Econometric Estimates of Hedonic Price Indexes for Personal Computers in Russia

Alexander Parkhomenko*

Higher School of Economics
and
Erasmus University Rotterdam

Double Degree Program
Master thesis

September 20, 2007

*alex.parkhomenko@par-ma.com www.par-ma.com

Abstract

Economists have noted for decades that Consumer Price Index (CPI) in the developed countries is overstating inflation by 0,5-2,0% per year. A significant part of this bias is found to be caused by the effects of new goods and quality change. Information and communication technology (ICT) products are mostly subject to these effects. An increasing weight of these products in the Russian CPI may lead to a substantial upward bias in the Russian CPI. Nowadays hedonic price indexes are believed to be one of the most efficient ways to eliminate the bias. They can be used in two ways: to estimate the bias in CPI and to elaborate an alternative to official price indexes for ICT products. In this study we estimate hedonic price and quality indexes for Personal Computers, the most widespread ICT product, in Russia. Using 21 months data (03.2004-11.2005) we estimated a 25% fall in PC prices for 20 months (about 16% on 12 months scale). We have also estimated that elementary price index for PC may be biased upward by 17-27% per year due to the usage of traditional matched models. Hence, the Russian CPI can be overstated by 0,19-0,31% per year. Hedonic quality indexes indicate a significant quality growth of PC (GAGR 19% per year) which is the best explanation for the rapidly falling prices.

Keywords: *Hedonic Regression, COLI, CPI, Hedionic index, Personal Computer, CPI bias, Consumer Price Index, Quality-adjustment, ICT*

JEL Classification: C 43, E31

Contents

1 Introduction

In the last two decades considerable attention has been drawn to the methods of computing price indexes for Information and Communication Technology (ICT) products: the discussion started in the USA and then has been continued throughout the globe. Report prepared by Boskin Commission (1996) raised the problem of biases in the price indexes for ICT products: it showed that traditional matched models indexes can substantially overestimate inflation, because they are not able to measure the peculiarities of ICT industries (i.e. fast rotation of goods, huge quality differences among products on the market, short product life cycle, etc). The Commission showed that the use of matched model indexes leads to inflation rates overestimation by 0,6% per year in the US official CPI (CPI-U). Similar results were obtained by Crawford (1998) for Canada, Shiratsuka (1999) for Japan, Hoffmann (1998) for Germany and Cunningham (1996) for the UK (See Appendix, Table 5).

But the growing discussion does not only concern price measurement (inflation), or price indexes, but also deflators. Deflators are crucial for computing such items as investment, labor productivity, economics growth measures, etc. For example, in the USA growth acceleration after the 1995 was mainly driven by the increased investment in ICT products that lead both to an increase in capital stock and labor productivity growth (Bosworth and Triplett, 2001). In this respect, correct measurement of deflators is crucial for understanding the sources of economic and productivity growth. Another issue to be solved concerns international comparability, aspecially for ICT deflators. Papers by Wyckoff (1995) and Eurostat (1999) demonstrate that there is a huge dispersion in ICT deflators in OECD and European countries, accordingly.[1]

These differences are so huge that they cannot be explained by market conditions, regulation differences or other similar factors. As both studies suggest, most part of the variation comes from the differences in quality adjustment procedures across countries, and that makes international comparison of real investment in

[1]Wyckoff (1995) estimates the range for ICT deflators for OECD countries in the 1980s from -72% to +80% per year. Eurostat (1999) estimated a smaller dispersion for the period of the early 1990s for European countries – from -47% to -10%.

ICT impossible (as it is usually calculated through deflation). So, this also makes any attempt to estimate the impact of ICT on economy across countries quite challenging.

Despite the fact that price indexes are the main measures of inflation and are used to calculate real (deflated) values of macroeconomic indicators, little attention is paid to them in Russia and other former USSR countries (CIS). The inability of Russian statisticians to eliminate biases in the price indexes used will inevitably lead to biased measures of inflation and economic growth. Given that the Russian government is proposing the stimulation of ICT industries development, the inability to eliminate biases for these products would lead to inefficient policy decisions, because the price indexes for ICT products would be most likely biased up, while productivity growth, investments, consumption would be underestimated.

In this paper we would like to estimate hedonic price and quality indexes for personal computers (PC) in Russia. That would help us to find out whether there needs to be as much concern about ICT products price methodology as in the OECD countries. Hedonic indexes and hedonic methods are very useful and are often used for calculating quality-adjusted price indexes. We have chosen PCs as an object of our research in order to make the comparison with the results obtained for OECD countries possible.

Recent studies of hedonic price indexes for PC show that quality adjusted prices decline by 25-35% a year in the USA (Pakes, 2002, Berndt, Ernst R. and Neal J. Rappaport, 2001, Berndt, Ernst R., Zvi Griliches and Neal Rappaport,1995), 34% in Germany (Moch, 2001), 33-36% in France (Bourot, 1997) and 28-34% in Taiwan (Jang et al.,1996). There is no evidence about quality-adjusted price indexes for PCs in Russia: Russian statistical agency (Rosstat) computes a price index for PC as part of the CPI, but it is not publicly accessible.[2] Investment deflators for ICT are not developed as well.

This study provides evidence on quality-adjusted prices for PCs in Russia for the period of 03.2004-11.2005. We are using characteristic hedonic method to compute them. As it is almost impossible to collect data for the whole country we have

[2]Problems with methodology of price index computing for such goods as PCs might be the main reason why Russian statistical agency do not publish these indexes.

collected data for the most representative, from our point of view, city in Russia - Yekaterinburg, which is located in the middle of Russia and is a big industrial center. Using these data we calculate 10 hedonic price indexes and 8 hedonic quality indexes: we have added "superlative" Edgeworth-Marshall and Walsh indexes to the commonly used in hedonic literature Laspeyres, Paasche and Fisher indexes.

The paper is organized in the following way: Section 2 gives the basic set up of hedonic price and quality indexes, briefly discusses hedonic regression, and also presents the classification of hedonic price and quality indexes. Section 3 describes the data and variables, presents descriptive statistics. Section 4 presents and debates empirical results – econometric estimates of hedonic regressions, price and quality indexes. It also discusses the international comparability of results and presents estimates of possible Russian CPI and PC elementary price index biases.

2 Hedonic Indexes

Hedonic index is any price index, which uses information from hedonic regression. Hedonic regression describes how product price could be explained by its product characteristics.

For example, for a linear econometric model, assume that at each period t we have n_t goods, which could be described by a vector of k characteristics $(z_{1it}, ..., z_{kit})^T$. Thus the hedonic (cross-sectional) regression is:

$$P_{it} = c_{0t} + \sum_{j=1}^{k} c_{it} z_{jit} + \xi_{it} \tag{1}$$

for each $t \in \{1, ..., T\}$, where P_{it} – price for ith product at period t, z_{jit} – jth characteristic for product i at time t, $i \in \{1, ..., n_t\}$ and n_t is the number of observation in period t.

2.1 Hedonic Price Indexes

There are several ways the hedonic price indexes can be constructed. Following Triplett (2004) we will distinguish two methods – direct and indirect. The direct

method uses only information obtained from the hedonic regression, while the second method combines information derived from the hedonic regression and matched models. In the last case, data used for estimating hedonic regression and calculating matched models indexes are different.[3] In our study it is almost impossible to use indirect methods, because we neither know the quality-adjustment method used by Russian statistical agency (Rosstat) nor we have any data appropriate for matched models.

Direct method could be divided into Time Dummy Variable and Characteristic methods. The Time Dummy Variable is simpler, because it assumes implicit prices (coefficients of the hedonic regression (1) - c_{it}) to be constant over adjacent time periods. This assumption generally does not hold (for example, see evidence in Silver and Heravi, 2002, 2003, Berndt and Rappaport, 2003) since implicit prices reflect both demand and supply (See Pakes, 2002 for discussion). We use Characteristic method, which relaxes this assumption, based on the usage of fitted prices from hedonic regression. This method generally should lead to a more stable estimates, because ordinary least squares (OLS) estimates guarantee that the regression always passes through it's mean.[4]

Given (1), the corresponding chain hedonic price index[5] would look like:

$$HPI(0,T) = \prod_{t=0}^{T} \frac{\widehat{P}_{t+1}(z^{\tau})}{\widehat{P}_{t}(z^{\tau})}$$

where $HPI(0,T)$ – hedonic price index (chain) for period from 0 to T, $\widehat{P}_{t+1}(z^{\tau})$ – estimate of price obtained from hedonic regression at period $t+1$ with mean char-

[3]This difference in sources of information might be quite crucial, especially for a statistical agency. Matched models are computed on a monthly basis and data are usually gathered by statistical agency. In contrast to that information for hedonic regression is gathered by vendors or other research companies. The size of the sample is larger than for matched models, but regression is usually updated on an annual- or semiannual basis.

[4]As it will be shown later, fitted prices are calculated using mean characteristics of the specified periods, which are quite close to the sample mean. This automatically means that fitted price estimates should not be very sensitive to outliers, omitted variable bias and other errors.

[5]In the study we also calculate base indexes, which are defined as a relative of price of T period for the good with mean characteristic and price of 0 period for the good with the same mean characteristics. See detailed description in Table 1.

acteristics of period τ – z^{τ}. $HPI(0,T)$ shows how much the price of characteristics bundle changed over time from period 0 to period T. A specification of z^{τ} – mean characteristics for the certain period, determines the type of HPI. For example, if we set z^{τ} equal to the mean of the characteristics for the previous period t : z^{t}, we would get a Laspeyres-type index. Setting z^{τ} equal to z^{t+1} – Paasche-type index and so on. Fisher-type index is defined as a square root of product of Laspeyres- and Paasche-type indexes. Edgeworth-Marshall – uses arithmetic mean of mean characteristics of two periods t and $t+1$. Walsh-type index uses geometric average of two periods. And finally, base quality index does not update characteristics (quality) and uses fixed base characteristics – z^{0}. A detailed taxonomy of hedonic price indexes is presented in Table 1.

Similarly, base hedonic price index would look like:

$$HPI(0,T) = \frac{\widehat{P}_T(z^{\tau})}{\widehat{P}_0(z^{\tau})}$$

The base index would directly compare a bundle of mean characteristic z^{τ} at just two points of time – 0 and T. Hence, it is independent of track that prices had between 0 and T periods of time – $\{1, ..., T-1\}$.

2.2 Hedonic Quality Indexes

Hedonic quality index is similar to quantity index in traditional index theory – it measures how the price of obtaining set of characteristics had changed over time. For example, if we are willing to estimate the effect that characteristic growth (or decline) has had on the price of a computer for one period – from t to $t+1$, then the hedonic quality index would look like:

$$HQI(t,t+1) = \frac{\widehat{P}_{\eta}(z^{t+1})}{\widehat{P}_{\eta}(z^{t})} \tag{2}$$

where η, as in the case with price indexes, determines the type of the index. So, the chain quality index would look like:

$$HQI(0,T) = \prod_{t=0}^{T} \frac{\widehat{P}_\eta(z^{t+1})}{\widehat{P}_\eta(z^t)}$$

and base index:

$$HQI(0,T) = \frac{\widehat{P}_\eta(z^T)}{\widehat{P}_\eta(z^0)}$$

If we choose past period prices – i.e. $\eta = t$ as a mean of estimation of (2) then we will get a Laspeyres-type index. If we choose current prices $\eta = t + 1$, than – Paasche-type index. Fisher-type index is defined as a square root of production of Laspeyres- and Paasche-type indexes. Edgeworth-Marshall – as a fraction of two prices – for period t and $t + 1$. And finally, the most simple example is when we use base (implicit) prices for all estimates. In hedonic quality indexes we do not use Walsh-type index because it could not be calculated for some cases when the estimates of implicit prices (i.e. coefficients of hedonic regression (1) - c_{it}) are negative. The detailed taxonomy is presented in Table 1.

2.3 Functional Form

Despite a long history of hedonic regressions research only several functional forms were used – linear, double log and semilog form. In our study we will use a linear specification for our cross-section regression presented in (1). We do it for several reasons. First of all, our final goal is to estimate hedonic price, but not a log-price. The application of log or semilog form requires the usage of either nonlinear least square estimator (or other appropriate method) or OLS and correction of estimated price for an error term (Pakes, 2002). Secondly, we would like to make the result more transparent for a broad set of readers, especially for policy-makers. With the modest and noisy data available the usage of Box-Cox test for each month may

Table 1

Classification of Hedonic Indexes within characteristic method*

	Chain	Base
Price index		
Laspeyres	$\prod_{t=0}^{T} \frac{P_{t+1}(\mathbf{z}^t)}{P_t(\mathbf{z}^t)}$	—
Paasche	$\prod_{t=0}^{T} \frac{P_{t+1}(\mathbf{z}^{t+1})}{P_t(\mathbf{z}^{t+1})}$	$\frac{P_T(\mathbf{z}^T)}{P_0(\mathbf{z}^T)}$
Fisher	$\sqrt{\prod_{t=0}^{T} \left\{ \frac{P_{t+1}(\mathbf{z}^{t+1})}{P_t(\mathbf{z}^{t+1})} \frac{P_{t+1}(\mathbf{z}^t)}{P_t(\mathbf{z}^t)} \right\}}$	$\sqrt{\frac{P_T(\mathbf{z}^T)}{P_0(\mathbf{z}^T)} \frac{P_T(\mathbf{z}^0)}{P_0(\mathbf{z}^0)}}$
Edgeworth-Marshall	$\prod_{t=0}^{T} \frac{P_{t+1}((\mathbf{z}^{t+1}+\mathbf{z}^t)/2)}{P_t((\mathbf{z}^{t+1}+\mathbf{z}^t)/2)}$	$\frac{P_T((\mathbf{z}^T+\mathbf{z}^0)/2)}{P_0((\mathbf{z}^T+\mathbf{z}^0)/2)}$
Walsh	$\prod_{t=0}^{T} \frac{P_{t+1}(\sqrt{\mathbf{z}^{t+1}\mathbf{z}^t})}{P_t(\sqrt{\mathbf{z}^{t+1}\mathbf{z}^t})}$	$\frac{P_T(\sqrt{\mathbf{z}^T\mathbf{z}^0})}{P_0(\sqrt{\mathbf{z}^T\mathbf{z}^0})}$
Base quality		$\frac{P_T(\mathbf{z}^0)}{P_0(\mathbf{z}^0)}$
Quality index		
Laspeyres	$\prod_{t=0}^{T} \frac{P_t(\mathbf{z}^{t+1})}{P_t(\mathbf{z}^t)}$	—
Paasche	$\prod_{t=0}^{T} \frac{P_{t+1}(\mathbf{z}^{t+1})}{P_{t+1}(\mathbf{z}^t)}$	$\frac{P_T(\mathbf{z}^T)}{P_T(\mathbf{z}^0)}$
Fisher	$\sqrt{\prod_{t=0}^{T} \left\{ \frac{P_{t+1}(\mathbf{z}^{t+1})}{P_{t+1}(\mathbf{z}^t)} \frac{P_t(\mathbf{z}^{t+1})}{P_t(\mathbf{z}^t)} \right\}}$	$\sqrt{\frac{P_T(\mathbf{z}^T)}{P_T(\mathbf{z}^0)} \frac{P_0(\mathbf{z}^T)}{P_0(\mathbf{z}^0)}}$
Edgeworth-Marshall	$\prod_{t=0}^{T} \frac{P_{t+1}(\mathbf{z}^{t+1})+P_t(\mathbf{z}^{t+1})}{P_{t+1}(\mathbf{z}^t)+P_t(\mathbf{z}^t)}$	$\frac{P_T(\mathbf{z}^T)+P_0(\mathbf{z}^T)}{P_T(\mathbf{z}^0)+P_0(\mathbf{z}^0)}$
Base (implicit) prices		$\frac{P_0(\mathbf{z}^T)}{P_0(\mathbf{z}^0)}$

*For simplicity of representation, we skip the sign of fitted value "^". However, all estimates are done with the usage of fitted values (estimate of price from hedonic regression). All price fitted values are calculated for the mean characteristics of the corresponding time periods

be seen as a step towards increasing statistical significance in exchange for robustness of results. Thirdly, there is no evidence that choice of functional form has a significant influence on the hedonic indexes. Moreover, Box-Cox test may give preference to nonlinear models as a compensation for omitted variables, even if the true functional form is linear.

3 Data Description

The econometric estimate of hedonic regression requires detailed data on prices and relevant characteristics of PCs. In our study we used a data base of monthly commercial advertisements "Puls Cen"[6], that containes both prices and characteristics of PCs for the Russian city of Yekaterinburg. With population over one million people and central location, Yekaterinburg is quite representative: we expect price information from one city to be representative of all Russia, because PC is an internationally tradable commodity and arbitrage makes large price differences impossible. Moreover, a large fraction of PCs in Russia is sold via established national retailers that have universal price patterns throughout the country.

Personal Computer is technically just a set of components and nowadays most companies only assemble computers using spares produced by their separate divisions (outsourcing) or buying them on the market. Consumers can easily combine and upgrade these components themselves according to their needs and level of computer expertise. Each component described by a set of measurable technical characteristics can be used as a proxy for quality measures or product characteristics of a PC. Consumers are not interested in technical characteristics but rather in product characteristics, like PC speed, memory capacity or the quality of a movie picture on the display. These product characteristics are hard to measure, and that is why most researchers use technical characteristics as a proxy. For example, microprocessor speed might be a good proxy for speed, video memory – for video, etc. In this study we use the following characteristics, classified into four groups (Analogous classification could be found at Moch, 2001):

[6] `www.pulscen.ru`

- **Speed.** As a proxy we use microprocessor speed in MHz. We also use a dummy variable for processor type – either Intel (1) or others (0).
- **Capacity.** Hard Disk capacity in Gb and PC memory capacity in Mb.
  - **ODD Dummy.**[7] We used four dummies for the presence of CD-ROM, CD-RW, DVD-ROM/CD-RW and DVD-RW drives.
- **Video.** Video memory in Mb.
- **Price.** Price is the dependent variable. It is a final sale price all taxes included in Russian Rubles.

3.1 Descriptive Statistics

Table 2 shows mean values of PC characteristics over time. We can see a fast growth of characteristics – almost every month average model is upgraded by a more powerful PC. For the period of 21 months (03.2004-11.2005) PCs microprocessor speed has grown by about 30%, memory – about 50%, hard disk capacity – almost 80%, video memory - by nearly 90% and the usage of more productive ODDs, like DVD-RW and DVD-ROM/CD-RW, has increased significantly. Average ruble price has grown by only 19%, and that is slightly higher than CPI growth for that period. Such an increase in the mean value of characteristics is typical for PC markets in most countries and is explained by fast goods rotation new products enter the market very frequently forcing old ones out , quality change, etc.[8]

[7] Optical Disk Drive

[8] For discussion see paper by Moch and Triplett (2002).

Table 2

Descriptive statistics of Yekaterinburg city market for PCs

Month	Pentium-IV Dummy	MHz	Memory. Mb	Hard Disk, Hb	Video memory, Mb	CD-ROM	CD-RW	CR-RW-DVD-ROM	DVD-RW	Mean Price, Ruble
03.2004	39,36%	2119,50	253,76	52,45	75,62	58,89%	9,91%	8,75%	0,87%	12638,38
04.2004	39,48%	2140,32	253,10	52,49	68,74	44,98%	10,68%	10,36%	0,32%	13171,16
05.2004	42,81%	2169,59	273,20	57,88	83,76	47,19%	20,63%	7,81%	1,88%	12655,87
06.2004	41,02%	2188,12	275,93	57,51	82,25	52,40%	12,57%	10,18%	0,60%	12965,10
07.2004	42,21%	2220,84	275,12	57,89	87,06	55,84%	13,96%	10,06%	0,97%	13433,98
08.2004	47,10%	2285,41	301,96	62,47	97,61	44,40%	18,92%	15,44%	4,25%	13604,48
09.2004	45,41%	2263,63	303,51	60,39	96,49	44,98%	6,11%	19,21%	3,49%	13486,31
10.2004	47,62%	2336,15	301,71	62,95	98,29	47,14%	27,14%	14,76%	4,76%	14215,24
11.2004	43,64%	2380,18	304,27	58,35	102,85	47,03%	24,15%	16,10%	3,39%	13656,82
12.2004	49,80%	2402,64	319,74	60,49	120,88	52,65%	21,22%	17,55%	3,67%	13758,77
01.2005	48,79%	2488,31	318,45	65,99	115,32	53,14%	10,63%	21,74%	7,25%	13742,91
02.2005	35,68%	2550,80	359,19	79,38	112,97	22,47%	38,33%	13,22%	9,69%	13981,04
03.2005	34,82%	2553,49	360,57	79,20	115,14	27,68%	36,16%	16,07%	8,93%	13668,07
04.2005	34,21%	2565,63	364,21	79,61	121,05	28,29%	30,92%	12,83%	12,17%	13835,54
05.2005	37,74%	2575,10	350,67	80,49	117,13	27,92%	12,45%	18,11%	15,09%	14282,16
06.2005	37,50%	2578,76	341,54	79,71	123,55	22,60%	9,62%	15,38%	7,69%	13379,99
07.2005	52,58%	2584,43	353,65	76,70	131,63	13,40%	10,31%	18,56%	9,28%	13945,28
08.2005	48,44%	2562,34	359,00	78,75	104,25	12,50%	6,25%	11,72%	11,72%	13241,38
09.2005	47,92%	2602,40	370,67	77,92	98,67	16,67%	5,21%	19,79%	14,58%	13679,58
10.2005	42,24%	2671,17	391,72	88,97	121,10	7,76%	5,17%	35,34%	10,34%	14590,80
11.2005	38,69%	2687,27	372,79	91,09	141,55	10,22%	2,19%	24,09%	17,52%	15015,71

4 Empirical Results

This section consists of three parts. In the first one we would discuss econometric estimates of hedonic regressions. The second part is devoted to the discussion of hedonic indexes estimates. The last part is examining possible biases in elementary price index for PC, which can arise due to the usage of traditional matched models, and in the Russian CPI due to the bias in the elementary price index for PC.

4.1 Econometrics Estimates of Hedonic Regressions

Table 6 (Appendix) shows the econometric estimates of hedonic regressions. Table 7 (Appendix) shows heteroscedastic-consistent p-values of t-statistics.

As for statistical properties of hedonic regression estimates, we would like to admit two points. First of all, most part of independent variables are significant at the 5-10% confidence levels almost in all regressions and have expected signs in most cases. However, there are some variables with p-value "blowing-up" in some periods - Hard disk, Video Memory, CD-ROM and CD-RW. This is might be due to a combination of multicollinearity and data errors.[9] However, in this study multicollinearity cannot bring a significant fraud, because it does not seriously affect the estimate of hedonic price near mean characteristics.

Secondly, estimates of coefficients are not very stable over time due to a number of reasons. First, we should admit that coefficient instability is not only a consequence of a noisy data. Hedonic regression or hedonic function represents equilibrium prices. This makes hedonic function sensitive to changes in preferences, technologies or level of competition on the market. Indeed, Pakes (2002) using IDC data reports significant instability of some estimates of coefficients over time. For example, his estimates of PC's speed coefficient ranges from -4,72 to 16,79 in a basic specification and from - 2,7 to 5,12 for augmented specification in

[9]Hedonic regression requires a quality data, that is really hard to find in Russia, because no attempts have been made by Rosstat to consult sample collection procedures with PC's vendors, which potentially can provide these data. The USA BLS and Statistics Canada experience suggests that these consultation programs can lead a significant improvement in data quality. For evidence – Triplett (2004) at pages 177-178.

different years.[10]

Secondly, omitted variables in combination with multicollinearity and data errors might be also responsible for the instability. With this evidence it becomes clear that quality-adjustment methods, like time-dummy or "option cost" method that use just a subset of all coefficient estimates, should be avoided, because single coefficients might be substantially biased. However, fitted price calculated near the mean characteristics tends to be very stable, independent of omitted variables and other issues, because of the O.L.S. properties.

4.1.1 Omitted Variables

Omitted variables (characteristics) can lead to a biases in coefficients estimates. It might occur in the case when omitted variables are correlated with the variables in regression.In our case, data base does not have a large number of variables and it's very likely that some variables are omitted. Moreover, it seems that these omitted variables very correlated with the included (present) ones. Penetration of DVD-RW was quite low in 2005 and only expensive and very powerful PC were equipped with it. So, if an expensive PC, had a more productive TV card or had additional accessories, that are not captured by the present characteristics, we might expect a biased estimated for DVD-RW dummy variable. Indeed, if we look at the estimates in January estimate for a DVD-RW dummy was 9234,85[11] (about $300) while the price of DVD-RW was only $150. So, the difference of $150 is attributable to the omitted variable bias.[12]

As this example suggests, there are might be several omitted variables and each of them influence included variables. The extent of bias depends on the partial correlation and could be assessed only empirically.[13] But the bias in coefficients estimates does not automatically mean a bias in the corresponding hedonic indexes. Triplett (2004), using large BLS data, shows that omission of variables significantly

[10]For more empirical evidence – see also paper by Berndt and Rappaport, 2001.

[11]Data from Table 6(Appendix).

[12]Triplett (2004, p.154) received the same result with CD-RW dummy variable with the BLS data when he was testing for omitted variables bias.

[13]For an empirical assessment see papers by Triple (2004) and Benkard and Bajari (2003).

biases the estimates of coefficients, but leads only to a small bias in the hedonic price index. Benkard and Bajari (2003) also show that the bias in hedonic price index exist, but it quite modest. They have estimated just a small upward bias about 1,4% per year.

4.2 Hedonic Indexes Estimates

In a situation of a fast technological progress markets are characterized by fast goods rotation, i.e. fast product entrance and exit, and quality change. In such a situation calculation of price indexes is a challenging task. We used direct hedonic method – or more precisely, characteristic method.

4.2.1 Hedonic Price Indexes

In table 3 you can find estimates of hedonic price indexes. As the table shows all indexes show a significant price decline, even though average prices are growing with a pace of Russian official CPI. Base quality index shows the most rapid price decline: GAGR about 20-25% while other chain indexes are around 16% GAGR. Possibly, it can be explained by the properties of PC short life cycle – older, out-of-date PC are experiencing faster price decline, because they are loosing their market share with the emergence of new goods.

Base indexes also show a more rapid price fall (except Paasche) than chain indexes with a greater difference between laspeyres and Paasche indexes: base indexes fall with more than 20% GAGR in comparison with 16% GAGR of chain indexes.

Generally speaking, the usage of base indexes should be avoided until there is a possibility to calculate chain indexes for at least two reasons. First, calculating price change for several periods using only starting and ending points – 0 and T means that we ignore the track, the way the price developed over the period $[0; T\,]$. Traditional index theory and cost of living index theory strongly support indexes that use more information between $[0; T\,]$ (Divisia index, for example). Second argument concerns econometric issues – base indexes are calculated using only two regressions. That in turn, suggests that the error for a base index should be higher

than for a chain index, which in our case uses 21 regression. This should be true due to the diversification of errors which may arise while collecting a sample, errors in prices or characteristics, etc.

Indeed, if we look at the absolute difference between chain and base indexes (Figure 1) we would find out that larger number of observation usually leads to lower difference: simple correlation coefficient are from -0,13 up to -0,42.

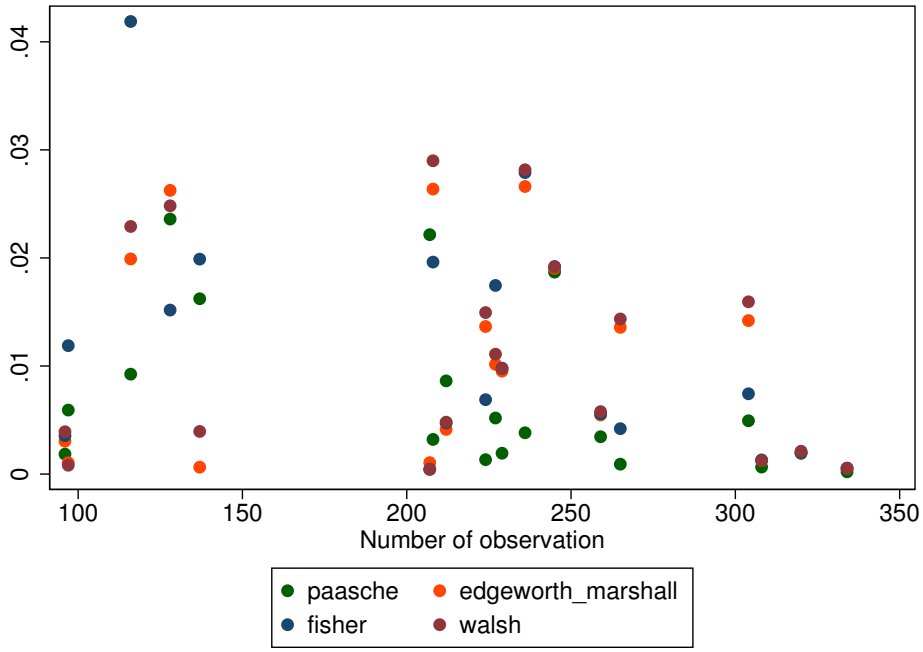

Figure 1: Price indexes: absolute value of difference between hedonic chain and base indexes

4.2.2 Hedonic Quality Indexes

In table 4 estimates for hedonic quality indexes are presented. These indexes show a significant quality growth. That supports an idea that rapid quality growth leads to a decreasing quality-adjusted prices, while the nominal prices are rising significantly.

Base prices index shows the most rapid quality growth: GAGR from 18 to 28% while other chain indexes are around 19% GAGR. As in the case with price indexes, base indexes are significantly different from chain indexes. The first ones grow with GAGR of 18-28%, while the the latter with GAGR of near 19%. It is also worth

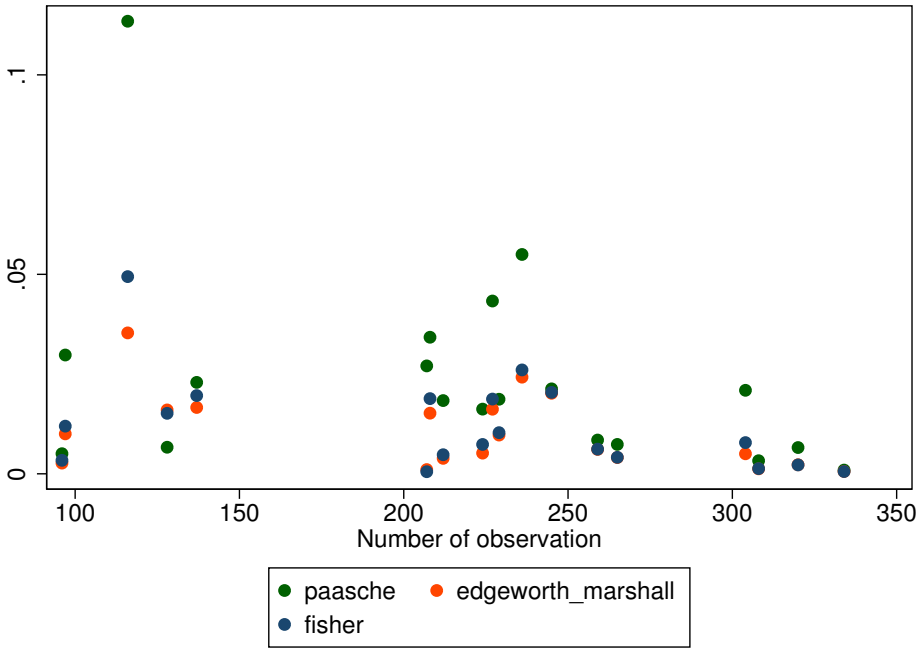

Figure 2: Quality indexes: absolute value of difference between hedonic chain and base indexes

mentioning the dispersion of estimates within these two group: chain indexes seem to give very close estimates – GAGR from 19,12% to 19,23%. While the dispersion for base indexes are several times larger. We think that explanation for this is the same as for the price indexes. Indeed, as for the econometric issues, if you look at the absolute difference between base and chain indexes (Figure 2), one can find that size of a sample has a negative influence on the difference.[14]

[14]Correlation coefficient ranges from -0,43 to -0,38.

Table 3

Estimates of hedonic price indexes on month-to-month basis										
	Chained Indexes					Base Indexes				
Month	Laspeyres	Paasche	Edgeworth-Marshall	Fisher	Walsh	Base quality	Paasche	Edgeworth-Marshall	Fisher	Walsh
03.2004	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
04.2004	107,40%	107,87%	107,63%	107,63%	107,64%	107,40%	107,87%	107,63%	107,63%	107,64%
05.2004	92,40%	92,61%	92,51%	92,51%	92,49%	93,00%	92,41%	92,70%	92,71%	92,70%
06.2004	95,70%	95,93%	95,82%	95,82%	95,82%	95,62%	95,91%	95,76%	95,76%	95,76%
07.2004	100,61%	100,80%	100,70%	100,70%	100,70%	100,29%	100,86%	100,58%	100,57%	100,58%
08.2004	92,94%	92,18%	92,55%	92,56%	92,56%	93,71%	92,53%	93,10%	93,12%	93,14%
09.2004	95,40%	95,36%	95,38%	95,38%	95,38%	93,64%	95,17%	94,43%	94,40%	94,41%
10.2004	100,97%	100,52%	100,75%	100,75%	100,75%	99,18%	101,38%	100,33%	100,27%	100,27%
11.2004	104,53%	104,92%	104,73%	104,73%	104,73%	110,58%	104,54%	107,39%	107,52%	107,55%
12.2004	96,78%	98,28%	97,53%	97,53%	97,50%	94,81%	96,41%	95,63%	95,61%	95,59%
01.2005	95,06%	92,72%	93,83%	93,88%	93,78%	92,75%	94,93%	93,93%	93,84%	93,82%
02.2005	98,58%	97,70%	98,13%	98,14%	98,14%	94,60%	98,22%	97,11%	96,39%	97,04%
03.2005	94,51%	94,52%	94,52%	94,52%	94,52%	93,01%	94,66%	93,15%	93,83%	93,02%
04.2005	96,90%	96,77%	96,83%	96,83%	96,83%	94,93%	97,26%	95,41%	96,09%	95,24%
05.2005	101,03%	100,56%	100,80%	100,80%	100,80%	100,28%	100,47%	99,44%	100,38%	99,36%
06.2005	102,43%	101,91%	102,17%	102,17%	102,18%	106,07%	102,23%	104,81%	104,13%	105,08%
07.2005	98,61%	99,61%	99,11%	99,11%	99,10%	101,59%	99,02%	99,21%	100,30%	99,02%
08.2005	97,47%	97,77%	97,61%	97,62%	97,63%	96,80%	95,41%	94,99%	96,10%	95,14%
09.2005	105,49%	106,41%	105,95%	105,95%	105,95%	104,96%	106,23%	106,25%	105,59%	106,34%
10.2005	93,18%	94,75%	93,99%	93,96%	93,96%	84,24%	95,68%	92,00%	89,78%	91,67%
11.2005	101,96%	100,73%	101,34%	101,34%	101,36%	104,32%	102,36%	101,27%	103,33%	100,96%
Total	-25,96%	-26,08%	-26,06%	-26,02%	-26,10%	-34,69%	-24,82%	-31,37%	-29,93%	-31,98%
GAGR	-16,50%	-16,58%	-16,57%	-16,54%	-16,59%	-22,56%	-15,73%	-20,22%	-19,21%	-20,65%

Table 4

Estimates of hedonic quality indexes on month-to-month basis								
	Chained Indexes				Base Indexes			
Month	Laspeyres	Paasche	Edgeworth-Marshall	Fisher	Base prices	Paasche	Edgeworth-Marshall	Fisher
03.2004	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
04.2004	99,54%	99,97%	99,76%	99,75%	99,54%	99,97%	99,76%	99,75%
05.2004	103,21%	103,44%	103,32%	103,32%	103,43%	102,78%	103,09%	103,10%
06.2004	100,15%	100,38%	100,26%	100,27%	100,17%	100,48%	100,32%	100,32%
07.2004	100,81%	100,99%	100,90%	100,90%	100,75%	101,32%	101,03%	101,03%
08.2004	103,93%	103,08%	103,52%	103,50%	103,54%	102,23%	102,91%	102,89%
09.2004	99,40%	99,35%	99,38%	99,37%	99,60%	101,22%	100,35%	100,41%
10.2004	101,84%	101,39%	101,61%	101,61%	100,98%	103,22%	102,00%	102,09%
11.2004	100,18%	100,55%	100,36%	100,36%	100,54%	95,05%	97,94%	97,76%
12.2004	100,83%	102,40%	101,60%	101,61%	102,79%	104,53%	103,62%	103,66%
01.2005	111,44%	108,70%	110,10%	110,06%	108,84%	111,40%	110,00%	110,11%
02.2005	103,94%	103,01%	103,48%	103,48%	103,39%	107,35%	105,10%	105,35%
03.2005	100,38%	100,39%	100,38%	100,38%	100,23%	102,01%	100,90%	101,12%
04.2005	101,25%	101,11%	101,18%	101,18%	100,74%	103,21%	101,68%	101,96%
05.2005	99,13%	98,67%	98,90%	98,90%	99,22%	99,41%	99,31%	99,31%
06.2005	100,33%	99,82%	100,07%	100,07%	100,01%	96,39%	98,55%	98,19%
07.2005	100,39%	101,41%	100,89%	100,90%	100,99%	98,43%	99,89%	99,70%
08.2005	95,86%	96,16%	96,00%	96,01%	98,23%	96,82%	97,61%	97,52%
09.2005	100,23%	101,11%	100,68%	100,67%	100,40%	101,61%	100,95%	101,01%
10.2005	105,08%	106,85%	105,93%	105,96%	104,06%	118,20%	109,47%	110,91%
11.2005	102,50%	101,27%	101,88%	101,88%	100,87%	98,97%	100,21%	99,92%
Total	34,06%	33,85%	34,00%	33,96%	31,81%	51,73%	39,68%	41,42%
GAGR	19,23%	19,12%	19,19%	19,17%	18,02%	28,42%	22,20%	23,11%

4.2.3 International Comparison

Personal Computer is the most studied ICT product. Nowadays, we have more than two decades of research in this field with large number of papers devoted to the hedonic method with application to PC. A very good overview of hedonic studies can be found in Triplett (2004). Moch and Triplett (2002) present a good international comparison of hedonic price indexes for PC and Berndt and Rappaport (2001) give an excellent quarter-century overview. As mentioned studies suggest, hedonic price index should fall from 20-35% per year (in US dollars). We estimate in this paper a 17% decline in rubles, the currency that have depreciated against the dollar for 1% for the period in question, giving the final estimate of -18% (in US dollars).

From the one hand, this confirms that the PC price trend in Russia and OECD countries is the same. From the other hand, the difference of 2-17% should not to be ignored. We see at least three different explanations for that:

- **Market conditions and competition.** Most OECD countries have well-developed laws of competition protection, collusions prevention, etc. On the contrary, Russia, as any other former USSR country, does not have much experience in developing and implementing pro-competitive measures. This leads to higher barriers of entry to PC market, higher probability of collusion and so on. Companies facing less competition would demand higher mark-ups and resist price decline forced by technological changes.
- **Consumer heterogeneity.** As Pakes (2002) notes, estimated coefficients (consequently, indexes) and seller mark-ups may be affected by the distribution of consumer tastes. So place-to-place differences in price indexes could be simply explained by consumer heterogeneity. For example, demand for higher quality products may be lower in Russia because of the network effect – less people are using PCs for communication and social networking. That might decrease a demand for additional characteristics, which would otherwise be required for photo- and videosharing.
- **Sample bias.** The sample can be biased, because companies might tend to place advertisements on the most valuable (in terms of price-quality relation) PCs, while they may be attributable just to a fraction of total sales.

- **Currency volatility.** The major aim of any price index is to measure a long term inflation. However, current Russian currency volatility may be associated with short term fluctuations and shock which can bias inflation measures in international comparison.

4.3 CPI and elementary price index bias

The use of traditional matched model indexes usually leads to an overestimation of inflation, because they cannot account for fast goods rotation and quality change (for an overview, see Triplett, 2004). In order to estimate a bias in elementary price index we need to compare traditional matched model index with the hedonic counterpart. We suppose that chain "superlative" hedonic index is the most precise index, i.e. appropriate for bias estimation.

We also need a matched model index that is currently used by Rosstat. Unfortunately, Rosstat does not publish official elementary indexes for PCs. Due to that we estimate an interval in which the bias should lie. In order to estimate the bias we use the following scheme. As for the lower bound, we assume that official price index would be at least 100%. (i.e., show no price change)[15] Upper bound is derived on the assumption that official price index would not exceed the average price growth. Average price growth for the sample is 18,81% for 20 months (or 10,90% per year).

Based on these assumptions an upward bias in elementary price index for PC is lying within the interval of 26,06-44,87% for 20 months (or 16,57-27,47% on a 12-months scale).

Personal computers have a 1,13% share in the Russian CPI. Given this, an upward bias in the CPI, caused by PC price index bias, could be from 0,19 to 0,31% per year.

[15]The validity of this assumption could be tested through the inspection of the CPI elementary price indexes – an official elementary price that shows a decline in prices can hardly be found. The official site of Russian Statistical Agency – `www.gks.ru`

5 Conclusion

Our results demonstrate the importance of quality-adjustment in computing price indexes for PCs and other similar ICT goods in Russia. The hedonic PC prices are falling with GAGR from -22,56% to -16,50% during a 21-months period (03.2004-11.2005). Falling prices are accompanied by a significant growth in characteristics and quality. Hedonic quality indexes grow with GAGR of 19,12-28,42%. According to an overview by Triplett (2004), Berndt and Rappaport (2001), Moch and Triplett (2002), hedonic price indexes for the USA, Germany and other countries decline by 20-35% per year. In our paper we estimate a price fall of about 17% (in rubles). Taking into account currency rate change, a price fall estimate is 18% per year (in US dollars), that is lower than the average for OECD countries. We see several reasons for this difference: the level of competition on the Russian PC market, consumer heterogeneity, sample bias and method of calculating the currency volatility.

We also calculate PCs elementary price index bias (16,57-27,47% per year) and a corresponding possible CPI bias (0,19-0,31% per year), that arise presumably due to the use of traditional matched models.

This paper can also have a set of important implications and recommendations for the Rosstat. First, we strongly recommend to start research on whether hedonic methods should be applied into the official practice. Most OECD countries, Australia, Japan, and Taiwan are using hedonic methods for calculating price indexes for many ICT products, including PCs.

Secondly, we strongly recommend beforehand to start process of finding appropriate data for hedonic regressions. It might come either from vendors or research companies. In both cases, Rosstat would have to negotiate sample collection procedures to increase the quality of data. Thirdly, we find that such methods like "time-dummy", "option-cost" or any other that use only a part of all estimated coefficients should be avoided. Methods that use all coefficients and, hence, estimate a price from hedonic regression are more reliable since they do not depend that heavily on omitted variable bias, multicollinearity and other issues.

As for the implementation of hedonic indexes in official practice, we would like to mention two option to be considered: first is either to implement hedonic

methods at regional level or estimate single regression for the whole country. In the first case, each regional branch of Rosstat will estimate it's own regression for it's region that it will be using for quality-adjustment. Second option means that Rosstat will estimate a single regression that will be used at regional levels for quality-adjustment.[16] Second option, concerns the hedonic method to choose. Indirect methods, that use price imputation, requires more resources and data, but reduces the variance of price indexes. Characteristic method is more simple, but requires timely data (each month).

[16]The same idea of a single regression for European Union is discussed by Konijn, Moch and Dalen (2002) within The European Hedonic Center, a project funded by Eurostat.

References

[1] Benkard, C. Lanier and Patrick Bajari (2003), "Hedonic Price Indexes with Unobserved Product Characteristics, and Application to PCs", National Bureau of Economic Research working paper no. 9980.

[2] Berndt, Ernst R. and Neal J. Rappaport (2003), "Hedonics for Personal Computers: A Reexamination of Selected Econometric Issues", presented at "R&D, Education and Productivity", an international conference in memory of Zvi Griliches (1930-1999), August 25-27, Paris, France.

[3] Berndt, Ernst R. and Neal J. Rappaport (2001), "Price and Quality of Desktop and Mobile Personal Computers: A Quarter-Century Historical Overview", American Economic Review, 91(2) (May), pp. 268-273.

[4] Berndt, Ernst R., Zvi Griliches and Neal Rappaport (1995), "Econometric Estimates of Prices in Indexes for Personal Computers in the 1990s", Journal of Econometrics, 68(1), pp. 243-268.

[5] Boskin, M.J. (Chair), E.R. Dullberger, R.J. Gordon, Z. Griliches and D.W. Jorgenson, (1996), Final Report of the Commission to Study the Consumer Price Index, U.S. Senate, Committee on Finance.

[6] Bourot, Laurent (1997), "Indice de Prix des Micro-ordinateurs et des Imprimantes: Bilan dune renovation." Working Paper of the Institut National De La Statistique Et Des Etudes Economiques (INSEE). Paris, France, March 12.

[7] Crawford, Allan (1998), "Measurement biases in the Canadian CPI: An update?", Bank of Canada Review, Spring, pp. 38-56.

[8] Cunningham, Alastair W.F. (1996), "Measurement Bias in Price Indexes: An Application to the UKs RPI", Bank of England, Working Paper, No.47.

[9] Eurostat Task Force (1999), "Volume Measures for Computers and Software", report of the Eurostat Task Force on Volume Measures for Computers and Software, June.

[10] Moch, Dietmar (2001), "Price Indices for Information and Communication Technology Industries: An Application to the German PC Market", Center for European Economic Research (ZEW) Discussion Paper No. 01-20, Mannheim, Germany

[11] Moch, Dietmar and Jack E. Triplett (2002). "International Comparisons of Hedonic Price Indexes for Computers: A Preliminary Examination." Draft. August 2002.

[12] Pakes A. (2002), "A Reconsideration of hedonic price indexes with an application to PC's". NBER Working Paper No.8715 (2002), January.

[13] Konijn, Paul, Moch Dietmar and Dalen, Jorgen (2002), "Searching for the European Hedonic Function for PCs", working paper.

[14] Shiratsuka, Shigenori (1999), "Measurement errors in Japanese Consumer Price Index", Federal Reserve Bank in Chicago, WP.

[15] Silver, Mick and Saeed Heravi (2002), "Why the CPI Matched Models Method May Fail Us: Results From an Hedonic and Matched Experiment Using Scanner Data", presented at Brookings Institution workshop "Hedonic Price Indexes: Too Fast, Too Slow, or Just Right?"

[16] Triplett, J. (2004), "Handbook on Hedonic Indexes and Quality Adjustments in Price Indexes: Special Application to Information Technology Products", STI Working Paper 2004/9, OECD, Paris, http://www.oecd.org/dataoecd/37/31/33789552.pdf.

[17] Wyckoff, Andrew W. (1995), "The Impact of Computer Prices on International Comparisons of Labour Productivity", Economics of Innovation and New Technology, 3(3-4), pp. 277-93.

6 Appendix

Table 5

Biases in CPI, % per year

Source of bias	Canada[1]	France[2]	U.S.A.[3]	Japan[4]	Germany[5]	U.K.[6]
Substitution effect: high level	0,10	—	0,15	0,00	0,10	0,05-0,10
Substitution effect: low level	0,00-0,10	0,05-0,10	0,25	0,10	—	—
Outlet substitution bias	0,07	0,05-0,15	0,10	0,10	0,05	0,10-0,25
Total	**0,17-0,27**	**0,10-0,25**	**0,50**	**0,20**	**0,20**	**0,15-0,35**
Quality change and new goods	0,30	—	0,6	0,70	0,60	0,20-0,45
Total	**0,47-0,57**	**0,10-0,25**	**1,10**	**0,90**	**0,75**	**0,35-0,80**

Based on:[1](Crawford, 1998), [2](Lequiller, 1997), [3](Boskin et al., 1996), [4](Shiratsuka, 1999), [5](Hoffmann, 1998), [6](Cunningham, 1996)

Table 6

Estimates of hedonic regressions for Yekaterinburg market for PCs

Month	Constant	Pentium-IV Dummy	MHz	Memory. Mb	Hard Disk, Hb	Video memory, Mb	CD-ROM	CD-ROM	CD-RW	CR-RW-DVD-ROM	DVD-RW	R2-adjusted	F-statistics	No. of observations
03.2004	2577,492	2756,832	1,578	9,208	14,788	14,362	852,194	852,194	2567,557	5961,297	17655,386	80,35%	156,42	343
04.2004	433,578	2209,127	2,746	9,326	26,171	8,250	1324,931	1324,931	2431,992	7358,506	21645,262	72,42%	90,86	309
05.2004	3943,462	2546,807	1,271	10,289	2,864	17,781	711,144	711,144	1132,225	5779,356	18422,944	80,50%	147,29	320
06.2004	1446,208	2422,462	2,513	10,175	2,525	10,104	933,347	933,347	622,731	5500,407	19126,740	75,16%	112,98	334
07.2004	36,425	1968,418	3,256	10,354	0,241	11,257	1065,613	1065,613	775,562	6268,021	16277,795	65,40%	65,49	308
08.2004	1614,255	1776,872	2,461	6,221	20,822	2,075	849,980	849,980	1152,203	5776,364	15518,609	85,35%	168,05	259
09.2004	-459,433	2605,971	3,171	9,183	17,040	1,047	996,464	996,464	774,169	4269,933	10074,500	81,74%	114,38	229
10.2004	2340,920	2271,440	2,040	14,554	26,282	4,209	-924,382	-924,382	-2381,862	2889,042	5987,404	65,74%	45,99	212
11.2004	4389,910	1647,061	2,147	7,163	4,346	-2,337	-654,085	-654,085	608,705	5756,836	14116,167	75,72%	82,42	236
12.2004	2152,393	1951,696	1,715	5,656	23,706	9,665	412,702	412,702	1483,783	5535,731	16325,193	78,98%	102,88	245
01.2005	72,621	1655,040	2,640	4,892	20,292	10,857	174,280	174,280	2407,564	5181,727	9234,853	86,77%	151,06	207
02.2005	336,362	2429,160	2,172	6,115	9,370	21,354	1027,257	1027,257	377,556	4834,244	8986,832	87,96%	184,40	227
03.2005	-1935,516	2831,782	2,694	4,071	17,775	22,292	1867,839	1867,839	885,381	4048,559	9043,333	85,65%	148,88	224
04.2005	-2898,818	2708,786	2,833	8,632	22,506	14,527	1564,575	1564,575	680,794	2935,114	6694,799	84,16%	179,86	304
05.2005	-3441,562	1627,676	2,959	10,808	11,388	22,499	2590,836	2590,836	761,746	2245,770	6116,202	39,86%	20,44	265
06.2005	-1913,460	2412,073	2,892	6,440	31,059	6,995	1061,151	1061,151	1529,034	4109,553	4854,140	82,35%	108,28	208
07.2005	298,698	2187,562	1,739	5,373	19,540	23,650	2075,281	2075,281	1677,358	3417,243	4351,429	83,77%	56,04	97
08.2005	-541,898	1675,773	2,464	5,845	20,537	21,073	760,776	760,776	1592,097	2009,104	2696,909	78,02%	51,08	128
09.2005	-3531,834	2467,168	3,602	8,545	0,474	14,408	1711,655	1711,655	3407,598	4265,898	4947,470	86,98%	71,52	96
10.2005	-6001,258	2783,891	4,778	6,298	4,187	19,745	866,104	866,104	239,042	2321,040	5043,277	82,38%	60,73	116
11.2005	-5765,723	3849,195	4,046	9,063	23,343	12,141	1534,547	1534,547	1339,171	1635,547	3510,645	85,26%	88,39	137

Table 7

P-value of t-statistics										
Month	Constant	Pentium-IV Dummy	MHz	Memory. Mb	Hard Disk, Hb	Video memory, Mb	CD-ROM	CD-RW	CR-RW-DVD-ROM	DVD-RW
03.2004	0,02%	0,00%	0,00%	0,00%	1,73%	0,19%	0,56%	0,00%	0,00%	0,00%
04.2004	66,00%	0,00%	0,00%	0,00%	0,58%	16,75%	0,11%	0,04%	0,00%	0,00%
05.2004	0,00%	0,00%	0,54%	0,00%	62,69%	0,00%	4,02%	1,81%	0,00%	0,00%
06.2004	8,76%	0,00%	0,00%	0,00%	68,41%	0,01%	0,79%	23,90%	0,00%	0,00%
07.2004	97,49%	0,00%	0,00%	0,00%	97,65%	0,12%	3,93%	28,74%	0,00%	0,00%
08.2004	6,66%	0,00%	0,00%	0,00%	0,01%	36,37%	3,87%	3,29%	0,00%	0,00%
09.2004	62,72%	0,00%	0,00%	0,00%	2,61%	68,31%	1,52%	29,61%	0,00%	0,00%
10.2004	10,14%	0,00%	0,21%	0,00%	0,31%	53,52%	22,36%	1,23%	0,69%	0,21%
11.2004	0,01%	0,00%	0,00%	0,00%	57,16%	54,45%	28,62%	42,08%	0,00%	0,00%
12.2004	5,96%	0,00%	0,03%	0,00%	0,06%	0,01%	61,26%	10,11%	0,00%	0,00%
01.2005	94,71%	0,00%	0,00%	0,00%	1,06%	0,00%	76,92%	0,09%	0,00%	0,00%
02.2005	75,98%	0,00%	0,00%	0,00%	6,26%	0,00%	2,59%	43,06%	0,00%	0,00%
03.2005	12,59%	0,00%	0,00%	0,01%	0,07%	0,00%	0,04%	7,30%	0,00%	0,00%
04.2005	1,47%	0,00%	0,00%	0,00%	0,00%	0,00%	0,05%	12,34%	0,00%	0,00%
05.2005	30,03%	6,80%	5,18%	0,26%	50,58%	1,89%	2,78%	60,66%	9,64%	0,02%
06.2005	9,79%	0,00%	0,00%	0,00%	0,00%	0,01%	1,19%	0,82%	0,00%	0,00%
07.2005	86,18%	0,00%	2,95%	0,41%	3,36%	0,00%	0,82%	3,61%	0,00%	0,00%
08.2005	70,06%	0,02%	0,03%	0,02%	0,65%	0,00%	24,89%	6,76%	1,09%	0,13%
09.2005	1,70%	0,00%	0,00%	0,00%	95,52%	0,54%	0,79%	0,06%	0,00%	0,00%
10.2005	0,06%	0,00%	0,00%	0,03%	64,19%	0,00%	35,47%	83,43%	0,06%	0,00%
11.2005	0,03%	0,00%	0,00%	0,00%	0,09%	0,03%	4,61%	32,79%	0,23%	0,00%