Price Indexes for Telecommunications Services

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I. Summary

The wired telecommunications industry shares many similarities with the wireless telecommunications industry. Consumer services tied to voice communications share most of the same service features between both wired and wireless. Therefore, it is not surprising to see service and pricing similarities. A similar pricing methodology can be applied to both wired and wireless telecommunications.

II. Introduction

This paper draws most of its information from previously written papers by several economists from the U.S. Bureau of Labor Statistics, Statistics Canada, and the Bank of Japan. These economists include James J. Gorko, Anthony Hill, and Rod Meaney of the U.S. Bureau of Labor Statistics, Francois Borde of Statistics Canada, and Yuko Koga of the Bank of Japan.

Contained in the following pages is a detailed recounting of the nature of both the wired and the wireless telecommunications industries in the United States of America. The following topics are treated in turn: 1) types of services and industry outputs, 2) the business model, 3) sample design, 4) industry recordkeeping practices, 5) publication structure and the relation to the CPC, 6) pricing methodology, 7) technical concerns, 8) survey vehicles, 9) time series data and analysis of published indexes, 10) future industry trends, and 11) the need for future work. Although wired telecommunications has been in existence for quite a while, wireless telecommunications is an emergent new technology that is still very much in its early growth stage.

A unique feature of the wired telecommunications carriers 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 making and in marketing by who generates it, which switches it, and by the distance over which it is transmitted.

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.

III. Definition of Industry Outputs/Types of Services

Definition of Industry Outputs

Output in the wired telecommunications carriers industry is defined to be the provision of telephone voice and data communications via telephone lines. The output, "calls", and access to a communications network, is measured by recurring charges and usage fees.

The primary output of wireless telecommunication is that of placing parties in communication with each other through a radio network, parallel to the traditional wireline network of the telephone system. Cellular telephone services include Traditional Cellular Service, Personal Communications Service (PCS), and Enhanced Specialized Mobile Radio (ESMR) and are defined as being “voice-grade” and interactive. Paging is defined as “less than voice-grade” because it involves only the sending of characters and/or numbers. Paging services however, can include customer notification of voice mail messages waiting at a voice mailbox provided by the paging company.

Types of Services

Local Service for *Wired Telecommunication*

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 for *Wired Telecommunications*

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. 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 for *Wired Telecommunication*

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 for *Wired Telecommunication*

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.

Cellular and Other (Voice Grade) *Wireless Services*

These services allow customers to converse or send data similar to a wireline service. There are three types of voice grade wireless services: Traditional Cellular Service, Enhanced Specialized Mobile Radio (ESMR), and Personal Communications Services (PCS). The distinction between these is primarily in how they are licensed and in the frequency and power level used in transmitting and receiving. To the buyer, the technical differences between the three are not noticeable. The services can be augmented with add-on features including services such as voice-mail.

Traditional Cellular Service licenses were sold according to Metropolitan Statistical Area (MSA) and Rural Statistical Area (RSA) as determined by the Federal Communications Commission. In the 1980's, there were about 300 licenses distributed for urban areas and about 400 for rural areas. There were only two licenses available for each MSA or RSA.

Enhanced Specialized Mobile Radio (ESMR) systems operate at a lower frequency and higher power settings than cellular service. ESMR uses an improved "push to talk" technology previously only used by dispatch services for taxicabs and mobile repair operations. This type of service is dominated by one company, Nextel, which holds about 95% of the market.

Personal Communications Services (PCS) are provided in the same manner as conventional cellular systems except that license areas are much larger. Licenses for service areas were auctioned based on Rand McNally Major Trading Areas (MTA). These systems work at a higher frequency and lower power settings, which requires more cell stations in a given area. There were about 5 licenses auctioned per MTA, which greatly increased competition in each area.

Paging

This service allows messages to be sent to a subscriber. Messages can be delivered or stored for later delivery. The messages can be just numbers or characters and numbers.

IV Business Model

A. Industry Organization

Wired Telecommunications Industry

The size of local exchange companies (LEC) varies greatly, from Pacific Bell(CA), which accounts for nearly 9% of total LEC revenues, to small companies that serve a few hundred residential customers in a single rural exchange. All of the ILEC's (Incumbent Local Exchange Companies) had a monopoly franchise to provide basic exchange switching in a specific geographic area. Larger and more urban exchanges provide a wider range of services and a larger array of pricing plans than do smaller and more rural exchanges. The competitive local exchange carriers (CAPs/CLECs)can provide service on their own terms with regard to their local service area and the geographical size of an exchange.

AT&T, as the largest IXC (Interexchange Carriers), provides virtually all types of toll and private line services. The major competitors also provide most types of toll services. There are some older forms of service, now "grandfathered", which only AT&T is required to provide. These are inconsequential operationally and financially. Some of the smaller interexchange carriers specialize in certain services, such as television and audio private line services.

1. Vertical integration: Vertical integration is not really a factor for wired or wireless since regulators have gone to great pains to prevent this. Horizontal integration has been dealt with by defining "not communications" activities as out of scope. As a practical matter, larger companies provide non-telecommunications products and services through separate subsidiaries. For smaller companies in wireless activities such as sales of equipment, and repairs, can be defined as a separate establishment at the same location and therefore out of scope.

2. Outsourcing/resellers: Resellers, as defined by NAICS, did not exist for the current sample. For the new sample, resellers are in their own industry. These are establishments (NAICS definition) that do not have their own facilities. In point of fact, almost all carriers have some facilities of their own. Which means that almost all "Competitive Local Exchange Carriers (CLECs)" are Wired Telecommunications carriers even though they might call themselves resellers based on significant resales of facilities based carrier services.

3. Array of services provided: The services that are priced include access charges, usage charges, and feature charges. Taxes are not included but charges that are "mandated" by regulators but whose revenues remain in the industry, are included. The Subscriber Line Charge (SLC), also referred to as the End User Line Charge (EULC), is industry revenue. The 911 surcharge is forwarded to authorities and is therefore a tax. Access charges are generally recurring monthly charges. Usage charges are usually timed charges, though occasionally on a per-call basis (like most local pay phone calls). Local features are services provided through the central office switching. This would include call waiting, call forwarding, caller ID and the like. Also included are automated information services (time, weather, concert information) which are "sponsored" services in which a third party pays to set up and maintain this "line". Features for long distance services can include automated billing analysis, special signaling, routing options, and backup features.

Wireless Telecommunications Industry

Providers of cellular and paging services can vary widely in size. The largest service providers of cellular services also tend to be large providers of paging services; whereas, the largest providers of paging services do not tend to be large cellular providers. Almost all companies seem to separate their cellular and paging operations from all other operations even in allied fields (pager sales vs. paging service). Paging or "messaging" establishments tend to be very concentrated. The largest company has approximately 22.5% of the market and the top four have 53% of the market. Cellular service is also concentrated although not to the same degree. The largest establishment has 10% of the market while the largest four have 33% and the top ten have 59% of the market. The large corporations in this industry tend to establish separate operating companies in different local areas. This helps them closely manage local and regional markets and cope with the differences in the different markets.

The qualitative difference between companies and the services they provide is in technology. Larger companies tend to have more advanced switching technology which allows smooth transition from one cell to another. The difference in the services a company offers is in the various contracts or plans offered and special features. Another variable is the geographic range covered by the service. Service areas are categorized as local, regional, or national.

1. Vertical integration: There is limited vertical integration in this industry. Along with providing services, establishments may also sell cellular phones and pagers.

2. Outsourcing/resellers: The main type of outsourcing or reselling is through roaming charges. Each cellular company operates in a particular area where it owns a license. When a customer is outside of this area, calls made or received are "roaming" calls. Almost all cellular companies have agreements with other companies to provide service to customers outside the company's operational area. Roaming calls are usually charged to the customer at a higher rate than non-roaming calls. Cellular providers compensate each other for these calls at an agreed upon rate.

3. Array of services provided: Various services may be offered including voice mail, call waiting, caller-ID, three-way calling, and call forwarding. Many cellular companies provide free information about movies, restaurants, shopping, and a variety of other topics accessed through a special phone number. For a fee, customers can subscribe to receive updates on various news topics, which are displayed on the screen of their cellular phone. Also, some providers are now able to allow their customers to access e-mail over their cellular phone. Many cellular phone companies are offering "family plans" which provide a phone to each family so they can communicate immediately with each other.

B. Identification of operating units

Wired Telecommunications Industry

In 1997, there were 1,430 local operating companies, inclusive of those, which are part of holding companies. A number of these local exchange carriers (LEC's) have operations in more than one state, and therefore, are under the regulatory control of more than one state regulatory commission. These units have been treated as separate profit centers for each state in which they operate. In 1997, the largest eight interexchange carriers accounted for 87.2% of interexchange company revenue. The remaining more than 200 companies accounted for the other 12.8% of the revenues is this segment of the industry.

Wireless Telecommunications Industry

This industry is limited to establishments providing communication services using radiotelephone transmissions. Regular telephone services, including microwave relays, are excluded. However, radiotelephone service, a service of regular telephone companies, is included in this industry. Establishments providing maintenance services on communications equipment, billing services, etc. are classified in various Business Services.

C. Governmental Regulation

Wired Telecommunications Industry

Individual states have regulatory authority over all of their intrastate telephone activity. Thus, the local operating companies are regulated by the state in which they operate. Rate schedules are available (intraLATA schedules) that show all of the prices available for local services.

Intrastate activities of IXCs are also subject to state regulation. States have granted broad flexibility to IXCs and some states allow IXCs to compete with LECs for intraLATA toll services. However, IXCs are required to use the same prices for both intraLATA and interLATA intrastate toll services.

The Federal Communication Commission regulates and oversees interstate and international telecommunications. They have deregulated all carriers except AT&T. AT&T, as the dominant carrier, is regulated under a "rate cap" procedure. This allows AT&T to adjust prices within parameters established by indexing base year revenues. Effectively AT&T is also deregulated at the interstate level.

Wireless Telecommunications Industry

The wireless communication industry is closely regulated in the US by the Federal Communications Commission (FCC). The FCC begins by auctioning licenses for the various types of wireless communications. These licenses permit the owner to use certain frequencies at particular power levels. The licenses can be freely sold to other companies. Prices for wireless communications are completely deregulated and can be changed freely.

In addition, the Federal Government regulates inter-state trade while state governments regulate intra-state trade. The Federal Government has determined that all radio wave communications are, by their nature, inter-state because these waves are not confined to state borders. Therefore, there are almost no state regulations regarding wireless communications. All regulation comes from the Federal Government through the FCC.

D. Public ownership/government subsidization

There is no public ownership or government subsidization in either of these industries.

All of the larger cellular phone providers are publicly owned corporations whose stock is traded on a major exchange. Many of them are subsidiaries of traditional telephone service companies. The smaller providers may be privately held companies. Paging service providers tend to be smaller corporations but all of the largest are still large enough to be publicly owned and traded or are subsidiaries of large corporations.

V. Sample Design

A. Sample Frames

1. Stratification variables – relation to classification structure

Wired Telecommunications Industry

The current Wired sample has two strata - Local Exchange Carriers (LEC) and Interexchange Carriers (IXC). The new sample has three strata - Incumbent Local Exchange Carriers (ILEC), Competitive Local Exchange Carriers (CLEC), and Interexchange Carriers (IXC).

Wireless Telecommunications Industry

The industry is divided into four explicit strata that correspond to the FCC licensing classifications. These strata include Traditional cellular telephones, PCS, ESMR, and Pagers. Airplane phones and train phones were truncated. Traditional cellular, PCS, ESMR, and Paging services are treated as separate establishments even when owned by the same company and at the same address. The frames represent those establishments that have their own facilities. Resellers of cellular and paging services exist but are relatively small compared to non-resellers. Data regarding resellers and their revenues are unavailable and thus are not part of the sample frame.

The stratification also corresponds with the organization of the industry. Each type of service uses different types of frequencies and different power levels.

2. Alternative Frames

Wired Telecommunications Industry

The FCC's 1996 Monitor Report was the master frame which provided a list of telecommunications companies, which states they operated in, and what strata they considered themselves in. The FCC 1997 ARMIS reports were used to provide revenues and access lines by company and state for the former Bell system companies and selected other large carriers. The USTA 1997 statistics were used to obtain revenues and access lines for those companies not covered by the ARMIS data. The Department of Agriculture's Rural Utilities Services had further data on revenues and access lines especially for small companies that borrowed from the USDA/RUS. Access line data was used to determine whether differences in revenue data and/or corporate names actually represented separate

companies or just different names. The Unemployment Insurance File was not used as a frame source.

Wireless Telecommunications Industry

The administrative frame generally used by BLS in establishment based surveys is derived from mandatory filing for unemployment insurance purposes. This frame was not used for this industry. The lack of stratification variables by FCC licensing classification was one limitation. The need to identify units by licensing geographic area was the second limitation.

The source for information on establishments in the traditional cellular strata, the PCS strata, and the ESMR strata is the Cellular Telecommunications Industry Association (CTIA). The traditional cellular strata consists of those licenses awarded in the 1980's auctions for cellular service. This is a limited number, with only two carriers for each license area. The CTIA "Wireless Marketbook" lists the current owners of the license. The PCS frame is the same kind of frame except with the winners of the 1990's PCS license auctions listed. The ESMR frame consists of four companies with Nextel representing approximately 95% of the frame.

The frame for paging came primarily from the Personal Communications Industry Association (PCIA). The PCIA provided a list of the top 30 paging companies based on subscriptions. The top 25 companies of those thirty were chosen as well as a random sample of fifteen additional paging establishments.

B. Identifying the sample unit – record center relation to classification structure

Wired Telecommunications Industry

Unlike the production of goods or even most services, which are created at a single location, these services are provided by a network. As such, data is not likely to be available at anything short of an administrative center. Much, if not all, of the data we needed is created at billing centers. However, most of our reporters want to keep tabs on what is being provided to us so data is almost always provided at the corporate level.

With the wired telecommunications establishments, corporate data can be divided among many locations depending on product line. However, the quality of the data for most establishments does not suffer at the corporate level. In some cases however, changes in data systems has not resulted in improvements and there are significant disconnects between billed data and data available for corporate use. This is most certainly temporary and can be worked around.

Wireless Telecommunications Industry

Corporations in this industry that have cellular and paging operations usually set up separate companies in each service area. Companies keep records that correspond to the classification structure. They are able to provide information on the amount of each service that is used and the revenue received for each type of service. Data are kept at the corporate headquarters location for all operations nationwide. But the corporate headquarters unit can report on each separate operating company. These operating companies are established on a metropolitan area basis for cellular operations.

C. **Reporter Burden Issues**

Wired Telecommunications Industry

The biggest reporter burden issue with the current sample is over and that was drawing the sample of bills. However, our repricing system is not conducive to continuous cooperation. Because repricing is concentrated at the corporate level, a single person might get 50 to 100 forms each month. If the reporter was really trying to do a good job, he would check each locality to see if any special events occurred ("pricing-wise"). The new procedure will ask for an update of a sample of rates (not a sample of bills) which should reduce paper shuffle by 50 to 75 %. This results from asking for each rate only once, instead of the multiple times occurring with a bill sample. The rates will be collected in a "laundry list" format and no calculations will be asked of the reporter. There is a procedure in place which limits the number of rates selected for any "company" product level and at the same time maximizes the statistical sampling available by using off-the-shelf company reports.

Wireless Telecommunications Industry

The small number of firms operating in each area was a confidentiality and burden constraint for Traditional cellular services. In this industry, license areas coincide with metropolitan areas. There are only two licenses allocated per Metropolitan Statistical Area (MSA) or Rural Statistical Area (RSA). Therefore, companies regard this data as extremely sensitive and can be reluctant to provide it. The companies feared that it would be easy for competitors to figure out the pricing in their company. The increased competition due to the growth of PCS companies has eased these fears.

It was a burden for the large companies in the industry to report as many prices as would be needed. Large corporations operate in dozens of different areas, but they set up separate companies for each area. Although these regional companies operate separately, their records are generally maintained through the head office. The index would require a quote for each different area but all the quotes would have to come from the same place. That would require a single reporter to report for dozens of different areas.

The practice of obtaining an average weighted price should allow reporters to maintain some anonymity and will take into account the various options available for the many types of plans. The worksheets may seem complex at first glance and this may pose a problem for some reporters. Reporters are usually able to build a simple program that can easily extract the needed numbers from the company’s existing accounting systems into a spreadsheet.

VI. Industry recordkeeping practices

A. Data availability for wired and wireless telecommunications

Price data is available in many places such as Internet web sites, local retail outlets, etc. However these sources only have rate plans for customers opening new accounts rather than the rate plans actively being billed. Further, not all discounts are published or publicly available. These prices are not a comprehensive set of industry prices.

The pricing methodology permits companies to use information from existing accounting data. Companies already keep track of the amount of each service that is used and the revenue generated by each service. The methodology allows companies to average the various plans and

special features to provide a weighted average price. This prevents competitors from estimating the number of customers or market share held by a reporter.

B. Composite goods and bundling for wired and wireless telecommunications

Similar services are bundled and revenues per unit are averaged using weights corresponding to the amount of the service that is used. These include call waiting, call forwarding, 3-way conferencing, no answer transfer, and voice messaging. A very new feature in the U.S. is internet access.

The pricing method does not try to identify certain service plans that are typical for the company. It would be difficult to find a truly representative model service plan to price because new plans are constantly being introduced while old plans also continue to be used. However, companies do keep records of how many people use each feature and how often they are used. This allows them to provide weights for each type of service.

VI. Publication structure and relationship to the CPC

A. Publication Structure

Price Index Classification and Publication for Wired Telecommunications

Where unit values are being collected, the publication structure is the lowest level detail in classifying those 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.

In local services where there are recurring charges that apply, it is necessary to completely identify the unique 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.

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

Definition of the publication structure for wireless telecommunications

The publication structure consists of traditional cellular service, ESMR, PCS, and paging services. This structure only includes providing communication services using radiotelephone transmissions. Regular telephone services, including microwave relays, are excluded. However, radiotelephone service, a service of regular telephone companies, is included in this industry. Establishments providing maintenance services on communications equipment, billing services, etc. are classified in various Business Services.

Publication Structure

Wireless Telecommunications
Primary Services
Cellular and other wireless services, except paging

Paging

B. Why the structure was chosen and not other alternatives

Wired Telecommunications Industry

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.

Wireless Telecommunications Industry

The structure for wireless telecommunications was chosen because it is the best method for capturing changes in use of all primary and secondary services. It also allows the company to use its existing accounting data without revealing sensitive data. The publication structure is consistent with the bundling concept discussed earlier. Competing technologies in the telecommunications industry are direct substitutes and therefore are included in the same cell.

C. Relationship of publication structure to the CPC

The publication structures for wired and wireless telecommunications correspond with CPC V1.0 codes 8411 and 8412. CPC categorizes Telecommunications Services as Group 841 which is divided into Wired telecommunication services (8411), Wireless telecommunications services (8412), and Satellite telecommunications services (8413). Wireless telecommunications includes the provision of access to wireless telecommunications facilities (e.g. cellular, paging, and PCS) for the transmission of voice, data, text, sound, and full motion picture video between network termination points.

VIII. Pricing methodology

This section reviews the various methodologies that have been designed and experimented with to calculate price indexes for both wired and wireless telecommunications industries. They are the **bill method**, the **rate method** and the **unit value method**. Both the rate method and unit value method have been found to be the most effective in measuring price movements in the wired and wireless Telecommunications industries. The bill method has been found to be severely flawed. As a result, efforts are being made to discontinue the use of the bill method entirely, and to use soley the rate method and the unit value method.

For the wired telecommunications industry, both the rate method and the unit value method are acceptable methodologies for pricing the industry. As the unit value method has been found to be the best measure thus far for usage driven services, this is the preferable methodology for these services. Non-usage driven services, within the wired telecommunications industry, may be best measured by the rate method.

With the wireless telecommunications industry, services are all usage driven. Therefore, it is appropriate to use the unit value method across the board for this industry.

The remainder of this section will review each of our three methodologies, in detail, and will include limitations connected with each methodology.

A. Methodologies Chosen

The Rate Method

The first approach considered was using rates as a methodology to price the 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 characteristics of a transaction 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

Revenues from an example of a universe of ten bills 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.

The Unit Value Method

The approach that BLS decided to use for local service dependent on usage and all long distance service was one based on unit values. Also, this method was used for all wireless services pricing, including all types of cellular service and paging. This method was found to provide solutions to the problems in both the bill method and the rate/rate plan 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 telephone service described as being unique (based on destination, direction, etc.) is divided by number of minutes consumed for the service to yield a unit value. The value is multiplied by its base weight and aggregated within categories. Since categories maintain their weight relative to other categories, in this sense, it conforms to a fixed weight Laspeyres Index. "New" rate plans come from rate plans that already exist and can always be incorporated into 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.

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 or at least kept the same 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. Since unit values are always based on relatively homogeneous categories, 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. Once again, no new minutes are created outside of a relatively homogeneous category, again maintaining a fixed weight methodology, but are reallocated within a category. 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.

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.

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 from the base period had remained the same? ” 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.

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. BLS receives monthly data (revenue and minutes) from responding companies for a set of services described as unique. 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 is for the 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 within a cell (the lowest level of a published index) for all items is aggregated. The price index at any given level of aggregation is calculated by dividing the current month revenue by the revenue at the base date.

SAMPLE WORKSHEET
WIRELESS TELECOMMUNICATIONS (EXCEPT PAGING) WORKSHEET

PART I: AVERAGE UNIT PER ACCESS LINE

List all types of charges assessed by company for the selected area in column 1. Enter the total number of units for each type of charge in column 2. Enter the total number of access lines in column 3. Divide column 2 by column 3 and enter in column 4. The reporter may be reluctant to provide data for the columns 2 and 3. If the reporter will calculate the percentages, it is only necessary to fill out columns 1 and 4.

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4 (COLUMN 2/COLUMN 3)
TYPE OF CHARGE	**TOTAL UNITS: BILLED AND FREE**	**TOTAL NUMBER OF ACCESS LINES**	**AVERAGE NUMBER PER ACCESS LINE**
ACCESS LINE			1.0000*
			*BY DEFINITION
USAGE CHARGE BASED ON TIME			
Peak minutes	32,400,000		162
Off-peak minutes	26,600,000	200,000	133
Roaming minutes	2,000,000	200,000	10
Landline minutes			
Other charges			
USAGE CHARGES OTHER THAN TIME			
Landline, per call	400,000	200,000	2
Other charges, Daily rate	200,000	200,000	1
FEATURES/OPTIONS AND FEATURE PACKAGES			
Custom calling package	130,000	200,000	0.65
Call waiting	40,000	200,000	0.20
Call forwarding	20,000	200,000	0.10
3-way conference	10,000	200,000	0.05
No answer transfer	20,000	200,000	0.10
Voice messaging	40,000	200,000	0.20

WIRELESS TELECOMMUNICATIONS (EXCEPT PAGING) WORKSHEET

PART II: AVERAGE REVENUE PER UNIT

Copy all the charges in Part I, column I to Part II, column I. Obtain the net billed revenues for each type of charge and divide by the total quantity used of each charge. **OR**

The reporter may be reluctant to provide data for columns 2 and 3. If the reporter will calculate the average revenue, it is only necessary to fill columns 1 and 4.

COLUMN 1 TYPE OF CHARGE	COLUMN 2 TOTAL NET: BILLED REVENUE	COLUMN 3 TOTAL UNITS: BILLED AND FREE	COLUMN 4 (COLUMN 2/COLUMN 3) AVERAGE REVENUE PER UNIT
ACCESS LINE	5,350,600	200,000	26.7530
USAGE CHARGE BASED ON TIME			
Peak minutes	8,388,360	32,400,000	0.2589
Off-peak minutes	2,191,840	26,600,000	0.0824
Roaming minutes	1,944,400	2,000,000	0.9722
Landline minutes			
Other charges			
USAGE CHARGES OTHER THAN TIME			
Landline, per call	60,000	400,000	0.1500
Other charges, Daily rate	300,000	200,000	1.5000
FEATURES/OPTIONS AND FEATURE PACKAGES			
Custom call package	449,800	130,000	3.4600
Call waiting	194,000	40,000	4.8500
Call forwarding	103,000	20,000	5.1500
3-way conference	57,500	10,000	5.7500
No answer transfer	85,000	20,000	4.2500
Voice messaging	192,000	40,000	4.8000

WIRELESS TELECOMMUNICATIONS (EXCEPT PAGING) WORKSHEET

PART III: COMPUTE AVERAGE REVENUE BILL

Copy all the types of charges in Part I, column 1 to Part III, column 1. Copy average number per access line from part I, column 4 to Column 2. Copy average revenue per unit from part II, column 4. Multiply column 2 by column 3 and enter in column 4. Sum column 4 to base period total or "price".

COLUMN 1 TYPE OF CHARGE	COLUMN 2 AVERAGE NUMBER PER ACCESS LINE (Part I, Col 4)	COLUMN 3 AVERAGE REVENUE: PER UNIT (Part II, Col 4)	COLUMN 4 (COLUMN 2 X COLUMN 3) WEIGHTED REVENUE
ACCESS LINE	1.000	26.7530	26.7530
USAGE CHARGE BASED ON TIME			
Peak minutes	162	0.2589	41.9418
Off-peak minutes	133	0.0824	10.9592
Roaming minutes	10	0.9722	9.7220
Landline minutes			
Other charges			
USAGE CHARGES OTHER THAN TIME			
Landline, per call	2	0.1500	0.3000
Other charges, Daily rate	1	1.5000	1.5000
FEATURES/OPTIONS AND FEATURE PACKAGES			
Custom calling_package	0.65	3.4600	2.2490
Call waiting	0.20	4.8500	0.9700
Call forwarding	0.10	5.1500	0.5150
3-way conference	0.05	5.7500	0.2875
No answer transfer	0.10	4.2500	0.4250
Voice messaging	0.20	4.8000	0.9600
BASE PERIOD TOTAL			97.0686

The preceding worksheets provide an example of how such an average billed price is calculated in the cellular telephone industry. The final result is to calculate the monthly average price using fixed reference period weights for each component service. Part 1 displays the number of minutes for each component service, such as peak minutes, off-peak minutes, call waiting, call forwarding. The quantity weights are computed in column 4 per access line, yielding the average usage for each component service. Each month, an average revenue per unit is calculated for each component service. Part II Column 4 displays this information. The current month per unit charge is multiplied by the reference period per access line usage to yield the current month average bill computed on reference period quantity weights. Part III Base Period Total is the price used in the current month in the PPI to represent cellular telephone services in a given geographic region for the sample unit. This calculation methodology is in conformance with the Laspeyres index form adhered to by the PPI.

B. Alternative Methodology

The Bill Method

There has always been an assumption in the context of the construction of a telephone or wireless telecommunications price index that it is necessary to have access to two sources of information, a detailed set of telephone bills and prices for each and every bill 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 if 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 based on 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.

An example of a simple bill with different service components and the price for each component is shown below. Long distance calls, for clarity 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	: $ 3.50
Total monthly bill	$17.75

The respondent would be asked to update prices for all parts of the bill and to also provide discount information.

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 where:
n = total number of bills
b = base period
t = current period

j= individual call in bill i
m = total number of calls in bill i
and :
R_j 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

R_j = individual call rates for bill j
q_j = quantity of services for bill j
Q_{ib} = quantity of bills i in base period b

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)

Bill #	One Party Flat Rate Residence Access Line Group 1	Group 2	Group 3	Residence Touch Tone	Call Waiting	Call Forwarding
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 more profound 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 characteristics rather than actual customer bills and then re-pricing the specification chosen. This is essentially the rate plan approach discussed earlier.

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.

Limitations in the Bill Method

Respondent cooperation is 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 that would facilitate easy disaggregation. 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.

In the end, these respondent burden issues have been found to lead to an inadequate sample size for the two telecommunications industries. Respondents are unwilling to participate in repricing if too much time must be invested in the process. Cooperation from companies is key to having a large enough sample, which represents a given industry adequately.

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 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 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 also 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.

1.3 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 to 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. A sample of bills would 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 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 a too high level.
8. 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.

C. Limitations in the chosen methodologies

Limitations in the rate Method

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.

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.

Limitations in the Unit Value Method

The clear 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 macro average pricing 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 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 is 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.

The chief limitation in the methodology for the wireless telecommunications industry is that of introducing new features. New features can be introduced frequently in this industry because it is such quickly improving technology. When they are introduced, there is not a clearly proper method of introducing them into the index. The method gathers information on a specific set of features. When new ones are added by the company, they might draw new customers and allow an increase in prices which will increase revenues. It would be necessary to be aware of these new services otherwise the revenue and weights of other services would be incorrect.

BLS concluded that by using unit values variance would be minimal. A minute of service within specified categories would be treated equally

IX. Technical concerns

A. Quality adjustment issues

The unit value methodology reduces the need for quality adjustments with existing services. The use of average weighted prices will adjust for the changing popularity of the services provided.

B. New item bias concerns

There is a strong concern about new item bias. New services in this industry are expected to be introduced frequently and to become popular quickly. When completely new services are introduced there is concern about when to include them and how to adjust for their weight. The introduction of new products or service features after the index reference date is problematic for a Laspeyres index. However, if the index is not augmented to show these new services, new item bias would result.

C. Impact of customization on the pricing methodology

Customization is fully captured by the pricing methodology. The diverse plans and services can be included by obtaining the weighted average of each service rather than trying to establish typical plans to re-price. This is because new plans are continuously being introduced to new customers. While old customers are allowed to move into new plans, they are also able to continue with their previous service plan. The different plans also include many types of discounts that are not always available and sometimes are only available to particular clients such as corporate customers. Therefore, there can be hundreds of slightly different service plans in effect at any time. Even the uncommon features are given a relative weight and are included in the index.

D. Problems defining and surveying the appropriate unique item caused by data availability

There is not really a problem defining and surveying the appropriate item as long as the services a company offers stay the same. If new services are introduced and are not identified, new item bias will result.

X. Survey vehicles

A. Methods used to secure initial sample unit cooperation

Cooperation was obtained through personal visits by knowledgeable field economists. This agency sends fully trained economists to make the first contact with sample units. These economists enlist cooperation, gather preliminary information, and help the reporter begin sending the repricing information.

B. Methods used to reprice

Reporters in this industry are asked to provide the information used to calculate a weighted average for customers in an operational area. Revenues and number of customers in an area are used to develop an average profile but are not needed if the reporters can make the calculation themselves. They are usually able to set up a spreadsheet and extract the data each quarter from the company database. They can either e-mail the spreadsheet as an attachment or send it on a disk through regular mail.

C. Strategies to secure and maintain data quality

Secure computer systems keep the data confidential. The industry analyst maintains data quality by reviewing the data for any abnormalities. The analyst contacts companies regarding any drastic changes or new services being introduced. If a reporter has not reported in some time the analyst contacts the company to determine if there is a problem and how to fix it. The analyst also maintains files on the industry and the company and keeps track of developments in the industry.

XI. Time series data and analysis of published indexes

A striking observation is the fact that public switched toll service and cellular service prices have moved in a roughly similar magnitude over the 18 months that we have measured both services. While competition played a part in this, there were many elements involved. First, there were economies of scale. A linear expansion in cellular telephone base stations allowed for an exponential growth in the number of potential customers. Secondly, the FCC licensed two cellular companies and at least three PCS companies per metropolitan area, which created meaningful competition. Third, the Communications Act of 1996 largely exempted the cellular industry from regulation. Large carriers are buying them whenever possible to fold them into the single source provider concept. Lastly, these same carriers have attempted to establish either national footprints or national alliances with other carriers to carry wireless long distance minutes over their own networks. Large LECs are also putting together these footprints. They can absorb the local usage into their own networks in the same manner as the long distance carriers absorb the long distance calls.

Ultimately, a vast amount of wireless traffic is routed over the wired networks. This convergence of the two technologies on a structural basis makes both modes increasingly subject to the same cost pressures of maintaining a wired infrastructure. Added to this is the increased demand on this infrastructure by the expanded use of internet traffic. This suggests that the recently observed similarity in price movement for public switched toll service and cellular service may well continue for quite some time to come. The three graphs at the end of this section display PPI

index movement for: 1) public switched toll service, 2) interstate business special access switched toll service, inbound, and 3) public switched toll service compared to cellular service.

By examination of each of the three graphs provided below, one sees that, in addition to a convergence in the long-term price movements of both wired and wireless telecommunications and a noticeable degree of volatility in the short-term, there is also a downward trend in price levels over the long-term for the two industries. The third graph displays this comparison quite clearly. Since the beginning of 1999 when the index for the industry was first introduced, wireless (cellular) telecommunications has seen ever declining prices. Wired telecommunications began its long-term price decent a couple of years earlier. This downward movement in wired prices can also be observed in the first graph provided, which compares the declining prices of both residential and business switched toll services.

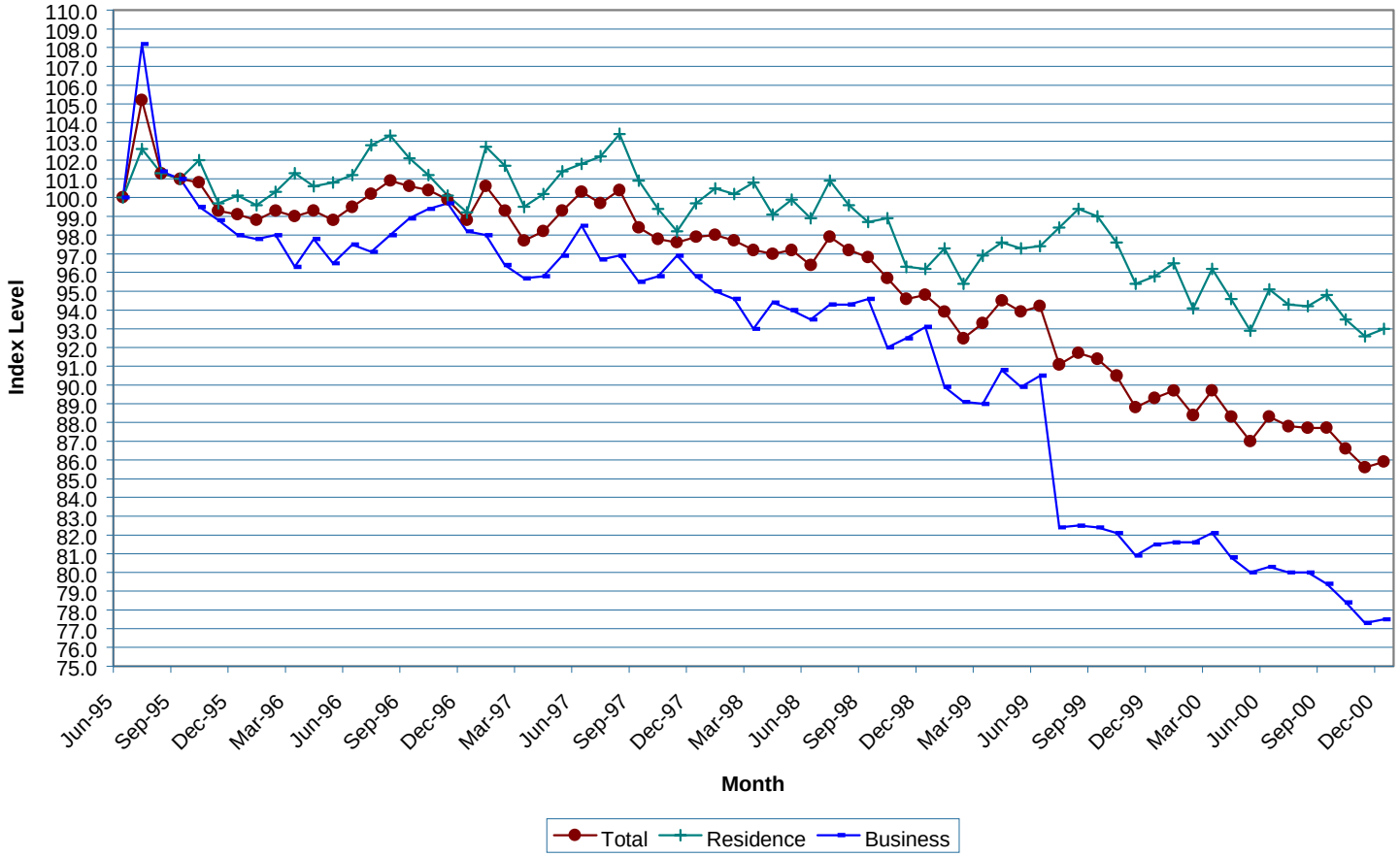
Ever increasing competition has been the driving force behind much of the price decline in the wired and wireless telecommunications industries. In the case of wired toll services, government deregulation began the movement toward increased competition between the major service providers. Wireless companies have always had the advantage of operating in a near regulation-free market. As a result, increased competition has been a norm for this industry.

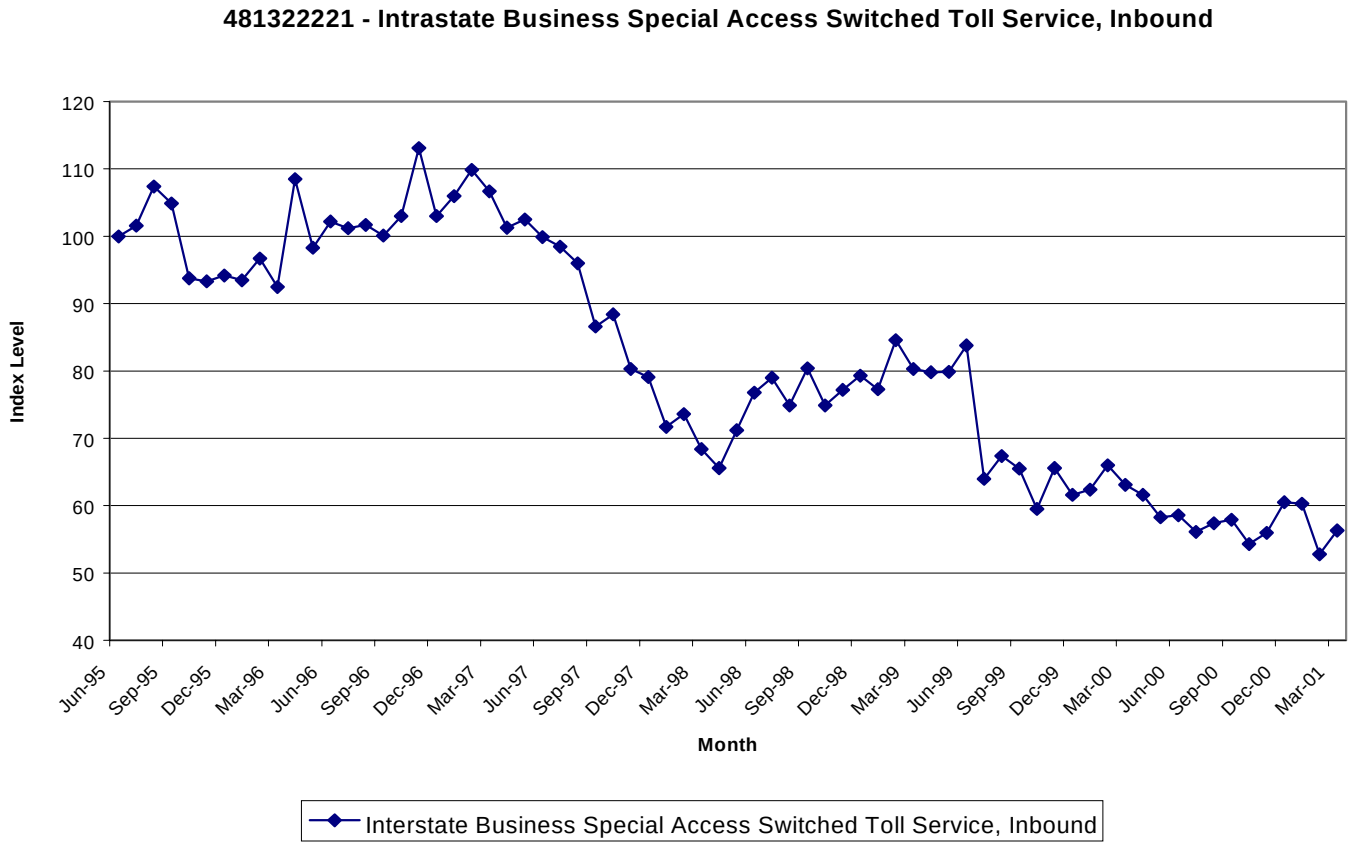
The short-term volatility and long-term downward trend in prices for the wired telecommunications industry is noticeable not only on an aggregate level, but also on a more detailed level. The second graph provided shows the long-term movement in prices for interstate business special access switched toll services, inbound. When comparing this graph to the line for public switched toll services for business on the first graph, one sees an almost perfect overlap of price movements.

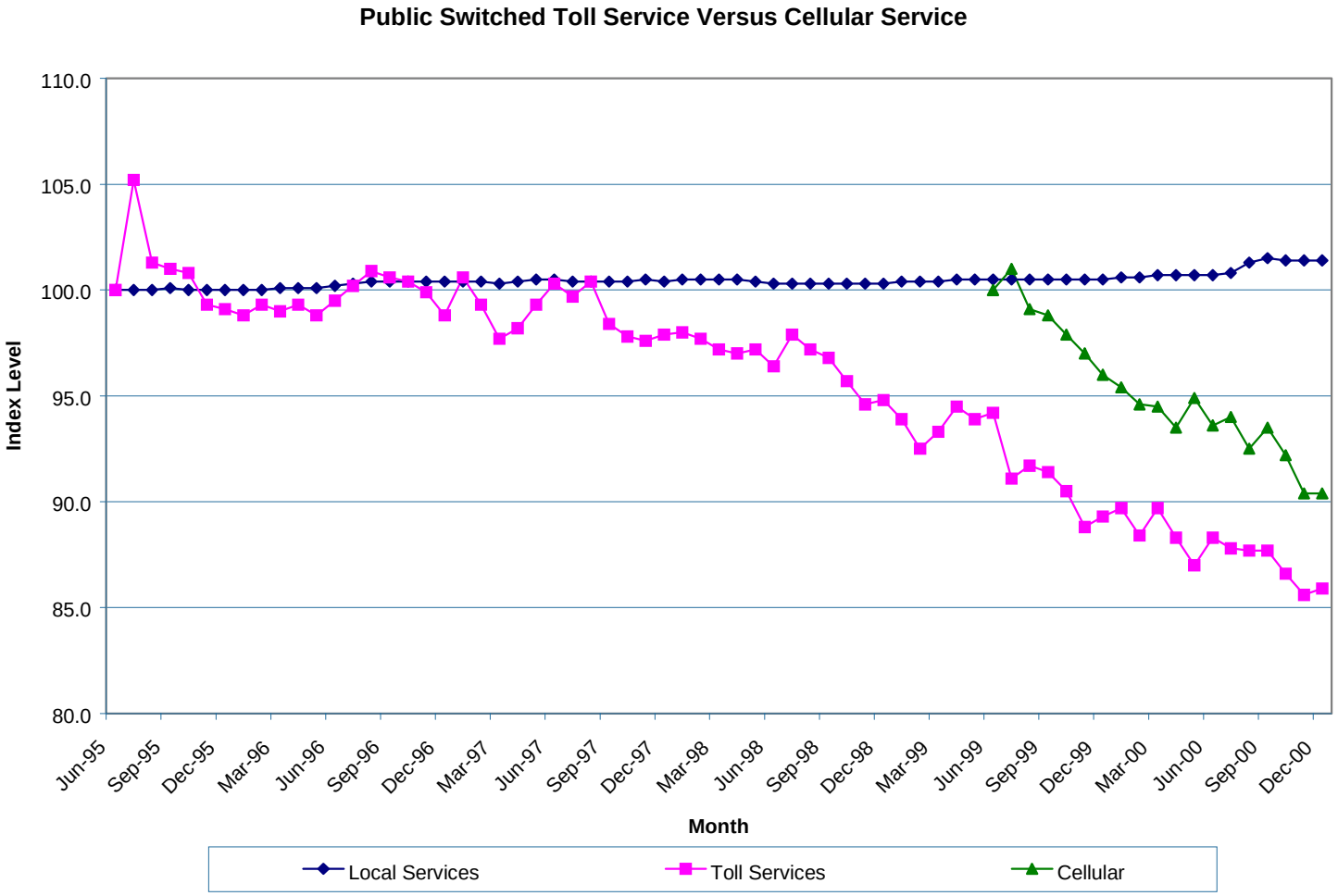
It should be noted that the third graph shows price levels for local wired telephone services remaining constant over time. This differs greatly from the downward movements of both wireless telecommunications and wired long-distance toll services. This would make sense, due to the fact that this branch of the telecommunications world is still under strict government regulation.

In conclusion, comparing the data from the following graphs to what is known about the recent history of U.S. wired and wireless telecommunications industries, one can feel confident that the methodologies explored in this paper and being implemented by the U.S. in its measurement of wholesale prices are valid. Between the rate method and unit value method, we are producing statistical measurements, which are consistent with real life price movements.

Public Switched Toll Services




481322221 - Intrastate Business Special Access Switched Toll Service, Inbound
Index Level
120
110
100
90
80
70
60
50
40
Jun-95
Sep-95
Dec-95
Mar-96
Jun-96
Sep-96
Dec-96
Mar-97
Jun-97
Sep-97
Dec-97
Mar-98
Jun-98
Sep-98
Dec-98
Mar-99
Jun-99
Sep-99
Dec-99
Mar-00
Jun-00
Sep-00
Dec-00
Mar-01
Month
Interstate Business Special Access Switched Toll Service, Inbound


Public Switched Toll Service Versus Cellular Service
110.0
105.0
100.0
95.0
90.0
85.0
80.0
Index Level
Jun-95
Sep-95
Dec-95
Mar-96
Jun-96
Sep-96
Dec-96
Mar-97
Jun-97
Sep-97
Dec-97
Mar-98
Jun-98
Sep-98
Dec-98
Mar-99
Jun-99
Sep-99
Dec-99
Mar-00
Jun-00
Sep-00
Dec-00
Month
Local Services
Toll Services
Cellular

XII. Future trends expected to affect the industry

Wired Telecommunications Industry

There are no known trends which are likely to affect cooperation any differently than now. Current cooperation is difficult because of the work load and the fact that these companies are constantly trimming expenses.

Wireless Telecommunications Industry

The new trend in the industry is the introduction of what is called 3rd Generation (3G) wireless communications. These new technologies introduce the ability to transmit and receive larger amounts of information than was possible with preceding technologies. This allows wireless phones to access the internet. With traditional cellular operations, a telephone call would open a channel to a cell and the signal would be in use for the duration of the call. 3G technology breaks down data into packages of information and sends them to a cell that forwards them to the final receiver where they are reassembled. The packaging of information is known as General Packet Radio Service (GPRS) and allows more information to be sent at once. This means that more phones can use the same airwaves at the same time and more information can be transmitted faster than before. This method of packaging information and sending it is similar to the way the internet works which allows the phones to work so well with the internet.

In addition, some major cellular phone making companies have teamed up to develop a standard for how content from the Internet is filtered for mobile communications. This standard is called Wireless Application Protocol (WAP). WAP is a set of rules for transforming internet information so it can be displayed on the small screen of a mobile telephone or other portable device. WAP converts internet pages and information into a simple format. Further in the future, Mobile Station Application Execution Environment (MExE) will permit more complex data to be transmitted. It will allow JAVA based graphics.

Europe, North America, and Japan each have different standards for digital cellular communications. These incompatible standards do not permit travelers to use phones internationally. Over the next few years 3G technologies will converge allowing customers to roam between international networks. Each of the existing standards are compatible with GPRS, only requiring modifications of current networks.

Mobile internet access has been slower to catch on in the US than in other countries mainly because of the limitations on bandwidth a company can control. Transmitting internet type information requires more bandwidth than simple voice transmissions but in the US a carrier can own no more than 45 megahertz of spectrum in any one market, less than in most other countries. Previous auctions included bandwidths that were narrower and not useful for mobile internet access. The FCC recently auctioned larger spectrums of bandwidth which has helped companies move quicker in offering internet access. Wireless companies are asking for the government to relax these restrictions further so they can offer better internet services.

Another development in the US wireless communications industry is the creation of an electronic exchange called e2open.com by IBM. The project will handle internal purchasing requirements for most of the large telecommunications equipment companies including Nokia, Motorola, Nortel Networks, Ericsson, and Philips. The system is a joint venture which is expected to cut costs by handling the companies' procurement needs.

Technology advancement is expected to further consolidate the industry. Companies with smaller bandwidths to control will not be able to offer the same scope of services that are offered by larger companies. At the same time, larger companies searching for more bandwidth to consolidate with what they already own, will be looking for acquisitions.

XIII. Need for future work

A. Concerns about survey methods employed and the need for time series analysis and possible methodological changes

The only major concerns with the survey methods are with the problem of introducing new services. When new services are available in either wired or wireless communications they need to be introduced into the index. If they are not introduced the revenue will be incorrectly weighted towards other features. When new services are included in the index it is necessary to adjust the weights. The difficulty is in determining how to adjust indexes to account for the new weights and new services.

B. Concerns about the accuracy of index movement and other related index movement concerns

If revenues increase because of new services being introduced, the weights of old services will be wrong. This could cause index bias. Without the introduction of new services, the methodology should be sufficient for capturing genuine price movements.

XIV. Conclusion

This paper provides a clear 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. The calculation of the price index using the unit value approach provides the closest approximation to the conceptual model given practical constraints. Despite its limitations, this approach accurately reflects price movement in the two industries discussed, but remains dependent on the level of cooperation received from communications companies.

Rapid changes in technology are causing fast paced changes in underlying technology and available service features. Increased competition from service providers using different technologies is causing significant price competition. This has resulted in an extremely dynamic industry characterized by frequent product innovation and complex competitive pricing strategies. This has led us to develop a pricing methodology sensitive to competitive discounting. Also, a periodic augmentation process must be operationalized to allow for new services and features to be included in the survey data.