.20	0.02	0.13
		%mc		%mc		%mc		%mc		%mc		%mc	
Merging	Mean	0.8		1.1		1.2		1.6		1.5		2.5	
	Median	0.7		1.1		1.2		1.4		0.8		1.9	
	Max	2.1		2.0		2.9		3.0		6.3		10.3	
	Min	0.2		0.4		0.3		0.9		0.4		0.6	

Notes: The top panel of the table shows the mean and the median percentage changes in prices and quantities of the merging and non-merging firms due to mergers at various points in time. The bottom panel presents statistics on the marginal cost reduction required for the postmerger prices to remain unchanged.

TABLE 14 – PREDICTED CHANGES IN VARIABLE PROFITS AND CONSUMER SURPLUS DUE TO MERGERS (in million of dollars)

	1995Q2				1998Q2				2001Q2			
	HP and Compaq		Dell and Compaq		HP and Compaq		Dell and Compaq		HP and Compaq		Dell and Compaq	
Consumer Surplus	-0.65		-1.14		-0.89		-1.79		-1.06		-2.01	
Average consumer surplus (in $)	-0.0033		-0.0057		-0.0042		-0.0084		-0.0048		-0.0090	
	Profits	Revenues	Profits	Revenues	Profits	Revenues	Profits	Revenues	Profits	Revenues	Profits	Revenues
Industry Total	5.64	-53.77	7.79	-62.68	12.05	-102.65	18.55	-190.93	12.73	-56.58	21.56	-183.02
Acer	0.60	5.78	0.82	7.99	0.77	5.94	1.32	10.03	0.73	3.45	1.43	6.65
Compaq	0.87	-35.60	1.18	-48.20	1.35	-82.50	1.60	-145.80	0.92	-57.00	0.01	-131.77
Dell	0.72	6.53	-0.11	-67.24	3.65	23.70	1.76	-153.00	6.15	25.90	5.39	-126.60
Gateway	0.81	7.04	1.12	9.95	1.89	13.85	3.20	23.03	2.00	9.18	3.95	17.88
HP	-0.15	-56.06	0.73	8.00	0.31	-93.13	3.65	25.20	0.94	-49.93	6.18	24.15
IBM	0.92	7.61	1.29	10.82	1.57	12.05	2.62	19.57	1.42	8.10	3.17	17.82
NEC	1.52	8.41	2.27	12.61	1.84	12.48	3.06	20.53	0.07	0.42	0.15	0.84
Sony	0.00	0.00	0.00	0.00	0.18	1.61	0.31	2.74	0.34	2.32	0.84	5.43
Toshiba	0.35	2.52	0.48	3.39	0.49	3.35	1.03	6.77	0.16	0.98	0.44	2.58
Total Welfare	4.99		6.65		11.16		16.76		11.67		19.55	

Notes: Calculated changes in variable profits, revenues and consumer surplus as a result of the mergers. All numbers are in million of dollars, except for the average consumer surplus which is in dollars. Total welfare is calculated as consumer surplus plus profits.

TABLE 15 – PREDICTED CHANGES DUE TO MERGERS IN PRICES AND QUANTITIES FOR THE DIFFERENT SEGMENTS

			1995Q2				1998Q2				2001Q2			
			HP and Compaq		Dell and Compaq		HP and Compaq		Dell and Compaq		HP and Compaq		Dell and Compaq	
			%p	%q	%p	%q	%p	%q	%p	%q	%p	%q	%p	%q
Home	Merging	Mean	0.61	-7.26	0.84	-9.31	1.04	-10.69	1.34	-12.55	1.19	-5.84	2.45	-14.12
		Median	0.48	-4.49	0.76	-7.24	1.06	-8.63	1.45	-13.31	0.62	-3.43	1.72	-12.22
	Non-Merging	Mean	0.02	0.23	0.02	0.48	0.02	0.77	0.03	0.66	0.01	1.70	0.03	2.58
		Median	0.02	0.31	0.02	0.73	0.01	0.06	0.02	0.09	0.00	0.65	0.02	1.60
Small Business	Merging	Mean	0.58	-4.61	0.83	-6.46	1.00	-8.59	1.31	-9.76	1.12	-5.90	1.88	-10.45
		Median	0.48	-2.84	0.76	-4.22	1.06	-6.96	1.26	-9.61	0.60	-3.77	1.65	-7.99
	Non-Merging	Mean	0.02	1.64	0.03	2.38	0.02	1.42	0.03	2.93	0.01	0.87	0.04	2.65
		Median	0.02	2.08	0.02	3.17	0.01	2.10	0.02	3.78	0.00	0.20	0.02	2.46
Large Business	Merging	Mean	0.55	-2.53	0.85	-4.23	0.97	-3.39	1.29	-4.64	1.00	-3.67	1.88	-6.12
		Median	0.48	-2.05	0.76	-3.26	0.99	-3.89	1.26	-3.84	0.53	-2.02	1.65	-5.40
	Non-Merging	Mean	0.02	1.06	0.02	1.36	0.02	1.05	0.03	2.00	0.01	0.91	0.03	2.72
		Median	0.02	1.05	0.02	1.39	0.01	0.81	0.02	1.74	0.00	0.62	0.01	2.03

Notes: Percentage changes in prices and quantities from mergers in different periods, calculated for the three different segments. Postmerger prices and marginal costs are taken from the whole market calculations.

TABLE 16 – PREDICTED CHANGES IN VARIABLE PROFITS AND CONSUMER SURPLUS DUE TO MERGERS (in million of dollars) FOR THE HOME SEGMENT

	1995Q2				1998Q2				2001Q2			
	HP and Compaq		Dell and Compaq		HP and Compaq		Dell and Compaq		HP and Compaq		Dell and Compaq	
Consumer Surplus	-0.17		-0.28		-0.36		-0.60		-0.71		-0.67	
Average consumer surplus (in $)	-0.0017		-0.0028		-0.0035		-0.0058		-0.0067		-0.0063	
	Profits	Revenues	Profits	Revenues	Profits	Revenues	Profits	Revenues	Profits	Revenues	Profits	Revenues
Industry Total	2.34	7.98	2.66	3.22	1.69	-45.03	0.89	-56.85	4.82	-29.59	5.44	-58.78
Acer	0.07	0.54	0.12	1.06	0.12	0.90	0.12	0.86	0.12	0.50	0.13	0.54
Compaq	-0.22	-8.02	-0.33	-11.87	-0.65	-30.76	-1.99	-57.15	-0.24	-26.46	-2.40	-60.89
Dell	0.03	0.18	-0.27	-8.38	0.36	2.33	-0.86	-23.74	2.40	11.29	-0.31	-33.45
Gateway	0.16	1.05	0.27	2.14	0.87	6.39	0.88	5.79	2.29	10.87	3.58	16.61
HP	-0.12	-3.90	0.02	0.17	-0.93	-37.85	0.76	4.33	-0.26	-29.02	3.54	12.87
IBM	2.03	17.44	2.13	18.19	0.42	3.30	0.43	3.17	0.09	0.49	0.16	0.84
NEC	0.48	1.48	0.80	2.78	1.33	9.06	1.35	8.23	0.01	0.03	0.01	0.05
Sony	0.00	0.00	0.00	0.00	0.18	1.60	0.19	1.66	0.39	2.54	0.67	4.29
Toshiba	-0.08	-0.79	-0.08	-0.87	0.00	0.00	0.00	-0.01	0.03	0.17	0.06	0.37
Total Welfare	2.17		2.38		1.33		0.29		4.11		4.77	

Notes: Calculated changes in variable profits, revenues and consumer surplus as a result of the mergers. All numbers are in million of dollars, except for the average consumer surplus which is in dollars. Total welfare is calculated as consumer surplus plus profits.

TABLE 17 – PREDICTED CHANGES IN VARIABLE PROFITS AND CONSUMER SURPLUS DUE TO MERGERS (in million of dollars) FOR THE SMALL BUSINESS SEGMENT

	1995Q2				1998Q2				2001Q2			
	HP and Compaq		Dell and Compaq		HP and Compaq		Dell and Compaq		HP and Compaq		Dell and Compaq	
Consumer Surplus	-0.19		-0.34		-0.16		-0.45		-0.15		-0.40	
Average consumer surplus (in $)	-0.0036		-0.0065		-0.0030		-0.0082		-0.0026		-0.0069	
	Profits	Revenues	Profits	Revenues	Profits	Revenues	Profits	Revenues	Profits	Revenues	Profits	Revenues
Industry Total	4.15	-17.04	5.56	-18.06	4.78	-41.14	9.72	-87.60	3.85	-12.14	8.26	-61.10
Acer	0.42	4.24	0.62	6.28	0.64	5.04	1.37	10.67	0.50	2.38	1.32	6.24
Compaq	0.46	-19.79	0.80	-25.21	-0.12	-42.73	0.35	-69.04	-0.16	-18.70	-0.49	-42.68
Dell	0.59	5.58	-0.40	-39.21	2.46	16.60	0.54	-84.47	2.17	8.80	1.67	-53.90
Gateway	0.49	4.51	0.71	6.67	0.91	6.86	1.93	14.54	0.48	2.21	1.30	6.04
HP	-0.29	-31.93	0.77	8.71	-0.76	-39.13	2.00	14.92	-0.10	-12.48	1.57	6.60
IBM	2.16	18.86	2.41	21.05	0.91	6.98	1.86	14.03	0.74	4.20	2.16	12.15
NEC	0.44	2.72	0.70	4.46	0.40	2.80	0.86	6.08	0.04	0.23	0.11	0.62
Sony	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.70	0.33	2.17
Toshiba	-0.12	-1.23	-0.06	-0.81	0.34	2.44	0.81	5.67	0.08	0.52	0.29	1.66
Total Welfare	3.96		5.22		4.62		9.26		3.70		7.86	

Notes: Calculated changes in variable profits, revenues and consumer surplus as a result of the mergers. All numbers are in millions of dollars, except for the average consumer surplus which is in dollars. Total welfare is calculated as consumer surplus plus profits.

TABLE 18 – PREDICTED CHANGES IN VARIABLE PROFITS AND CONSUMER SURPLUS DUE TO MERGERS (in million of dollars) FOR THE LARGE BUSINESS SEGMENT

	1995Q2				1998Q2				2001Q2			
	HP and Compaq		Dell and Compaq		HP and Compaq		Dell and Compaq		HP and Compaq		Dell and Compaq	
Consumer Surplus	-0.21		-0.38		-0.38		-0.65		-0.36		-0.91	
Average consumer surplus (in $)	-0.0044		-0.0079		-0.0071		-0.0122		-0.0061		-0.0154	
	Profits	Revenues	Profits	Revenues	Profits	Revenues	Profits	Revenues	Profits	Revenues	Profits	Revenues
Industry Total	3.62	-3.03	4.18	-4.47	5.88	-13.77	10.19	-30.96	5.02	-8.05	13.65	-29.47
Acer	0.06	0.54	0.09	0.88	0.16	1.23	0.31	2.33	0.12	0.59	0.33	1.56
Compaq	0.54	-8.04	0.78	-9.89	1.64	-12.80	2.82	-23.12	1.02	-12.94	2.58	-27.99
Dell	0.15	1.25	0.96	-15.83	1.34	8.48	3.97	-31.61	2.33	9.70	6.89	-23.50
Gateway	0.07	0.53	0.10	0.83	0.27	2.00	0.52	3.84	0.12	0.56	0.33	1.58
HP	1.11	-11.38	0.38	4.27	1.81	-17.10	1.17	7.92	0.78	-9.65	1.59	8.00
IBM	1.85	16.11	1.92	16.69	0.35	2.37	0.72	5.08	0.54	3.07	1.60	8.89
NEC	0.06	0.15	0.12	0.54	0.12	0.87	0.25	1.80	0.03	0.16	0.08	0.45
Sony	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.12	0.06	0.44
Toshiba	-0.22	-2.19	-0.18	-1.96	0.18	1.19	0.43	2.80	0.05	0.33	0.18	1.10
Total Welfare	3.41		3.80		5.50		9.54		4.66		12.74	

Notes: Calculated changes in variable profits, revenues and consumer surplus as a result of the mergers. All numbers are in millions of dollars, except for the average consumer surplus which is in dollars. Total welfare is calculated as consumer surplus plus profits.