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Demand for Wildlife Hunting in British Columbia

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Abstract

We present estimates of the demand for hunting licenses by residents and non residents in British Columbia for the period 1971–2000. We obtain estimates of both short-run and long-run price elasticities and discuss their revenue implications for future fee increases. We further find the demand by non residents to be strongly correlated with U.S. income variation over the business cycle; however, we find no such role for cyclical income variation for resident hunters. Finally, we demonstrate that hunters respond differently to conservation surcharges on hunting licenses relative to direct licensing charges, which has implications for policy makers introducing environmental surcharges in various contexts.

Key Words: recreation demand; environmental surcharges; resource revenues and rent capture

JEL Categories: Q21, Q26, Q28

Demand for Wildlife Hunting in British Columbia

I. Introduction

Wildlife game resources constitute an important source of economic well being in many jurisdictions, providing both use and non-use benefits to citizens. To prevent open access exploitation and potential extirpation of wildlife game resources, governments allocate take, and monitor and enforce hunting regulations. To do so, governments generally establish a system of hunting licenses. Often these consist of a general license and some form of species license that limits the potential harvest of a particular species, usually larger game. In many instances, these species licenses are sold on a "first-come, first-served" basis. In some cases, licenses to hunt prominent species, such as bighorn sheep or grizzly bears, are auctioned off so that the government collects the resource rent accruing to these animals. With the exception of auctions, hunting fees are generally not designed to capture the resource rents, but they often fail even to cover the operating costs of hunting programs and certainly not the spillover costs associated with hunting.[1] The broad purpose of the current paper is to examine the capture of wildlife resource rents in British Columbia.

The problem of generating revenue for wildlife management is not unique to any jurisdiction. Numerous state fish and wildlife management agencies in the United States have previously experienced severe financial problems. While costs of providing wildlife management services had gone up for a variety of reasons, including greater demands by the

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[1] Spillover or externality costs refer to the effects of hunting on *in situ* (non-use) benefits (van Kooten, Stennes and Bulte 2001), restricting access for other recreationists during hunting season (for safety reasons), noise, incidental or accidental take of "wrong" animals (termed by-catch in the fishery literature), and so on.

public for protection of non-use values, revenues from user fees had fallen as a result of inflation and the failure of State legislators to increase fees (Reiling et al. 1980; LaPage 1981; Anderson et al. 1985). Many fish and wildlife agencies resolved their fiscal problems by lobbying state legislatures to increase license fees, using demand analysis to demonstrate that fee increases would be beneficial all around. Similar efforts are only now beginning to appear in Canada, even though funding challenges have been the same.

In this paper, hunting data for the Province of British Columbia are used to examine the demand for hunting by both residents and non residents. Our objective is an empirical specification of these demand relationships suitable for assessing the revenue implications of variations in hunting license fees. For purposes of wildlife management and revenue generation, we are also interested in whether income variation is important, particularly the sensitivity of non resident demand to fluctuations in income. Finally, since BC charges hunters a wildlife conservation fee, it is of interest to gauge the response of hunters to this surcharge. Although in principle it acts simply to increase the hunting license fee, as a designated environmental surcharge it is possible that hunters may respond differently – and our results suggest this is indeed the case. This has direct implications concerning rent capture from wildlife as well as broader implications for the introduction of environmental conservation surcharges in other contexts.

We begin in the next section by examining hunting licenses and fees in British Columbia over the past three decades and using this information to specify our models of supply and demand for hunting. In Section 3, we present estimation results for a variety of different models of hunting demand. In section 4, we discuss the key results of the empirical analysis, placing them in a broader policy context.

2. Modeling Demand for Hunting Licenses in British Columbia

All hunters in British Columbia require a Basic hunting license, which by itself only permits small game hunting. For large game, individual Species licenses are also required. The fees for the Basic hunting licenses and Species licenses vary depending upon the age of the hunter, the residence of the hunter and, for the Species licenses, the type of animal involved. For Basic hunting licenses, there are separate fee schedules for juniors, adults and seniors. The Species licenses fees, however, are not differentiated by age. Both Basic and Species license fees are differentiated by place of residence: BC Resident, Canadian Non-BC Resident, and Non Canadian Resident. While in principle one could investigate quite narrow markets (e.g., demand for grizzly bear licenses by BC Resident juniors), our analysis considers two broadly defined markets, both of which are important sources of revenue for the British Columbia government. The first is the market for basic hunting licenses for adult BC Residents and the second is that for basic hunting licenses for adult Non Canadian Residents.[2] For simplicity, we refer to these markets as Residents and Non Residents. Further, our best information concerning Non Residents is that they are primarily from the United States, which is how we treat this group in what follows.[3]

Figures 1 and 2 present the historical development of basic hunting license fees, both in real and nominal terms, and the numbers of such licenses sold for Residents and Non

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[2] Junior and senior aged hunters are excluded.

[3] This information is based upon discussions with the Ministry of Land, Air and Water Protection.

Residents.[4] An immediate conclusion from these figures is that hunting fees in British Columbia have not kept up with inflation, especially fees charged Non Resident hunters. For Non Residents, the depreciation of the Canadian dollar over the 1990s has contributed to the fall in real fees. The other interesting feature is the contrasting behaviour of the quantity of licenses purchased by Residents and Non Residents. For Residents, the number of basic hunting licenses has trended downwards over time – from over 150,000 hunters in the early 1970s to some 80,000 today. This has been noted in other studies of hunting demand and is generally attributed to changing attitudes toward hunting (see, e.g., Reiling et al. 1980). For Non Residents, there is no evidence of a secular decline in hunting. Although the number of licenses purchased falls during the 1970s, with a very large decline coincident with the large price increase of 1973–74, it has trended steadily upwards since 1982.

It is also of some interest to consider how government revenues from licenses have fared over this period; Figure 3 presents estimated total revenue from the hunting fees across all categories and species (including animal royalties as discussed below). In 1974, as a result of a dramatic fee increase imposed on Non Residents (Figure 2) and a smaller increase on Residents (Figure 1), real and nominal revenues increased substantially. Since then, real revenues have remained relatively constant, declining somewhat during the late 1990s (after 1994), while nominal revenues generally increased only to decline slightly after 1995. During the three decades from 1971 to 2000, nominal revenues increased by an average 8.3% per year, while real revenues increased by only 3.0% annually.

There are two other types of fees hunters face in British Columbia. First, as already

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[4] The Resident fees are deflated by the Canadian CPI and those for Non Residents are deflated by the US CPI. Note that the Non Resident fees are set in Canadian dollars; values in Figure 2 have been converted to US dollars.

noted, a conservation surcharge is levied on all hunters in British Columbia purchasing a basic hunting license; a further conservation surcharge applies to the purchase of black and grizzly bear species licenses. The revenue is dedicated to the conservation of wildlife through the Habitat Conservation Trust Fund. The surcharge was first introduced in the 1984/85 fiscal year at $C3 for Residents and Non Residents alike. It was increased in 1989-90 to $C5 for Residents and $C30 for Non Residents. Since then, these surcharges have remained unchanged so that in real terms they have eroded over time.

Second, Non Resident hunters are required to employ a guide outfitter.[5] Guides are legally liable to pay royalties for animals taken by Non Resident hunters, but the royalties are typically passed on to the guided hunter. Royalties were introduced in 1982 and are imposed on ten major mammal species; they currently range from $C25 for wolves to $C600 for grizzly bears. In principle, these royalties act as an additional expected cost to hunting these species and should, when increased, reduce the demand for hunting licenses.

2.1 Demand and Supply of Hunting Licenses

In general terms, we can specify the demand for hunting licenses as:

$$(1) \qquad h_t = h(\boldsymbol{f}_t, m_t, h_{t-1}, \boldsymbol{z}_t, t),$$

where $\boldsymbol{f}_t$ is a vector of license fees at time t that may bear on the purchase of a basic license, m_t is a measure of income, $\boldsymbol{z}_t$ is a vector of other factors (e.g., age, gender, other costs associated with hunting, price and availability of other leisure activities), and t is a time trend that takes into account long-term secular trends that may influence hunting activity. We also include a lagged dependent variable, h_{t-1}, for two possible (related) reasons. First, like many

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[5] With the exception of Non Resident hunters accompanied by a blood relative who is a BC Resident.

consumption goods, there is likely to be a degree of persistence in the purchase of hunting licenses from year to year – behavior is influenced in part by habit. Alternatively, it may capture factors related to the positive or negative experience from hunting in the previous period. Imagine one year is particularly good for hunting, say due to weather conditions, and this motivates high current demand. In the following year, because of the good conditions previously, hunting demand is again higher than otherwise.

According to the Ministry responsible for setting all fees for hunting licenses, the supply of licenses is perfectly elastic in any one year at the fees set by the Ministry. There are no restrictions on the quantity of licenses sold once the fee has been established. Over time, license fees are adjusted; however, there is no evidence that the pricing decisions are influenced in any way by possible determinants of demand. Our best understanding is that fees have been set on the basis of political and budget considerations, with little or no reference to the market for hunting licenses. On this basis, we are confident that we can treat the license fees as exogenous variables in our model and estimate the demand for licenses directly using equation (1).

A number of other estimation issues arise. First, hunting is only one of many activities and is therefore affected by prices of other consumer goods. We address this by specifying all fees in real terms deflated by the consumer price index. For the Resident models, we use the Canadian CPI. For the Non Resident models, we use the US CPI after first converting the fees to US dollar values. (We do not explicitly identify the exchange rate adjustment in the formulas below.) As long as these other prices have tended to rise more or less with the CPI, this is a reasonable first approximation. Similarly, we have no information on other costs associated with hunting, such as fixed costs of equipment (vehicles, rifles, tents, special clothing, etc.) and variable costs of travel, ammunition and so on.[6] A second and somewhat related concern is the lack of data concerning individual characteristics that might affect demand, such as gender and socio-economic characteristics of hunters. This information is not collected and maintained by the BC government so it is not possible to include in our analysis.

The next issue to address is the measurement of fees. For Resident hunters, the demand for a basic hunting license will depend upon the basic license fee, denoted fb_t. Demand also depends upon species license fees, denoted fs_{it} for species i. In effect, Basic and Species licenses are complementary goods. Because there are a number of Species licenses and because Species license fees are co-linear as they are typically adjusted all together, it is not possible to include these individually in our empirical models. Instead, we construct a simple geometric index over the N categories of species defined as follows:

$$fs_t = \prod_i (fs_{it} / p_t)^{1/N} \tag{2}$$

where p_t is the consumer price index.

Finally, the conservation surcharge, denoted cs_t, is an additional cost to purchasing a basic hunting license. (It too is deflated by the CPI.) While it would be natural simply to add this to the license fee, which we do consider, it is of interest to consider whether demand responds differently to the surcharge. If hunters truly believe that the surcharge will be used to fund wildlife conservation, their response to variation in this surcharge may differ relative to their response to general fee increases. There are two possible related explanations for this. First, habitat conservation may be viewed as an alternative public good for which there is a willingness to pay, irrespective of current and future expected use. A second, somewhat more

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[6] Ward and Beal (2000) for example introduce travel costs in their modeling of demand for recreation, which is a useful direction for further research, particularly for Non Resident demand.

sophisticated argument is that hunters treat these types of charges as an option price related to the option value of the hunting experience available in the future, given that future availability of the hunting experience (supply of adequate wildlife game animals) is uncertain (Graham-Tomasi, 1995). Our data set does not allow us to discriminate between these two explanations, but we are able to examine whether the response to increase in the surcharge is the same as to general fee increases. Whether or not this is the case is of some relevance for environmental policy more generally.

Identical considerations apply to the model for Non Resident licenses with one additional aspect. Non Residents must pay royalties, either directly or indirectly, on large game taken. As with the Species Licenses, it is necessary to construct an index of these royalties, which is defined as

$$(3) \qquad fr_t = \prod_i (fr_{it} / p_t)^{1/N} ,$$

where fr_{it} is the royalty fee for species i. As with the species licenses, this is a price index for a good complementary to the basic license. It is dependent, however, on a successful hunt. If the subjective probability of a successful hunt varies substantially over time, it is not possible to identify a price response to variation in royalty costs.

The other variables included in the model are the de-trended of per capita disposable incomes (measured in real terms, deflated by the CPI), denoted y_t, and a linear trend. Per capita disposable income is de-trended using the band pass filter described in Baxter and King (1999). This filter is designed to extract the business cycle frequency component of economic time series. Following Baxter and King, we define the business cycle frequency to be between

2–8 years.[7]

We expect that hunting is positively related to individuals' disposable income. Over the sample period 1971-2000, this can manifest itself in two ways. First, over the sample there has been a secular increase in the per capita disposable income of both residents and non-residents of British Columbia. This may well contribute to a secular increase in the demand for hunting; as individuals become wealthier they are likely to increase their consumption of leisure activities such as hunting. Confounding this, however, is a possible secular move away from hunting as a leisure activity over our sample period. The linear trend in the model in principle captures the net effect of both these contributions to hunting license demand.

The second way in which income may contribute to hunting license demand is through cyclical fluctuations. It seems very likely that during periods of strong economic growth – periods when per capita income is above trend – demand for hunting may be relatively high. Conversely, during periods of unusually low economic growth, demand for hunting may be relatively low.[8] For this reason, we include a measure of the cyclical variation of per capita income. An alternative and more common strategy would be simply to include the level of per capita disposable income directly into the regression (assuming a log linear demand specification). With a linear trend in such a model, this is equivalent to including linearly de-trended income. We chose not to do this, however, because this is often a poor way of obtaining business cycle fluctuations of aggregate income data. In our case, it works

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[7] See data appendix for details of series construction.

[8] This is not the only reasonable conjecture, particularly for BC residents where hunting may have relatively low costs (e.g., no significant travel). It is possible that during recessionary periods, the opportunity cost of leisure may be low, increasing the demand for hunting. Similarly, during expansionary periods, the opportunity cost of leisure may be quite high causing hunters to forgo recreational activity.

particularly badly for British Columbia income. As this is somewhat non standard, the de-trended income series is presented in Figure 4.

2.2 Empirical model

For estimation purposes, we consider a log-linear version of equation (1). For the two markets, our general models are as follows:

$$\ln h_t^R = \alpha_0 + \alpha_1 \ln h_{t-1}^R + \alpha_2 \ln fb_t^R + \alpha_3 \ln fs_t^R + \alpha_4 cs_t^R + \alpha_5 \ln y_t^R + \alpha_6 t + u_t^R \tag{4}$$

$$\begin{aligned} \ln h_t^{NR} = \beta_0 + \beta_1 \ln h_{t-1}^{NR} + \beta_2 \ln fb_t^{NR} + \beta_3 \ln fs_t^{NR} + \beta_4 fr_t^{NR} + \beta_5 cs_t^{NR} + \\ \beta_6 \ln y_t^{NR} + \beta_7 t + u_t^{NR} \end{aligned} \tag{5}$$

where we have introduced the superscript notation R and NR to discriminate between Resident and Non Resident variables. u_t^R and u_t^{NR} are assumed to be mean zero innovations. While ideally we would like these to be independently and identically distributed, this does not appear to be the case; consequently, we use the Newey and West (1987) heteroskedasticity and autocorrelation robust covariance estimator for inference.[9]

We also consider alternative assumptions on the fee variables. For the resident model, we consider two combined fees:

Combined Fee 1 = $\ln(fb_t^R + fs_t^R)$

Combined Fee 2 = $\ln(fb_t^R + fs_t^R + cs_t^R)$

For the Non Resident model, the two combined fees are:

Combined Fee 1 = $\ln(fb_t^{NR} + fs_t^{NR} + fr_t^{NR})$

Combined Fee 2 = $\ln(fb_t^{NR} + fs_t^{NR} + fr_t^{NR} + cs_t^{NR})$

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[9] We cannot reject the hypothesis of serial correlation of order two in many of our models. While modeling this directly is desirable, we chose not to do so because of our limited sample.

For both Resident and Non Resident models, the first combination fee assumes that the basic license fee and the associated fees for hunting larger game (species fees and royalties) can be aggregated to provide one general fee. The second combined fee makes the assumption that the conservation charge is treated by hunters as simply an additional charge for hunting.

3. Empirical Results

We estimate equations (4) and (5) and various restricted versions of these models over the sample 1971–2000. Data sources and construction are provided in the Appendix. The results are reported in Tables 1–3. Models that use the unrestricted fee structure are identified as R1 and N1 for Resident and Non Resident, respectively. Models that use Combined Fee 1 are identified as R2 and N2; those that use Combined Fee 2 as R3 and N3.

3.1 Resident Results

Results for the Resident models are reported in Table 1. A number of common results are worth highlighting. First, in all cases the lagged dependent variable is positive, quite large and statistically significant. We interpret this as evidence of habit in consumption behaviour.[10] Second, as we might expect from Figure 1, we observe a negative and statistically significant coefficient on the trend term, consistent with a secular movement away from hunting. Third, in all cases the coefficient on cyclical disposable income is statistically insignificant indicating a zero income (cyclical) elasticity of demand for hunting licenses by BC Residents.

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[10] An obvious explanation for the results in Table 1 is that Resident hunting license demand is well described by a unit root with drift in contrast to our implicit assumption that it is trend stationary. We did experiment with models in first differences but were unable to obtain any useful relationship between quantity and price for hunting licenses. The difficulty of discriminating between first difference and trend stationarity in small samples is well known.

Finally, all of the models reported in Table 1 have very high adjusted R-squared values. This should not, however, be taken as strong evidence in favour of these models; much of the fit is determined by the linear trend term and the strongly significant lagged dependent variable term.

Turning to the fee variables, when we include all of the fees in an unrestricted fashion (model R1), we obtain a statistically significant short-run elasticity estimate of -0.30 on the basic license fee; in contrast, the two other fee variables are statistically insignificant. Model R1' amends R1 by dropping the species index while Model R1" drops the remaining insignificant variables. Across these three models the elasticity coefficient on the basic license fee appears to be reasonably stable, around or just below -0.3.

One way to interpret the results of R1–R1" is that the demand for basic hunting licenses by Residents is only sensitive to the basic license fee; it is insensitive to the species index fee – the price of a complementary good – as well as to the conservation surcharge. For the species index, we may be simply expecting too much from an aggregate fee index, one which may not be relevant for many purchasers of basic licenses (i.e., those not involved in large game hunting). The conservation surcharge, however, is more directly related to the basic license fee paid by all hunters. The results in R1–R1" indicate that the surcharge is not treated by hunters as simply an additional charge to hunting, possibly because they view it as a price paid for an alternative complementary good (wilderness conservation or the option value of future hunting). We can test this formally by asking whether the elasticity on the surcharge in regressions R1 and R1' evaluated at the mean (recall the surcharge is entered into the regression in levels) is statistically different from that on the basic license fee. Not surprisingly, given the estimates reported, we strongly reject this hypothesis. (Marginal significance levels for this test are reported for each model in the “ Equality of elasticities” row.)

An alternative interpretation of the results in R1–R1" is that the fee variables are co-linear and it is difficult to obtain precise information about the contribution of each component of the hunting fees. To address this, we consider the combined fees defined previously. Model R2 combines the basic license fee and the species index; R3 combines these fees with the conservation surcharge. In both cases, the elasticity coefficient is statistically significant although now somewhat smaller in absolute value, around -0.19. The elasticity coefficient is also stable across the specifications reported in R2' and R3', which remove the statistically insignificant variables from R2 and R3. The most interesting result from these models concerns the conservation surcharge in R2. The coefficient on the surcharge, while negative, is insignificantly different from zero, evidence that the surcharge is not treated as a simple additional charge to hunting. As before, when we test the equality of elasticities between the combined fee and the surcharge elasticity in R2 we strongly reject the null hypothesis of equality. For completeness, the elasticity estimate from model R2 for the conservation surcharge, evaluated at the mean, is -0.01.

On the basis of model fit, it is not possible to discriminate between the models of Table 1. Nor is it possible to test directly whether the aggregation of the fees in R2 and R3 is appropriate, since the combined fees are not testable parameter restrictions on the more general model R1. What we can do is consider non-nested hypothesis tests (Davidson and Mackinnon 1994). These tests are reported in Table 3. We consider three possible models: R1", R2', and R3'. If our null hypothesis is R1" when we include the information from either R2' or R3' (i.e., the predicted values from these models are included in model R1"), we are unable to reject R1" – evidence in favour of R1" and the disaggregate fee variables. In contrast, when either R2' or R3' is the null hypothesis tested against R1", we can weakly reject (between 10 and 15 percent marginal significance levels) these two hypotheses. The last set of tests reported are for the hypotheses R2' and R3' against each other, where it is not possible to reject either hypothesis against the other. These results taken together provide some evidence in favour of the disaggregated model R1". This further supports the conclusion that the conservation surcharge can appropriately be treated as having a zero elasticity, distinct from the basic license fee elasticity of between -0.2 and -0.3.

Finally, we can consider the long run elasticities on the fee variables from the models in Table 1, as well as the implications of both the short- and long-run elasticities for revenue maximization. To calculate long-run elasticities, we divide the short-run elasticity by one minus the lagged dependent variable coefficient. This number is reported for each model at the bottom of Table 1. These elasticity estimates vary somewhat across the models and fee definitions. For the basic license, if we take model R1" as our preferred specification, we obtain a long-run elasticity of -0.95; alternatively, on the combined fees we get a long-run elasticity of about -0.80. Underneath these estimates are marginal significance levels for two hypothesis tests: (1) that the long-run elasticity is zero; and (2) that the long-run elasticity is minus one, or unit elasticity. In all cases, we reject (1) and fail to reject (2) .

The elasticity results have a direct revenue implications for the government in setting hunting licenses fees. Our best estimates suggest that, in the short run, the demand for hunting licenses by Residents is inelastic. As a consequence, in the short run there will be an increase in revenues associated with an increase in fees. Over the longer term, however, because the long-run elasticities are close to minus one, fee increases on Resident licenses are likely to be revenue neutral. More precisely, we cannot reject the hypothesis that a fee increase for Resident licenses will be revenue neutral in the long run.

For completeness and as a check as to whether certain observations are influential to the estimation of the Resident demand curve, particularly with regard to the fee elasticity coefficient, it is useful consider a plot of the (short-run) demand curve of model R" (our preferred specification). To do so, we first obtain the residuals from two regressions: (1) the quantity variable against all regressors excluding the fee variable, and (2) the fee variable against all remaining regressors. This strips out all other variation and captures only the variation between fees and quantities; that is, the demand curve for these licenses. These residuals are plotted in Figure 5, along with the regression line for these two variables (with slope -0.26, by construction, identical to that reported in Table 1). One immediate concern is whether the 1974 observation, which appears to be quite influential, is dominating the estimation. To examine this, we consider the demand curve if we drop this pair of residuals; as is evident from Figure 5, this has little bearing on the relationship between quantity of licenses and fees.

3.2 Non Resident Results

Table 2 reports a similar modeling exercise for Non Residents licenses. As before, we first consider a disaggregate fee structure with some further refinements, models N1–N1", and then consider the combination of Non Resident fees (defined above) in models N2 and N3.

As with the Resident models, we observe a positive and significant coefficient on the lagged dependent variable. For these models, it is somewhat smaller, ranging from 0.37 to 0.60 depending upon the specification, but still suggests a fair degree of persistence in hunting license demand by Non Residents. In contrast to the Resident model, we get quite different results for the trend and the cyclical per capita disposable income variable. In the case of the trend, no stable result emerges across the models. If we focus on the models that have been simplified (i.e., those with insignificant variables removed), then the trend coefficient is statistically insignificant, consistent with our visual inspection of the hunting license data for Non Residents (Figure 2). Further, in contrast to the Resident models, we observe strong and statistically significant income elasticity coefficients, ranging from 3.70 to 4.69 (with long-run elasticities somewhat larger). Evidently, there is a strong cyclical component to hunting demand by Non Residents.

The fee coefficients or elasticity estimates follow a similar pattern to those for the Resident models. When we consider all of the fees (or fee indices) individually, we do not obtain much useful information; some of the coefficients are incorrectly signed while others are statistically insignificant. As the basic license fee is the most direct and applicable price measure, we first consider keeping this in the model and dropping the species and royalty index, model N1'. Here we obtain a statistically significant basic fee elasticity of -0.28, fairly similar to that for Residents. Again, the conservation surcharge coefficient is statistically insignificant, suggesting that the conservation surcharge has no effect on hunting license demand. Model N1" drops the surcharge to obtain a preferred specification for demand which, in summary, has a fair degree of persistence, a short-run inelastic price response and a strong cyclical income elasticity.

Inspection of Figure 2 suggests a natural experiment to check the elasticity estimates from Table 2. Between 1973 and 1974, basic license fees rose by approximately 175 percent while the quantity of licenses fell by approximately 43 percent, giving an elasticity at this point of approximately -0.24, very similar to the estimates in Table 2. Of course, this ignores changes in the other determinants and information from the rest of the sample but it is encouraging that the large swing in price and quantity in 1974 is consistent with our model. An obvious concern, however, is that this observation is very influential.

As with the Resident demand, we can plot the relationship between fees and quantities implied by the regression (i.e., the residuals after fees and quantities have been projected onto the other regressors). This relationship for model N1" is reported in Figure 6. Clearly, two observations are influential: 1972 and 1974, as suspected. If we remove these observations, the slope coefficient is considerably smaller, approximately -0.09. To the extent that the fee rise in 1974 is valuable information, it doesn’t seem sensible to exclude these observations from our analysis; however, the importance of this and other influential observations should be borne in mind.

The results for the combined fees are quite similar. The price elasticity is somewhat less, approximately -0.22, as is the income elasticity, which is now approximately 4.00. The conservation surcharge when included (model N2) is again statistically insignificant. If we consider the adjusted R-squared statistics, there appears to be some evidence in favour of the combined fee models, although the difference is not that great. As before, we consider non-nested hypothesis tests to discriminate between these models (see Table 3). The results tend to favour N2' and N3 over N1", though it is not possible to discriminate between N2' and N3' on the basis of these tests. So in contrast to the Resident models, the evidence favours the combined fee models, possibly treating the conservation surcharge as simply an additional component of the total license fee.

The long-run elasticities also provide different conclusions relative to the Resident models. First, they are much smaller in value, ranging from -0.66 for model N1" to -0.43 for models N2' and N3. As before, these estimates are all statistically different from zero. Moreover, for models N2' and N3 these are statistically different from minus one, unit elasticity (marginal significance levels of 0.000). For model N1", we can reject a unit elasticity coefficient at a marginal significance level of 0.15. The weight of evidence suggests that the demand for hunting licenses by Non Residents is inelastic both in the short- and long-run, indicating that an increase in fees would increase revenues for the British Columbia government.

Finally, for completeness Figure 7 reports the estimated demand curve for model N3, our (weakly) preferred specification. As with model N1", 1972 and 1974 are very influential observations. If we drop these observations, then the fee elasticity is again considerably less, approximately -0.10. As discussed previously, it is not obvious that we wish to discard the information from these outliers, particularly the 1974 fee rise. Note also that if we do discount these observations we are left with the conclusion that Non Resident demand is even more inelastic than the estimates presented in Table 2.

4. Discussion

A number of interesting points merit further discussion. First, for both the Resident and Non Resident models, we use a measure of cyclical variation in per capita disposable income as a determinant of hunting license demand. This is designed to capture the influence of short-run fluctuations in income in contrast to the general increase in real per capita disposable income occurring over time. The latter is difficult to identify because of the other trend influences on hunting, particularly the recognized movement away from hunting as a leisure activity. Interestingly, we obtain very different results for Residents versus Non Residents and, moreover, these results are not too difficult to explain. Non Resident hunting demand is pro-cyclical, making it similar to other tourism activities.[11] Non Residents are likely to incur significant fixed travel costs to hunt in BC; moreover, as Non Residents are likely to have other less expensive hunting alternatives, they are more likely to travel to BC to hunt large game, which is relatively expensive. In contrast, Residents hunting demand is not cyclical. As the costs of hunting are much smaller for Residents, both for fees and fixed travel costs, it seems reasonable that the general demand for basic hunting licenses is less likely to depend upon transitory fluctuations in disposable income. We might conjecture that the margin affected by cyclical income variation for Residents is the demand for more expensive game, an issue we leave for future research.

The second point of interest concerns the elasticity results and the implications for revenues. If demand is inelastic then an increase in price will raise revenues. Similarly, if demand is elastic revenue will decrease with an increase in price, while, with unit elasticity, revenue is unaffected by changes in prices. Our results suggest that raising fees for Residents may raise revenues in the short run, but is likely to be revenue neutral in the longer run. In contrast, it appears possible to increase government revenues from the sale of Non Resident licenses. This is likely to be particularly appealing to the BC government since these hunters have no direct political constituency, although the effect on guides and outfitters must be borne in mind. Perhaps more importantly, the inelastic or unitary elastic hunting demand is

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[11] Empirical studies of tourism generally include an income component, as would seem reasonable. In a recent study for Australia, Lim and McAleer (2001) use cointegration to model tourism demand. In addition to finding a long-run relationship between tourism and income, for one of the countries they identify significant dynamic effects, which can be loosely interpreted as similar to our cyclical variation.

potentially useful for wildlife management since it suggests that if reduced hunting is warranted for wildlife conservation purposes, higher fees can be imposed to reduce hunting without detrimental effects on license revenue. Of course, it is necessary to be careful about all such statements. While the log linear specification we use may be a reasonable local approximation, it may not be so in all instances, particularly if significant fee raises are being considered. As well, higher fees may also affect compliance, leading to more instances of unlicensed hunting and unreported kills (loss of royalty revenues).

Finally, we consider the response of hunting demand to the introduction and subsequent increases in a conservation surcharge, the proceeds from which are dedicated to the conservation of wildlife through the Habitat Conservation Trust Fund. Our results point to some specific and general conclusions for governments setting environmental charges as additional fees to resource use. Specific to our data, we find no evidence that variation in the conservation surcharge has had much impact on hunting demand by Residents or Non Residents. For Residents, it appears to have zero elasticity. For Non Residents, it may arguably have a non zero elasticity but overall demand is fee inelastic. This suggests that for British Columbia there is further scope to raise revenue for wildlife conservation in this manner.

More generally, we interpret the result on the conservation surcharge as evidence that, although the charge is levied as a simple additional cost to all hunting licenses, it is treated differently by all hunters. One interpretation is that it is viewed as the price of an alternative public good, wildlife conservation, one with very inelastic demand (consistent with the small magnitude of the surcharge). Alternatively, it may be that hunters treat these charges as an option price to retain the option of hunting experience available in the future. Option demand appears to be quite inelastic. Where this matters for policy makers is assessing the impact on resource use from introducing such a charge. To assess the impact of an environmental surcharge both on participation as well as on revenues generated requires some measure of demand response. The natural candidate is an elasticity of demand estimate based upon previous price variation. Our results suggest that elasticity measures associated with usage fees do not provide a useful measure in this regard; there would be a tendency to overestimate the effect on demand from such charges. We suspect that this result may be quite general and it argues for further empirical work evaluating the effects of environmental surcharges applied to resource usage.

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Data Appendix

Hunting Licenses and Fees

All of the hunting fee and licenses purchased data are provided by the British Columbia Ministry of Land, Water and Air Protection. This data is proprietary though in some instances it may be possible to obtain the data upon request from the authors.

Consumer Price Indices

Residents: Canada Consumer Price Index (CPI), 1996 Basket, Monthly. CANSIM II Series V735319. Series is averaged to obtain annual series.

Non Residents: US Consumer Prices Monthly. International Financial Statistics [11164…ZF…]. Series is averaged to obtain annual series.

Exchange Rate

Canada US Dollar Exchange rate. CANSIM II Series V37426. Monthly series is averaged to obtain annual series.

Per Capita Disposable Personal Income

Both Residents and Non Residents series are constructed using aggregate measures of personal disposable income divided by total population. The series are then put into real terms by deflating using the CPI indices identified above.

Residents:

(i) BC Personal Disposable Income is constructed from two annual series: (1) CANSIM I Series D45164 (1948–1996) and (2) CANSIM II Series V691726 (1981–2002). The two series are spliced by using the CANSIM I series up until

1980.

(ii) Population data is constructed from two annual series: (1) Persons; British Columbia. CANSIM I Series D31245 (1948–1995) and (2) British Columbia Both Sexes All Ages. CANSIM II Series V469818 (1971–2002). The two series are spliced by using the CANSIM I series up until 1970.

Non Residents:

(i) United States; Disposable Personal Income: CANSIM II Series V122016. Data are seasonally adjusted quarterly data at annual rates. Annual series is constructed by averaging quarterly data.

(ii) Population data is from the International Financial Statistics [11199Z..ZF...].

Construction of Cyclical Income Measures

The per capita real disposable income series for both Residents and Non Residents are filtered using the approximation to the Band Pass filter described in Baxter and King (1999). The moving average length is set to two. The business cycle frequency is defined to be 2–8 years, which is standard in the macroeconomics literature. The income series are constructed over the period 1948 to 2002 and it is these series that are filtered. In constructing the filtered data, we lose the first and last two observations, so the series we work with are defined over 1950–2000.

Table 1: British Columbia Residents Models

Dependent variable: Quantity of Basic Licences (log)

Explanatory Variables	R1	R1′	R1″	R2	R2′	R3	R3′
Constant	3.4858	3.4823	3.9311	3.3851	3.3012	3.5011	3.5443
	0.9631	0.9554	1.0618	1.0412	0.9372	0.9341	0.9084
Lag dependent variable	0.7732	0.7734	0.7253	0.7722	0.7768	0.7633	0.7574
	0.0775	0.0768	0.0822	0.0852	0.0773	0.0741	0.0724
Basic license fee (log)	-0.3097	-0.3080	-0.2600				
	0.1050	0.0660	0.0572				
Species price index (log)	0.0011						
	0.0527						
Conservation surcharge	0.0085	0.0084		-0.0028			
	0.0067	0.0060		0.0068			
Combined Fee 1 (log)				-0.1966	-0.1904		
				0.0567	0.0452		
Combined Fee 2 (log)						-0.1984	-0.1917
						0.0546	0.0448
Income (log)	-0.6844	-0.6828		-0.2695		-0.2556	
	0.5408	0.5312		0.5646		0.5319	
Trend	-0.0101	-0.0100	-0.0086	-0.0060	-0.0064	-0.0056	-0.0057
	0.0026	0.0024	0.0019	0.0024	0.0021	0.0020	0.0019
$\overline{R}^2$	0.9661	0.9675	0.9673	0.9611	0.9636	0.9632	0.9644
Equality of elasticities	0.0087	0.0002	-	0.0045	-	-	-
Long run elasticities	-1.3658	-1.3593	-0.9465	-0.8634	-0.8528	-0.8384	-0.7902
	0.0416	0.0118	0.0007	0.0409	0.0203	0.0136	0.0057
	0.5682	0.4773	0.8281	0.7349	0. 6724	0.6123	0.4293

Notes: Coefficients are estimated by OLS. The sample is 1971-2000. The number of observations is 29. Combined Fee 1 combines the basic license fee and the species price index. Combined Fee 2 combines the basic license fee, the species price index and the conservation surcharge. Numbers below coefficient estimates are Newey and West (1987) standard errors calculated using a lag truncation parameter of two. Equality of elasticities reports the marginal significance levels for an F-test of the equality between the elasticity of the surcharge and the basic license fee or, where relevant, the combined fee. The numbers below the long run elasticities estimates are marginal significance levels for (1) an F-test of the null hypothesis that the long run elasticity estimates are equal to zero; and (2) that the long-run elasticity estimates are equal to minus one.

Table 2: Non Residents

Dependent variable: Quantity of Basic Licences (log)

Explanatory Variables	N1	N1′	N1″	N2	N2′	N3
Constant	5.3746	4.7294	4.4919	5.3679	5.3943	5.2829
	0.8031	1.4952	1.3190	1.0871	0.9873	1.0129
Lag dependent variable	0.3693	0.5747	0.5969	0.4917	0.4887	0.5019
	0.0955	0.1375	0.1230	0.1104	0.0990	0.1015
Basic license fee (log)	0.1644	-0.2793	-0.2639			
	0.0956	0.1165	0.1061			
Species price index (log)	-0.1788					
	0.0409					
Conservation surcharge	-0.0035	0.0023		-0.0003		
	0.0029	0.0038		0.0027		
Royalties index	-0.0022					
	0.0022					
Combined Fee 1 (log)				-0.2203	-0.2208	
				0.0460	0.0437	
Combined Fee 2 (log)						-0.2189
						0.0455
Income (log)	3.6995	4.6347	4.6883	4.0374	4.0374	4.0397
	0.7630	1.0989	1.1177	0.9589	0.9302	0.9733
Trend	0.0100	-0.0061	-0.0039	-0.0002	-0.0004	0.0008
	0.0049	0.0058	0. 0034	0.0024	0.0014	0.0014
$\overline{R}^2$	0.8995	0.8383	0.8419	0.8831	0.8879	0.8883
Equality of elasticities	0.0823	0.0397	-	0.0004	-	-
Long run elasticities	0.2607	-0.6566	-0.6545	-0.4334	-0.4318	-0.4396
	0.0763	0.0064	0.0109	0.0000	0.0000	0.0000
	0.0000	0.1308	0.1584	0.1584	0.0000	0.0000

Notes: Coefficients are estimated by OLS. The sample is 1971-2000. The number of observations is 29. The dependent variable is the logarithm of number of hunting licenses. Combined Fee 1 combines the basic license fee, the species price index, and the royalty index. Combined Fee 2 combines the basic license fee, the species price index, the royalty index and the conservation surcharge. Coefficients are estimated by OLS. Numbers below coefficient estimates are Newey and West (1987) standard errors calculated using a lag truncation parameter of two. Equality of elasticities reports the marginal significance levels for an F-test of the equality between the elasticity of the surcharge and the basic license fee or, where relevant, the combined fee. The numbers below the long run elasticities estimates are marginal significance levels for (1) an F-test of the null hypothesis that the long run elasticity estimates are equal to zero; and (2) that the long-run elasticity estimates are equal to minus one.

Table 3: Non-Nested Tests

BC Residents Models		Non Residents Models	
Hypotheses R1″ and R2′		Hypotheses N1″ and N2′	
Null: R1″	0.641	Null: N1″	2.461
	0.528		0.022
Null: R2′	1.639	Null: N2′	-1.006
	0.114		0.325
Hypotheses R1″ and R3′		Hypotheses N1″ and N3	
Null: R1″	0.525	Null: N1″	3.097
	0.605		0.005
Null: R3′	1.524	Null: N3	-1.562
	0.140		0.132
Hypotheses R2′ and R3′		Hypotheses N2′ and N3	
Null: R2′	0.660	Null: N2′	0.304
	0.516		0.764
Null: R3′	-0.098	Null: N3	0.123
	0.923		0.903

Notes: Numbers below coefficient estimate are marginal significance levels, based on the Newey and West (1987) covariance estimator, for a two-sided t-test on the predicted values of the alternative hypothesis included in the null hypothesis regressions.

Figure 1: Basic Licenses for Residents

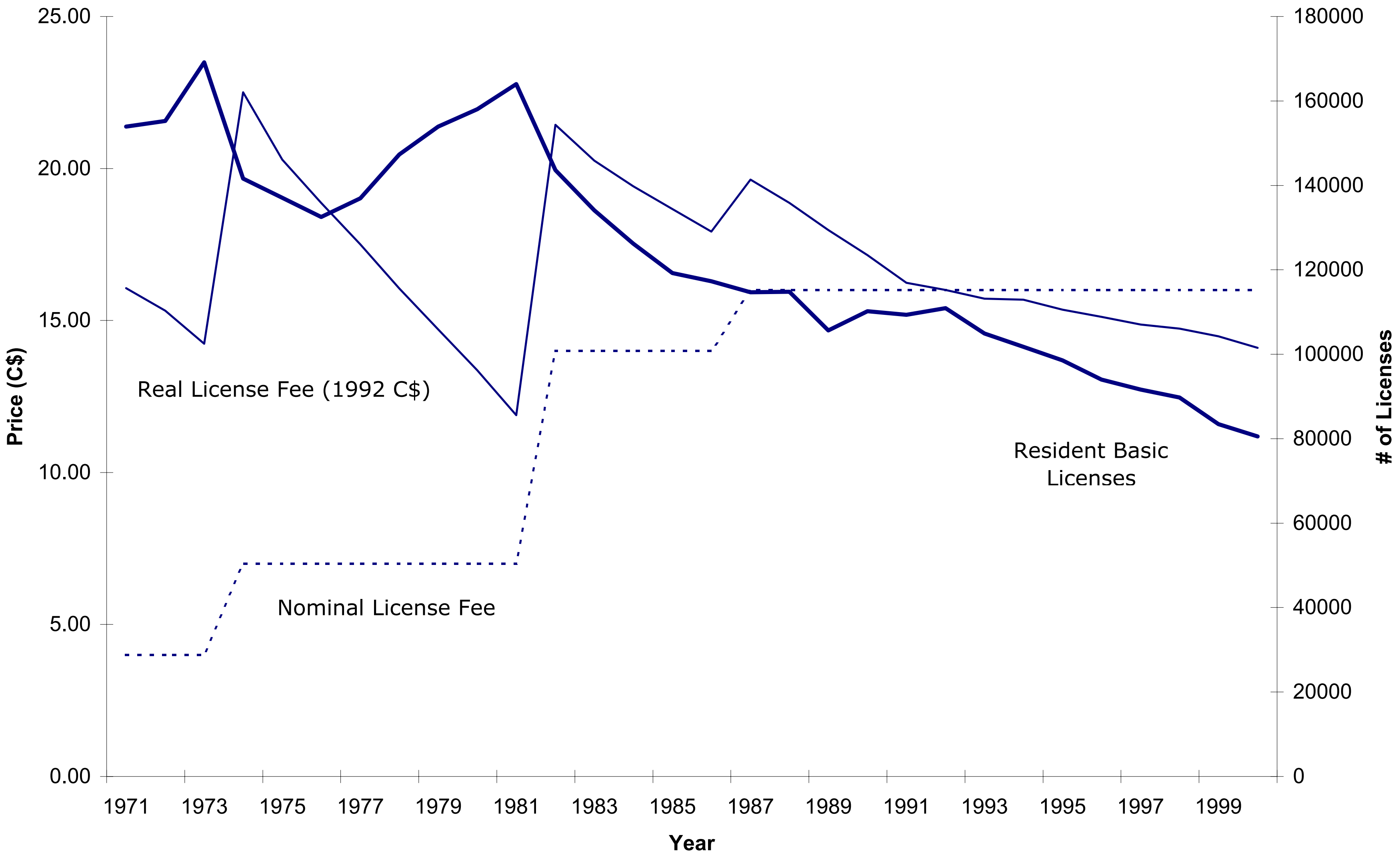

Figure 2: Basic Licenses for Non Residents

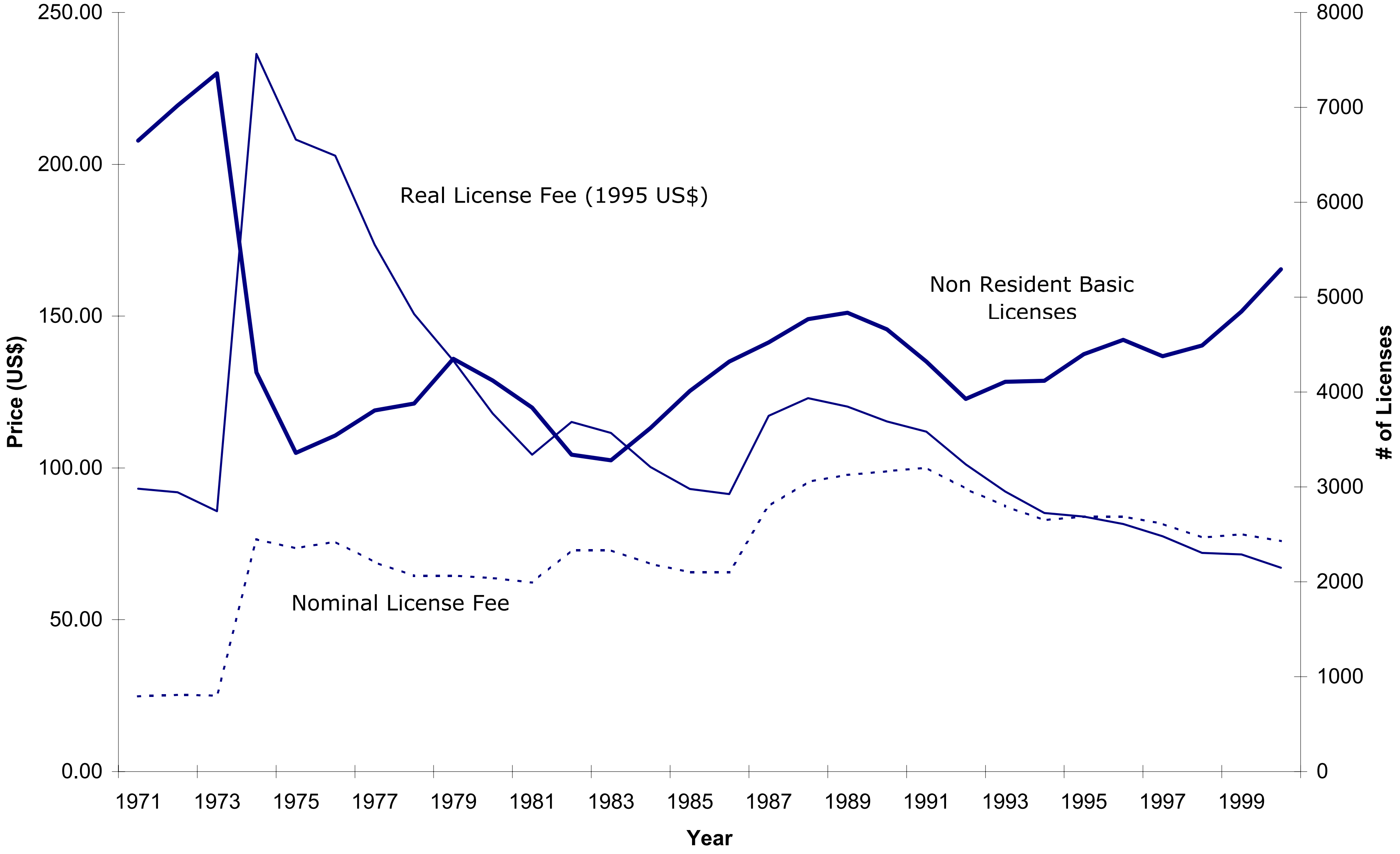

Figure 3: Hunting License Revenue

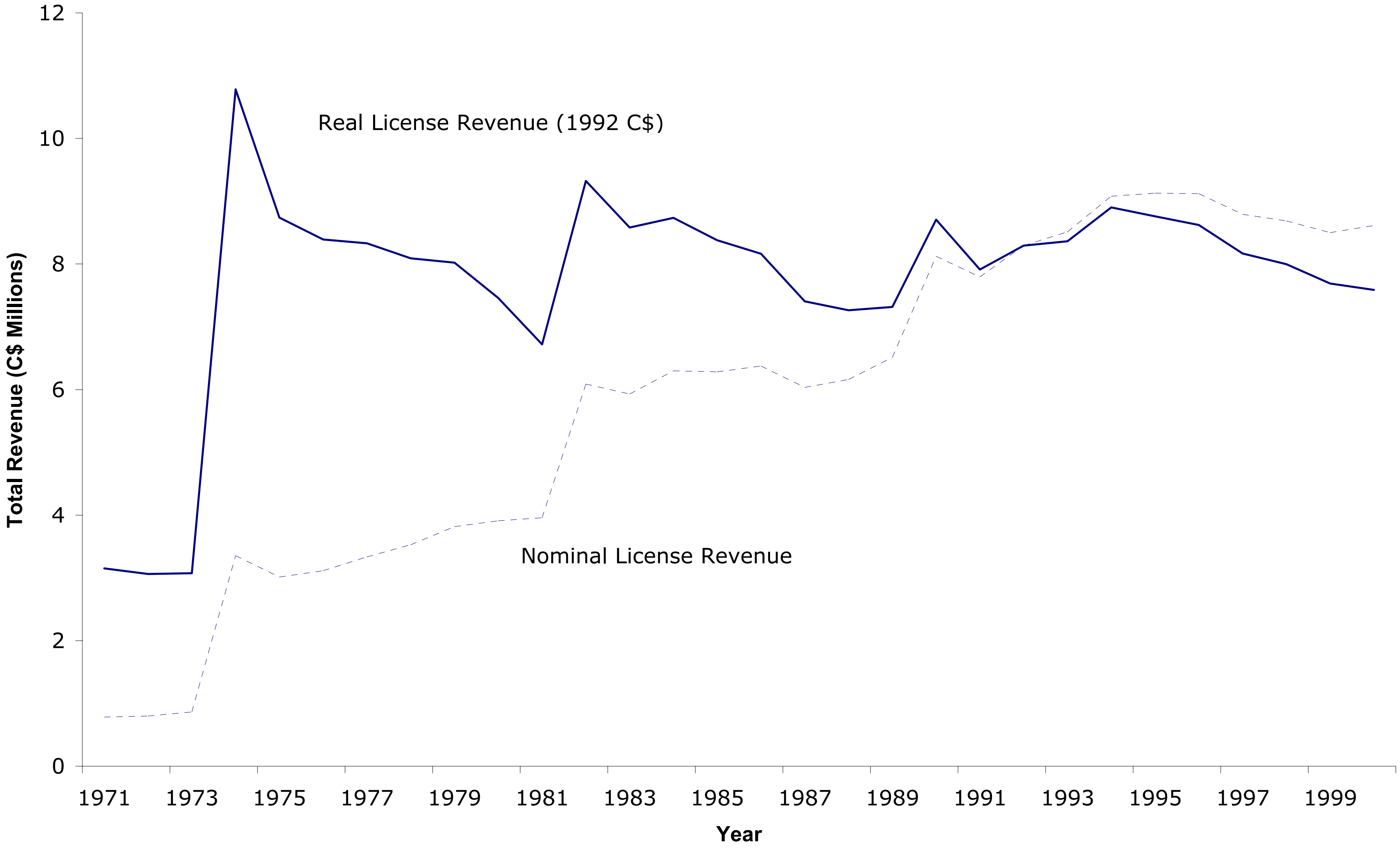

Figure 4: Personal Disposable Income

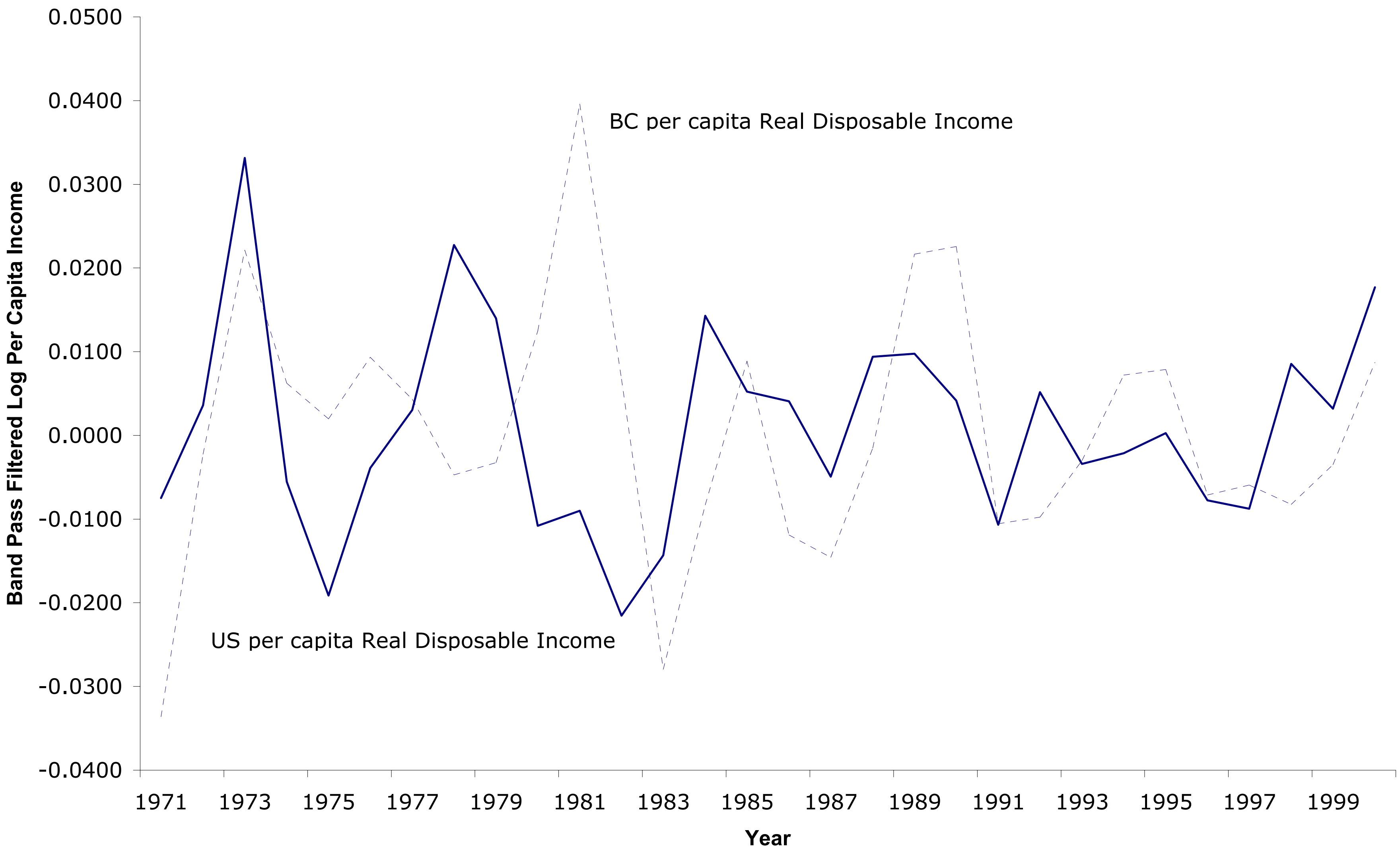

Figure 5: Estimated Demand Curve R1"

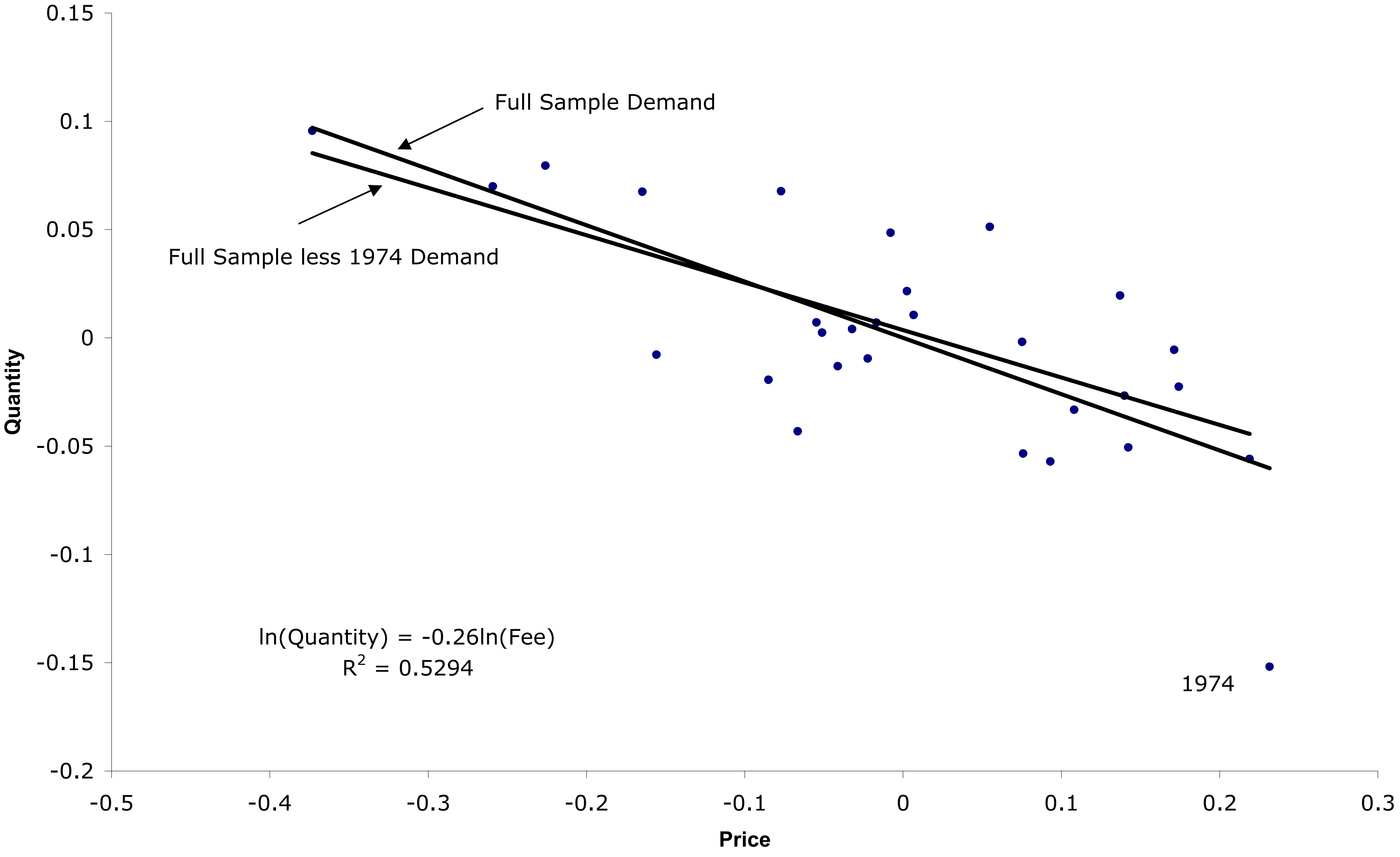

Figure 6: Estimated Demand Curve N1''

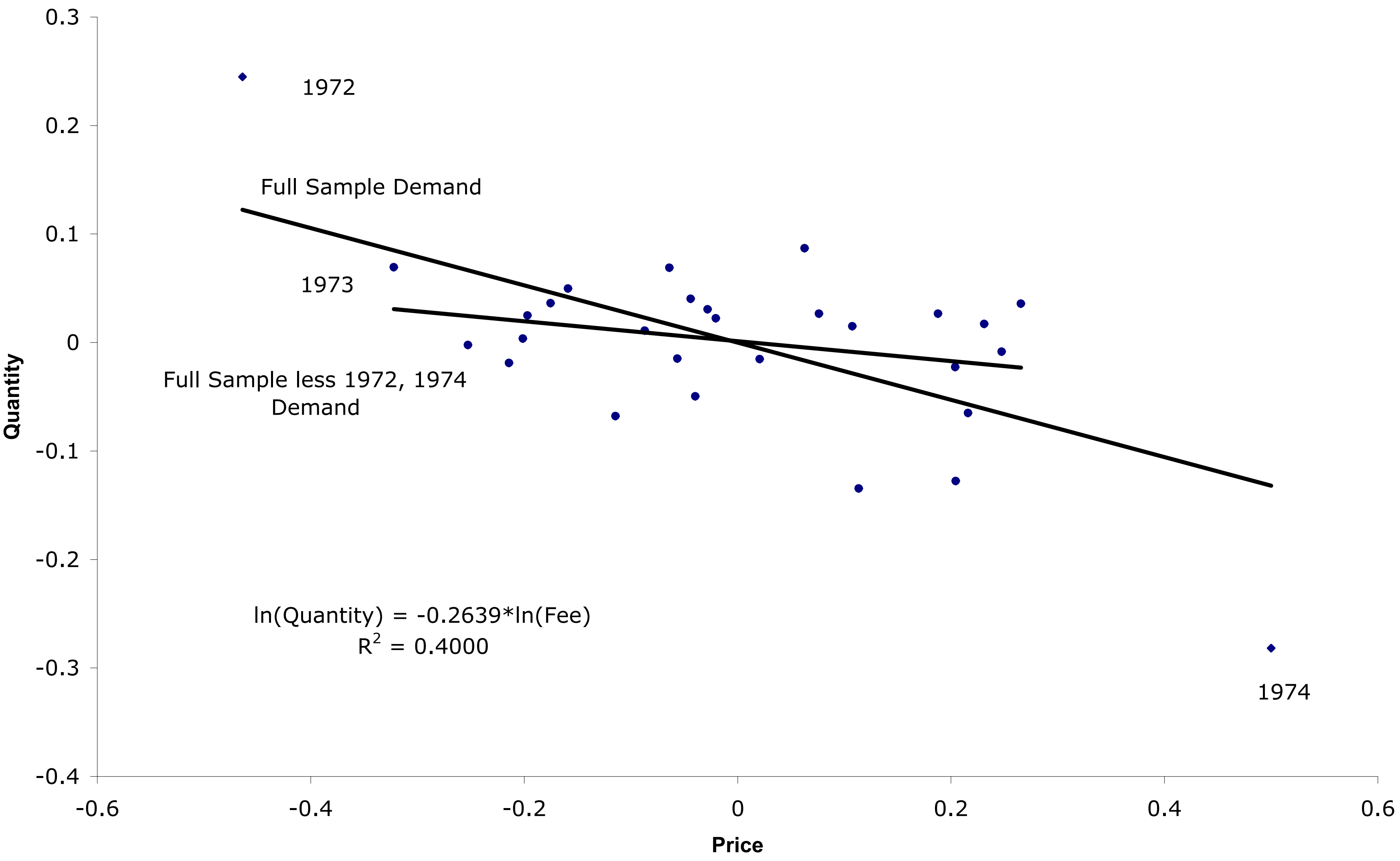

Figure 7: Estimated Demand Curve N3