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# Indicators of wireline/wireless competition in the market for telecommunication services[*]

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**Résumé / *Abstract***

Nous soutenons la thèse selon laquelle la concurrence dans les télécommunications sans fil a déjà un effet important sur les marchés de services filaires, malgré les prévisions historiques de la théorie de l'élasticité-prix suggérant un pouvoir dominant sur le marché (concurrence défavorable) des services filaires. Nous traiterons l'argument de l'élasticité en soi, ainsi que de récentes tendances observables dans le marché des services filaires. Nous suggérons, entre autres que :

- Les arguments fondés sur les élasticités historiques observées peuvent être faibles dans les cas où il existe un compétiteur potentiel offrant un service dont les tarifs étaient beaucoup plus élevés dans le passé, mais dont la différence de prix entre les produits pertinents s'amoindrit. Dans ces cas, le compétiteur peut avoir eu une faible influence sur la demande dans le passé, mais est susceptible d'avoir une influence beaucoup plus grande lorsque la différence de prix se resserre.

- Nous pouvons utiliser un modèle de type logistique pour l'offre et la demande ayant comme facteur clé la différence de prix pour décrire de telles situations. Dans ce cas-ci, une telle méthode produirait des résultats compatibles avec une élasticité de la demande plus forte en absolu que celle observée dans les données historiques.

- En ce qui a trait aux tendances observées de la demande, nous avons noté que le nombre total de services filaires desservis par Bell Canada suit un modèle remarquablement stable de variation selon les saisons et les tendances mais qui a été soudainement interrompu durant les quatre dernières années. Ce changement, orienté vers la demande actuelle bien en dessous des niveaux compatibles avec la tendance précédente, indique des modifications substantielles de la nature même du marché des services filaires. Puisque le marché global des services de télécommunications a continué de prendre de l'expansion depuis ce temps, cela démontre des changements dans le processus décisionnel des clients entre les différents modes de télécommunication.

- La correspondance entre les déplacements des services filaires et le nombre de clients utilisant les services sans fil (pour le service filaire de base) ou sans fil et Internet haute-vitesse (pour le service filaire secondaire ou total) nous permet d'estimer les pertes de services filaires, produisant des nombres compatibles avec une réduction approximative de près de 8 % de la taille totale du marché des réseaux filaires pour la fin de 2003 (en excluant environ 3 % de pertes concurrentielles), comparativement à ce que la demande aurait été si la croissance avait continué.

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[*] We thank Margaret Sanderson and Andrew Tepperman for valuable comments on an earlier draft

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*We address evidence that competition from wireless telecommunications may already be having a substantial effect on the market for wireline services, despite historical estimates of price elasticity suggesting substantial market power (weak competition) in wireline services, considering both the elasticity argument per se and the observable recent trends in the wireline market. Among other points, we suggest that:*

- *Arguments based on observed historical elasticities may be weak in cases where there exists a potential competitor offering a service whose price was substantially higher in the past, but where the price difference between the relevant products has lessened. In these cases, the competitor may have had little effect on demand in the past, but can have a much greater effect as the price difference narrows.*

- *We can use a logistic-type demand relation, with the price difference as a key factor, to model such situations. In the present case, doing so produces results compatible with a substantially higher absolute elasticity of demand than would be observable in historical data.*

- *With respect to observed trends in demand, we note that the total number of wirelines serviced by Bell Canada showed a remarkably stable pattern of seasonal and trend variation which has been interrupted quite abruptly over the last four + years. The change, in the direction of actual demand well below levels compatible with the previous trend, indicates substantial changes in the nature of the wireline market. Since the total market for telecommunications services has continued to expand over this time, this suggests changes in consumers' choices between different modes of telecommunication.*

- *Relating the wireline displacements to the numbers of wireless customers (for primary wirelines) or wireless and high-speed internet (for secondary and total wirelines) allows us to estimate wireline losses, producing numbers compatible with a reduction of up to 8% in the total size of the market for fixed wirelines as of the end of 2003 (after excluding approximately 3% of the competitive losses), relative to what demand would have been had the previous growth trend continued.*

## 1. General introduction

The degree of competition, actual and potential, in a market is a key factor in deciding upon regulatory policy. Whether or not two products or services do in fact serve the same market is a key question to answer before the degree of competitiveness can be evaluated. These points are of substantial interest at the present time, where technological changes in telecommunications services bring fixed-wireline and wireless services closer in price, and where the degree to which one provides competition to the other may therefore be changing. The extent to which wireline and wireless services are in 'intermodal' competition is in some degree controversial; see Phoenix Center (2004) and Petkantchin (2004), for example, for contrasting views.[1] The present study will evaluate some of the evidence which emerges from recent data on demand and price.

On a statistical level, competitiveness of a market for a product is often examined by estimating price elasticities of demand, either with respect to the product itself or with respect to the price of a currently- or potentially-competing product. If a firm faces a large (in absolute value)[2] own-price elasticity of demand for its product, this implies that demand for its output responds substantially to changes in price, suggesting the presence of near substitutes (loosely, a highly competitive environment). By contrast, a low (in absolute value) own-price elasticity of demand for its product implies insensitivity, suggesting the absence of very similar alternative products or services (loosely, a less competitive environment). We may also use elasticity to describe demand conditions faced by a set of producers, so that for example each firm may face individual demand which is sensitive to price, while overall demand for the product is relatively insensitive. The distinction between firm and market demand has not been of great importance in the past in the

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[1] Related work by Quigley (2004) provides critical evaluation of the role of the regulator's policies in rapidly changing technological conditions, and of their effect on investment and innovation.

[2] The own-price elasticity of demand is defined as $e = \frac{p_x}{X}\frac{dX}{dp_x}$, where $X$ is demand for a product or service and $p_x$ is its price. This elasticity is almost invariably negative. For compatibility with much of the literature in this area we will generally refer to the negative of this quantity, so that an increase represents an increase in price sensitivity, and will use the symbol $\epsilon$ ($\equiv -e$.)

wireline market, as there was a single provider; with the recent introduction of competition in providing residential wireline services, however, the distinction has become noteworthy.

There are several complexities involved in using price elasticity information. First, price elasticities will in general change as prices themselves change; that is, they are not in general constant at different points on the demand curve.[3] Information derived from another part of the demand curve may be a poor indicator of what will be observed where prices change substantially. Second, short-run and long-run elasticities will differ for goods whose consumers display some 'inertia': substantial time may be required for consumers to adjust fully to changed prices and relative prices, and the full effects may therefore not be visible for some time. As well, even given a relatively stable environment, elasticities must be estimated from demand data, with the usual and well-known problems associated with estimation of demand curves where market equilibria in supply and demand are the observed points. All of these points are evidently relevant to the market for telecommunication services.

In the first section (Part A) of this study, we will address the *a priori* applicability of the test based on critical elasticity of demand (Werden 1998; Phoenix Center 2004) to this context, and will also consider consistency of data with alternative views of demand conditions. In Part B, we will look at the evidence provided by trends in demand data, recent changes in those trends, and the implications for alternative views of competition in this market.

# Part A: An evaluation of recent elasticity arguments concerning competition in the market for telecommunication services

## 2. Elasticity arguments

As noted above, there are two contrasting positions on the question of competitiveness of the market for telecommunication services, exemplified by the contributions of Petkantchin (2004) and the Phoenix Center (2004). The

[3]Of course, there do exist specific functional forms for which elasticity is constant.

former argument essentially examines the number of competitors in the markets for local, long-distance, and wireless services, and recent entrants and announced entrants to these markets via Voice over Internet Protocol (VoIP) technology; the large number of companies and alternative technologies involved in provision of a given service is strongly suggestive of a competitive environment. The second argument hinges, instead, on the numerical value of an elasticity parameter.

Inverses of elasticities have traditionally been used as indicators of market power; a low firm-level value of $\epsilon$ is indicative of substantial market power (whereas a low market-level value does not preclude intensive competition within the market). The argument in Phoenix Center (2004) is related to this standard interpretation. Because the argument is closely tied to the value of the elasticity parameter, it is dependent upon the quality of our information about the elasticity, and our degree of confidence that the elasticity is remaining approximately stable. That is, the complexities in evaluation of elasticity information noted in the introduction are important in evaluation of the argument. We will begin therefore by outlining key elements of the argument, following which we will consider the questions of stability over time and under conditions of technological change, and of short-run vs long-run distinctions.

The concept of the critical elasticity of demand takes into account profit margin as well as demand elasticity, to evaluate whether a price increase of specified size will be profitable. For a particular margin of price over variable cost, there will be some $\epsilon$ sufficiently great that a price increase of a given percentage[4] will not be profitable, and this value is the critical elasticity. Where this point lies depends on the shape of the demand curve as well as on the size of the increase and profit margin; various functional relations between these quantities and the necessary elasticity range (e.g. for linear or constant-elasticity demand) are given in Werden (1998), although Phoenix Center (2004) uses only a linear form. Since profitability requires that the actual value of $\epsilon$ be lower than a particular point, higher values of $\epsilon$ –more elastic demand – make profitability of a price increase less likely. In other words, we see in different terms the standard inverse relationship between $\epsilon$ and market power. We also see that if our estimate of the actual elasticity of

[4]This is often taken as 5%. As well, the increase is presumed to be non-transitory, which in practice is often taken to mean that it lasts at least one year.

demand is incorrect or out of date, we may be led to a false conclusion with respect to the potential profitability of a small increase in price.

As Werden (1998: 392) notes, 'Critical elasticity calculations are not always useful.' Werden then gives an example of this which has a good deal in common with wireline vs. wireless provision of telecom services, referring to the case of *United States v. Archer-Daniels-Midland* and the market for high-fructose corn syrup.

This market had the property that corn syrup was cheaper than sugar, and so was used in its place for most commercial purposes. Evaluated by $\epsilon$, the producers of corn syrup would have appeared, taken as a group, to have substantial market power;[5] small price increases would leave corn syrup cheaper than sugar, and since corn syrup would remain the cheaper alternative, it would lose very few customers. At a certain level of price increase, however, the price of corn syrup would approach that of sugar. Around that price, users of sweeteners would be prepared to switch en masse back to sugar. The apparent (collective) market power of the corn syrup producers would not extend to a price increase large enough to reach the price of sugar: sugar was a potential substitute, although this substitutability would not be apparent in elasticity estimates as long as the price differential remained substantial.

Replace 'corn syrup' with 'fixed wirelines' and 'sugar' with 'wireless' in the preceding paragraphs, and it is apparent that some of the same considerations apply. Of course, the analogy is imperfect; the degree of differentiation of the two telecommunications services is evidently greater. However, the relevant point for our present study is not the degree of similarity of the two services (which obviously differ in mobility), but the degree to which one service (wireless) may substitute for the other (wirelines); the mobility advantage of wireless allows easy substitution of wireless for wireline, but substitution in the other direction is not as convenient. The telecommunications case differs also in that the price of the potential substitute, wireless services, is falling to meet that of the currently-cheaper alternative.

Using various assumed margins and a hypothetical price increase, the Phoenix Center (2004) study suggests that the critical elasticity is in the

[5] Of course, with a number of producers, collusion would be necessary to exploit any potential market power; that individual producers have low market power, and relatively high firm-level price elasticities, is consistent with the conditions just stated.

vicinity of 1.25–2.0, and compares these values with a published estimate (Rodini et al. 2003) of 0.62. Numerous past studies of wireline demand have produced estimates of the own-price elasticity of demand in the region of 0.5, and there can be little doubt that this was a reasonable description of the market in the past. The question now is whether it remains, and will remain in the near future, an accurate representation of this market, faced with substantial technological change in competing services. In the Werden (1998) corn syrup/sugar example, the value of $\epsilon$ for the corn syrup market[6] would be well below 1 when the two products' prices were substantially different. If a change (e.g. in production technology) moved the prices close together, the situation would change rapidly, and the historical estimate would cease to provide a reliable indicator of the current state of the market.

Analytically, this state of affairs can be represented by a demand curve that changes slope relatively abruptly when price reaches the vicinity of the price of a potential substitute. To represent such a class of demand curves, we can use for example a transformation of the logistic function $(e^{-(p-\alpha)/\beta})^{-1}$; consider in particular

$$X = k(1 - (1 + e^{-(p-\alpha)/\beta})^{-1}), \tag{2.1}$$

where $X$ is demand for a product of interest (e.g. wireline service), $p$ is its price, and $\alpha, \beta, k$ are parameters specific to the market. The parameter $\alpha$ may be interpreted here as the price of the potential substitute, while $\beta^{-1}$ controls the shape of the curve, i.e. the 'sharpness' of the switch to the substitute when $p$ is near $\alpha$. The logistic function or related functions ("$S-$ curves") are often used to model related processes such as adoption of technology, adoption of new products, and switching from one product to another; see in particular Hodges and Vanston (2003, especially Appendix A) for detailed examples, and Johansson (1979) for a treatment of models and estimation methods.

The upper panels of Figure 1, that is Figures 1a-1 and 1a-2, present some examples of demand curves of this type, for various values of $\beta^{-1}$ and for

[6] We are referring here to the elasticity of total market demand; individual producers' elasticities may, as discussed earlier, be very different. In particular, the size of this market as a whole may be insensitive to price changes at a particular price level, while demands faced by individual firms may nonetheless be sensitive because of competition from other producers of the same product.

various price gaps $p - \alpha$ (note that negative quantities represent the present situation in which wireline access service costs less than wireless). The vertical axis represents the demand at each price as a percentage of the maximum demand (occuring when the price of the competitive service is high). The lower panels, Figures 1b-1 and 1b-2, indicate the corresponding (absolute) elasticities in each case.

We are now in a position to evaluate conclusions based on critical demand elasticity in a market such as that just described. In the next section we examine data on residential wireline demand, price of local access services, and price of similar local services provided by wireless, to evaluate the potential applicability of this description to the local telecom market.

Before doing so we will emphasize that we are addressing primarily the absolute size of the wireline market, and not the share taken by different providers–that is, we examine the size of the pie rather than the relative sizes of the slices. The estimated proportion of residential wirelines provided by Bell Canada in its operating territory within Ontario and Quebec was 96.9% in the fourth quarter of 2003.[7] The size of the wireline market itself–the total number of wirelines in service–has not been stable but has shown long-term trend growth, followed by a recent pattern of departure from that trend, which is of interest to us in the present study. Whereas competition from other providers of the same service affects market share (e.g. Sprint competes with Bell in providing wireline service in major urban areas), competition from alternative products or services such as wireless affects total market size. Alternatively, as two services come into closer competition, one should redefine the market to include both services (e.g. telecommunications services provided by either wireline or wireless). Viewed in this way, the market share of Bell wireline services is not the 96.9% just mentioned but the share of total consumer telecommunications demand captured by Bell fixed wirelines.

## 3. Consistency with observed price series

Consider a price of the alternative, $\alpha$, which is falling–as has been the case with wireless services. A given existing price of wireline access, $p_0$, will then be approaching the steepest part of the demand curve as $\alpha$ approaches

[7]Bell Canada Enterprises, Fourth Quarter 2003 Supplementary Financial Information, BCE Investor Relations, p. 12. The losses are to facilities-based competition only.

$p_0$. For $p_0$ well below $\alpha$, $\epsilon$ is small, demand is inelastic, and by traditional measures including tests based on critical elasticity, the firm (if there is only one supplier) appears to have substantial market power. As $p_0$ and $\alpha$ become closer together, $\epsilon$ rises (with a rapidity governed by $\beta$), and demand becomes elastic, indicating a lack of market power. This is so even though estimation of $\epsilon$ on a sample of data taken when $\alpha$ was higher, and therefore $\alpha$ and $p_0$ farther apart, would have shown a value implying high market power. In other words, as the price of the potential substitute falls, elasticity may rapidly move from inelastic to highly elastic values, implying radically different results from small price increases, and entirely different conclusions about market power. Elasticity estimates based on historical data may be entirely unable to represent this effect.

To apply the model (1) to this market, we need data on a number of key elements: (i) the actual demand for fixed-wireline services, (ii) the price of wireline local services, and (iii) the price of equivalent local service if provided by wireless. As well, because the model describes only the effect of price and abstracts from long-term growth in the market (for example, because of population or income growth), we need to adjust wireline demand data to produce figures from which these long-run trends have been removed, and which therefore represent approximately comparable environments at different dates. We do so by adjusting the wireline demand data for trend growth,[8] allowing us to focus on changing relative prices as a source of demand variation. Finally we also need to obtain (iv) the base level of demand for wireline access, $k$, which applies when prices of wireline and wireless local service are far apart: that is, when the price of wireless is sufficiently high that it exerts essentially no effect on wireline demand (in Figures 1a-1 to 1a-4, this is the value at the left of the graph, corresponding with prices much lower than the price of wireless services, and set to 100 in those figures to represent the maximum as a percentage).

The first series (i) is readily obtained. The price of wireline local services (ii) is also fairly easily obtained, from historical data on local access revenue and numbers of subscribers. The third element is more difficult to construct;

[8]The long-run trend is estimated as a function of time and seasonal effects, and for each data point the trend value is removed and replaced by the mean of the trend, to place points at different dates and seasons on a common footing.

a series of estimated prices of local telecom services, if provided entirely by wireless, was estimated from total wireless local revenues and numbers of subscribers, and projected backward using data on relative costs of local and long-distance wireless calls. The series was adjusted to remove the cost to the consumer of additional services not packaged with standard wireline local telephone service, such as *Call Answer* or *Call Display*.[9] Some apparent seasonality in the resulting numbers was estimated and removed. The prices of the two forms of local service have become much closer over the sample period. In the initial period the two prices are quite different, allowing us to compute an estimate of the quantity (iv), which we do by taking an approximate upper bound on demand from the observations in this region.[10] The current (August 2004) price gap between wireline and wireless local access services is estimated to be about $10.

Note that the difference between wireless and wireline access prices is falling during this period because of decreasing access price for wireless, while the price of wireline service remains approximately constant through the period.

We now make a very rough estimate of the shape parameter $\beta^{-1}$, which governs the rapidity of demand changes as prices of two potential substitutes become closer, in this market. Re-write the model (2.1) as

$$\ln\left(\frac{X}{k-X}\right) = -(p-\alpha)\beta^{-1}, \tag{3.1}$$

and given series of data representing the three elements listed above (respectively $X, p, \alpha$ as well as a value of $k$), we can estimate $\beta$ from the sequence of points. Using data from March 1995 through February 2004, and bearing in mind that some of these data have been interpolated or back-cast from observations occuring later, we can obtain an estimate of $\beta^{-1}$ by linear regression or simply by inspecting the sequence of values $\beta^{-1}$ that solves equation (3.1) at

[9]These computations were made by Serguei Preobrajenski of Bell Canada.

[10]More specifically, we take for $k$ a value slightly in excess of the maximum observed value of wireline demand, since the value of $k$ must exceed actual demand at all points. Sensitivity to various values of $k$ was checked; values farther in excess of maximum observed demand tend to produce smaller estimated values of $\beta^{-1}$.

each data point. In doing so, we typically see values in the range of 0.1–0.25. We emphasize that these are very rough estimates, primarily because of the short period available in which adjustment to lower wireless prices is taking place, so that we are drawing inferences from a restricted part of the logistic curve; as well, we are constrained by limitations of the pricing data and other measures. Nonetheless, we do see evidence of the curvature associated with a relation such as the logistic.

Note (see Figures 1b-1, 1b-2), that for $\beta^{-1}$ of 0.1 or 0.25, demand for wireline access becomes elastic as the price difference declines to \$6.25 and \$7.10 respectively. The current price difference between wireless and wireline access of about \$10. per month yields inelastic demand, but there is clearly the potential in this model for demand to become elastic if the price difference continues to decline. The general decreasing trend in wireless prices and the relatively small further decline necessary in this model to produce elastic demand suggest that the market could be near the verge of significant demand shifts from wireline to wireless.

From the estimated $\beta^{-1}$ and other parameters we can compute examples of the effects on demand in the model of changes in the relative price of wireline and wireless services. Table 1 gives some examples for particular values of $\beta^{-1}$; recall that these examples describe changes in total size of the market for wireline services, not changes in market share.

**Table 1**

Approximate percentage reduction in size of total market
(wireline displacement by wireless competition)
as a function of price gap and $\beta^{-1}$, in the logistic model

| Price gap (wireless-wireline) | $\beta^{-1} = 0.1$ | $\beta^{-1} = 0.2$ | $\beta^{-1} = 0.3$ |
|---|---|---|---|
| \$20 | 12% | 2% | 0.2% |
| \$15 | 18% | 5% | 1% |
| \$10 | 27% | 12% | 5% |
| \$5 | 38% | 27% | 18% |

For example, at the current access price difference between wireless and wireline of about \$10, and for $\beta^{-1}$ of 0.2, the loss of wireline local access demand (i.e. excluding facilities-based competitors) is 12%. The implication in this example is that the total size of the market for wirelines would be 88% of what it would have been in the absence of wireless competition. As Bell Canada's share of that market is presently about 96.9%, the wireline local access demand serviced by Bell Canada would in this case be approximately 85% of what it would have been in the absence of both types of competition. Note that the incumbent's loss of share of the wireline market (about 3%) to the facilities-based competitors is in this example much less important that the loss attributable to shrinking of the wireline market itself because of wireless competition. While the figures in this table are subject to various uncertainties, the important point is that the sensitivity of wireline demand to the price difference between wireline and wireless is *dynamic*, and that demand can begin to respond substantially as the price difference falls.

Note that the estimated parameter values, and the associated demand relation at a point in time, correspond with *short-run* adjustments to changes in the relative price of wireline and wireless services. To the extent that we expect to see gradual changes over time in the response to changed relative prices, we would expect to see the demand effects tending to increase over time. To take an example, consider consumers who face a monthly wireline price fixed at $24. while the wireless price falls from $60. to $25. Consumers will adjust at different rates to this changed environment: some will not switch, some may immediately cancel wireline service, some take some time to become informed about price changes and may switch after one year, and some who will eventually decide to give up wireline service may take years to do so. In data for (to continue with the example) two years following the price change, we will fail to observe the slow-to-shift consumers, and so will under-estimate the long-run effect of the change on wireline demand. The present data set has some characteristics of this example, although actual prices remain some distance apart: data observed at present likely do not constitute a long-run equilibrium adjustment to current relative prices, so that we may observe further changes even in the absence of further relative price convergence.

Note also that we would expect to see clearer indications of long-run behaviour in circumstances in which the 'inertia' is less, for example in the market for local services in new housing units, where a switch to wireless services does not entail a decision to disconnect existing wireline service.

To summarize our conclusions from Part A:

- Arguments based on observed historical elasticities may be weak in (e.g.) cases where there exists a potential competitor whose price was substantially higher in the past, but where the price difference is falling. In these cases, the competitor may have had little effect on demand in the past, but can have a much greater effect as the price difference narrows. Such circumstances can be represented by a logistic-type demand relation with the price difference as a key factor.
- Application of such a model to the local telecom services market suggests gradual adjustment of total market demand for wirelines to changes in relative price (i.e. a low value of $\beta$) in the vicinity of the point of price equality between the services. The elasticity nonetheless rises well into the highly elastic region (that is, the region in which the elasticity is indicative of low market power of the incumbent service provider) in such cases, as the prices of the two services converge. This suggests that the market at the present time may be characterized by a substantially higher

absolute elasticity of demand than is observable in historical data, and that this effect may become stronger in the future if prices continue to converge.

- We may expect considerable 'inertia' in consumers' choices between the two services, that is, a short-run adjustment which is smaller than the long-run adjustment that will eventually be observed. For new service orders (e.g. installations in new housing units), however, this inertial effect would presumably be smaller, suggesting that a more dramatic effect would be observable in the short run in such circumstances.

## Part B: Trends in demand for fixed-wireline services

In Part B we consider evidence of changes in market conditions which comes directly from observed demand changes, rather than from elasticity estimates.

### 4. Trends and departures from trend

We begin by presenting, in Figures 2a/3a/4a, indicators of the trends in the total number of residential wirelines in service in each month through the period January 1990 through December 2003, as well as the division of this total into primary and secondary residential wirelines. To retain confidentiality with respect to actual numbers of wirelines, the values for numbers of lines are divided in each case by the value of the data series in December 1999, leaving values which are percentages of the December 1999 figure. As well, seasonal fluctuations have been removed in these graphical representations.

Each of the panels also shows a fitted trend series, construction of which will be described below. Two features are immediately apparent, which will be the focus of this section: first, the data show a very stable pattern of trend growth for the ten years 1990 through 1999, well tracked by the fitted trend.[11] Second, there is an apparent change in the pattern of trend growth beginning around the start of 2000; the trends fitted based on the data through the end of 1999 cease to follow the actual data closely. The trends were in each

[11] We must allow for the substantial seasonality in primary, and therefore total, wirelines in service; the fitted trend used in the analysis contains seasonal components, although these are not shown in the figures.

case constructed from projection on twelve linearly-additive monthly dummies (i.e. summing to the constant) for seasonality, and on the cumulative sum of housing-unit starts in Ontario and Quebec for trend growth, as well as an autoregressive term to capture short-term deviation from the trends.[12] For long-term projections, the autoregressive term is omitted.

As the figures would suggest, and as would be expected given the regular trend, measures of fit of these trend-growth representations are extremely high. Of course, such projections are sensitive to the trend model used. While housing data were chosen for these figures because of the natural link with wireline installations, projection on a linear trend would also have been a reasonable strategy for projection, *a priori*. Because housing starts were relatively high in the first few years of the present decade, the projection onto the trend based on cumulative housing starts tends to produce higher numbers than projection on the linear trend; we will indicate a range based on both sets of values in the text.

To examine each of these points on a finer scale, consider Figures 2,3 and 4, panels b and c. Figures 2b/3b/4b plot total, primary and secondary residential lines, from January 1990 through December 1999 only. This is the period of apparently stable trend growth, and it is clear that the fitted trend is very close throughout this period. From the match between fitted and actual values at the end of this period, it is clear that this time pre-dates the apparent break in the trend pattern. Figures 2c/3c/4c plot only the period from January 2000 through February 2004; here we see the substantial and growing deviation between actual data and what would have been predicted based on previous patterns: that is, we see a growing 'gap' between the patterns of growth visible in the decade of the 1990's, and those holding in the first few years of the present decade. It is clear that both primary and secondary wirelines show a very steady increase in this gap between actual demand and the demand for these lines which would have been observed given previously-observed trends.

Note that these patterns provide some *prima facie* evidence in favour of the view that an important change in the nature of this market has taken place in recent years, a change which it is natural to attribute to changes

[12]The housing start data are Cansim series J6007 and J6010. Housing *starts*, rather than *completions*, were used because of data availability at the individual unit level. Clearly, however, any of various trending series would provide an adequate proxy for the growth in these wireline installations.

in available telecommunication technologies, since the technology and price of wireline services *per se* have not changed substantially over this period. These trend representations suggest losses of approximately 3–6% of primary wirelines, and about 34–40% of secondary wirelines, relative to what would have been observed had past market trends been maintained. Together these figures represent around 7% (linear trend) –11% (trend based on cumulated housing starts) of the total trend demand for installed wirelines in the Bell region.

Although projections are inevitably based on imperfect models, this estimated loss of wireline demand is suggestive of some quite substantial change in conditions, given that this gap has arisen over only four years in what was previously a market noteworthy for its stability. Some part of the change in demand for Bell Canada's services *per se*, as opposed to total market size, must be accounted for by the facilities-based competition in the fixed-wireline market which captured about 3% of the market; nonetheless the estimated losses appear to have an additional component beyond this 3%.[13] This indeed is the conclusion which follows from Statistics Canada (2004), which shows a small but growing proportion of Canadian households which have only wireless service. Note that the lower-end estimates of *primary* wireline losses relative to trend could approximately be accounted for purely by the losses to facilities-based competitors, leaving no component for losses to wireless: however the Statistics Canada evidence on wireless substitution, among other evidence, suggests that this lower-end estimate is in fact implausibly low.

In the rest of this part, we will relate these gaps between trend and actual wireline demand (i.e. displacements of wirelines) to growth in wireless and high-speed internet demand using a Digital Subscriber Line (DSL) or cable access.[14] We use the gaps based on the cumulative housing-start trend model, as depicted in Figures 2–4, rather than on the linear trend. We note that these gaps, being non-stationary time series with clear upward trends, could be related to various other trending time series; while tests for co-integration would allow us to eliminate some potential explanatory factors, the sample of data beginning in 01/2000 is too short to allow formal inference of this type. We

[13] Subtracting this 3% loss to competition from the total demand reduction relative to trend, we are left with 4% (linear trend) or 8% (trend based on housing data, our preferred model).

[14] Note that we use data enumerating all high-speed and wireless customers.

can however examine the projection of the gaps onto two natural explanatory factors: the size of the wireless market, and the number of high-speed internet access subscribers. We can therefore make some estimate of the impact per subscriber of these services on demand for fixed wirelines, *conditional on* the supposition that the growth of these technologies has been the important change in this market observable in Figures 2-4. We emphasize that, because of the pronounced trends in the data series, these gaps could be projected onto any of a large number of trending data series, with similar statistical fits. The measurement of effects that we undertake below is therefore not intended to indicate statistical confirmation of their importance, but only measurement conditional on the attribution of changes to these effects.

The explanatory factors that we will use are as follows. For primary wireline displacements (that is, primary wirelines that are either dropped or never installed because of an alternative means of communication), we use the number of consumer wireless subscribers. For secondary wireline displacements, we use the number of consumer wireless subscribers plus the number of high-speed internet connections in service, and we use the same sum for total wireline displacements. That is, secondary wirelines may no longer be needed either because the secondary wireline has been substituted by a wireless telephone, or because the secondary line was needed primarily for internet access, and became unnecessary with the high-speed access which permits simultaneous internet and telephone usage. Since total displacements are made up of primary and secondary wirelines, the total figure must depend on any factor relevant to either of the components, and therefore includes both wireless and high-speed access.

Discriminating between high-speed access and wireless as potential explanatory factors in wireline displacements is infeasible on the available sample because of the similar trends in the two series. We therefore attribute displacements to one or the other on *a priori* grounds using some simple facts about the technologies, such as the fact that high-speed internet makes a secondary wireline purely for internet use obsolete, and may therefore displace a secondary wireline, but cannot displace a primary wireline. As a consequence, in the models for secondary and total wireline displacements where either high-speed or wireless may be a factor, we use the sum as the explanatory factor.

Table 2 records the coefficients in the least-squares regression of wireline displacements (primary, secondary, total) on a constant and the indicated explanatory factor.

**Table 2**

Estimated coefficient on explanatory factor in models of wireline displacements

| Class of wireline | Explanatory series | Coefficient (s.e.) |
|---|---|---|
| Primary | wireless | 0.15 (.009) |
| Secondary | wireless+high-speed | 0.08 (.003) |
| Total | wireless+high-speed | 0.16 (.008) |

Taken at face value, these coefficients would have the following interpretation. For every 100 new consumer wireless customers (in the Ontario/Quebec region), on average 15 primary wirelines were displaced (disconnected, or never installed in a new housing unit). This figure is roughly comparable with the results of Barros and Cadima (2000) and Sung and Lee (2002), both of which involve much more extensive data analysis than has been possible here.[15] For every 100 new customers subscribing *either* to wireless or high-speed internet, on average 8 secondary wirelines, and 16 in total (primary + secondary) are displaced.[16] The total displacement of wirelines is estimated to be approximately 9%, and is consistent with the results of Part A of this study. It

[15]The similarity arises despite the fact that these studies pertain to countries (Portugal, Korea) where fixed-wireline market penetration is far below that in Canada.

[16]Note that the figure for the total is not the sum of primary and secondary because the explanatory variable is not the same–high-speed access being excluded in considering primary wireline displacements.

is important to emphasize again however that the coefficients in Table 2 are dependent upon our choice of explanatory series; because of the pronounced trends, many explanatory factors could be found which would provide a similar statistical fit. The results should therefore not be viewed as tests of the statistical significance of the effects of the explanatory factor, but as measurement of the size of the effect, given the assumption that we have used appropriate explanatory factors.

These figures refer to estimated displacements whose impact was felt in the sample period; bearing in mind, again, the distinction between short-run and long-run adjustments, we must note that some displacements resulting from these new wireline/high-speed customers could fall outside the sample period, and would not be reflected in these figures.

To summarize our conclusions from Part B:

- The total number of wirelines serviced by Bell Canada showed a remarkably stable pattern of seasonal and trend variation which has been interrupted quite abruptly over the last four+ years. The change, in the direction of actual demand well below levels compatible with the previous trend, indicates substantial changes in the nature of the market. Since the total market for telecommunications services has continued to expand over this time, this suggests that some market development has led to changes in some consumers' choices between different modes of telecommunication. The observed patterns appear compatible with the general conclusions of Part A.
- The reduction in total demand relative to trend appears to have been roughly evenly split between primary and secondary lines. This pattern of relative displacements seems unlikely to continue, however, as the stock of secondary wirelines falls to a low level.
- Relating the wireline displacements to the numbers of wireless customers (for primary wirelines) or wireless and high-speed internet (for secondary and total wirelines) allows us to estimate wireline losses per customer using the other services, producing numbers compatible with a reduction of approximately 9% ± in the total size of the market for fixed wirelines to date, relative to trend.

## 5. Concluding remarks

We noted in the introduction that there are conflicting views of the competitive effects of wireless service on wireline demand, exemplified by Phoenix Center (2004) and Petkantchin (2004). Broadly, there are many indications of increasing competition affecting incumbent local service providers, both from market structure and from the trends in demand described, for the Bell Canada region, in section B of this paper. By contrast, past price elasticity estimates suggest little competitive effect.

We point out in this paper several reasons why the price elasticity estimates may be the less reliable evidence in this case. The estimates are based on historical data, which do not describe the present state of a changing market; when we model a potentially-evolving elasticity using a logistic model based on the price gap between two forms of service (similar to the "$S-$ curve" commonly used in modelling technology adoption), we see that historically-low elasticities are compatible with much higher values arising as the prices of two potentially-competing services become closer. This allows a possible resolution of the differing forms of evidence: the low historical estimates are compatible with higher current and future values of the elasticity, which in turn are what would be expected given the other evidence of current competition described in, e.g., Petkantchin (2004). These considerations suggest that historical elasticity information should be interpreted very circumspectly in a market which is undergoing fundamental changes.

## References


Barros, P. and N. Cadima (2000) The Impact of Mobile Phone Diffusion on the Fixed-Link Network. Center for Economic Policy Research (CEPR) discussion paper 2598.

Bell Canada Enterprises (2003) Fourth Quarter Supplementary Financial Information, BCE Investor Relations, Montreal.

Hodges, R.L. and L.K. Vanston (2003) Forecasts of Access Line Competition in the Local Exchange. Technology Futures Inc., Austin, Tx.

Johansson, J.K. (1979) Advertising and the S-curve: a New Approach. *Journal of Marketing Research* 16, 346-354.

Petkantchin, V. (2004) Do We Still Need to Regulate Telephone Services? Economic note, Montreal Economic Institute.

Phoenix Center for Advanced Legal and Economic Public Policy Studies (2004) Fixed-Mobile 'Intermodal' Competition in Telecommunications: Fact or Fiction?' Policy Bulletin No. 10.

Quigley, N. (2004) Dynamic Competition in Telecommunications: Implications for Regulatory Policy. C.D. Howe Institute Commentary 194.

Rodini, M., M.R. Ward and G.A. Woroch (2002) Going Mobile: Substitutability Between Fixed and Mobile Access. Working paper, University of Texas at Arlington.

Statistics Canada (2004) Residential Telephone Service Survey.
http://stcwww.statcan.ca/english/sdds/4426.htm

Sung, N. and Y.-H. Lee (2002) Substitution between Mobile and Fixed Telephones in Korea. *Review of Industrial Organization* 20, 367-374.

Werden, G.J. (1998) Demand Elasticities in Antitrust Analysis. *Antitrust Law Journal* 66, 363-414.

Figure 1a-1
Logistic demand:
inverse of beta = 0.10, 0.20

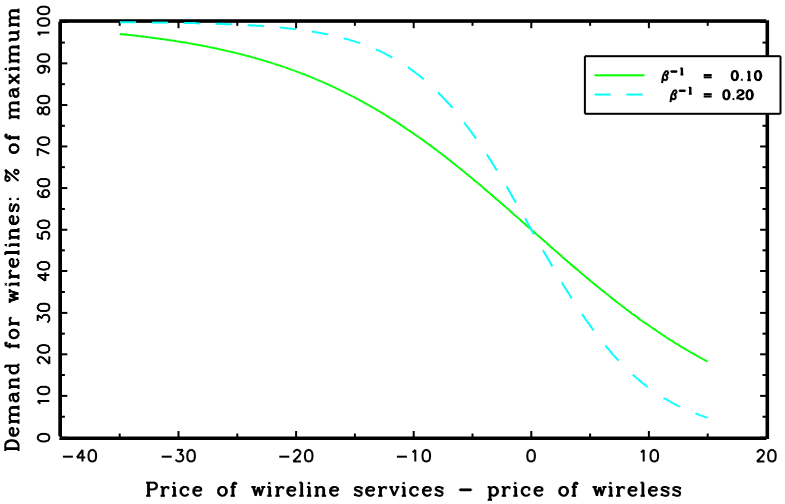


Figure 1a-2
Logistic demand:
inverse of beta = 0.30, 0.50

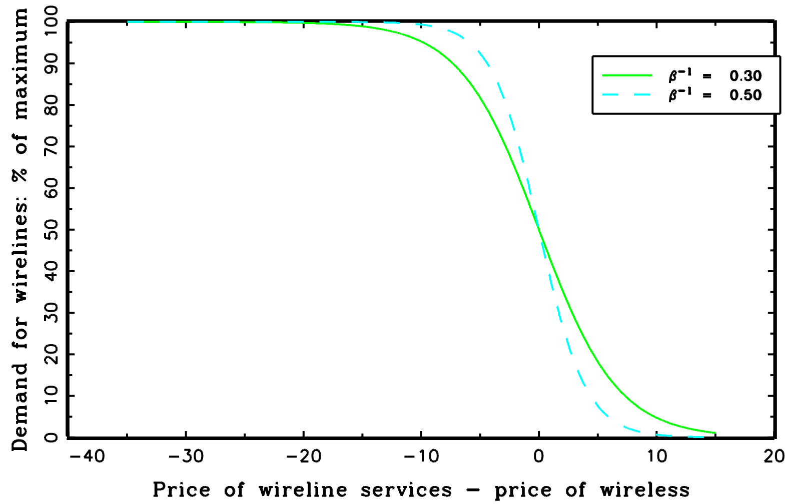


Figure 1b-1
|Elasticity| vs. price of wireline services:
inverse of beta = 0.10, 0.20

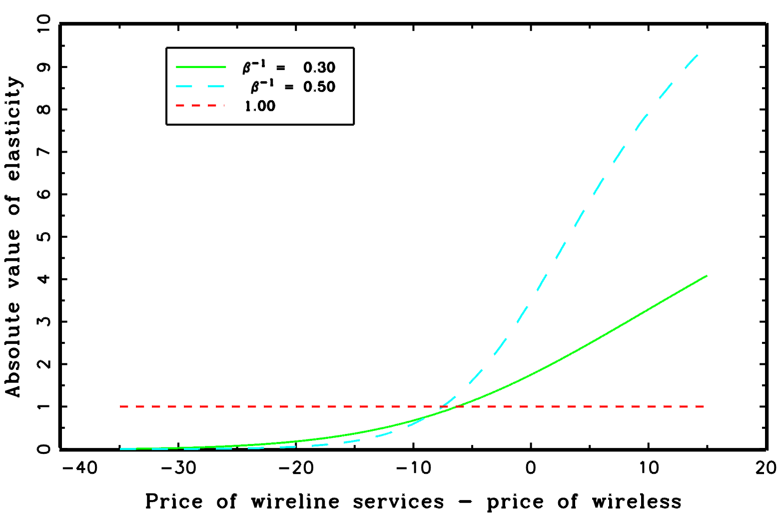


Figure 1b-2
|Elasticity| vs. price of wireline services:
inverse of beta = 0.30, 0.50

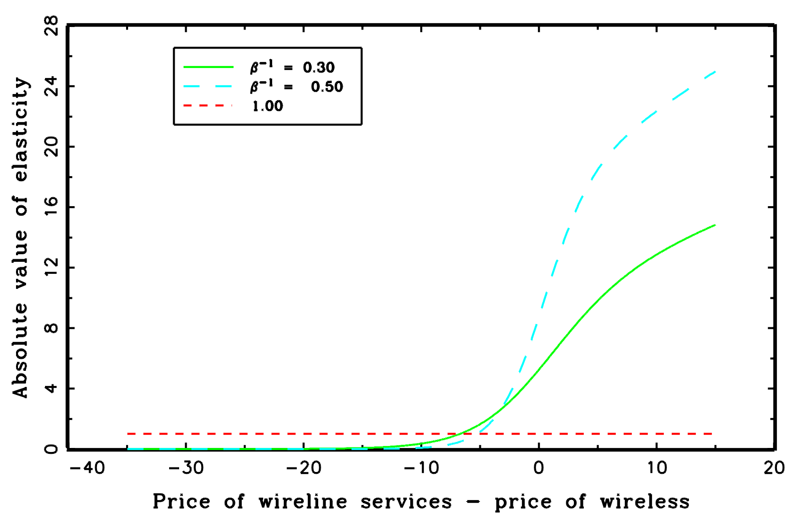

Figure 2a
Total wirelines, actual, fitted and projected,
projection from 1/2000 through 12/2003

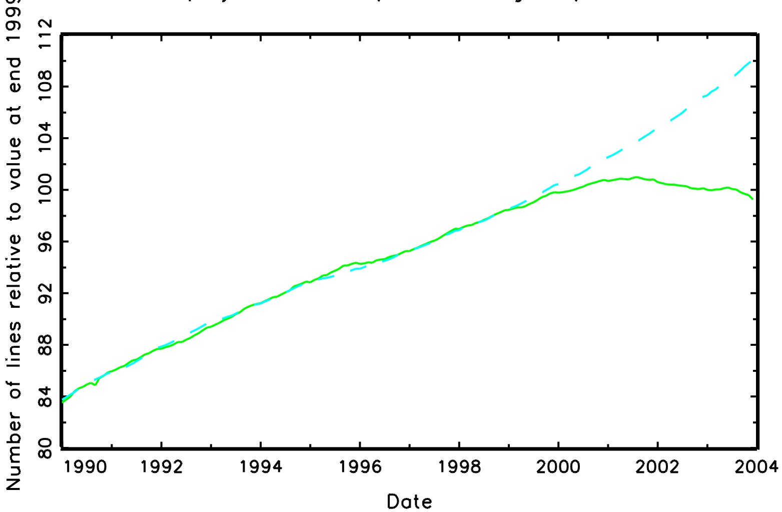


Figure 2b
Total wirelines, actual and fitted, to end of 1999

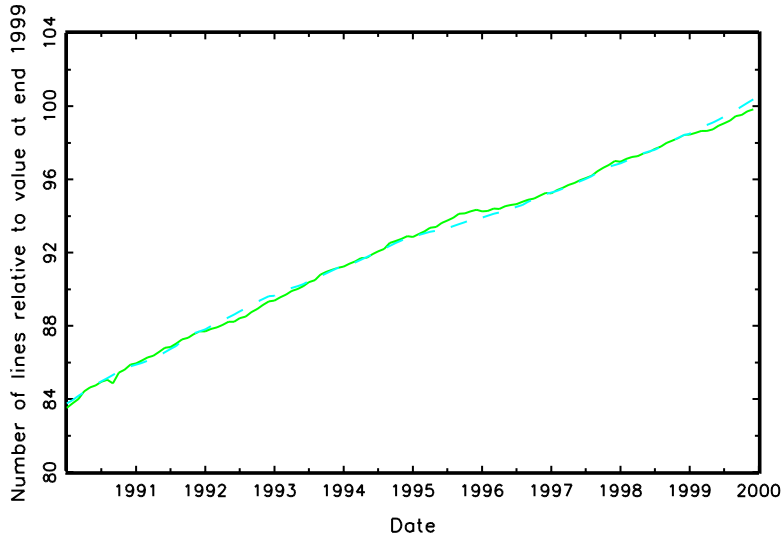


Figure 2c
Total wirelines, actual and projected,
from 1/2000 through 12/2003

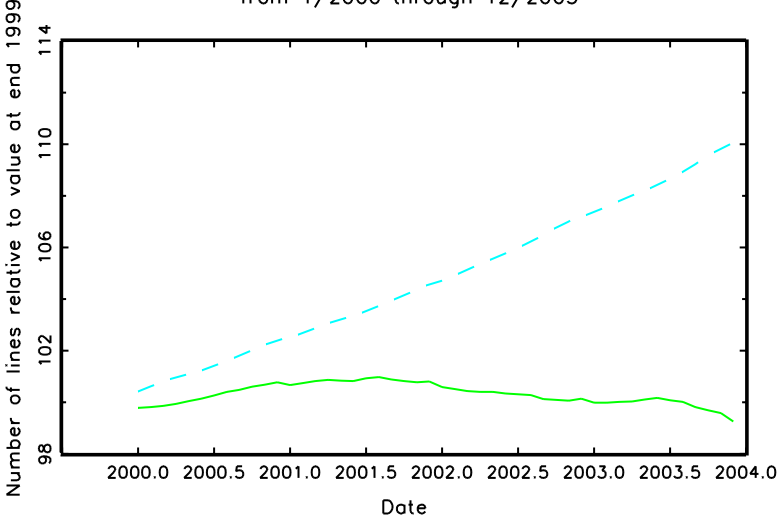

Figure 3a
Primary wirelines, actual, fitted and projected,
projection from 1/2000 through 12/2003

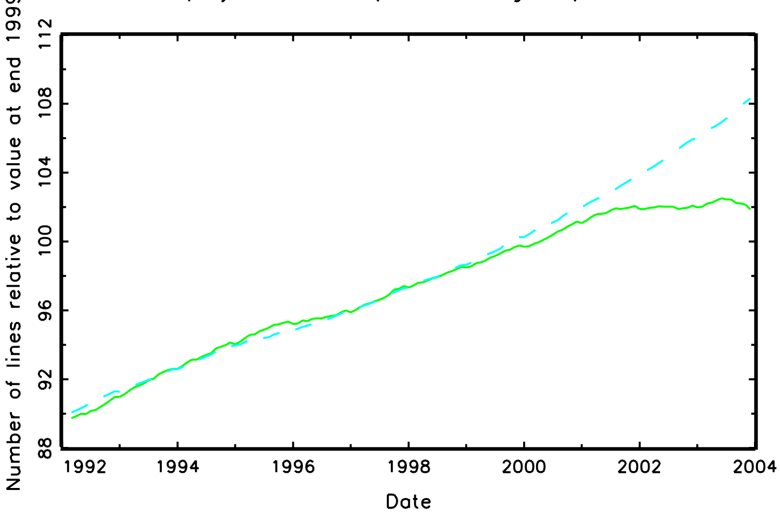


Figure 3b
Primary wirelines, actual and fitted, to end of 1999

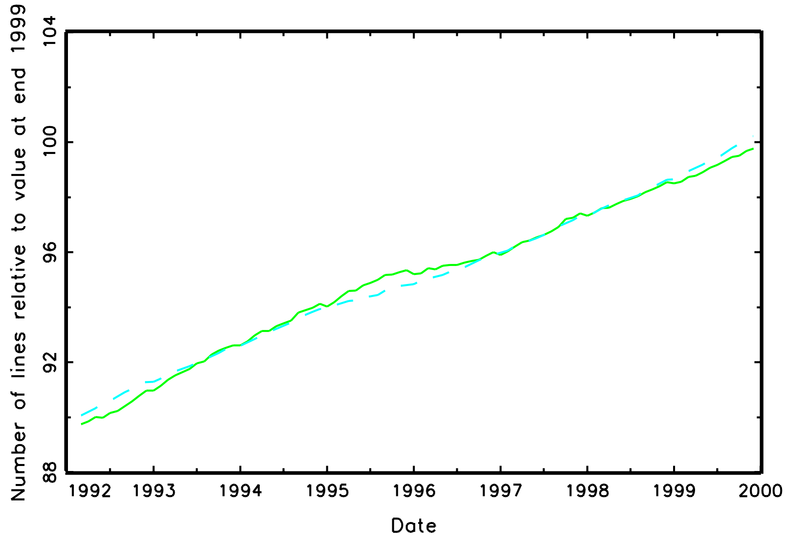


Figure 3c
Primary wirelines, actual and projected,
from 1/2000 through 12/2003

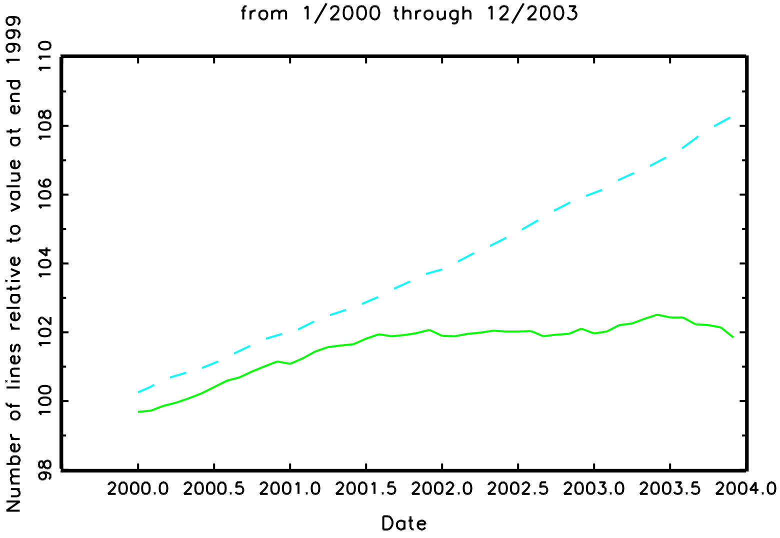

Figure 4a
Secondary wirelines, actual, fitted and projected,
projection from 1/2000 through 12/2003

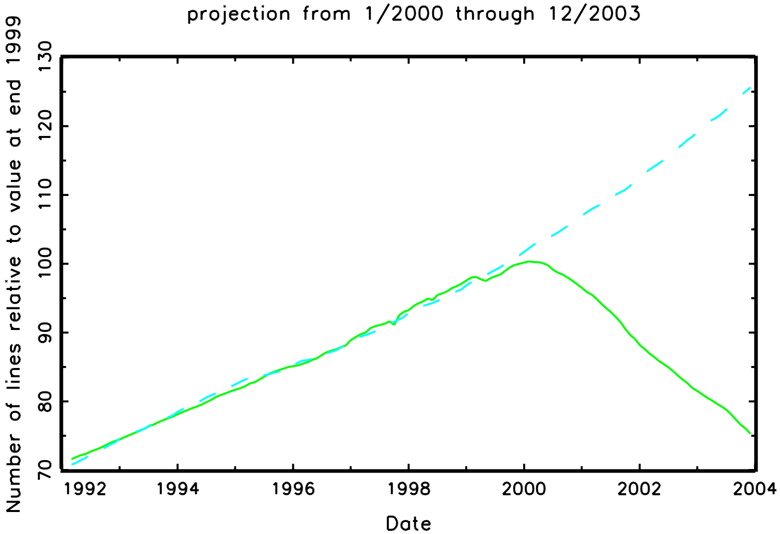


Figure 4b
Secondary wirelines, actual and fitted, to end of 1999

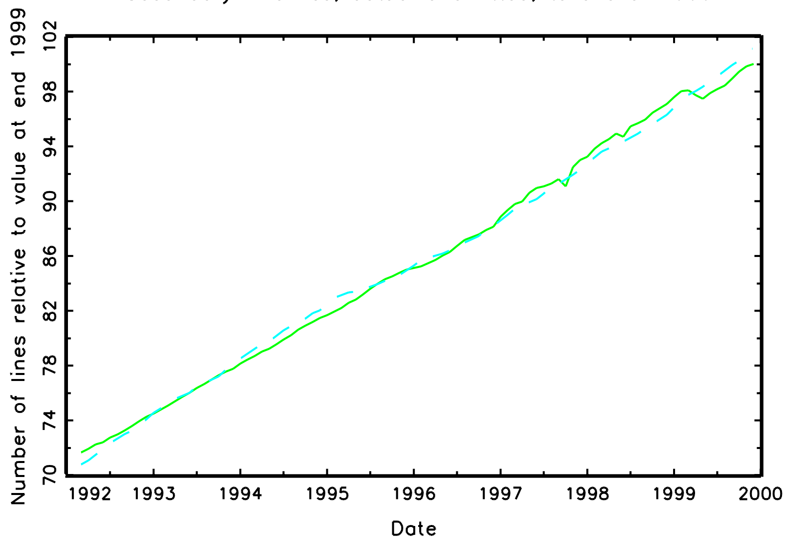


Figure 4c
Secondary wirelines, actual and projected,
from 1/2000 through 12/2003