# Automization in the CPI, Quality Assurance and EFQM

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8th Ottawa Group Meeting on Price Indices
Hosted by Statistics Finland, Helsinki, August 2004

[1] The authors thank Ms. Svetlana Gluzman and Ms. Merav Yiftach from the Israeli Central Bureau of Statistics for their assistance in preparing this paper. Any mistakes are the sole responsibility of the authors.

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## 1. Abstract

The Israeli Central Bureau of Statistics (ICBS) has redesigned, in recent years, its procedures for computing the CPI. These included introduction of new technology and automization of fieldwork and editing processes. An important factor in the new system is process control and auditing. In order to estimate the "intuitive" improvement in the CPI, the Consumer Prices Division is in the midst of assimilating EFQM methods, including quality indices of the CPI procedures. The purpose of this paper is to present the methodology that was developed to enhance the validity of the CPI procedures and to discuss the relationship between the EFQM model and the CPI. Quality indices may be constructed through this system in order to track future improvements in the CPI. Portions of this paper will be based on Chapter 12 *Organization and Management* of the new international manuals on CPI and PPI. This coincides with an additional objective of the Prices Department at ICBS: to align the Israeli indices with many of the procedures presented in these manuals[2].


## 2. **Introduction**

In 1996 ICBS initiated the CPI Development project, which was mostly completed at the end of 2001. During the project, ICBS conducted a joint examination of the three intertwined surroundings of the CPI: methodology, technology and field operations- and their connection to the structure and organization of the professional units responsible for construction, collection, computation, analysis, publication and dissemination of the CPI. ICBS believed that the first step in solving many of the complicated issues of the CPI was to build anew the infrastructure of the index, using advanced technological means. The technological and organizational features of the new system were designed to enhance the methodology of the index and the preceding field operations. Therefore, the system has two major and connected parts: the price collection sub-system and the price compilation and analysis sub-system.

[2] Another paper in the series of issues examined within this framework was first presented at the ECE-ILO meeting on Consumer Price Indices, December 2003, Geneva. "The Treatment of Seasonal Products in a CPI" reviewed the feasibility of the methodology introduced in chapter 22 of the manuals, in a "real" CPI, by simulating actual price and quantity data from the Israeli CPI in the seasonal formulae.

**The price collection sub-system** structure is based on a wide area network communication system for ICBS regional offices and operations using handheld and personal computers. Connected to this network are the price collectors (field and office), field supervisors and the commodity analysts. The tasks performed in the collection sub system include detailed scheduling of price collection to each price collector, price collection and automatic logical checking at the micro and macro level. The principle behind the automatic logical checking at the collection stage was to move editing, logical and statistical checks, from the headquarters to the field operations- as close as possible to the reporting occurrence.
**The prices compilation and analysis sub-system** structure is based on a local area network communication system for the CPI headquarters. Connected to this network are the officials providing subject (commodity analysts), methodology, publication and information services. The tasks performed in this sub-system include: planning, quality control, final nesting of price observations (already filtered in the collection process), index computation, analysis, research and publication.

The project has brought about new modes of cooperation and improved working procedures. Analysis, planning, development and assimilation of new technologies have led to already reaped benefits of methodological analysis.

In this paper we will examine the automatic logical checking in both sub systems- collection and prices, and attempt to build quality indices to measure the methodological improvement already achieved or to be achieved in the future. In addition, we will review other quality checks made by officials from both field operation and CPI analysts. Section 3 describes the quality control process enabled by the automization of the CPI; section 4 presents quality indices devised in the measurement process of the EFQM framework and in section 5 a brief summary of the paper and possible work for the future are presented.

### 3. Quality checks in the CPI

These include checks at various stages in the index compilation process: fieldwork, editing and computation stages.

### 3.1 Quality checks in fieldwork

Checking processes begin in fieldwork. The fieldwork is the first stage of current CPI compilation and is a major infrastructure of the index. An important principle to achieve in the automization process is to have editing, logical and statistical checks as near as possible to the reporting occurrence in order to minimize errors at later stages of the index computation. Here we have two kinds of checks at fieldwork- logical editing of data during price collection in the software designed for the hand held computers and back checking of fieldwork by the survey division officials in the main or regional office[3].

#### 3.1.1 Automatic checks

**3.1.1.1. Price changes -** The price entered is compared with the price for the same defined chosen product in the same outlet in the previous month and the price collector is queried when the price change is outside preset percentage limits. The limits may vary according to specific products or consumption groups. The percentage limits were determined by looking at historical evidence of price variation[4]. If there is no valid price for the previous month, for example, because the produced good was out of stock and no transaction could be made; the check is made against the last "real" price entered for the same chosen product.

**3.1.1.2. Maximum/minimum prices-** A query is raised if the price entered exceeds a maximum or is below a minimum price for the group of goods or services of which the particular product is representing. The range is updated every three months and is derived from the validated maximum and minimum values observed for that price transaction in the previous month expanded by a standard scaling factor. This factor varies between price transactions.

**3.1.1.3. Comprehensiveness checks**

Data completeness is vital for the calculation of the CPI. For each chosen product there may not always be many data required, but all data are vital for calculation and

[3] For a detailed discussion on back checking refer to the Manual on CPI, pp. 219 or the Manual on PPI, pp. 311-312.

[4] The percentage limits for seasonal products like fresh fruits and vegetables are 30%, for seasonal clothing and footwear 20%, for non seasonal products 15% are for regular services 10%.

identification of the chosen product at the following month. While the most important data for the index are the prices, if the price observation is lacking some additional data, identification of the product may be insufficient and would require some form of imputation. Therefore, comprehensiveness checks are intertwined inside the system to avoid skipping fields with vital information, like price, product descriptions, etc.

#### 3.1.1.4. Chosen product description

Accurate price transaction descriptions are critical in ensuring price transaction continuity. Descriptions should be comprehensive to ensure that the price collectors or reporters can price the same chosen product in each collection period. They must record all information that uniquely defines the chosen product selected. Accurate chosen product descriptions assist the price collector, respondent, and CPI staff in choosing a replacement for a chosen product that has been terminated and also helps to identify changes in quality. The technological system assures better accuracy and transparency of the chosen product. It enables the price collector to bring much more and accurate information, regarding the sampled product, than he or she could in paper questionnaires. While in the paper questionnaire, there was a limit to the number of characteristics and attributes, in the computer all these are in the database and are shown to the price collector. In addition, each change made in the chosen product, is automatically marked by an "item remark" as a quality change, non quality change, correction/completion, temporarily/ seasonally ran out, permanently ran out, or unavailable. If there hasn't been any change in the chosen product, it will be automatically marked as "no change".

#### 3.1.1.5. Logical editing for running out of items

After three months that the chosen product was in status of "temporarily ran out", a query is raised to remind the price collector to make sure that the sampled product is back in business. If it isn't, he should either replace the sampled product or change its status to "permanently ran out". The options in the item remarks will be "no change", "quality/non-quality change" and "permanently ran out". After three months that the product has been in the status of "permanently ran out", a query is raised to remind the price collector that he should either choose a new product for the defined item, or mark it as "unavailable". The options of item remarks in that case will be "new product" or "unavailable".

### 3.1.2 Back checking and process auditing

The second type of checks is a beck check at the end of each collection period and process auditing. The checks are not automated[5] but performed by the survey division's officials, who function as the auditor of price collection, as another important tool for improving and monitoring data collection. There are four kinds of auditing and back checks in the Israeli CPI:

1. The auditor occasionally accompanies collectors during fieldwork- whether data are collected by phone (CATI) or personal visits (CAPI). The auditor actually ensures that the price collector is following proper procedures and instructions and performing the collection competently. The auditor also functions as a trainer, which means that he (or she) gives some coaching to correct any errors. After returning to the office, the auditor is required to file a standard report detailing his observation. This report includes findings, problems encountered in the collection process, and a recommended course of action. Auditors may advise that a collector receive extra training on certain aspects of price collection, raise general problems where solutions need to be disseminated to all price collectors, or revise existing instructions or procedures.
2. The auditor occasionally replaces the permanent collector in the field. He actually collects prices from the work portion of each price collector once a year. During price collection the auditor assess the competence of the price collector, identifies common mistakes and evaluates the need for extra training, validates that he follows procedures and instructions of price collection, identifies areas where collection is problematical, and most importantly, reviews the comprehensiveness of the description of the chosen product. At the end of price collection, the auditor compiles a report detailing his observation as mentioned in paragraph 1 above.
3. Another way of monitoring the standard of price collection is to carry out a back check – a retrospective check of fieldwork at the outlet level. At the end of each collection period the official from the survey division addresses 10% of the outlets in the sample of each work portion of each price collector, to

[5] However part of the process is based on the information provided by the database of the automatic process of price collection.

make sure that the price collector actually visited the outlet and in addition to see to that the chosen products which were marked as "unsold" or "temporarily unavailable" are actually unavailable or not sold at the outlet.

4. In addition, at the end of each collection period, the official from the survey division calls all the outlets, in which price collection was unattainable for some reason (the outlet was closed, the owner refused to hand out the prices etc.), to confirm the information and to see if there is a possibility to collect prices from them.
5. Another mean for auditing is also a back check of the solutions given to the computer queries by the price collectors. The official from the survey division follows the reference of the price collector to the automatic logical editing of data. The tool he uses to do so is a special module built for follow up and control. For each price collector the auditor perceives the type, the number, and the percentage of queries rose during price collection. At the end of each month the auditor compiles a report, which sums up the treatment of each price collector. Feedback is given to price collectors according to the results of the quantitative data. Thus price collectors recognize the value of each logical editing of data, each logical editing of data gets the appropriate attention, and the quality of the data is improved.

### 3.2 Quality checks by CPI head office staff

There are several types of editing and statistical process controlling carried out by the commodity analysts from the CPI head office staff. The two main categories to be discussed below are (i) weekly checks on the prices and description that are fed into the database on a daily basis by the CAPI and CATI price collectors and (ii) monthly checks on the indices of items, consumption groups and aggregated CPI[6].

#### 3.2.1 Weekly editing by CPI head office staff

Since the computer system enables more efficient editing than a paper based system, one dozen quality checks are performed during the weekly editing process. In order to ensure consistency in the editing process, all analysts are trained to use the queries and to provide identical solutions for same situations. The training process is a

[6] Periodical checks are performed on the sample of outlets and business layers; however these are not part of the monthly process and therefore are not discussed in the paper.

continuous one with the relevant officials meeting at a set time each week to discuss the more complicated issues encountered during the editing process.
The computer supported quality checks in the editing process are:

1. Double check on all automatic substitutions of items
2. Check on items whose attributes have not changed and even so were determined to be non-comparable
3. Check on new items that were deemed comparable to the former ones
4. Check on "non-quality adjusted" substitutions that were deemed comparable.
5. Check on substitutions that include remarks on sale or other special price.
6. Check on substantial price changes that arrived without a remark from the price collector
7. Check on vat. and exchange rates
8. Check on price level compared to other observations
9. Check on price scaling
10. Check on other remarks sent by price collectors
11. Check on remarks sent through message module (new)
12. Perform price scaling according to editing rules[7]

The analysts are required to document cases that may not have been covered in past by the editing rules; these are discussed at the weekly meeting and a consistent solution is formulated to ensure identical treatment and minimization of bias in the editing process.

### 3.2.2 Monthly editing by CPI head office staff

After all transactions in the database have been edited by the commodity analysts, the computation of the product price indices and aggregate indices of consumption groups begins. These stages are observed by three types of statistical checks: (i) index levels (ii) index changes and (iii) contribution of indices to overall aggregates.

[7] Discounts and sales are divided into three categories: (i) regular discounts, (ii) options to receive or purchase at discounted prices other items and (iii) an option to receive more of the same product with a discounted price. According to the editing rules regular discounts are considered price reductions, options to receive other products are not price reductions and options to receive "more of the same" are considered price reductions in certain situations and require price scaling. These are double checked at this stage.

**3.2.2.1** ***Index levels*** – Item price indices are aggregated into product indices. When products are homogeneous and/or services are subject to government controlled price regimes, deviations in item price index levels may indicate a flaw in the index. Therefore, at this stage, the outlying indices are detected by the system and double checked to ensure that the correct prices were recorded in the former stage.

**3.2.2.2** ***Index changes*** – Price change boundaries are narrowed at the computation stage to allow for additional checks by the commodity analysts.
While logical checks in the price collection sub-system queried the price collectors when abnormal price changes were detected, the boundaries in the system must be quite wide in order to allow the price collector to complete the price collection in a fairly flexible manner. This is crucial to ensure cooperation of the outlet proprietors.

**3.2.2.3** ***Index contributions*** – At this stage, contribution to the overall index is studied by the analysts for all five levels of the index, i.e. from the product index level up to the major consumption group level that comprises the total CPI. The contribution to the total CPI is a function of current relative importance (current weights) and actual price changes. Products or consumption groups that were major contributors to the total CPI are double checked to ensure that all indices are logical before publication.

The CPI analysts prepare a monthly report for each major consumption group and refer to any unique or abnormal activity in the index and present these at the monthly meeting held 48 hours before publication of the CPI. At this meeting all groups are compared to ensure consistency throughout the CPI. The computer system was designed with standard queries from the CPI database to assist the analysts in their examination of the index. Highlights from the reports are reflected in the monthly press release and the monthly bulletin[8].

In section 3 we described several procedures of logical checks and process control that were enhanced by the introduction of modern technology in CPI compilation. In

[8] The press release and monthly bulletin include all price indices computed by the Prices Department: CPI and output and input PPI's. The other price divisions review their indices in similar fashion to ensure consistency "across the board".

the following section we discuss some of the quality measures devised in an EFQM framework that were also enabled by the new computer system.

**4. Quality assurance and EFQM**

As mentioned, the computerization project of the CPI in Israel was performed under the assumption that automization will improve the quality of the CPI significantly. Intuitively, we feel that there has been an improvement in the quality of the CPI as a result of computerization. However, beyond intuition, statistical measures for a "quality improved" CPI were not designed during the computerization project.

Possible improvements in the CPI may relate to any of the four fundamental types of survey errors: *coverage, sampling, measurement and non-response*. The first two are considered as "after the fact procedures" and are treated with statistical analysis tools. The latter two are more concerned with procedural flaws during fieldwork or computation stages and may be treated with behavioral tools. By computerizing and elaborating work processes and methodology at all levels of the dissemination of the CPI; by building modern foundations and accessibility to data sources and by moving logical and statistical checks from the headquarters to the field, we believe that we reduced measurement and non response error and thus CPI quality has indeed improved.

In order to empirically measure the improvement in the CPI, we introduced, in November 2002, EFQM[9] methodology into the Consumer Prices Division. The advantage of EFQM is that it relies on input from the CPI staff, rather than assessing quality of the CPI by external auditors[10]. CPI staff participated in workshops for a period of six months and devised short-term and long-term projects to improve the quality of the CPI, and CPI surroundings including services rendered by the Statistical Office to the users of the index. Recommendations connected to issues such as database security, better dissemination to the public, etc. are beyond the scope of this paper and will not be discussed here.

[9] EFOM is the European Foundation for Quality Management excellence model; a self-assessment diagnostic tool used to improve quality and performance. It is driven by result oriented philosophy and allows for flexible management strategy. For a detailed description see the Manual on PPI, pp. 318-319 or manual on CPI, pp. 224.

[10] External audits of a CPI are problematic due to the complexity and secrecy of the CPI.

As would be expected, many discussions during the workshops, focused on ways to estimate CPI quality before and after computerization. In this section we present several quality measures derived from these discussions in the EFQM framework.

It should be stated that a "true" comparison between price data collection using paper questionnaires and computerized data collection couldn't be conducted at this point, because of the complexity in comparing two different processes, and the fact that data from the pre-computerized era were not available[11].

### 4.1 Quality measures of the computerization

The assimilation of the automated price collection system into the CPI was staggered over an eight month period, between May – December 2001. During each stage, a group of price collectors moved from filling paper questionnaires to working with hand held computers (CAPI). The CATI was at the last stage. The data below starts at the beginning of the first stage, i.e. May 2001. The totals in the charts below are the number of observations existing in the database during each month. In the types of indices below we assume that changes in the following variables may indicate an improvement in the quality of the CPI:

1. Increase in number of "real" price observations
2. Decrease in number of observations with correction in the price made by the commodity analyst.
3. Decrease in number of observations with item remarks “temporarily ran out”, “permanently ran out” and “unavailable”.
4. Decrease in number of observations which an automatic query was raised with on line logical editing of data concerning the price.

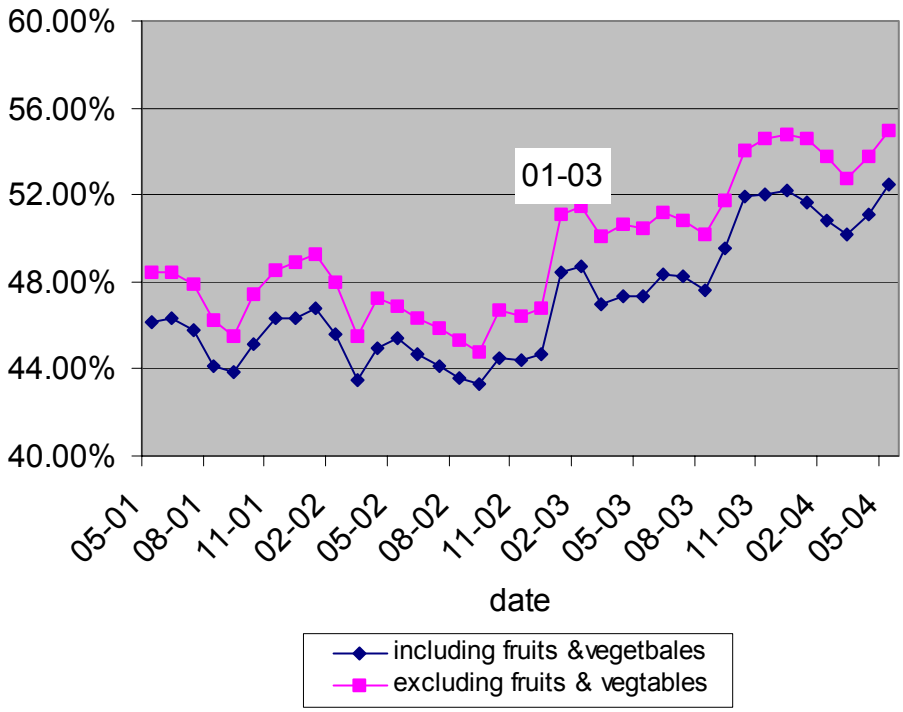
#### 4.1.1 Number of real observations

Collecting prices using hand held computers vs. paper questionnaires allows better accuracy and transparency of the chosen product. In addition, the system leads the price collector in every step in a way that minimizes mistakes and a need to make

[11] Recently we have computerized the housing index and benefited from the EFQM process by designing several quality measures at the planning stage. These will be presented later on in this section.

a correction of the price by the commodity analyst. Thus, if the index were to improve over time, due to the computerized process, we would expect an increasing number of real prices compared to imputed ones.

**Graph 1: percentage of real observations in the price collection sub-system**



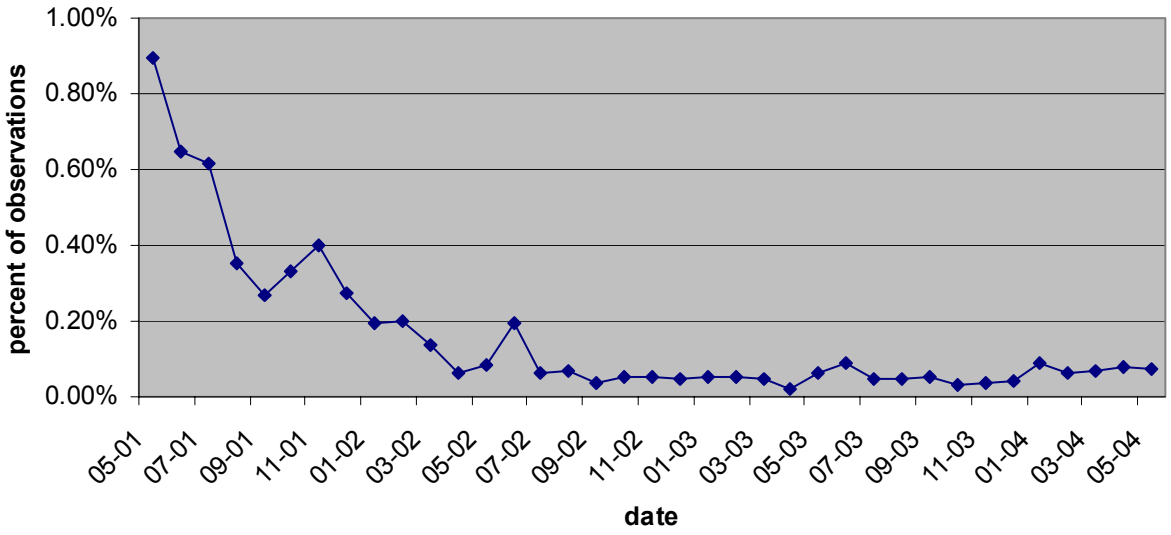

This variable "real observation" consists of situations in which a real price has been collected and thus there was no action of imputation. To be more specific, observations with item remarks "no change", "correction/completion", "quality/non quality change" and "new item" are included. Not included are observations with item remarks "temporarily/seasonally running out", "permanently ran out" and "unavailable". In graph 1 above we see an increase over time in the percentage of "real observations" since the beginning of the assimilation of the system – from 48.5% in May 2001 to 55% in May 2004. The percentage of real observations is always lower for the series including fruits and vegetables, due to seasonality imputations. Another interesting point is the decrease in real observation during the first eighteen months of the computerized system using the hand held computers. This may be explained by technical and other difficulties encountered by the price collectors in the early months of assimilation. After climbing along the "learning curve" the price collectors

consistently increased the percentage of real observations from the last quarter of 2002 and until May 2004.

### 4.1.2 Number of observations with commodity analyst's correction of the prices

Due to the fact that the system leads the price collector during all the process of price collection, we expected to find a decrease in the mistakes made in the field and in the number of observations in which a price correction by the commodity analyst is required.

**Graph 2: percentage of observations with corrections by commodity analysts**




In graph 2 above we observe an immediate decline in the percentage of price corrections during the first stage of assimilation. The tendency of decline continues and after about one year into the automated price collection stability in the percentage of price corrections is achieved (less than one twentieth of a percent of the prices needed correction by the commodity analysts). Obviously, the price collectors have fully exploited the learning curve in this case.

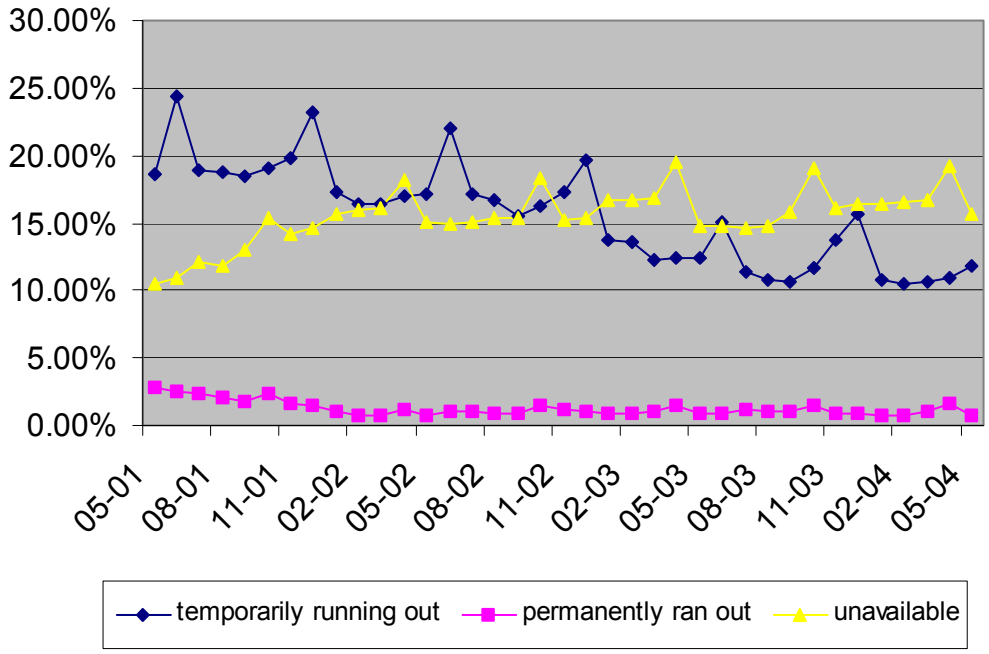
### 4.1.3 Number of observations with item remarks "temporarily ran out", "permanently ran out" and "unavailable".

As we mentioned above (3.1.1.5), after three months that the chosen product was in status of "temporarily ran out", a query is raised to remind the price collector to

make sure that the sampled product is "back in business". If not, he should either replace the sampled product or change its status to “permanently ran out”. After three months that the product has been in the status of “permanently ran out”, a query is raised again to remind the price collector that he should either choose a new product for the defined item, or mark it as “unavailable”.

The instruction for handling those statuses were the same in paper questionnaires but it was much harder to enforce them. We found it interesting to see how the technological means influence the quality of fieldwork and check on one hand, if there has been a decrease in the percentage of observations in statuses “temporarily/ permanently ran out and on the other hand check if there has been an increase in the percentage of observations in status “unavailable”.

**Graph 3: percentage of observations with "non-price" statuses**

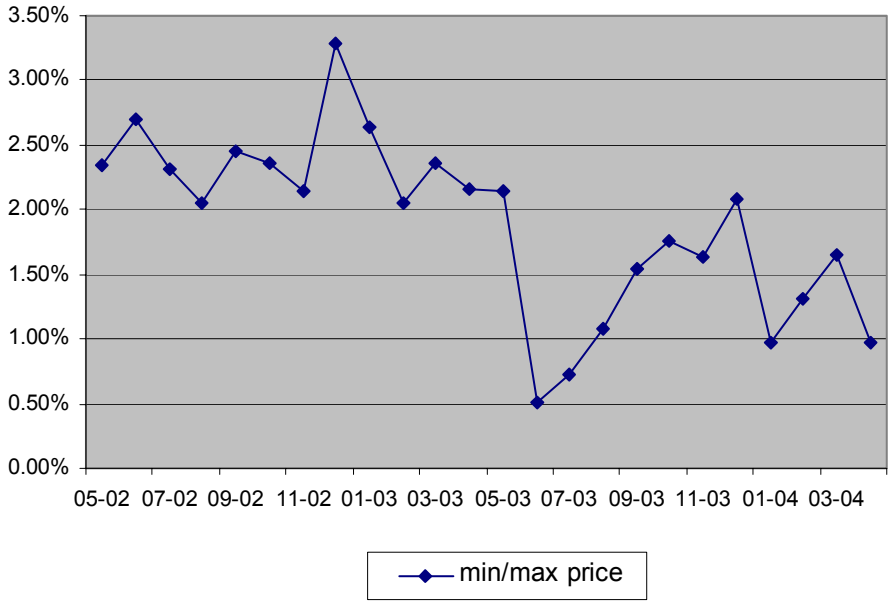



In graph 3 above we observe how the computer system has caused the price collectors to work more precisely according to the price collection rules. Over time the percentage of observations with temporarily or permanently ran out status has decreased (from about 20% to 10%) and unavailable status increased (from 10% to 15%. The increase in percentage of real prices, shown in graph 1 above is on account of the "non-price" statuses, therefore minimizing the need for price imputations.

### 4.1.4 on line logical editing of data

Although there are two kinds of on line logical editing of data in the price collection process - "percentage change" and "min/max", we chose to relate only to min/max. On line logical editing of data concerning the percentage change, may reflect changes in pricing schemes or market conditions and not necessarily changes in quality of the CPI compilation. When comparing the percentage of observations outlying the min/max boundaries in the beginning of the computerized process with the present situation (graph 4 below) we can detect a significant change (from about 2.5% of price observations to about 1%).

**Graph 4: percentage of observations outlying the min/max boundaries**



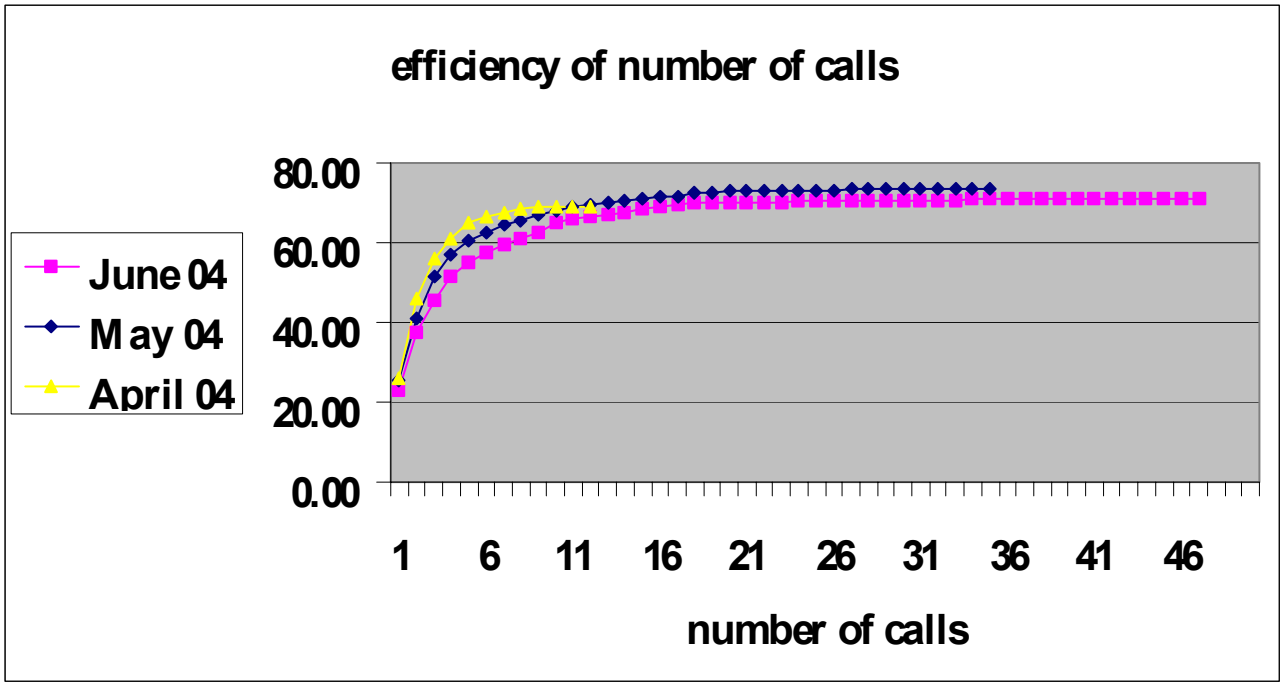

The improved procedures and control of the CPI collection process has decreased imputations and lowered variance, both at the price collection and index computation stages. Using this first set of quality measures has encouraged us that the computerization process has led to enhanced quality of the index, empirically and not only intuitively.

### 4.2 Price Indices of Housing

ICBS is currently (as of April 2004) assimilating a new module into the price collection and price compilation and analysis sub-systems. This module consists of

the housing price indices, i.e. owner occupied housing and rent price indices. The fact that this module was being designed when the Prices Division was well into the EFQM workshops led to the introduction of possible quality measures, already during the planning stage. For example, computer assisted telephone interviewing allows for more efficient calling procedures and therefore enables the price collectors to attempt more calls for each sampled household. However, if one were to analyze the distribution of successful enumeration per number of calls, different decisions on what is an efficient breakeven point may be arrived at.

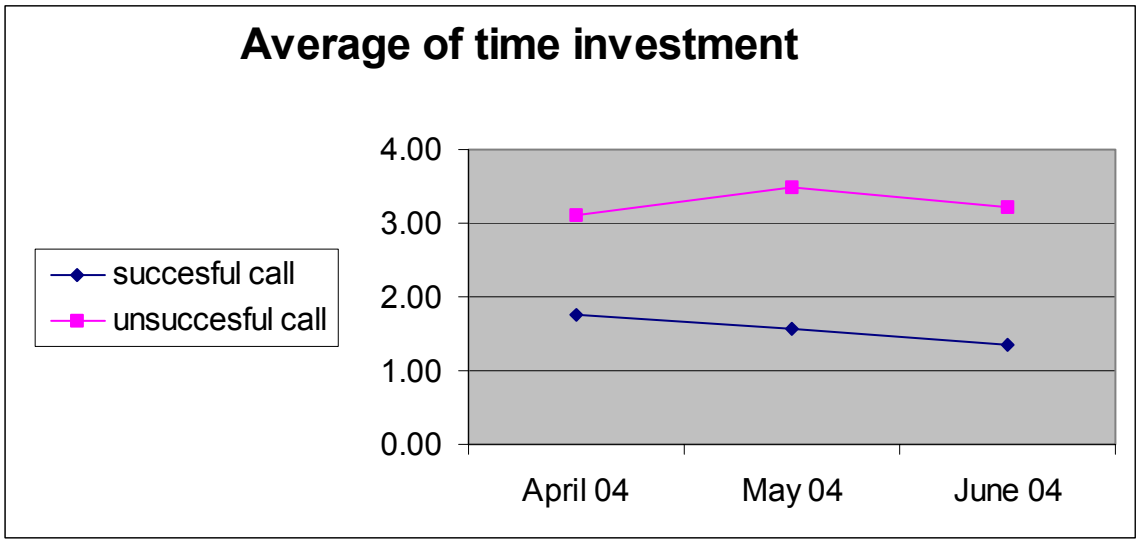
**Graph 5: number of calls per successful enumeration of households in housing indices**




In graph 5 we observe that 65% of the households were successfully enumerated by up till 10 phone calls; an additional 10 calls increased the percentage of completed households to 70% and any call above the 20$^{th}$ did not contribute to the index. Based on this kind of analysis one may decide (subject to budget constraints) what may be an optimal enumeration plan for the index. While we are only in the first months of the new module, by planning quality measures at the design stage and implementing them at assimilation stage, we hope to fine tune procedures in real time.
It should also be stated that the computer assisted telephone interview module for the rent indices leads to reduced costs per call, therefore enabling more calls per

household; a recommended procedure only if it leads to higher response rates at the given budget constraints.

**Graph 6: average time (in minutes) per calls in the housing index**




In graph 6 above we observe a slight increase in the time invested for the unsuccessful calls[12]. In addition we see that the successful calls are handled more efficiently in the CATI module. Since unsuccessful calls can eventually lead to successful ones and increase the response rates of the household rent survey, we are now contemplating the possibility of allowing for increased calls per household and still remain within budget constraints.

The measurement tools that we implemented, although very humble at this stage of EFQM project, seem to indicate that there was an improvement in the quality of the CPI.

## 5. Summary and future work

ICBS completed a development project for the CPI that included enhancement of the technological systems along with improvement of procedures and methodology. Naturally, as in any technological project, most of the financial and human resources

[12] *Unsuccessful calls* are registered in the data base in one of the following cases: refusal, voice machine, non-connection, wrong number, etc. *Successful calls* are tallied only if the CATI questionnaire is completed as far as the critical fields are concerned in the pre-determined design..

were invested in the development of complicated and modern technology and on training for the various users of the system. Quality measures concerning the influence of computerization on CPI procedures were not included as part of the design at the planning stage. Only after the officials felt that all systems were stable and resources were not expended all the time for problems connected to technological systems, we were able to address the issues of quality assurance and continuous improvement of the CPI. This is being achieved by the adoption of the EFQM framework for the CPI. This framework has led to many favorable results for CPI and its surroundings. In this paper we concentrated on measures for quality assurance and continuous improvement. These measures are centered on procedural errors in the index, and on minimization of non-response, i.e. behavioral tools. These in turn may reduce the need of statistical tools that address flaws in coverage and sampling.

Influence of computerization on the CPI is a difficult measurement task, especially when budget constraints do not allow for the operation of manual and computer systems in identical periods. Therefore the quality measures that we devised for the main components of the system can only indicate future improvements and not always explain what happened to the CPI during the "transfer period" from a paper based system to a computer based one. After the introduction of EFQM, additional modules that are being added on to the system, like housing price indices, are already benefiting from our building of quality measures at the design and assimilation stages. Cost-benefit analysis on procedural issues can lead to an improvement of the index in real time and still keep within the budget constraints. Future work includes expanding of quality measures for all fundamental types of CPI survey errors.