

Wired Telecommunication Carriers

Price Indexes

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Service industries have historically provided numerous conceptual and operational challenges in the development of output price indexes. The development of output price indexes for the Wired Telecommunications Carriers industry is an excellent example of difficulties encountered when trying to define a unique output that is compatible with a repriceable unit of measure, while maintaining constant quality for the service provided. Indexes for Wired Telecommunications Carriers (hereafter also referred to as the "telephone industry") were developed independently in the United States and Canada. While classification differences due to the infrastructure of services in each country exist, the methodological approach to pricing the service is very similar. This paper reviews the two countries' experience in developing an output index for telephone services. The paper is structured in four sections.

The introduction presents general remarks on the different types of services covered in the calculation of the indexes and gives a definition of the output for the telephone industry.

Part I examines the two countries different methodologies for development of the price indexes based on the output definition. Experience in trying to measure prices in this sector of the economy led to a definition of an operationally useable unit of measure and a method of collecting output price change over time. The approaches developed for long distance service and local service are examined individually where there are differences due to unit of measure and constant quality considerations. There is little difference in the approach towards residential and business service. This is because most of the differences in these two types of services relate to greater usage of service and not to the service itself. Three units of measure were considered in pricing services in the industry. The three methods, bill, rate, and unit value are examined in this section.

Part II shows the differences in classification of services, derived from the infrastructure of communication services found in the two countries.

Part III of the paper looks at technical aspects of the industry. These are influenced by the approaches examined in Part I but are examined more closely. This section looks specifically at frequency of the introduction of new services, new weights, how quality change is handled, and the revision policies in the two countries.

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INTRODUCTION

General remarks

A unique feature of the Telephone industry is that there is essentially only one production function for basic telephone services. Electronically, there is either an analog or digital signal moving from point A to point B by copper wire or fiber optic cable. It can be sent over a short distance or a long distance. It can be a voice grade signal or a non-voice grade signal. The signal can be generated by a business phone, a residential phone, or by a public phone. Virtually all the capital equipment and labor between those two points is interchangeable among all kinds of basic telephone services.

"Product" lines are differentiated largely by marketing and regulatory considerations. While the signal remains undifferentiated in its production and transmission, it is differentiated in rate setting and in marketing by who generates it, who switches it, when it is transmitted and by the distance over which it is transmitted. It is further differentiated by who buys it.

Service lines and service classes for the telephone industry therefore do not represent different production processes or services as much as they represent different marketing considerations. Some of these considerations are locked into regulations, for example, the business/residence differentiation.

It should be noted that this paper uses examples from traditional narrowband telephone service also known as "Plain Old Telephone Service" or POTS. This has been done to keep examples simple and recognizable. The paper does not deal explicitly with those services generically known as wideband or broadband services that use greater capacity than POTS. However, these services are billed in the same general way as narrowband services, that is they have fixed recurring monthly charges, non-recurring charges, and usage charges.

Types of services and definition of output

Local Service

These are services provided by a local central office. They include basic access to the local telephone lines as well as enhanced local service provided by the central office facilities. Enhanced services include features such as call waiting and call forwarding. Local service can be to a residence, business, or to a public pay telephone.

Public Switched Telephone Service

This includes all long distance or toll service (that is, not local) that is routed through a public network. This category is divided into Switched Access Toll Service and Special Access. Switched access services are routed through a local wire center while special access services

are routed from the customer's premises directly to a carrier's point of presence. Public Switched Telephone Service can be to a residence or business.

A further way to break down services in this area is by geographical boundaries. Toll services in the U.S. can be International, Interstate, or Intrastate. Toll services in Canada can be intra provincial, to an adjacent province, to other provinces in Canada, to the U.S. and to other International destinations. In addition, services may be Inbound, where the traffic is originated by someone other than the party paying for the service (e.g. "800" numbers) or Outbound where traffic is paid for by the user or explicitly authorized by the party paying for the service (e.g. a collect call).

Two other services offered in the industry are private line services and sales to re-sellers.

Private Line Service

The revenue generated by Private Line Services is small compared to local and long distance services, but it does represent a different type of service. Private Line Service is defined as service dedicated to the exclusive use of the customer. The customer controls access and usage to his dedicated lines. Within the limits of the service options, the customer selects transmission speed and other qualitative aspects of the service. These services are not routed through a public network but through dedicated circuits reserved for the use of a specified individual customer. The circuits are measured in capacity from point A to point B, but the customer leases a level of capacity rather than earmarked circuits or switches.

Sales for Resale

Sales for Resale are sales of services or leasing of facilities for use by other carriers. Sales can be network access resales that provide basic access to the public switched telephone network or toll service resales that provide carriers long distance services to their customers.

Definition of output

Output in the Telephone industry is defined to be the provision of telephone voice and data communications via telephone lines thereby providing access to a communications network. The output price is measured by recurring charges and usage fees. Developing an operational method to measure these fees and charges while at the same time conforming to Laspeyres price index theory is a complex undertaking. The paper titled: "Price Indices for Telephone Services" written by B. Schultz and distributed as Room Document during the Third Meeting of the International Working Group on Price Indices held in Voorburg, Netherlands, April 1997, clearly demonstrates, from a conceptual point of view, the difficulty for constructing a price index for telephone services.

PART I

This section reviews the various methodologies that have been designed and experimented to calculate price indexes. They are the bill method, the rate method and the unit value method. Each description includes a review of the problems associated with each methodology at the end of each sub-section.

1.1 The Bill Method

There has always been an assumption in the context of the construction of a telephone price index that it is necessary to have access to two sources of information, a detailed set of telephone bills in a base period and prices for each and every service on these telephone bills through time.

Individual telephone bills are used to define a calling structure in a base period and serve as a weighting pattern for the calculation of a price index. The time span for this base period would be a full year, which is, by definition, free of seasonal variations.

Prices for individual telephone bills that can be followed through time and used in the calculation of price relatives is the other information which is essential for the calculation of the total price index.

This method of proceeding is the conceptually accepted approach in calculating price indexes and movements in these indexes reflect price changes only and are not altered by changes in the calling patterns. Therefore, the ideal approach in this industry would be to provide monthly re-pricing on an actual bill holding all calling characteristics constant. Coupled with a statistically valid sample based on probability selection, this approach should lead to the calculation of an index reflecting pure price change on a month to month basis. In the United States, this was the approach used by the Bureau of Labor Statistics when the industry was sampled and introduced in 1995. This was also the preferred method for Statistics Canada.

An example of a simple bill with different service components and the price for each component is shown below. Long distance calls, for clarity's sake, were excluded from the example.

Example of a local residence bill (excluding measured rate service)	
One party flat rate residence access line, group 1 rate :	\$10.00
Residence touch tone:	\$ 0.75
Call waiting :	\$ 3.50
Call forwarding :	<u>\$ 3.50</u>
Total monthly bill	\$17.75

In the United States, the respondent would be asked to update prices for all parts of the bill and to also provide discount information. In Canada, where tariff prices are not changed, but are subject to discounting, the monthly discount would be solicited.

A respondent providing prices for all aspects of the bill, even if those aspects are never repeated in combination in the exact same way as originally determined, provides a method for pricing the recurring charges and usage fees in a statistically valid way. This prototype methodology can be applied to both of the major types of service in this industry, local service and long distance service. A bill would need to be evaluated each month as though it was being re-priced for the first time. This is an estimated price because the customer may not always make the same number of calls, for the same duration of time, to the same destination each month. The respondent would be asked to estimate a price for a bill that was exactly like the one selected at initiation. Knowledge of how one part of the bill may affect another part is essential for this type of re-pricing. This is because one part of a bill may be discounted based on the presence of other services in the bill. This is in contrast to rates priced separately that may not reflect discounting as well as volume discounts.

Using a Laspeyres index formula of the form

$$I_t = \frac{\sum_{i=1}^n P_{it} Q_{ib}}{\sum_{i=1}^n P_{ib} Q_{ib}} \times 100$$

where:

n = total number of bills

b = base period

t = current period

the price index using the Bill Method is calculated by multiplying the individual rates of each part of the bill. These are substituted for price in the equation to yield

$$I_t = \frac{\sum_{i=1}^n \left(\sum_{j=1}^m R_j q_j \right)_{it} \times Q_{ib}}{\sum_{i=1}^n P_{ib} Q_{ib}} \times 100$$

where:

$$\left(\sum_{j=1}^m R_j q_j \right)_{it}$$

is equal to the total value of a bill i at time t

j = individual call in bill i

m = total number of calls in bill i

and :

R_j = individual call rates for bill j

q_j = quantity of services for bill j

Q_{ib} = service characteristics of bills i in base period b

1.1.1 The U.S. Experience

In the United States, the Bureau of Labor Statistics used the bill method when price indexes for this industry were introduced into the PPI for the first time in 1995.

Actual bills can be very long with complicated billing especially for large business accounts. A relatively simple example with a universe of ten residence bills, that does not include any measured rate service, provides an idea of the complexity of measuring prices using the bill method.

Example of a simple universe of 10 residence bills (excluding measured rate service)						
<u>Bill #</u>	<u>One Party Flat Rate</u>	<u>Residence Access Line</u>	<u>Residence</u>	<u>Call</u>	<u>Call</u>	
	<u>Group 1</u>	<u>Group 2</u>	<u>Group 3</u>	<u>Touch Tone</u>	<u>Waiting</u>	<u>Forwarding</u>
1	\$10.00			\$0.75	\$3.50	\$3.50
2	\$10.00			\$0.75	\$3.50	\$3.50
3	\$10.00			\$0.75	\$3.50	\$3.50
4	\$10.00			\$0.75	\$3.50	
5	\$10.00			\$0.75	\$3.50	\$3.50
6	\$10.00			\$0.75		
7		\$8.75		\$0.75	\$3.50	\$3.50
8		\$8.75		\$0.75		
9		\$8.75		\$0.75	\$3.50	
10			\$7.50			

Recognizing that respondents may be resistant to re-pricing actual bills, fallback procedures were developed. These procedures were intended to maintain the essential characteristics of the bill and also preserve the calling patterns of the customer.

In the case of local service, fallback procedures began with a step of disaggregation to a single line if there was more than one on the selected bill. Recurring charges would be easily captured, but collecting measured rate service, that is service based on the number of calls or the number of times a service is used, could be a potential problem. If individual calls were available from company records on a selected bill, the fallback called for a statistical selection of calls based on probability. If only summary data were available on a bill, a statistical selection based on probability of a combination of time bands and distance bands were requested.

The resistance to pricing an entire bill for message toll service (long distance) was expected to be even greater than for local service. Complexity of service and length of the bill could be expected to be even greater, particularly for large business customers. As a result, a fallback procedure called for a statistical probability selection of phone calls. This is similar to the procedure developed for local message rate service.

Recognizing respondent resistance to the use of any part of an actual bill, a second fallback was developed. This involved disaggregation by characteristic rather than actual customer bills and then re-pricing the characteristic, which had been chosen through time. This is essentially a rate plan approach that will be examined in the section describing alternative approaches.

In the U.S., there was some resistance to providing information using the bill method. However, most respondents agreed to supply information using this approach, with the notable exception being the large providers of toll service that is based on usage. The section below examines other problems of pricing wired telecommunications services using the bill method.

In the U.S. respondent cooperation was a concern at two points, first at the collection visit and then during re-pricing.

At the collection visit, respondents had records of bills, but not in a way where detailed services would be easily identified. This meant that selection would likely be based on a random selection not on revenue size. Small bills would have as likely a chance of selection as large bills. This would result in a sample limited to or biased towards residence and small business accounts with little selection of large accounts. Not all companies did this, but enough of them did to provide a probable bias in the sample in favor of basic services. It also meant the volume discount changes, most prevalent in large accounts, would not be shown in the index.

During re-pricing, the "frozen" bill selected at initiation would be updated using rates for different recurring charges contained on the bill, in addition to the fees outlined. Some respondents balked at this re-pricing method, not because they doubted its validity, but rather because they claimed it would be a burden for them to first look up a list of rates and then enter these rates into the bills. In some cases, respondents would only cooperate if they could send in rate sheets that would be updated in the BLS headquarters office in Washington.

Bundling or unbundling of services can also create pricing problems in the telephone industry. Bundling and unbundling refers to consolidation (bundling) or separation (unbundling) of related characteristics. Historically, basic residential local service consisted of a monthly charge (rate), plus taxes etc., and a nominal charge for installation. Companies began to rationalize their billing practices by instituting marginal cost pricing. Originally, the recurring monthly charge contained non-recurring or "one-time" costs for "order-writing" (general administrative overhead for setting up or changing a service), installation, moves (physically changing the phone locations at a customer premise), and access to the public

switched telephone network. Over time, these nonrecurring costs were removed from the cost basis of the switched access rate and separately rated. Re-pricing problems occurred when some or all of these charges were unbundled. For example, consider the case of when an order writing charge is unbundled from the monthly recurring charge. The order writing charge is a one-time charge (per occasion) whose cost had been averaged in with other costs in the recurring monthly charge. If the respondent does not note the unbundling of services and price change is reported, there is no opportunity to quality adjust for the change. Unless all the bundled services are outlined in the specification the effect is likely to be to show price change when in fact the change was a result of a service becoming unbundled.

An additional problem with bundled services in this industry is the difficulty for respondents to determine how much effect a change in one part of a bill has on another part of the bill. Telephone companies often discount parts of one recurring service as a result of a change in another part of a recurring service. For example, a new account with features such as caller ID or call waiting, with basic service may be charged a different price than an existing account with the exact same service. There is clearly some type of price change involved in this scenario, but because the repricing specification is based on a specific bill, this type of price change would not be reflected. Another example is if a bill based on a flat rate per month service was unbundled to a message rate access line plus charges for usage. Respondents would have no direct knowledge of what effect a change like this would have on an accompanying rate change.

The introduction of new rate plans can be a mechanism of price change that would not be captured using the bill method of pricing. This highlights another shortcoming of the bill method. Companies introduce new rates in a number of ways. One way is to eliminate existing plans that would necessitate customers being switched to a new plan. Changes such as these would normally get reflected in the price index as price change or if necessary, quality adjusted if sufficient information were available. Therefore, this type of change does not create a problem using the bill method of pricing. However, if the company switched some customers and not others, the index would likely not reflect the shift of some customers to the new plan because the old plan continues to exist. Changes such as these may bias the index because the new rate never gets reflected in the index until the industry gets re-sampled. A third method, similar to the second is that companies "grandfather" in the old rate for existing customers, but new customers must pay according to the new rate plan. These types of transactions create a new item bias that is not likely accounted for in the index using the bill method.

The intent of the bill method was to preserve the characteristics of the bill and the calling patterns of the customer. These are in fact maintained by the bill method, but they did not necessarily always reflect overall price change. For the bill method to be a viable method of pricing, it requires that knowledgeable respondents be able to provide an estimate of the effect of those changes on the total bill by examining the discounted parts. Respondents were not always able to do this. A respondent providing rate information would also find difficulty in this regard. This is because they would be estimating a price for a transaction that does not exist on its own. One rate is likely bundled with other rates to form a rate plan or bill. An advantage readily apparent with rate pricing is that it does provide a re-pricing

method easily recognizable by respondents. At first it appears that it also can be equally well applied to both local and long distance service. Although customers may not actually be purchasing a rate, and therefore in a sense it is an estimated price, it is the foundation of what all transactions prices are based on. It could be considered a transaction price albeit not truly reflecting all discounts, but in many cases no worse than pricing bills.

1.1.2 The Canadian Experience

In Canada, when presented with the bill approach, telephone company representatives showed reluctance in supplying such detailed information, arguing that it would be time consuming, that data were decentralized and that it would necessitate an unacceptable amount of resources, both human and material to meet these requirements. In fact, they were not convinced of the validity of calculating a price index in this manner.

The telephone companies reasoned that had they supplied the needed information this approach would have necessitated the re-pricing of millions of individual calls at every period. To put it another way, the construction of a price index based on this approach would have been equivalent to running another billing system for all telephone companies at every period of time. Even tariffs for long distance calls that do not change frequently through time have new plans introduced at any point in time by various telephone companies. This makes the calculation of such a price index even more complicated to manage.

Sampling of individual telephone bills was proposed as an alternative to reduce telephone company response burden. This approach was also dismissed based on the reasoning that if databases of individual telephone bills were to be read for sampling purposes, it was just as easy to ask for all the individual bills. However re pricing a sample of bills would have been a simpler exercise than re pricing all individual bills.

Assuming that telephone companies would have adhered to this approach of sampling, an additional unknown was whether the sample of bills would have been drawn according to sampling specification (either one out of ten bills for example or one out one hundred) and would have been representative of the entire universe of telephone bills. There was no study done to determine the optimum size of such a sample.

1.1.3 Conclusions

1. Good respondent cooperation is the key to the development and publication of any price index. The first problem in the case of Wired Telecommunications Carriers was that organizing information by telephone bill required respondents to be agreeable to providing detailed information at the collection interview that was not necessarily compatible with the way that they kept these records.
2. Respondents would be asked to report ongoing monthly information in a manner that was not always compatible with the way that they conducted business.
3. It would be difficult to capture volume discounts.

4. There would be a problem though not readily apparent in pricing a bundled service via the bill method. If the service became unbundled at some point, respondents would have difficulty providing values for the services that had been separated.
5. Related to bundling and unbundling of services is an additional problem. Respondents may not know how a change in one part of an estimated bill may affect the price of another part of a bill that had been estimated, a crucial concern for pricing by the bill method.
6. For practical reasons, a sample of bills could be very small, likely leading to a large variance for the sampled items.
7. Price change as a result of the introduction of new rate plans would not always be captured using the bill method.
8. The resulting price index would be upward biased because it would not take into consideration the fact that people do change telephone companies when more advantageous plans are introduced by competitors. The same call through time could be re-priced at too high a level.
9. The resulting index could be biased downward for consumers remaining with the same telephone companies. The assumption that consumers would immediately take advantage of the introduction of new calling plans is not necessarily true. In practice, people have to phone telephone companies to ask for a change in plan. If they do not, they cannot take advantage of the introduction of a new plan.

In the U.S. the combination of all of the problems outlined above prompted the BLS to reexamine its methodology for pricing the telephone industry for the sample scheduled to be introduced in 2000. Though Statistics Canada did not conduct experiments with detailed telephone bills, it had arrived at a similar conclusion. An alternative method of pricing was needed. The result was that pricing would be based on a different approach outlined in the section on alternative methods for pricing telephone services.

Two alternative methods were considered for pricing telephone services; the rate method and the unit value method. The benefits and problems with these methods are examined below.

1.2 The Rate Method

An alternative approach to the Bill method was to use rates or tariffs as a methodology to measure price movement in the telephone industry. Rates are based on a specific set of characteristics, such as unlimited calling within a given area code with accessibility to a given number of telephones. As long as service characteristics are completely specified and held constant, rates can be an acceptable method of measuring price.

Again using a Laspeyres index formula of the form

$$I_t = \frac{\sum_{i=1}^n P_{it} Q_{ib}}{\sum_{i=1}^n P_{ib} Q_{ib}} \times 100$$

And substituting rates for prices in the current period, yields

$$I_t = \frac{\sum_{i=1}^n R_{it} Q_{ib}}{\sum_{i=1}^n P_{ib} Q_{ib}} \times 100$$

where: R_{it} = rates for bill i at time t

and: Q_{ib} = quantity of rates i in base period b

It has already been established that pricing by the bill method was considered too burdensome. In Canada, companies refused to cooperate if the bill method was used. In the U.S. where the BLS had better success in pricing bills, respondents complained that they would have to look up rates to enter into selected bills, an additional step in pricing. In some cases, respondents would only cooperate if they could send in rates that would be entered onto the bills. This required additional work by BLS. Rate information supplied by respondents would be entered onto the bill selected at initiation for index calculation at the headquarters office by BLS staff. Whether respondents entered price information or BLS entered the information, the bill method was a two step process. Repricing by the rate method would eliminate the second step in this process.

Revenues from the example of a universe of bills from the previous section, and a chance of selection for each rate are calculated in the chart below.

Example of a simple universe of residence rates with relative chance of rate selection				
	# of bills	Billing rate	Revenue (dollars)	Chance of selection
One party flat rate residence access line, Group 1	6	\$10.00	\$ 60.00	0.42105
One party flat rate residence access line, Group 2	3	\$ 8.75	\$ 26.25	0.18421
One party flat rate residence access line, Group 3	1	\$ 7.50	\$ 7.50	0.05263
Residence touch tone	9	\$ 0.75	\$ 6.75	0.04737
Call waiting	7	\$ 3.50	\$ 24.50	0.17193
Call forwarding	5	\$ 3.50	\$ 17.50	0.12281
Total			\$142.50	1.00000

Using rates would require only one entry per rate selected and would be based on probability.

As can be seen in the above chart, concerns about a bias towards smaller accounts would be somewhat alleviated by using rates. Companies maintain records for different rate categories, since they are part of rate plans. Reporting on rates for a large versus small account would be no different to a respondent, unlike a bill that was large or had complex billing.

It is clear that the rate method addresses a number of problems associated with the bill method. It offered improvement over the bill method in some areas, but this is where there is a divergence in approach for local service and long distance service. Much of local service is based on flat rate charges. Where there are no charges for usage, it is appropriate to use rate information for pricing, but where service is based on usage, another approach was needed.

Although using rates versus bills for local service had advantages, there is one drawback associated with the rate approach. Rates are the basis of transactions, but they do not necessarily reflect all discounts. Therefore, it would be necessary to solicit an average discount for each rate selected.

The success of using rates for local service is dependent on completely specifying the characteristics of the rate. This is necessary so that any changes in characteristics can be quality adjusted. All rate elements need to be specified, but important characteristics including rate group boundary changes and number of telephones in a local calling area need to be specified. Changes in these characteristics are examined in the section on quality adjustment in Part III.

The U.S. uses the rate method to price local service that does not depend on usage. However, local service that is dependent on usage is very similar to long distance service. The characteristics of such service continually change, except that all usage has a common denominator. It is based on a per minute charge. It was necessary to develop an approach suitable for pricing a service based on usage.

1.3 The Unit Value Method

The approach that the BLS in the U.S. and Statistics Canada decided to use for local service dependent on usage and all long distance service was one based on unit values. This method was found to provide solutions to the problems in both the bill method and the rate method. This section briefly examines how using unit values provides a solution to many problems found in the other methods. It looks at how price indexes are calculated and possible drawbacks of using unit values in price indexes.

A unit value for telephone services is defined in terms of minutes. The revenue for a uniquely defined telephone service (based on destination, direction, etc.) is divided by the number of minutes consumed to yield a unit value. The value is multiplied by its base weight and aggregated within categories. Categories maintain their weight relative to other categories. In this sense, the resulting index conforms to a fixed weight Laspeyres Index. The U.S. employs a methodology using "new" rate plans (usually discounted) that come from "old" rate plans within a category. They are regrouped within the category and can always be incorporated within the index. . In effect, the unit value method can be considered as the rate method, but on a per minute basis. Telephone companies keep records of this information and track it on an ongoing basis for their own purposes. A detailed summary of price index calculations in both the U.S. and Canada is provided later in this section.

The benefits of this approach over the bill method are clear after considering many of the potential weaknesses in the bill method. It also has many of the beneficial aspects of the rate approach because it is an extension of this approach. The following is a brief review of its advantages over the bill method and also an explanation of how using unit values can solve problems with the rate method.

There would be no bias towards smaller accounts using unit values. While respondents may steer away from large or complex bills under the bill method, there would be no proclivity to do so and in fact they could not, under the unit value method. In addition, respondent burden would be reduced under the unit value method as compared to the bill method. Respondents keep records and are interested in per minute values for their own financial interests. They would merely be providing information that is part of their routine record keeping.

The unit value approach also provides a solution to a potential problem with the rate method. Using rates, price change may not be captured due to the bundling or unbundling of services. Neither the bill method nor the rate method of pricing will always capture these changes when service is tied to usage. The bill method requires respondents to be knowledgeable of how changes in one part of a bill affect another part of a bill. The rate method requires the respondent to know how a change in one rate causes change in other rates. Also, just as important, a rate plan change may cause a number of customers to move to another rate plan. This too may not be readily apparent to a respondent. However, the information is available in the record keeping for revenue and number of units in one plan versus another. Respondents track "where customers go" by the number of minutes in a given rate plan. Unit values are calculated based on the assumption that tariffs within a detailed service category are relatively homogeneous. Although the U.S. allows for new rate plans no new

minutes are created outside a specific category (thus maintaining the fixed weight methodology), but are reallocated within the category. In this way, unit values account for price change as a result of bundling services or unbundling services as compared to pricing via the bill method or the rate method.

The introduction of new rates is often used as a mechanism to trigger price change in the telephone industry. Conventional methods of pricing will continually follow prices or rates as long as they are in existence, unless there is a mechanism for replacements. Only when a new sample is collected is there a systematic replacement of bills or new rates. However, unit value pricing is useful in capturing price change as a result of the introduction of new rates. Much the same as an unbundled service, new rates are established at the "expense" of an old rate. In the U.S. methodology, no new minutes are created outside of a relatively homogeneous category but are reallocated within a category, again maintaining a fixed weight methodology. In this manner price change as a result of new rates are incorporated.

The pricing approach for private lines is the same as services priced using the unit value method except that instead of being in terms of minutes they are priced in terms of a standardized kilobits per second per mile.

The pricing approach for sales to resellers is the unit value method. Sales to these establishments are in minutes of service.

1.3.1 Calculation of the Price Index

The index calculation begins with the definition of a unit value at the most detailed level of aggregation. The unit value is defined as the ratio of revenues in dollars to quantities in minutes. This method allows the re-pricing of a service, represented by a group of sub-services having the same price structure through time, by using their generated revenue and minutes.

It is important to have a homogeneous grouping of sub-services that can be re-priced from one period to another. Characteristics of calls at the most detailed level must be nearly identical to expect similar price movement in each category. Substitution inside a group of services should have hardly any impact on the price change of a service at the smallest level of detail if tariffs within the individual category are homogeneous. At the limit, the individual service category should be defined as a single long distance call to be able to capture pure price changes through time. In practice it would require too much resources to be able to re-price all these individual telephone calls.

After a service unit price has been calculated, it is multiplied by its corresponding monthly average quantity of minutes in the base year. This calculation answers the question: "How much revenue would have been generated in the current period, if the volume of minutes had remained the same as in the base period?" This multiplication results in what is called hypothetical revenue and represents the numerator of the Laspeyres price index formula. The Laspeyres price index will be obtained by taking the ratio of the hypothetical revenue to the base period revenue.

Discounts for period t are valued as a percentage of total gross revenues at period t . These percentages represent the sum of different discounts applied for any level of service by plan. This means that it is not possible to measure the real price paid for any particular long distance call because the discount for any particular service is unknown. Therefore, the value of the discount can only be used at the aggregated level of each type of service.

1.3.1.1 The U.S. Approach

Beginning with a Laspeyres index formula

$$I_t = \frac{\sum_{i=1}^n P_{it} Q_{ib}}{\sum_{i=1}^n P_{ib} Q_{ib}} \times 100$$

And substituting unit values for P_{it} yields:

$$I_t = \frac{\sum_{i=1}^n \left(\frac{\sum_{j=1}^m P_{jt} Q_{jt}}{\sum_{j=1}^m Q_{jt}} \right) \times Q_{ib}}{\sum_{i=1}^n P_{ib} Q_{ib}} \times 100$$

where:

$$\left(\frac{\sum_{j=1}^m P_{jt} Q_{jt}}{\sum_{j=1}^m Q_{jt}} \right) = U_{it}$$

the average unit value of all the individual phone calls j within a specific service sub category i at time t

and: Q_{ib} = quantity of minutes of service sub category i in base period b

This can also be restated as:

$$I_t = \frac{\sum_{i=1}^n U_{it} Q_{ib}}{\sum_{i=1}^n P_{ib} Q_{ib}} \times 100$$

The U.S. unit value index defines a homogeneous grouping at a level of detail that includes how a call is routed to its destination, the direction of the call, and geographic characteristics. How a call is routed is dependent on whether it is switched through the public network or whether it is routed through the local wire center. The direction indicates that the call is either inbound or outbound. The geographic characteristics refer to whether the service is intrastate, interstate, or international. Other characteristics, such as time of day are assumed to be relatively constant through time, although there may be short-term fluctuations.

Specifically:

1. The BLS receives monthly data (revenue and minutes) from responding companies for a set of uniquely defined services. The data is for all current accounts in the uniquely described service. Therefore it includes new accounts. The monthly data comes with revised data for the previous four months.
2. The information pertains to smallest level of detail (e.g. Business toll, Switched access, Outbound, International) for each responding company.
3. Revenue is divided by minutes at the smallest level of aggregation to obtain a unit price ($R/Q=P$) for each service from each company.
4. If not already included in the company reported revenue, a percent volume discount is applied to yield a net unit price.
5. The unit price for each item from each company is multiplied by the base weight established for the item. The base weight for each item is a function of a company's chance of selection in the original sample and company revenue obtained at the collection visit.
6. The current revenue for all items is aggregated within a cell (the lowest level of a published index).
7. The price index at any given level of aggregation is calculated by dividing the current month revenue by the revenue at the base date.

1.3.1.2 The Canadian Approach

As for the concept of unit value, the Canadian approach is essentially the same as the U.S. approach. The only difference is in the level of detail of classification of the service.

A unit-price can be defined as:

$U_{c,m,t}$ for service plan c , mileage band m , in time period t , as the ratio of total revenue from the sale of Telephone services $i = 1, \dots, N$ to total quantity of output transacted in the same time period t . That is:

$$U_{c,m,t} = \frac{\sum_{i=1}^n P_{c,m,t}^i Q_{c,m,t}^i}{\sum_{i=1}^n Q_{c,m,t}^i}$$

Geographic characteristics, period of the day, mileage band and country destination for overseas long distance calls are different levels of specifications which allow for the identification of a homogeneous group of services with minimum substitution.

The price index was calculated retrospectively from a database containing the same customers from the beginning of the period to the end of the period. Having the same customers through time reduced in a way the substitutions between categories of services, which could be attributable to new customers or to customers leaving a telephone company. For the current or ongoing time period, the price index calculation was based on revenues and quantity figures of all customers, including new comers and excluding customers who leave a telephone company. This approach introduces the potential for revisions when the index is published on a higher frequency than an annual index and comes into contradiction with the calculation, which was performed initially. It is not possible to identify customers who will remain with the same company for the current period under review.

The calculation of the price index was done according to the following steps:

- 1- Revenues and quantities were available at the most detailed level, that is; mileage band (distance covered by a communication), specific period of the day (rate = deep, peak, shallow, unknown), specific settlement (geographic arrangements called intra, adjacent, Canada, USA, overseas, other).
- 2- Revenues were divided by minutes at the most detailed level of aggregation to obtain a unit price ($R/Q=P$).
- 3- Unit prices of particular services were multiplied by the minutes of their corresponding monthly-averaged base period. Any hypothetical revenue figures (the numerator of the Laspeyres price index formula) obtained at an aggregated level were the result of the sum of revenues from a lower level of aggregation. Hypothetical revenues which would be derived by multiplying an *aggregated unit price* by its corresponding average minutes from the base period would give different results than results obtained from detailed calculations because of aggregation biases.
- 4- Price indexes were calculated by dividing hypothetical revenues for the current period by the corresponding actual revenues of the base period.
- 5- Calculations of the price index after discount at the total plan level were done by applying current period actual discount percentages to current period total plan hypothetical revenues. Net price indexes, were therefore equal to the ratio of the total net hypothetical revenue in the current period over the total net average real revenue of the base year.
- 6- At the end of the current year, a new average of minutes and revenues can be calculated to be used as a base period for subsequent years.

Calculating hypothetical revenues at the most detailed level of aggregation allows the construction of price indexes at different levels of aggregation, either geographical aggregations or time aggregations.

Preliminary analysis of the unit values for some individual service categories showed that there were regular fluctuations through time when price stability was expected to be the norm. This is an indication that the service categories may sometimes not be homogeneous

enough to isolate pure price change from calling pattern changes. More work needs to be done in the definition of the classification of these services to attenuate this problem.

1.3.2 Drawbacks of the Unit Value Approach

The problem with unit value pricing is that significant product mix problems prevent its use in Laspeyres type indexes under most conditions. However, Statistics Canada and the BLS in the U.S. concluded that the relative homogeneity of rates in the telephone industry could lead to a more representative index than with the bill method. The question to consider was whether the variance introduced as a result of price averaging would be better, compared to the bias introduced in imperfect sampling of bills and difficulties in maintaining a constant quality index by using the bill method. For telephone service based on usage, current period prices are not directly observed, they are derived from current period revenues and from current period quantities. Therefore it has been argued that the change in the calculated price index for an individual service category, from period to period would show both price changes and calling structure changes. How much of this distortion exists has not been quantified.

Intuitively, if the price variance within an individual service category is small from one period to the next, it could be expected that structure change would have very little impact. Therefore, most of the change would be attributable to price changes within the individual call category and not to structure changes. At the limit, if prices within a detailed service category were all identical within a given time period, the calculated price index based on unit values and on prices would be identical for the category. Further, if the individual service category were defined finely enough, the price index based on unit prices would tend to be equivalent to the price index based on observed prices.

As there is no reason however why the calling structure of all the individual categories would remain exactly the same through time, though finely they may be defined, the unit value approach will not guaranty a true measure of pure price changes through time but will only be an approximation. Aggregation of individual telephone calls into service categories is also a source of bias, though believed to be small.

BLS in the U.S. and Statistics Canada concluded that by using unit values, variance would be minimal. A minute of service within specified categories would be treated equally.

PART II

2 Price Index Classification and Publication**2.1 The U.S. Approach**

Where unit values are being calculated, the publication structure begins at the lowest level of detail of classification of these services, and therefore the most detailed level being collected. This includes local service based on usage and toll services. For example, in the business toll service area, prices would be collected for switched access versus special access service, but further broken down to whether calls were inbound or outbound, and whether they were intrastate, interstate, or international. A complete listing of these services can be found on the following page.

In local services where there are recurring charges that apply, it is necessary to uniquely identify the service. For example, different rates apply to services based on how many telephones can be reached in the local area or other features such as call waiting or call forwarding. The common element among these services is that they recur month after month and have a rate associated with them. See appendix # 1 for an example of the types of recurring charges that may be collected for an establishment.

Publication Structure**Wired Telecommunications Carriers****Local Service**

- Residence Local Service
- Business Local Service
- Pay telephone Local Service
- Other Local Service

Public Switched Telephone Service**Residence Toll Service**

- Intrastate
- Interstate
- International

Business Toll Service**Switched Access Toll Service****Outbound Switched Toll Service**

- Intrastate
- Interstate
- International

Inbound Switched Toll Service

- Intrastate
- Interstate
- International

Special Access Toll Service**Outbound Special Access Toll Service**

- Intrastate
- Interstate
- International

Inbound Switched Toll Service
 Intrastate
 Interstate
 International
 Other Business Toll Service
 Intrastate
 Interstate
 International
 Other Toll Service
 Intrastate
 Interstate
 International
 Private Line Services
 Intrastate
 Interstate
 International
 Sales for Resale
 Network Access Resales
 Toll Services Resales
 Miscellaneous Telephone Services
 Directory Services
 Other Services

The U.S. structure provides much greater detail than that found in the Central Product Classification (CPC). The CPC for telecommunications services only distinguishes Wired Telecommunications from Wireless and from Satellite Communications.

2.2 The Canadian Approach

The classification / publication structure for Canadian Wired Telecommunications Carriers is currently limited to a single output index for long distance telephone calls made by businesses.

The classification structure for constructing price indexes was arrived at by using two fundamental principles. The classification should be as detailed as possible to minimize problems of substitution within individual classes of services and it should be as short as possible for practical considerations to keep calculations within limits.

The classification used in the calculation of the price index can be described as follows going from top to bottom:

For each province:

- Calls by plan
 3 plans in 1998
- Calls within a province with no additional services by;
 Time of day (4 categories)
 Mileage band (up to 13 bands)
- Calls within the province with additional services by;

- Time of day (4 categories)
- Mileage band (up to 13 bands)
- Calls within adjacent provinces to the province where calls originated by;
 - Time of day (4 categories)
 - Mileage band (up to 10 bands)
- Calls to other provinces in Canada by;
 - Time of day (4 categories)
 - Mileage band (up to 12 bands)
- Calls to the United States by;
 - Time of day (4 categories)
 - Mileage band (up to 13 bands)
- Calls to overseas countries, first 25 countries in terms of generated revenues and to other overseas countries regrouped into broad categories

Argentina	Japan
Australia	Republic of Korea
Austria	Mexico
Belgium	Netherlands
Brazil	Norway
Chile	Philippines
China	South Africa
Cuba	Sweden
Denmark	Switzerland
France	United Kingdom
Germany	Venezuela
Hong Kong	Other Asia Pacific
India	Other Europe
Ireland	Other Middle East
Italy	Other Africa
Other Africa	Other America

Depending on the plan, up to a maximum of 250 individual service categories are used in the calculation of the price index for each month for a total of around 400 by province and 4000 for Canada.

The classification that has been used for the calculation of the index was developed from databases that were available from telephone companies and went much beyond the Central Product Classification. The Central Product Classification for telecommunications services, 841 within Division 84, distinguishes only wired telecommunications from wireless and from satellite telecommunications. It does not provide further detail.

Though the Canada total index is derived from detailed information, no other detail is available for reasons of confidentiality and of data limitations.

Results cannot be published on a provincial basis, as there is usually only one telephone company in each province; a minimum of three companies is required before data can be released. Prices after discounts are used in the construction of the telephone price index and

in other price index programs. As a result, only three indexes would be available for Canada for publication on an after discount basis. However plans change through time, they either disappear to be replaced by other plans or they are bundled with other plans. As a result there is no guaranty of continuity at the plan level through time and therefore indexes cannot be published at this level of detail.

Monthly and quarterly indexes were not published, as there were month to month and quarter to quarter variations that could not be explained. Rates have not been renegotiated in the recent past with Federal Authorities. It is the introduction of more advantageous plans offered to customers that pull prices down. It is probably changes in the calling structure and therefore in unit values which cause price indexes to increase from month to month and from quarter to quarter. Because of the above reasons, the only possibility left for publication is a total index on an annual basis.

PART III

3 Technical Aspects

The section below examines the technical aspects of the development and maintenance of Producer Price Indexes in the U.S. and Canada. Specifically, this section will look at the frequency of the introduction of new services, new weights, revision policies, and how quality change is handled.

3.1 PPI for U.S. Wired Telecommunications Carriers

In many ways, the technical aspects of telephone services price indexes follow the standard approach for industries in general in the PPI. These areas include:

1. An industry is resampled approximately once every seven years
2. Industry and cell weights are based on a specific year (currently 1992) for all industries in the PPI
3. As in all PPI industries, weights are carried forward from the base date due to changes in historic price relatives for all indexes. Therefore relatives within an industry can be changed or updated based on current information for new samples. Once a new sample is introduced cell weight relatives change only due to changes in price relatives. (Unit values can change relatives within a cell, but not outside the cell.)
4. There is a four-month revision policy; i.e. prices can be back corrected up to four months, after which they are considered final.
5. Whenever possible, indexes are explicitly quality adjusted.

The unit value approach has no effect on the revision policy of the index. However, it does impact the frequency of the introduction of new services, cell weights, and quality change. The effects are outlined below.

3.1.1 Introduction of New Services

A. Local Service - Recurring Charges

Substitutions occur in local services with recurring charges only when explicitly notified by the respondent. Traditional PPI methodology handles substitutions in this way and is likely a one for one service substitution.

B. Toll and Local Service - Usage

Because an industry is re-sampled only once every seven years, there is a possibility that the sample will not reflect the current mix of services in the marketplace. In an industry such as telephone services, and particularly toll services, this can be a problem because new rates are often used as a pricing mechanism and may not be captured using normal substitution procedures. The unit value approach for toll services automatically accounts for the introduction of new items since they come from existing plans. The introduction of new plans is incorporated into the calculation of the index. The ultimate effect of the unit value

approach is to ensure that the new services are included in the index as they appear in the industry. The index would always have an item sample in place that fully represented current production.

3.1.2 New Weights

A. Local Service - Recurring Charges

Local service with recurring charges do not allow for weight changes to items in the index.

B. Toll and Local Service - Usage

The unit value approach not only provides for an up-to-date sample of services in the industry, but also automatically re-weights the newly introduced service within the array of reports from a company. The introduction of new products or services creates a weighting dilemma in most industries. This is because producers do not know in what quantities the good or service will be consumed. This knowledge is gained after the fact. New telephone plans are different because of the assumption that they are created from those service plans already in existence. The weight of an old plan is decreased and applied to a new plan within those services that are based on usage.

3.1.3 Quality Change

Most substitutions in the industry result from changes in the pricing structure itself. One advantage of unit value pricing is that prices self-adjust in these pricing structure changes because all services are measured in terms of a per minute price. However, local service based on flat charges is subject to changes that may require quality adjustment. For example, a change in the definition of rate groups for local service involves comparing services that are qualitatively different, since rate groups are defined by the number of phones that a caller in the group can reach. The other major problem is the conversion from a pricing structure that involves calling usage patterns. A good example is a change from a flat rate service to a measured rate service.

A. Local Service - Recurring Charges

The following is a brief summary of how substitutions and associated quality adjustment will be handled for a number of changes in recurring charges anticipated in local service.

1. Rate Group Boundary Changes and Extended Area Service Changes

Rate group boundary changes occur when there is a change in the number of phones in one or more of the rate groups. Telephone exchanges (signified by the first three digits of a local telephone number) are continuously grouped together based on the number of telephones (and/or telephone lines) that are contained in the grouping. These groupings of exchanges constitute a local calling area. Exchanges are placed into a specific rate group depending on the number of telephones in their local calling area. When rates are adjusted, often the

definition of the rate groups changes, that is, there may be a change in the number of phones in one or more of the rate groups.

When the number of telephones in the local calling area increases due to the extension of the geographic boundaries of the local calling area, it is referred to as "extended area service". This change may be made on an optional or non-optional basis.

Change in the above services will be handled the same. If the price determining variable that is to be held constant is the number of lines in the local calling area, then if possible in the link month a price comparison would be made to the rate group that now contains this number.

2. Bundling/Unbundling of Services

Bundling of services refers to cases where elements that were separately priced became priced as a single unit. Conversely, unbundling refers to cases where a single price covered more than one element that became separately priced. In most cases it should be possible to make a direct comparison of price by obtaining the former prices bundled (or unbundled) and comparing them to the new prices unbundled (or bundled). The difficulty with this solution is that it relies on a complete listing of all elements of the specification. Particularly in the case of a service becoming unbundled, this was not always done. Pricing a service relies on delineating all revenue generating activities of the service. Since many of the activities bundled into a service did not generate revenue in the view of respondents, they are not outlined in the specification. The problem is that unless specifically noted by the respondent, a service becoming unbundled could reflect price change when in fact no change occurred. (See Appendix # 1 - Example # 3, for an example of unbundling voice mail from flat rate service.)

3. Switch From Flat Rate to Message or Measured Rate Service

Flat rate service is priced based on a fixed monthly rate for unlimited calling (use of service). Message rate service is priced based on the number of calls or the number of times a service is used. Measured rate service is priced based on the actual usage of the service; thus it depends on the characteristics of calls, for example the duration, distance, time of day, and day of call.

In the absence of information from the respondent on the pattern of calling or usage (likely estimated if available), a link to show no change will be necessary if a switch is made from flat rate service to either message or measured rate service. Price change could not be determined when comparing two services based on different units of measure.

B. Toll Service and Local Service - Usage

There will be very little quality adjustment for local service dependent on usage or long distance service. This is because all services are priced based on the same unit of measure (per minute) within relatively homogeneous groupings. The key to this approach is the

assumption that most change is due to price structure change and not calling structural change. It will not be possible to quantify calling structural changes and therefore no quality adjustment will be done due to these changes. It is important that calling characteristics such as number of minutes consumed during specific day parts remain relatively constant. In limited cases, where a change is quantifiable across a grouping (e.g. a surcharge specifically levied for underground wiring that leads to improved service), some quality adjustment can be done.

C. Private Lines

Changes in Private Lines will most likely be for upgrades of service. However, users generally upgrade service to take advantage of increased volume availability that is eligible for volume discounting. Private Lines will be priced with a unit of measure using a standardized unit based on a scale of kilobits per second per mile. All Private Line service can be expressed in these terms. No quality adjustment will be done when a change is from one type of private line service to another. This will be regarded as a change due to price structure change and reflected in the index.

3.2 Canadian PPI Wired Telecommunications Carriers

The calculation of a long distance telephone call production price index for business users has been published fairly recently. The first publication of 1996 and 1997 data was available in the spring of 1998 while data for 1998 were available in the spring of 1999. As mentioned earlier in the paper, data are available on a yearly basis for the time being. The vast majority of Canadian telephone companies were included in the calculation of the long distance telephone calls index.

3.2.1 Weights

The calculation of an aggregate index usually relies on a detailed revenue and or expenditure structure in a base period, the denominator in the Laspeyres price index formula. These revenue and expenditure figures are independent of the collection of prices and are only there to serve as an aggregation tool. In the case of the Consumer Price Index or in the case of the Industrial Product Price Index, the weights W_0^i show the importance of specific categories of expenditure or revenue to the total expenditure or revenue. They are used in the calculation of sub-aggregates price indexes and of the total index in such a way that individual category price changes through time are weighted according to the importance of the individual category to the total. Practically, the Laspeyres price index formula is re-expressed using weights because the numerator is not a directly observable aggregate.

$$I_t = \frac{\sum_{i=1}^n P_t^i Q_0^i}{\sum_{i=1}^n P_0^i Q_0^i} \quad I_t = \sum_{i=1}^n \left(\frac{P_t^i}{P_0^i} \right) * W_0^i$$

where:

$$W_0^i = \frac{P_0^i Q_0^i}{\sum_{i=1}^n P_0^i Q_0^i}$$

In the case of the telephone index the procedure for calculating the total index is simplified because quantities are available in the base period. Therefore the Laspeyres index formula does not need to be re-expressed in terms of weights to arrive at a total index. The aggregate index is rather derived by calculating the ratio of base period quantities re-valued at current period prices to base period quantities at base period prices. Therefore there is no need to calculate weights as in the case of the CPI and of the IPPI.

The calculation of the price index is based on the same customers through time. Therefore new customers are not taken into consideration in the calculation of the price index and customers who are leaving a telephone company sometime after the beginning of the base period are not taken into consideration either in the calculation of the price index. This procedure was adopted in order to maintain as much as possible a stable calling structure through time.

This approach however has some limitations. The calling structure becomes less and less representative as one moves further away from the base period. This is also true for the consumer price index but in the case of telephones, the structure may become out of date more rapidly when new services are introduced frequently. To alleviate this problem, the base period calling structure could be updated more frequently than in the case of the CPI and of the IPPI.

The index is currently based on the 1996 calling structure. Calculations have been done for 1996 and 1997 based on the same customers through time and 1998 calculations were based on actual customers, including new customers. Potentially, price indexes for the period from 1996 to 1998 could be revised if the same customers are to be considered over that period. Price indexes for 1998 could also be revised if the base structure is changed to 1998. In this case, the 1996 and 1997 series should be linked to the new base. The linking period could be the fourth quarter of 1997. Until now none of the above scenarios have been implemented.

3.2.2 Quality Changes

Quality changes can be taken into consideration with the introduction of more recent calling structures. So far the 1996 calling structure has been used to calculate indexes from 1996 to 1998 and will probably be used to calculate the 1999 index. If continuity for individual plans cannot be maintained any longer, or that there are too many changes in the plans which are offered to business customers, then the calling structure could be changed from 1996 to 1999. This remains to be determined.

3.2.3 Revisions

The telephone long distance call index has not been revised for 1997. Results for 1998 were obtained by taking into consideration customers who had left telephone companies and who had joined telephone companies during 1998.

If it is decided to rerun the index with the same customers from 1996 to 1998, then 1996 would remain at 100, but the 1997, and the 1998 indexes would be revised. The alternative for not revising the 1997 index would be to introduce the 1998 calling structure as the new weighting structure. Tests would have to be performed to verify if results would be significantly different under this scenario.

Conclusion

This paper provides an example of how there can be a wide margin between what the theory suggests should be done in the construction of price indexes and what the practice dictates.

Both countries chose the Wired Telecommunication Carriers in the calculation of their respective price indexes as they are described in the Central Product Classification. Wireless Carriers have not yet been incorporated into the price index calculation in Canada and Satellite Carriers still need to be covered. Further research efforts should be made to arrive at a better coverage of telecommunication carriers.

Calculations of aggregate price indexes were based upon detailed service categories defined and supplied by telephone companies. To become a more valuable tool, the CPC should offer a more detailed breakdown of products by service carrier upon which price indexes would be built. It is essential to have some level of detail in the construction of price indexes.

Computing price indexes by using the same level of detail would facilitate international comparisons. The NAPCS (North American Product Classification System) project between the United States, Canada and Mexico is a step in the right direction in putting together a product classification which can be utilized in the context of more than one statistical program.

After experimenting with different approaches, and because of practical considerations, both Agencies decided to use the unit value approach for the construction of the price index for long distance calls . The unit value approach provides the closest approximation to the conceptual model of re-pricing each and every phone call through time and implicitly accounts for quality changes. In order to improve upon the quality of the results, the definition of the detailed service categories needs to be refined to insure that unit value movements through time are mainly attributable to price movement and not to calling structure changes.

According to industry sources, the unit value approach accurately reflects price movement in the industry. Further improvement over the unit value method for calculating a telephone price index will depend to a large extent on the level of cooperation received from telephone companies.

APPENDIX

Example # 1 - Calculation of cell level price per sample establishment - Rate Method for Residence Local Service (base period t)

The following example shows information for an establishment with recurring charges. Note that each rate was subject to probability selection (interval = \$600,000) and is at a level of unique service. For example, "Res - One Party Flat Rate, Group 4" is for basic local residence service with Between 30,001 and 60,000 telephones in the calling area.

Billing Code	Description	Sampling Factor (1)	Units	Rate (base)	Revenue
9ZS	Res - Subscriber Line Charge	1.0000	753,278	3.500	\$2,636,473.000
1FR	Res - One Party Flat Rate, Group 5	1.0000	305,468	18.750	\$5,727,525.000
1FR	Res - One Party Flat Rate, Group 4	1.0000	165,837	14.950	\$2,479,263.150
1FR	Res - One Party Flat Rate, Group 3	1.0000	104,936	11.950	\$1,253,985.200
1FR	Res - One Party Flat Rate, Group 2	1.0000	79,241	9.950	\$788,447.950
1FR	Res - One Party Flat Rate, Group 1	1.0000	27,486	6.500	\$178,659.000
1MR	Res - One Party Measured Rate, Group 5	1.0000	58,946	13.750	\$810,507.500
1PO	Res - Lifeline Service	5.3293	32,167	3.500	\$600,000.000
ESX	Res - Call Waiting	1.0000	675,834	1.750	\$1,182,709.500
EPZ	Res - Call Forwarding	2.9876	114,759	1.750	\$200,828.250
	Message Units - Zone A	1.0000	279,035	0.100	\$27,903.500
	Message Units - Zone B	1.0000	157,285	0.080	\$12,582.800
	Message Units - Zone C	1.0000	75,934	0.060	\$4,556.040
Sum of Revenue					\$15,903,440.890
Percent Change					
Index (Price) for establishment in time period t					100.0000

Note: Interval = \$ 600,000.00

(1) inverse of the probability of selection

Example # 2 - Calculation of cell level price per sample establishment - Rate method for Residence Local Service (period t + 1)

Note a number of rate changes and the overall price increase.

Billing Code	Description	Sampling Factor (1)	Units	Rate (base)	Revenue	Rate (first chg.)	Revenue (first chg.)
9ZS	Res - Subscriber Line Charge	1.0000	753,278	3.500	\$2,636,473.000	\$3.500	\$2,636,473.000
1FR	Res - One Party Flat Rate, Group 5	1.0000	305,468	18.750	\$5,727,525.000	\$19.000	\$5,803,892.000
1FR	Res - One Party Flat Rate, Group 4	1.0000	165,837	14.950	\$2,479,263.150	\$15.200	\$2,520,722.400
1FR	Res - One Party Flat Rate, Group 3	1.0000	104,936	11.950	\$1,253,985.200	\$12.200	\$1,280,219.200
1FR	Res - One Party Flat Rate, Group 2	1.0000	79,241	9.950	\$788,447.950	\$10.200	\$808,258.200
1FR	Res - One Party Flat Rate, Group 1	1.0000	27,486	6.500	\$178,659.000	\$6.750	\$185,530.500
1MR	Res - One Party Measured Rate, Group 5	1.0000	58,946	13.750	\$810,507.500	\$14.000	\$825,244.000
1PO	Res - Lifeline Service	5.3293	32,167	3.500	\$600,000.000	\$3.750	\$642,857.143
ESX	Res - Call Waiting	1.0000	675,834	1.750	\$1,182,709.500	\$1.900	\$1,284,084.600
EPZ	Res - Call Forwarding	2.9876	114,759	1.750	\$200,828.250	\$1.900	\$651,428.571
	Message Units - Zone A	1.0000	279,035	0.100	\$27,903.500	\$0.110	\$30,693.850
	Message Units - Zone B	1.0000	157,285	0.080	\$12,582.800	\$0.085	\$13,369.225
	Message Units - Zone C	1.0000	75,934	0.060	\$4,556.040	\$0.065	\$4,935.710
Sum of Revenue					\$15,903,440.890		\$16,687,708.399
Percent Change							1.049314
Index (Price) for establishment in time period t + 1					100.0000		104.9314

Note: Interval = \$ 600,000.00

(1) inverse of the probability of selection

Example # 3 – Calculation of cell level price per sample establishment - Rate Method for Residence Local Service (period t + 2 with Quality Adjustment)
Change 2 is a quality adjustment only. It shows Voice mail (not sampled) being included in base access lines for free. The quality adjustment is due to the Bundling of voice mail in basic flat rate service. In the base period when the establishment was sampled, voice mail was a separately rated service with a value of \$1.00. It is now part of a bundled service.

Billing Code	Description	Sampling Factor (1)	Units	Rate (base)	Revenue	Rate (first chg.)	Revenue (first chg.)	Rate (2nd chg.)	Revenue (2nd chg.)
9ZS	Res - Subscriber Line Charge	1.0000	753,278	3.500	\$2,636,473.000	\$3.500	\$2,636,473.000	\$3.500	\$2,636,473.000
1FR	Res - One Party Flat Rate, Group 5	1.0000	305,468	18.750	\$5,727,525.000	\$19.000	\$5,803,892.000	\$19.000	\$5,803,892.000
1FR	Res - One Party Flat Rate, Group 4	1.0000	165,837	14.950	\$2,479,263.150	\$15.200	\$2,520,722.400	\$15.200	\$2,520,722.400
1FR	Res - One Party Flat Rate, Group 3	1.0000	104,936	11.950	\$1,253,985.200	\$12.200	\$1,280,219.200	\$12.200	\$1,280,219.200
1FR	Res - One Party Flat Rate, Group 2	1.0000	79,241	9.950	\$788,447.950	\$10.200	\$808,258.200	\$10.200	\$808,258.200
1FR	Res - One Party Flat Rate, Group 1	1.0000	27,486	6.500	\$178,659.000	\$6.750	\$185,530.500	\$6.750	\$185,530.500
1MR	Res - One Party Measured Rate, Group 5	1.0000	58,946	13.750	\$810,507.500	\$14.000	\$825,244.000	\$14.000	\$825,244.000
1PO	Res - Lifeline Service	5.3293	32,167	3.500	\$600,000.000	\$3.750	\$642,857.143	\$3.750	\$642,857.143
ESX	Res - Call Waiting	1.0000	675,834	1.750	\$1,182,709.500	\$1.900	\$1,284,084.600	\$1.900	\$1,284,084.600
EPZ	Res - Call Forwarding	2.9876	114,759	1.750	\$200,828.250	\$1.900	\$651,428.571	\$1.900	\$651,428.571
	Message Units - Zone A	1.0000	279,035	0.100	\$27,903.500	\$0.110	\$30,693.850	\$0.110	\$30,693.850
	Message Units - Zone B	1.0000	157,285	0.080	\$12,582.800	\$0.085	\$13,369.225	\$0.085	\$13,369.225
	Message Units - Zone C	1.0000	75,934	0.060	\$4,556.040	\$0.065	\$4,935.710	\$0.065	\$4,935.710
	Voice mail incl in 1FR, Group 5	1.0000	305,468					-\$1.000	-\$305,468.000
	Voice mail incl in 1FR, Group 4	1.0000	165,837					-\$1.000	-\$165,837.000
	Voice mail incl in 1FR, Group 3	1.0000	104,936					-\$1.000	-\$104,936.000
	Voice mail incl in 1FR, Group 2	1.0000	79,241					-\$1.000	-\$79,241.000
	Voice mail incl in 1FR, Group 1	1.0000	27,486					-\$1.000	-\$27,486.000
	Sum of Revenue				\$15,903,440.890		\$16,687,708.399		\$16,004,740.399
	Percent Change						1.049314		0.9591
	Index (Price) for establishment in time period t + 2				100.0000		104.9314		100.6370

Note: Interval = \$ 600,000.00

(1) inverse of the probability of selection

