Nº 275 ISSN 0104-8910

DYNAMIC HEDONIC REGRESSIONS: COMPUTATION AND PROPERTIES

Renato Galvão Flôres Junior
Victor Ginsburg

Janeiro de 1996

DYNAMIC HEDONIC REGRESSIONS: COMPUTATION AND PROPERTIES[1]

Renato G. Flôres Jr and Victor Ginsburgh

(preliminary version: December 1995)

1. Introduction.

Hedonic regressions, pioneered by Griliches (1961), have found many interesting and diversified applications. In studies of the art market, for instance, Chanel (1993), de la Barre et al. (1994), Ginsburgh and Jeanfils (1995) have used them to generate time series of returns on specific art goods which were subsequently analysed by econometric methods. Chanel et al. (1992), Ginsburgh (1994) and Goetzmann (1993) discuss the merits of the technique against the alternative of repeat sales regression, i.e., regressions based on observations of repeated sales of the same good.

The common practice, in most of the studies, is to run the regressions in a "static" way: given the set of prices, the hedonic characteristics and, perhaps, some extra continuous explanatory variables, the regression is run and its results analysed. However, if the aim is to produce a price index series - which, by definition, will arise from the coefficients of time dummies - a problem is posed. Indeed, as interest lies in successively calculating new values of the index, repeated use of the static regressions poses a theoretical riddle: the new observations change the past values of the index, as each time a different series is generated. This is obviously a consequence of the fact that

[1] Thanks are given to Patrick Waelbroeck. Support from the Belgian Government initiative PAI nr. 26 and from the Université Libre de Bruxelles is gratefully acknowledged.

both past and future observations affect any given value of the index. A second drawback is that, when only one regression is run to compute the hedonic index, a restriction on the evolution of the coefficients associated to the categories is imposed, namely that they do not change over time. If this is violated, the hedonic index is probably not capturing the "true" price effect one is looking for. Evolving coefficients may also be interpreted as movements in tastes; in this context, it is important to have a price index which - though in an approximate way - takes such movements into account, specially in sensitive fields as the art market. This point deserves further theoretical research, which will not be pursued here.

Motivated by the questions above, we develop in this paper a dynamic approach for updating the hedonic regressions. Not only the approach answers the main issues but, also, interesting properties can be extracted from the evolving hedonic coefficients. The structure of the paper is as follows[2]. In the next section the dynamic regressions are described and the main recursive formulae are presented. Sections 3 and 4 discuss interpretations related to the index generated and to the hedonic coefficients, respectively. Section 5 concludes with a few comments on some practical aspects of the methods. Two Appendices complement the exposition. In the first, the recursive character of the regressions is given an algorithmic treatment; the second deals with the choice of the dummies for the quality variables.

2. The dynamic regression.

We consider a sample of N prices p, divided into T periods - sometimes referred to as months, with n_t observations in period t, $1 \leq t \leq T$, $\sum_t n_t = N$. The explanatory variables comprise

[2] This is mainly a theoretical paper; an enlarged version, with an application, is in progress.

different sets of dummies for the qualities, a set of time dummies for the periods and also some continuous variables.

The set of periods is divided into $T=T_0+T_1$. T_0, which comprises a certain number of initial periods, will be called "the basis". A preliminary hedonic regression of lnp is run with the observations in the basis. After this, the dynamic regressions can be run in two different ways, depending on how the observations of each new period are treated:

i) they are cumulatively added to the sample and a regression is sistematically re-run with the restriction that the coefficients of the time dummies until the previous period are set equal to their value in the last regression;

ii) each time only the new period is added to the basis, and a regression is re-run.

Notice that each regression has a new variable: the new dummy for the added period. Time dummies can be used or not in the basis; in the affirmative case, the regressions in ii) are also run with the same restriction as in i) for the coefficients of the base periods.

An hedonic price index I_t is generated by the series of coefficients of the time dummies in either method. Our purpose is to analyse the properties of this index and of the associated estimates for the hedonic variables. Before this, we develop the recursive formulae for them.

Let $n_T=\Sigma_{t'=1,\dots,t}n_{t'}$, and Z_T and Y_T be the $n_T$xm and n_Tx1 matrices with, resp., the observations until time t on all m explanatory variables but the time dummies and the log-prices. It might be necessary to split Z_T into $Z_T = [Z_0' \; Z_1']'$ where Z_0 is related to the base periods and Z_1 to the remaining observations. Accordingly $Y_T = [Y_0' \; Y_1']'$, and Y_T or only Y_1 will be corrected by the previous indexes I_T or I_1. If procedure ii) is used, $Z_T = Z_0$ and $Y_T = Y_0$ for all T'. We now concentrate on the first procedure, adaptations for the other being immediate[3] .

[3] See Appendix 1.

During time t+1, new observations Z_{t+1}, n_{t+1}xm, and Y_{t+1}, n_{t+1}x1 are generated. Calling Y^*_T vector Y_T duly corrected by the previous indexes, the new hedonic regression to be made projects vector $Y^* = [Y^*_T{}' \; Y_{t+1}']'$ on the space generated by the columns of the matrix

$$\begin{bmatrix} Z_T & \mathbf{0} \\ Z_{t+1} & \mathbf{1} \end{bmatrix} .$$

The parameters of interest can be obtained in many different ways. We shall deduce them with the aid of recursive regressions formulae (see Harvey(1981)). For this, we suppose known the coefficients of the regression of $Y^*_{T'}$ on $Z_{T'}$, which will be stacked in the (column) vector b_t .

The new value of the index is the coefficient of the last "variable", i.e., the column with n_T zeroes and n_{t+1} ones. As known, it is equal to the one from the regression between two sets of residuals; namely those from projecting Y^* and $u = [0' \; 1']'$ on the first m columns above, what we shall call matrix Z_{T+1}. Analytically, the index will be:

$$I_{t+1} = [u'(I - Z_{T+1}(Z_{T+1}'Z_{T+1})^{-1}Z_{T+1}')u]^{-1}u'(I - Z_{T+1}(Z_{T+1}'Z_{T+1})^{-1}Z_{T+1}')Y^* \tag{1}$$

The number within the first brackets will be equal to n_{t+1} minus the sum of all entries in the lower diagonal n_{t+1}xn_{t+1} block of matrix

$$Z_{T+1}(Z_{T+1}'Z_{T+1})^{-1}Z_{T+1}' .$$

With a little algebra this sum can be written as:

$$1'Z_{t+1} (Z_{T'}'Z_{T'} + Z_{t+1}'Z_{t+1}) ' Z_{t+1}'1 \tag{2}$$

As for the right member of the product, it is u' times the residuals of the regression of Y^* on $Z_{T'+1}$. These can be evaluated with the aid of the following recursive update of b_t, called β^* :

$$\beta^* = b_t + (Z_{T'}'Z_{T'})^{-1} Z_{t+1}'(I + Z_{t+1}(Z_{T'}'Z_{T'})^{-1} Z_{t+1}')^{-1}(Y_{t+1} - Z_{t+1}b_t) \quad (3)$$

so that the right member will finally be:

$$1'(Y_{t+1} - Z_{t+1}\, \beta^*) \quad (4)$$

and the index can be written as:

$$I_{t+1} = (\text{mean}Y_{t+1} - \text{mean}Z_{t+1}\, .\, \beta^*) / (1 - n_{t+1}\, .\, \text{mean}Z_{t+1}\, (Z_{T'}'Z_{T'} + Z_{t+1}'Z_{t+1})^{-1}\text{mean}Z_{t+1}') \quad (5)$$

where, if X is a rxq matrix, meanX is a 1xq vector with the column means.

As for the quality coefficients, they come from the regression of Y^* on $Z_{T'+1}$ excluding now from both the effect of u. Given that this effect equals, for each variable, the mean of its last n_{t+1} observations times u, the first $n_{T'}$ observations are unchanged and recourse to b_t can again be made to obtain those coefficients:

$$\beta_{t+1} = b_t + (Z_{T'}'Z_{T'})^{-1} Z_{t+1}'(I + Z_{t+1}(Z_{T'}'Z_{T'})^{-1} Z_{t+1}')^{-1}[(Y_{t+1} - \text{mean}Y_{t+1}\mathbf{1}) - (Z_{t+1} - \mathbf{1}\, .\, \text{mean}Z_{t+1})b_t] \quad (6)$$

Finally, before starting the calculations related to the observations in t+2, the b_t coefficients themselves should be updated:

$$b_{t+1} = b_t + (Z_{T'}'Z_{T'})^{-1} Z_{t+1}'(I + Z_{t+1}(Z_{T'}'Z_{T'})^{-1} Z_{t+1}')^{-1}[(Y_{t+1} - I_{t+1}\mathbf{1}) - Z_{t+1}\, b_t] \quad (7)$$

In Appendix 1 the formulae above are set into an algorithmic framework; the extension to case ii) being also presented.

3. The index and the hedonic characteristics.

First notice that both $\{I_t\}_{t \in T}$ make for a true time series, as the incorporation of new observations does not change the previous values of the index. Also, by taking the coefficients of the quality dummies in each regression, a time series for each quality can be generated. For the sake of easing the exposition in this and the next section, there is no loss of generality if only two sets of quality dummies, with q_1 and q_2 categories, the time dummy and one continuous variable are considered.

Let β_{it}, $2 \le i \le q_1$, and γ_{jt}, $2 \le j \le q_2$, be the regression coefficients of the quality dummies in period $t \in T_1$ and c_t the estimate of the constant. This means that, for both dummies, one category has had its effect confounded with the constant, the β_{it} and γ_{jt} actually being differential values with respect to the effect of the corresponding first category.

Let I_t be the value of the index and d_t of the estimate of the coefficient of the continuous variable. Taking the expectation of each observation in period t, adding up over all observations/equations for the period and dividing by n_t one gets[4] :

$$\text{mean}_t\,(E\ln p) = c_t + \textstyle\sum_{i=2,\dots,q1} \beta_{it}\,(n_{it}/n_t) + \sum_{j=2,\dots,q2} \gamma_{jt}\,(n_{jt}/n_t) + I_t + d_t\,\text{mean}_t\,X \qquad (8)$$

We now evaluate the effect of the first category of each dummy. To this, we need the following

[4] Use of Elnp in all that follows is for theoretical rigour; one could also use lnp and assume that the various averages of the residuals would be approximately zero.

Assumption : The weighted average of the effects of each dummy in period t is zero. In other words, if $\{ef_{it}\}_{1\leq i\leq q1}$ and $\{ef^*_{jt}\}_{1\leq j\leq q2}$ are the effects of the quality dummies in period t, then

$$\sum_{i=1,\ldots,q1} ef_{it}n_{it} / n_t = \sum_{j=1,\ldots,q2} ef^*_{jt}n_{jt} / n_t = 0 \quad .$$

As $\beta_{it} = ef_{it} - ef_{1t}$ and $\gamma_{jt} = ef^*_{jt} - ef^*_{1t}$, the Assumption implies that

$$\sum_i \beta_{it}n_{it} / n_t = - ef_{1t} \quad \text{and} \quad \sum_j \gamma_{jt}n_{jt} / n_t = - ef^*_{1t} \tag{9}$$

However, from (8) it is evident that, taking for instance the first dummy:

$$\sum_i \beta_{it} (n_{it}/n_t) = \text{mean}_t (\text{Elnp}) - c_t - \sum_j \gamma_{jt} (n_{jt}/n_t) - I_t - d_t \,\text{mean}_t X \tag{10}$$

The effect of category 1 for this dummy is then defined by the relationship:

$$ef_{1t} = - [\text{mean}_t (\text{Elnp}) - c_t - \sum_j \gamma_{jt} (n_{jt}/n_t) - I_t - d_t \,\text{mean}_t X] \tag{11}$$

In an analogous fashion the effect ef^*_{1t} can be defined, and the constant may be "cleaned" from the influence of both, giving way to:

$$\begin{aligned} k_t &= c_t - ef_{1t} - ef^*_{1t} = \\ &= 2 \,\text{mean}_t (\text{Elnp}) - c_t - \sum_i \beta_{it} (n_{it}/n_t) - \sum_j \gamma_{jt} (n_{jt}/n_t) - 2 I_t - 2 d_t \,\text{mean}_t X = \\ &= \text{mean}_t (\text{Elnp}) - I_t - d_t \,\text{mean}_t X \end{aligned} \tag{12}$$

The last equality, which is obtained by means of (8), tells that, if from the crude arithmetic mean of the expected prices in period t, one subtracts the hedonic index and the term given by the average of the continuous characteristic, a residual k_t is produced. This number has an important interpretation.

The behaviour of the residual process $\{k_t\}_{t \in T}$ is crucial for understanding both the role played by I_t and its reliability. If we look at (12) as a relationship between random variables, when $\{k_t\}$ is a white noise with a small variance, this will mean that, after extracting from the arithmetic mean of the $Elnp_t$ the average effect of the continuous variable and the hedonic index, what remains is a true residual, signalling that no fancies or quality trends not captured by the regressions took place during the time length of the observations. Actually, no persistent trend should be expected in $\{k_t\}$. If this occurs, there is an underlying fashion moving the market which is not being accounted by the index. Moreover, if process $\{k_t\}$ is highly volatile there exists an excessive volatility in the market under study, probably due to (known or hidden) hedonic characteristics, which is again "outside" the index. In any case, as happens with all residual series, inspection of the behaviour of $\{k_t\}$ is fundamental in shedding light on how the qualitative (hedonic) characteristics acted during the sample period, and on how good was their specification in the regressions.

The construction of ef_{1t} and ef^*_{1t} may look somewhat artificial. It is, indeed, as well as inevitable when working with dummy variables. A change in the choice of the "confounded category" will of course change all the ß's and γ's, and the effects of the new confounded categories. The rationale for our Assumption comes from what could be called a sensible constraint. A formal justification that this constraint really is a sensible choice in a least squares context is given in Appendix 2.

4. Analysis of the quality coefficients.

Comparisons between I_t and individual quality coefficients can also be done. However, one must distinguish between two series: the one with the coefficients themselves and the one with the coefficients weighted by the relative frequency of the corresponding observations in each period.

The first has a meaning with respect to the average price of all goods sold up to period t. To see this, taking expectations and summing over all n_i observations in the category i, after division by n_i one gets:

$$\beta_{it} = \text{mean}_i\,(\text{Elnp}) - [\,\Sigma_j\, \gamma_{jt}\,(n_{ij}/n_i) + \Sigma_{t'} I_{t'}\,(n_{it'}/n_i) + d_t\, \text{mean}_i\, X\,] - c_t \qquad (13)$$

summing instead over all observations and dividing by the total sample size n_T:

$$\text{mean}\,(\text{Elnp}) = c_t + \Sigma_i \beta_{it}\,(n_i/n) + \Sigma_j\, \gamma_{jt}\,(n_{ij}/n) + \Sigma_{t'} I_{t'}\,(n_{t'}/n) + d_t\, \text{mean}\, X$$

or, equivalently:

$$c_t = \text{mean}\,(\text{Elnp}) - [\,\Sigma_i \beta_{it}\,(n_i/n) + \Sigma_j\, \gamma_{jt}\,(n_{ij}/n) + \Sigma_{t'} I_{t'}\,(n_{t'}/n) + d_t\, \text{mean}\, X\,] \qquad (14)$$

Substitution of the above value of c_t into (13) gives a clue for interpreting the difference effects β_{it}'s: the difference between the average (log) price of all category i goods, corrected for the *remaining* qualitative and quantitative variables, and the average (log) price of all goods, corrected for *all* qualitative and quantitative variables, is equal to β_{it}. It must be pointed out that this is a kind of latent effect, since β_{it} can be evaluated even if in the last period t no observations fell into category i.

In view of the above, the natural reference to the β_{it}'s seems then to be the zero level, the sign of their values conveying information on whether the goods in category i are over or underpriced with respect to the market average.

The comparison between the coefficients of different categories of the same quality dummy can be further enhanced if one accepts the following explanation.

Suppose that in a given month t, two goods from categories i and i' were observed. Their expected prices are, respectively:

$$Elnp_{it} = c_t + \beta_{it} + \gamma_{jt} + I_t + d_t X_{it} \tag{15}$$

$$Elnp_{i't} = c_t + \beta_{i't} + \gamma_{j't} + I_t + d_t X_{i't}$$

the difference $\beta_{it}-\beta_{i't}$, which from the previous discussion equals the difference between the average (log) price of all category i and all category i' goods, both corrected for the effect of the remaining qualitative and quantitative variables, is also the invariant difference between the expected prices of any two i and i' goods in the given period, corrected by the effects of the other variables (with the obvious exception of time). This reasoning can be pursued to a certain extreme, allowing the (implicit) comparison of both coefficients even in a month when neither category appears in the sample.

Moreover, if we redo (13) only over the observations in period t, the result is:

$$mean_{it}(Elnp) = c_t + \beta_{it} + \sum_j \gamma_{jt}(n_{ijt}/n_{it}) + I_t + d_t\, mean_{it} X \tag{16}$$

subtracting (8) from the above expression and remembering the definition of the "confounded effects" one gets:

$$\beta_{it} = \{[mean_{it}(Elnp) - d_t\, mean_{it} X] - [mean_t(Elnp) - d_t\, mean_t X]\} - \sum_j \gamma_{jt}(n_{ijt}/n_{it}) - \{ef_{1t} + ef^*_{1t}\}$$

so that

$$ef_{it} = \{[mean_{it}(Elnp) - d_t\, mean_{it} X] - [mean_t(Elnp) - d_t\, mean_t X]\} - \sum_{j=1,\dots,q2} ef^*_{jt}(n_{ijt}/n_{it}) \tag{17}$$

which shows that the effect of the i-th category - in a month when it appears - can be interpreted as the difference between the two corrected means, minus a term which corrects for what we shall call "the other hedonic variable's bias" .

To avoid the artificial flavour of some of the previous extensions, analysis of the $\{\beta_{it}\}$ series could be made by setting a value equal to zero whenever category i does not appear in the corresponding period. This series will certainly be more volatile than the one with all calculated β_{it}'s, but may be more appropriate for certain purposes. A series somewhat close to it is $\{(n_{it}/n_t)\beta_{it}\}$, in which a zero is also present whenever the category does not appear in the given month. Its interpretation may follow similar lines, but it is preferrable to look at it as the component of the orthogonal decomposition of the i-categories effects in month t (see also Appendix 2).

5. Conclusions.

We developed two approaches for computing a series of "true" hedonic price indexes and generating evolving sets of coefficients of the quality characteristics. In the first approach, the number of observations continuously increases and, after a certain point, it may start to produce values close to those from the equivalent static regression[5] . In the second, each period is compared only to the basis, so that the results should be less sensitive to sample mix modifications, though the series will be more volatile than the previous one. Besides, if the sample sizes n_t , for some periods t, are rather small, the reliability of the index would be in trouble.

Waelbroeck (1994) computed the three indexes from a data base of 25082 prices of impressionist, modern and contemporary paintings sold at public auctions all over the world, and

---

[5] Theoretically, the values will never be equal because of the correction made - in the dynamic case - in the dependent variable.

found that the differences among the three series were not much remarkable. Though this needs further empirical confirmation, it may signal that the static index may be used as a first approximation in some cases.

Last but not least, beyond the need of additional empirical studies, the economic theory behind these dynamic regressions should be (re)examined.

APPENDIX 1: An algorithmic approach to the recursions.

Before describing the algorithms a warning should perhaps be made. The use of the recursive regressions had as one purpose to allow for an iterative way of calculating the successive indexes and coefficients. The (meta)algorithms below - or variations/improvements of them - can easily be programmed in a standard econometric software or a matrix manipulation language. However, as said in section 2, this is not the only way to compute the dynamic regressions. Indeed, depending on the size of the data base, its storage and retrieval routines, and the available computer power, one can simply directly run the chosen regression each time the full set of observations for the period has arrived. Though we also think that the recursive approach adds an interesting insight on the updating mechanism, the final computing choice will be a personal matter.

Case i) :

At the end of period t one has: the coefficient b_t, matrix $Z_{T'}$ and vector $Y^*_{T'}$.

Period t+1 generates the observations in: matrix Z_{t+1} and vector Y_{t+1}.

With these input data, the following steps should be performed:

#1. Compute: $meanY_{t+1}$, $meanZ_{t+1}$, $A = (Z_{T'}'Z_{T'})^{-1}$

$$B = Z_{t+1} (Z_{T'}'Z_{T'} + Z_{t+1}'Z_{t+1})^{-1} Z_{t+1}'$$

$$C = A\, Z_{t+1}'(I-B)$$

#2. Compute the intermediate parameter:

$$\beta^* = b_t + C\,(\,Y_{t+1} - Z_{t+1}\,b_t)$$

#3. Evaluate the index and the new β's:

$$I_{t+1} = [\mathrm{mean}Y_{t+1} - \mathrm{mean}Z_{t+1}\,.\,\beta^*] \,/\, [1 - (\,\mathbf{1}'\,B\,\mathbf{1}\,)\,/\,n_{t+1}\,]$$

$$\beta_{t+1} = \beta^* - C\,(\mathrm{mean}Y_{t+1}\,.\,\mathbf{1} - \mathbf{1}\,.\,\mathrm{mean}Z_{t+1}\,b_t)$$

#4. Compute the new b_{t+1}:

$$b_{t+1} = \beta^* - I_{t+1}\,C\,\mathbf{1}$$

and

$$Y^*_{t+1} = Y_{t+1} - I_{t+1}\,\mathbf{1}$$

#5. Store b_{t+1}, matrix $Z_{T'+1}$ and vector $Y^*_{T'+1}$ for the next iteration.

Case ii) :

Now, at the end of any period t one has always the same coefficient b_0, matrix Z_0 and vector Y^*_0 related to the base period. This means that matrix A will not change; we shall call it $A_0=(Z_0'\,Z_0)^{-1}$.

Period t+1 generates the observations in: matrix Z_{t+1} and vector Y_{t+1}.

With these input data, the steps to be performed are somewhat simpler:

#1. Compute: $\mathrm{mean}Y_{t+1}$, $\mathrm{mean}Z_{t+1}$, $B = Z_{t+1}\,(\,Z_0'Z_0 + Z_{t+1}'Z_{t+1})^{-1}\,Z_{t+1}'$

$$C = A_0\,Z_{t+1}'(I-B)$$

#2. Compute the intermediate parameter:

$$\beta^* = b_0 + C\,(\,Y_{t+1} - Z_{t+1}\,b_0)$$

#3. Evaluate the index and the new β's:

$$I_{t+1} = [\mathrm{mean}Y_{t+1} - \mathrm{mean}Z_{t+1}\,.\,\beta^*] \,/\, [1 - (\,\mathbf{1}'\,B\,\mathbf{1}\,)\,/\,n_{t+1}\,]$$

$$\beta_{t+1} = \beta^* - C\,(\mathrm{mean}Y_{t+1}\,.\,\mathbf{1} - \mathbf{1}\,.\,\mathrm{mean}Z_{t+1}\,b_0)$$

APPENDIX 2: The coefficients of the quality dummies.

In working with one complete set of dummy variables the problem of the "confounded effect" is easily solved: if the regression includes a constant the coefficient of the ommitted dummy can be thought of as the constant (actually it also is *in* the constant) and the "true coefficients" of all the others are those found in the regression plus the constant.

If two or more complete sets are used the situation is not so easy as the associated subspaces have a common intersection - the constant vector; the definition of a "true coefficient" becomes more arbitrary. One idea is to work in the intersections of each subspace generated by a set of dummies and the orthogonal complement of the constant vector. The regression with the modified variables can either include or not the constant but, in any case, though for each set there will still be as many dummies as the number of categories less one, the computed coefficients are the "true ones" in the sense that they have no additional part mixed up in the coefficient of the constant.

This could have been used in the dynamic hedonic regressions, however, it obliges a more cumbersome definition of the dummies and the "confounded" or rather now "missing" effect must still be found through a formula similar to the one in the Assumption. Moreover, a further question arises: The orthogonality condition should be imposed for the whole sample or for only the subsample of the last period ? We have opted for the latter, with a milder version of the above idea.

Actually, instead of working in the intersection of each subspace with the complement of the constant we have only imposed that the combined effect be orthogonal to it. Indeed, if the vectors for all the i-categories of the first dummy, for instance, are called $D_i \in \mathbf{R}^n$, $\sum_{i=1,\dots,q1} D_i = 1$, it is easy to see that, with the ef_{it} as defined in the text:

$< \sum_{i=2,\dots,q1} ef_{it}D_i + ef_{1t}D_1 , 1 > = 0$, i.e., the linear combination of the (standard) dummies by means of the proposed effects defines a vector in the subspace generated by them which is orthogonal to the constant. Notice that imposing the orthogonality only in period t makes the developments in sections 3 and 4 valid for both approaches.

REFERENCES

Chanel, O. 1993. Apports de l'économétrie à l'étude des champs culturels: application au marché des oeuvres d'art et à la demande télévisuelle. Thèse de Doctorat (nouveau régime) en Économie Mathématique et Économétrie, G.R.E.Q.E., Marseille.

Chanel, O., L.-A. Gérard-Varet and V. Ginsburgh. 1992. The relevance of hedonic price indexes. Processed.

de la Barre, M., S. Docclo and V. Ginsburgh. 1994. Returns of impressionist, modern and contemporary European paintings, 1962-1991. *Annales d'Économie et de Statistique* 35, 143-81.

Ginsburgh, V. 1994. Objective properties of art and its price. Processed; paper presented at the Annual Meeting of the Midwest Economics Association, Chicago, March.

Ginsburgh, V. and P. Jeanfils. 1995. Long-term comovements in international markets for paintings. *European Economic Review* 38, 538-48.

Goetzmann, W. N. 1993. Accounting for taste: art and financial markets over three centuries. *American Economic Review* 83, 1370-6.

Griliches, Z. 1961. Hedonic price indexes for automobiles: an econometric analysis of quality changes., in *The Consumers Price Index*, Government Printing Office, Washington, D.C.

Harvey, A. C. 1981. *Time Series Models* . Philip Allan Pub. Ltd., Oxford, U.K.

Waelbroeck, P. 1994. On the specificity of the art market. Séminaire d'économétrie, Année académique 1993-1994. Université Libre de Bruxelles, Bruxelles.

ENSAIOS ECONÔMICOS DA EPGE

200. A VISÃO TEÓRICA SOBRE MODELOS PREVIDENCIÁRIOS: O CASO BRASILEIRO - Luiz Guilherme Schymura de Oliveira - Outubro de 1992 - 23 pág. (esgotado)
201. HIPERINFLAÇÃO: CÂMBIO, MOEDA E ÂNCORAS NOMINAIS - Fernando de Holanda Barbosa - Novembro de 1992 - 10 pág. (esgotado)
202. PREVIDÊNCIA SOCIAL: CIDADANIA E PROVISÃO - Clovis de Faro - Novembro de 1992 - 31 pág. (esgotado)
203. OS BANCOS ESTADUAIS E O DESCONTROLE FISCAL: ALGUNS ASPECTOS - Sérgio Ribeiro da Costa Werlang e Armínio Fraga Neto - Novembro de 1992 - 24 pág. (esgotado)
204. TEORIAS ECONÔMICAS: A MEIA-VERDADE TEMPORÁRIA - Antonio Maria da Silveira - Dezembro de 1992 - 36 pág. (esgotado)
205. THE RICARDIAN VICE AND THE INDETERMINATION OF SENIOR - Antonio Maria da Silveira - Dezembro de 1992 - 35 pág. (esgotado)
206. HIPERINFLAÇÃO E A FORMA FUNCIONAL DA EQUAÇÃO DE DEMANDA DE MOEDA - Fernando de Holanda Barbosa - Janeiro de 1993 - 27 pág. (esgotado)
207. REFORMA FINANCEIRA - ASPECTOS GERAIS E ANÁLISE DO PROJETO DA LEI COMPLEMENTAR - Rubens Penha Cysne - fevereiro de 1993 - 37 pág. (esgotado)
208. ABUSO ECONÔMICO E O CASO DA LEI 8.002 - Luiz Guilherme Schymura de Oliveira e Sérgio Ribeiro da Costa Werlang - fevereiro de 1993 - 18 pág. (esgotado)
209. ELEMENTOS DE UMA ESTRATÉGIA PARA O DESENVOLVIMENTO DA AGRICULTURA BRASILEIRA - Antonio Salazar Pessoa Brandão e Eliseu Alves - Fevereiro de 1993 - 370pág.
210. PREVIDÊNCIA SOCIAL PÚBLICA: A EXPERIÊNCIA BRASILEIRA - Hélio Portocarrero de Castro, Luiz Guilherme Schymura de Oliveira, Renato Fragelli Cardoso e Uriel de Magalhães - Março de 1993 - 35 pág - (esgotado) .
211. OS SISTEMAS PREVIDENCIÁRIOS E UMA PROPOSTA PARA A REFORMULACAO DO MODELO BRASILEIRO - Helio Portocarrero de Castro, Luiz Guilherme Schymura de Oliveira, Renato Fragelli Cardoso e Uriel de Magalhães - Março de 1993 - 43 pág. - (esgotado)
212. THE INDETERMINATION OF SENIOR (OR THE INDETERMINATION OF WAGNER) AND SCHMOLLER AS A SOCIAL ECONOMIST - Antonio Maria da Silveira - Março de 1993 - 29 pág. (esgotado)
213. NASH EQUILIBRIUM UNDER KNIGHTIAN UNCERTAINTY: BREAKING DOWN BACKWARD INDUCTION (Extensively Revised Version) - James Dow e Sérgio Ribeiro da Costa Werlang - Abril de 1993 36 pág.
214. ON THE DIFFERENTIABILITY OF THE CONSUMER DEMAND FUNCTION - Paulo Klinger Monteiro, Mário Rui Páscoa e Sérgio Ribeiro da Costa Werlang - Maio de 1993 - 19 pág.

215. DETERMINAÇÃO DE PREÇOS DE ATIVOS, ARBITRAGEM, MERCADO A TERMO E MERCADO FUTURO - Sérgio Ribeiro da Costa Werlang e Flávio Auler - Agosto de 1993 - 69 pág. (esgotado).

216. SISTEMA MONETÁRIO VERSÃO REVISADA - Mario Henrique Simonsen e Rubens Penha Cysne - Agosto de 1993 - 69 pág. (esgotado).

217. CAIXAS DE CONVERSÃO - Fernando Antônio Hadba - Agosto de 1993 - 28 pág.

218. A ECONOMIA BRASILEIRA NO PERÍODO MILITAR - Rubens Penha Cysne - Agosto de 1993 - 50 pág. (esgotado).

219. IMPÔSTO INFLACIONÁRIO E TRANSFERÊNCIAS INFLACIONÁRIAS - Rubens Penha Cysne - Agosto de 1993 - 14 pág. (esgotado).

220. PREVISÕES DE M1 COM DADOS MENSAIS - Rubens Penha Cysne e João Victor Issler - Setembro de 1993 - 20 pág.

221. TOPOLOGIA E CÁLCULO NO Rn - Rubens Penha Cysne e Humberto Moreira - Setembro de 1993 - 106 pág. (esgotado)

222. EMPRÉSTIMOS DE MÉDIO E LONGO PRAZOS E INFLAÇÃO: A QUESTÃO DA INDEXAÇÃO - Clovis de Faro - Outubro de 1993 - 23 pág.

223. ESTUDOS SOBRE A INDETERMINAÇÃO DE SENIOR, vol. 1 - Nelson H. Barbosa, Fábio N.P. Freitas, Carlos F.L.R. Lopes, Marcos B. Monteiro, Antonio Maria da Silveira (Coordenador) e Matias Vernengo - Outubro de 1993 - 249 pág (esgotado)

224. A SUBSTITUIÇÃO DE MOEDA NO BRASIL: A MOEDA INDEXADA - Fernando de Holanda Barbosa e Pedro Luiz Valls Pereira - Novembro de 1993 - 23 pág.

225. FINANCIAL INTEGRATION AND PUBLIC FINANCIAL INSTITUTIONS - Walter Novaes e Sérgio Ribeiro da Costa Werlang - Novembro de 1993 - 29 pág

226. LAWS OF LARGE NUMBERS FOR NON-ADDITIVE PROBABILITIES - James Dow e Sérgio Ribeiro da Costa Werlang - Dezembro de 1993 - 26 pág.

227. A ECONOMIA BRASILEIRA NO PERÍODO MILITAR - VERSÃO REVISADA - Rubens Penha Cysne - Janeiro de 1994 - 45 pág. (esgotado)

228. THE IMPACT OF PUBLIC CAPITAL AND PUBLIC INVESTMENT ON ECONOMIC GROWTH: AN EMPIRICAL INVESTIGATION - Pedro Cavalcanti Ferreira - Fevereiro de 1994 - 37 pág. (esgotado)

229. FROM THE BRAZILIAN PAY AS YOU GO PENSION SYSTEM TO CAPITALIZATION: BAILING OUT THE GOVERNMENT - José Luiz de Carvalho e Clóvis de Faro - Fevereiro de 1994 - 24 pág.

230. ESTUDOS SOBRE A INDETERMINAÇÃO DE SENIOR - vol. II - Brena Paula Magno Fernandez, Maria Tereza Garcia Duarte, Sergio Grumbach, Antonio Maria da Silveira (Coordenador) - Fevereiro de 1994 - 51 pág.(esgotado)

231. ESTABILIZAÇÃO DE PREÇOS AGRÍCOLAS NO BRASIL: AVALIAÇÃO E PERSPECTIVAS - Clovis de Faro e José Luiz Carvalho - Março de 1994 - 33 pág. (esgotado)

232. ESTIMATING SECTORAL CYCLES USING COINTEGRATION AND COMMON FEATURES - Robert F. Engle e João Victor Issler - Março de 1994 - 55 pág

233. COMMON CYCLES IN MACROECONOMIC AGGREGATES - João Victor Issler e Farshid Vahid - Abril de 1994 - 60 pág.

234. BANDAS DE CÂMBIO: TEORIA, EVIDÊNCIA EMPÍRICA E SUA POSSÍVEL APLICAÇÃO NO BRASIL - Aloisio Pessoa de Araújo e Cypriano Lopes Feijó Filho - Abril de 1994 - 98 pág. (esgotado)

235. O HEDGE DA DÍVIDA EXTERNA BRASILEIRA - Aloisio Pessoa de Araújo, Túlio Luz Barbosa, Amélia de Fátima F. Semblano e Maria Haydée Morales - Abril de 1994 - 109 pág. (esgotado)

236. TESTING THE EXTERNALITIES HYPOTHESIS OF ENDOGENOUS GROWTH USING COINTEGRATION - Pedro Cavalcanti Ferreira e João Victor Issler - Abril de 1994 - 37 pág. (esgotado)

237. THE BRAZILIAN SOCIAL SECURITY PROGRAM: DIAGNOSIS AND PROPOSAL FOR REFORM - Renato Fragelli; Uriel de Magalhães; Helio Portocarrero e Luiz Guilherme Schymura - Maio de 1994 - 32 pág.

238. REGIMES COMPLEMENTARES DE PREVIDÊNCIA - Hélio de Oliveira Portocarrero de Castro, Luiz Guilherme Schymura de Oliveira, Renato Fragelli Cardoso, Sérgio Ribeiro da Costa Werlang e Uriel de Magalhães - Maio de 1994 - 106 pág.

239. PUBLIC EXPENDITURES, TAXATION AND WELFARE MEASUREMENT - Pedro Cavalcanti Ferreira - Maio de 1994 - 36 pág.

240. A NOTE ON POLICY, THE COMPOSITION OF PUBLIC EXPENDITURES AND ECONOMIC GROWTH - Pedro Cavalcanti Ferreira - Maio de 1994 - 40 pág.

241. INFLAÇÃO E O PLANO FHC - Rubens Penha Cysne - Maio de 1994 - 26 pág. (esgotado)

242. INFLATIONARY BIAS AND STATE OWNED FINANCIAL INSTITUTIONS - Walter Novaes Filho e Sérgio Ribeiro da Costa Werlang - Junho de 1994 -35 pág.

243. INTRODUÇÃO À INTEGRAÇÃO ESTOCÁSTICA - Paulo Klinger Monteiro - Junho de 1994 - 38 pág. (esgotado)

244. PURE ECONOMIC THEORIES: THE TEMPORARY HALF-TRUTH - Antonio M. Silveira - Junho de 1994 - 23 pág. (esgotado)

245. WELFARE COSTS OF INFLATION - THE CASE FOR INTEREST-BEARING MONEY AND EMPIRICAL ESTIMATES FOR BRAZIL - Mario Henrique Simonsen e Rubens Penha Cysne - Julho de 1994 - 25 pág. (esgotado)

246. INFRAESTRUTURA PÚBLICA, PRODUTIVIDADE E CRESCIMENTO - Pedro Cavalcanti Ferreira - Setembro de 1994 - 25 pág.

247. MACROECONOMIC POLICY AND CREDIBILITY: A COMPARATIVE STUDY OF THE FACTORS AFFECTING BRAZILIAN AND ITALIAN INFLATION AFTER 1970 - Giuseppe Tullio e Marcio Ronci - Outubro de 1994 - 61 pág. (esgotado)

248. INFLATION AND DEBT INDEXATION: THE EQUIVALENCE OF TWO ALTERNATIVE SCHEMES FOR THE CASE OF PERIODIC PAYMENTS - Clovis de Faro - Outubro de 1994 -18 pág.

249. CUSTOS DE BEM ESTAR DA INFLAÇÃO - O CASO COM MOEDA INDEXADA E ESTIMATIVAS EMPÍRICAS PARA O BRASIL - Mario Henrique Simonsen e Rubens Penha Cysne - Novembro de 1994 - 28 pág. (esgotado)

250. THE ECONOMIST MACHIAVELLI - Brena P. M. Fernandez e Antonio M Silveira - Novembro de 1994 - 15 pág.

251. INFRAESTRUTURA NO BRASIL: ALGUNS FATOS ESTILIZADOS - Pedro Cavalcanti Ferreira - Dezembro de 1994 - 33 pág.

252. ENTREPRENEURIAL RISK AND LABOUR'S SHARE IN OUTPUT - Renato Fragelli Cardoso - Janeiro de 1995 - 22 pág.

253. TRADE OR INVESTMENT ? LOCATION DECISIONS UNDER REGIONAL INTEGRATION - Marco Antonio F.de H. Cavalcanti e Renato G. Flôres Jr. - Janeiro de 1995 - 35 pág.

254. O SISTEMA FINANCEIRO OFICIAL E A QUEDA DAS TRANFERÊNCIAS INFLACIONÁRIAS - Rubens Penha Cysne - Janeiro de 1995 - 32 pág.

255. CONVERGÊNCIA ENTRE A RENDA PER-CAPITA DOS ESTADOS BRASILEIROS - Roberto G. Ellery Jr. e Pedro Cavalcanti G. Ferreira - Janeiro 1995 - 42 pág.

256. A COMMENT ON "RATIONAL LEARNING LEAD TO NASH EQUILIBRIUM" BY PROFESSORS EHUD KALAI EHUD EHUR - Alvaro Sandroni e Sergio Ribeiro da Costa Werlang - Fevereiro de 1995 - 10 pág.

257. COMMON CYCLES IN MACROECONOMIC AGGREGATES (revised version) - João Victor Issler e Farshid Vahid - Fevereiro de 1995 - 57 pág.

258. GROWTH, INCREASING RETURNS, AND PUBLIC INFRASTRUCTURE: TIMES SERIES EVIDENCE (revised version) - Pedro Cavalcanti Ferreira e João Victor Issler - Março de 1995 - 39 pág.(esgotado)

259. POLÍTICA CAMBIAL E O SALDO EM CONTA CORRENTE DO BALANÇO DE PAGAMENTOS - *Anais do Seminário realizado na Fundação Getulio Vargas no dia 08 de dezembro de 1994* - Rubens Penha Cysne (editor) - Março de 1995 - 47 pág. (esgotado)

260. ASPECTOS MACROECONÔMICOS DA ENTRADA DE CAPITAIS - *Anais do Seminário realizado na Fundação Getulio Vargas no dia 08 de dezembro de 1994* - Rubens Penha Cysne (editor) - Março de 1995 - 48 pág. (esgotado)

261. DIFICULDADES DO SISTEMA BANCÁRIO COM AS RESTRIÇÕES ATUAIS E COMPULSÓRIOS ELEVADOS - *Anais do Seminário realizado na Fundação Getulio Vargas no dia 09 de dezembro de 1994* - Rubens Penha Cysne (editor) - Março de 1995 - 47 pág. (esgotado)

262. POLÍTICA MONETÁRIA: A TRANSIÇÃO DO MODELO ATUAL PARA O MODELO CLÁSSICO - *Anais do Seminário realizado na Fundação Getulio Vargas no dia 09 de dezembro de 1994* - Rubens Penha Cysne (editor) - Março de 1995 - 54 pág. (esgotado)

263. CITY SIZES AND INDUSTRY CONCENTRATION - Afonso Arinos de Mello Franco Neto - Maio de 1995 - 38 pág.

264. WELFARE AND FISCAL POLICY WITH PUBLIC GOODS AND INFRASTRUCTURE (Revised Version) - Pedro Cavalcanti Ferreira - Maio de 1995 - 33 pág.

265. PROFIT SHARING WITH HETEROGENEOUS ENTREPRENEURIAL PROWESS - Renato Fragelli Cardoso - Julho de 1995 - 36 pág.

266. A DINÂMICA MONETÁRIA DA HIPERINFLAÇÃO: CAGAN REVISITADO - Fernando de Holanda Barbosa - Agosto de 1995 - 14 pág.

267. A SEDIÇÃO DA ESCOLHA PÚBLICA: VARIAÇÕES SOBRE O TEMA DE REVOLUÇÕES CIENTÍFICAS - Antonio Maria da Silveira - Agosto de 1995 - 24 pág.

268. A PERSPECTIVA DA ESCOLHA PÚBLICA E A TENDÊNCIA INSTITUCIONALISTA DE KNIGHT - Antonio Maria da Silveira - Setembro de 1995 - 28 pág.

269. ON LONG-RUN PRICE COMOVEMENTS BETWEEN PAINTINGS AND PRINTS - Renato Flôres - Setembro de 1995 - 29 pág.

270. CRESCIMENTO ECONÔMICO, RENDIMENTOS CRESCENTES E CONCORRÊNCIA MONOPOLISTA - Pedro Cavalcanti Ferreira e Roberto Ellery Junior - Outubro de 1995 - 32 pág.

271. POR UMA CIÊNCIA ECONÔMICA FILOSOFICAMENTE INFORMADA: A INDETERMINAÇÃO DE SENIOR - Antonio Maria da Silveira - Outubro de 1995 - 25 pág.

272. ESTIMATING THE TERM STRUCTURE OF VOLATILITY AND FIXED INCOME DERIVATIVE PRICING - Franklin de O. Gonçalves e João Victor Issler - Outubro de 1995 - 23 pág.

273. A MODEL TO ESTIMATE THE US TERM STRUCTURE OF INTEREST RATES - Antonio Marcos Duarte Júnior e Sérgio Ribeiro da Costa Werlang - Outubro de 1995 - 21 pág.

274. EDUCAÇÃO E INVESTIMENTOS EXTERNOS COMO DETERMINANTES DO CRESCIMENTO A LONGO PRAZO - Gustavo Gonzaga, João Victor Issler e Guilherme Cortella Marone - Novembro de 1995 - 34 pág.

275. DYMAMIC HEDONIC REGRESSIONS: COMPUTATION AND PROPERTIES - Renato Galvão Flôres Junior e Victor Ginsburgh - Janeiro de 1996 - 21 pág.