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Autores (as)	Cláudio Hamilton Matos dos Santos Márcio Bruno Ribeiro
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CHAPTER 8

HOW TO FORECAST OR EXPLAIN THE BEHAVIOUR OF PUBLIC REVENUES IN BRAZIL? OLD AND NEW ALTERNATIVES

Claúdio Hamilton Matos dos Santos*
Márcio Bruno Ribeiro*

Even a superficial search will show that there is no lack of recent texts on the dynamics of the Brazilian public accounts. Indeed, if we consider the main public finances and tax policy themes (dynamics and composition of the Brazilian public debt, evolution of the Brazilian taxation structure and/or tax reform proposals in Brazil, as well as "sustainability tests of the Brazilian public debt"), we can easily find around 40 texts and 1.600 pages – not taking into account articles in situation journals published by the various research and government agencies. There is no doubt that this number would increase significantly in a broader search on the subject. This abundance of texts is certainly an indication of the importance that the themes related to the Brazilian public finances have taken on in the last years.

However, there is much less literature aimed strictly at adjusting econometric specifications to the data on public sector revenues in Brazil. Indeed, after a reasonably careful search, one finds only eight texts with explicit specifications on the subject, namely: Hernández (1998), Reis *et al.* (1999), Issler and Lima (2000), Portugal and Portugal (2001), Melo (2001), Siqueira (2002), Guaranga and Mello (2002) and Muinhos and Alves (2003). This number includes partially redundant texts and that work with very different definitions, frequencies and aggregation levels. The situation improves a little if we use a broader definition of econometrics, so as to also include the "calibrated" models based on various systems of national accounting. Even so, the number of texts found does not reach one third of the forty mentioned above.

The aim of this text is to offer two contributions. Initially, we present a preliminary effort to map the broad econometric literature on the Brazilian public revenues published in the last decade (in the first two parts). Secondly, we present (in the third part) some strictly new specifications that we have been using at the Public Finances Coordination of Ipea.

* Planning and Research Technical Experts of the Directorate of Regional and Urban Studies (Dirur) of Ipea.

Attention should be drawn to the importance of the theme in at least two aspects. In the first place, a better understanding of the historical and future behaviour of public revenues allows the identification of the relationship between its determinants (tax rates, sectoral or macroeconomic variables etc.) and government collection, as well as preventing possible imbalances in the public budget. Secondly, there is a close link between the collection of revenues and the public policy process, since the tax and contribution revenues are earmarked to the various federal government programmes.

1 "ACCOUNTING" MODELS AND THE EXISTING DATA

"Accounting" models are those less focused on the adjustment of "good" econometric specifications for some specific variables and more focused on "systemic" understanding of the inter-relations between a relatively large set of variables. Such models can work with disaggregated "classic" variables (such as, for example, the various types of current revenues and public expenditures) and/or with variables logically related to the latter (such as stock variables or "fund flow" variables"), possibly of several sectors and/or interconnected institutions. Given that such models presuppose a lot of historical-institutional knowledge of the object under study and of how the various parts of it interrelate, it is no surprise that the main recent models of accounting consistency that include the Brazilian public finances came from public agencies. These agencies were in one way or another concerned with applied research, such as Ipea (for example, Carvalho, 2001, and Silva *et al.*, 2004) and the BNDES (Giambiagi and Pastoriza, 1997).

Carvalho's model (2001) systemizes much of the existing data on the Brazilian federal public revenues and seems highly representative of the Brazilian "calibrated" fiscal models. Thus, it seemed convenient to describe it briefly in sub-section 1.1. Very brief notes on the availability of data on the revenues of other government spheres and on the important work of Silva *et al.* (2004), *inter alia,* with multi-sectoral models are presented in sub-section 1.2.

1.1 The models of Carvalho (2001) and Giambiagi and Pastoriza (1997), the "method of the indicators" and the data on federal government revenues

One of the main objectives of Carvalho's model (2001) is to enable the construction of scenarios for the dynamics of the public sector net debt – understood as the sum of the external and internal net debts of the federal, state and municipal governments, as well as of the state-owned companies of these three government spheres – on the basis of hypotheses on the various components of the latter. Thus, the starting point of the model is the following accounting identities:

(I.1) DLSPj a" DLSP ^{ext}j +DLSP ^{int}j;

(I.2) DLSP ^{i}j a" DLSP ^{i}j (-1) + DN ^{i}j + AP ^{i}j;

(I.3) DN ^{i}j a" NFSP ^{i}j a" DP ^{i}j + Jur ^{i}j; e

(I.4) DP ^{i}j a" DC ^{i}j - RC ^{i}j [with i = external or internal and j = federal, state, municipal, federal state-owned, state state-owned or municipal state-owned].

Or, in words, *i)* the net debt of a government sphere j is given by the sum of its external and internal net debts; *ii)* the value of each one of these debts at the end of an accounting period is given by its value in the beginning of the period plus the nominal deficit (external or internal) of this government sphere in the period plus the relevant patrimonial adjustments; *iii)* the nominal deficit or nominal financing needs [internal or external] of a given government sphere j is given by its respective primary deficit plus the expenditures with the nominal interests of the respective debt; e *iv)* primary deficit (external or internal) of a given government sphere j is obtained by subtracting the respective revenues from the non-financial current expenditures of this government sphere.

The fact that the Brazilian Central Bank publishes monthly data on the internal and external net debts, financing needs, patrimonial adjustments and primary deficits and the expenditures with interests of the six government spheres mentioned above can lead the less informed analyst to thinking that there are detailed monthly series on the current revenues and expenditures of each one of those spheres. However, this is only true in the case of the federal government,[1] and the primary deficits of the other government spheres are only estimated by the Central Bank (CARVALHO, 2001, p. 7).[2] We will have a little more to say on the availability of state and municipal data in subsection 1.2. For now, it should be noted that identity *(I.5)* below presents a disaggregation of net current revenues of the federal government compatible with the monthly data effectively made available by the Central Bank and the National Treasury Secretariat (STN) of the Ministry of Finance.

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1. Both in the SGS-Bacen and in the website of the National Treasury (in government statistics-accounting). However, the data provided by these institutions are, in many cases, significantly different.

2. More precisely, the Central Bank estimates these primary results indirectly, based on the variation of the stocks of the debts of these government spheres and the data on payment of interests on these debts. Unfortunately, this procedure, known as "below-the-line method", generates significantly different

(I.5) Federal "Net" Current Revenues (*RCF) a"* Current Revenues under the Control of the Federal Revenue Secretariat (*RCRF)* + Welfare Revenues (*RC)* + Other Current Revenues-Fiscal Incentives-Transfers (*TR).*[3]

Identity (I.5) makes it clear that there are several possible concepts of "public revenues", even when limited to federal current revenues. Indeed, most of the studies that we will discuss in section 3.2 are concerned only about disaggregations of the current revenues under the control of the Federal Revenue Secretariat (SRF). Carvalho's text (2001) has the advantage of presenting the "full picture" of federal current revenues, so to speak.

In fact, Carvalho's model (2001) is worthy of note because of its explicit concern in working always with the highest degree of possible disaggregation among the variables mentioned in the (I.5) expression.[4] Carvalho (*ibid* p. 34) even argues that the diversity of Brazilian taxes and contributions is such, and their structural breaks so many and so large, that the "sticking to reality" of highly disaggregated models "(...), is, in general, much more appropriate than what occurs most of the time when simplified models, whose main determinant is the gross domestic product, are adopted." Even if one is not discussing the usefulness and clarifying power of disaggregated analyses, such as the ones allowed by Carvalho's model (2001),[5] it is interesting to note that the latter point is controversial. We will return to this matter in section 3.2, but for now it suffices to say that Carvalho uses the so-called " method of the indicators", that:

> consists of [forecasting the collection of some tax in the present period by the result of] multiplication of the collection of the previous period by (...) [*i)* a price index] that represents the inflationary variation to which the economic fact that generates the collection is subject; (...) [*ii)* an index of] quantity that represents the real variation

3. However, it should be noted that the STN data are much more detailed, disaggregating federal current revenues into tax, contribution, patrimonial, agriculture and livestock, industrial, service revenues, and other revenues. It should also be noted that while the Central Bank includes non-welfare contributions among "tax revenues", the STN calls "tax revenues" the aggregate of revenues obtained with taxes and rates, and calls "contribution revenues" the revenues obtained with welfare and non-welfare contributions. That is, the term " revenues under control of the Federal Revenue Secretariat" – used by Carvalho (2001) – is perhaps more appropriate to describe the "tax revenues" of the Central Bank.

4. For example, Carvalho (2001) disaggregates the revenues obtained from Income Tax on "natural persons", " legal entities" and " withholding at source", in addition to "fines paid for delays or mistakes in the payment of the various types of Income Tax". The revenue with Withholding Income Tax, in turn, is divided into "labour earnings", "capital earnings", "profit remittances abroad" and "other earnings". Finally, the revenues from Withholding Income Tax levied on labour earnings are disaggregated into "levied on the wages of public civil servants" and on "the wages of private sector employees".

5. Which are essentially the raw materials of texts such as, for example, Giambiagi (2006).

> of this generating fact; (...) [*iii)* an index that] represents the effect caused in the collection by modifications in the tax legislation; (...) [and *iv)* indices that] represent any [other] influences in the tax collection. (MELO, 2002, p. 35)

For example, Carvalho (2001) calculates the total revenue from collection of the importation tax with the importations of oil (a sub-component of the Importation Tax) in the following way:

Imp_oil = Imp_oil_{-1}* (1 + percentile change of the total oil importations measured in dollars)*(1 + variation of the percentage rate of the tax on oil importation)*(1 + percentile change in the value of the nominal exchange rate).

Therefore, it is clear that a forecast according to this formula will be as good as the forecasts of the total oil importations, the nominal exchange rate and the rate of the oil tax. Since Carvalho's model works literally with dozens of disaggregations of the variables in the table above and with a similar number of exogenous variables, it is intuitively clear that the necessary information requirements for a good forecast performance of the model are certainly very high, and its use as an instrument of instrument of elaboration of "scenarios" (obtained by means of combinations of exogenous variables) is potentially more fertile.[6]

We conclude this part of the text remembering that Giambiagi and Pastoriza's model (1997) should be mentioned in any good summary of "accounting" models on the Brazilian economy. For our purposes, however, it should be noted only that the "fiscal part" of the model assumes that GDP growth is the only determinant of the growth of current revenues, both of the central government and of states and municipalities. Other endogenous variables of the model are also calculated by the "method of the indicators".

1.2 Brief notes on the national accounts of Brazil and multi-sectoral models

Aggregated annual data on the Brazilian public sector revenues excluding the state-owned companies (which are treated as private companies), as well as their disaggregation into central government, states and municipalities, are also available in the national accounts published by the IBGE. The last data currently available, related to 2003, indicate that the central government revenues account for little more than two thirds of the total revenue. The states are left with something around 27% and the municipalities with close to 5% of these revenues. The IBGE also publishes every quarter an aggregated

6. Even so some care should be taken in the analysis of how robust the conclusions of the model are to small variations in the combinations of the exogenous variables adopted.

series of "taxes on products"[7] that is necessary for the calculation of the GDP at market prices, also published quarterly by the Institute.

It should also be noted that the fact that the GDP calculation requires the calculation of the value added by each "productive sector" of the economy – and, therefore, measures of incidence of taxes (on products and production)[8] at the sectoral level – enables the construction of so-called "multi-sectoral" models of accounting consistency. Indeed, based on data on the incidence of these taxes to the level of "39 productive sectors that are identified, with few exceptions, with the sectors of the product input matrix [published by IBGE]" – in addition to specific hypotheses on the demands for products from these sectors, among other variables – Silva *et al.* (2004) calculated estimates of the impact in the Brazilian tax collection of several changes in the calculation and incidence of the Cofins and the PIS contribution.[9] Even though multi-sectoral models are known to be complex, depending on a high number of questionable theoretical hypotheses, it is certain that they offer an important contribution to the literature that aims to explain the behaviour of public revenues in a given economy.

2 ECONOMETRIC SPECIFICATIONS PER SE

As mentioned previously, there seem to be few "tax collection functions" econometrically estimated for Brazil. Indeed, the sample found of texts published in the last decade and immediately relevant for our purposes has only seven elements, which, even though there might be other relevant specifications in texts that we are not aware of, at least makes the relative fragmentation of literature clear. Nevertheless, it seems useful to divide the eight texts mentioned in the introduction of this paper into three groups, namely, "conventional Keynesian", "atheoretical" and "intertemporal". The following discussion at the same time is based on this typology and tries to explain it in more detail.

We understand "Keynesian conventional" as models that are concerned with adjusting econometric equations for government revenues – generally tax revenues – as functions of the sum of their "generating fact" (generally

7. Which include IPI, ICMS, IImp, ISS revenues, among others. The joint revenue from IPI, IImp and ICMS accounts for more than 90% of this total in several years.

8. The IBGE lists as "other taxes linked to production", for example, the Cofins and the contributions for the PIS-Pasep and the education wage, among others. These must be distinguished from the "taxes on products" (such as the IPI or the ICMS).

9. Other recent examples of use of multi-sectoral models to clarify the dynamics of certain types of tax revenues in Brazil are Siqueira *et al.* (2001) and Kume (2004).

approximated by the GDP, or some component of the latter) and often also of the inflation rate. The expected effect of the GDP is positive,[10] while that of inflation is ambiguous because it will depend on the precise form of indexation both of taxes (Tanzi, 1977) and of levels of incidence of higher or lower rates (such as in recent discussions on whether the Brazilian income tax exemption cap should be adjusted and to what percentile). Thus, it is to be expected that inflation will affect public revenues in different ways in different contexts, so models of "variable coefficients" are commonly used for the elasticity-inflation of current revenues of the government (Hernandez, 1998; Portugal; Portugal, 2001). And since recurring "fiscal packages" can also change the elasticity – income of tax revenues along time, the hypothesis of variable coefficients is also justified by the latter variable (Portugal; Portugal, 2001).

The texts of Portugal and Portugal (2001) and Hernández (1998) used the same econometric instruments, that is, estimation by means of estimators of maximum probability of variable coefficient models by means of the so-called "Kalman filter". Such similarity was not, obviously, mere coincidence. On the one hand, the econometric technique used was to a large extent determined by the specificities of the theoretical diagnosis, that is, by the hypothesis that the relations in question would be subject to repeated structural breaks. On the other hand, it is symptomatic that both studies were carried out in the period immediately after the Real Plan. Actually, and in spite of all the "modernizing" rhetoric of the time, that period was marked by acute worsening of public accounts (Giambiagi, 2006) and the two texts present evidence that one of the causes of this worsening was the fact that the government stopped being a "partner of inflation", so to speak. Table 1 presents a summary of the two texts, allowing a comparison between the revenues analysed and models used.

The differences between the two texts are considerable. More obviously, Hernández (*ibid)* – whose work was aimed at providing inputs for the construction of the annual model of Reis *et al.* (1999) – uses annual data between 1951 and 1995 (thus 45 observations), while Portugal and Portugal (*ibid)* worked with quarterly data for the 1980:1-1997:3 period (thus 71 observations), which entails the inclusion of a treatment for the seasonality observed in the series in question. Moreover, Hernández assumes that the

10. As pointed out by Portugal and Portugal (2001)"(...) taxes are affected by the variations in the real income to the extent that these variations generate alterations in the tax base. Therefore, the direct taxes, such as the Income Tax, will be larger if there is growth in the wages and the real profits. In turn, indirect taxes, such as the IPI and the ICMS, will increase with the level of activity of the economy. For all these reasons it is thus expected that an increase in the product will generate an increase in the taxes "

income elasticities of the various types of current revenues of the public sector remain constant and attempts to analyse a complete disaggregation of the latter, while Portugal and Portugal work only with the most important taxes and assume that both the income elasticities and inflation of the latter can vary along time.

Naturally, the hypothesis of variable coefficients is not obligatory in Keynesian models. Muinhos and Alves (2003), for example, work with the hypothesis of constant coefficients because they adopt a small sample (the data used are quarterly between 1996:1 and 2002:2, i.e., 22 observations) and, therefore, with few structural breaks – so they can be treated with the use of conventional dummy variables of level and impulse. The text also stands out in the literature for estimating "conventional Keynesian" functions with data from the national accounts and without using inflation as an explanatory variable (given that the entire sample is from after the Real Plan). In fact, Muinhos and Alves estimate both the total taxes (T^T) and the direct taxes (T^d)[11] as a function of the GDP, of a autoregressive term and of dummies – both the seasonal β_j on account of the quarterly data, and pulse/level, that is:

$T^i_t = \acute{a}_0 + \acute{a}_1 T^i_{T-1} + \acute{O}_{(i=1..3)} \hat{a}_j Y_{t-j} + \acute{a}_2 D_{99} + \acute{a}_3 D_{97:4} + \mathring{a}_t$ [with i = T (total) and d(direct)][12]

11. Unfortunately, Muinhos and Alves do not make the source of the variables they use clear. As we saw above, the only "tax" variable directly available in the quarterly national accounts is the value of the "taxes on products". Thus, one may speculate that Muinhos and Alves calculated the "total taxes" applying the annual tax burden of the national accounts to the quarterly GIP data (such as Cavalcanti *et al.* 2002, a text quoted by Muinhos and Alves). In this case, one could calculate the "direct taxes" by subtracting the taxes on products from the total taxes. However, it should be noted that the concept of "tax burden" of the national accounts includes the contributions, so that very likely the "direct taxes" of Muinhos and Alves include the revenue from contributions (including welfare) and taxes on income and assets.

12. That is, Muinhos and Alves identify a structural break in 1999 and an "outlier" in the fourth quarter of 1997.

PICTURE 1

Summary of the texts of Portugal and Portugal (2001) and Hernández (1998)

Portugal and Portugal (2001). 1980:1-1997:3 Quarterly data	Hernández (1998). 1951-1995 Annual data
Variables studied	
Total current revenues	Total net current revenues (1) = (2) + (3) + (4) + (5) + (6)
Income Tax (IR)	IR (2)
Tax on Industrialized Products (IPI)	IPI (3)
Tax on Circulation of Goods and Services (ICMS)	ICMS (4)
-	"Other taxes" (5)
-	"Other net current revenues"[13](6)
Models used	
$ln(T_t/P_t)=i_t+\tilde{a}_t+\acute{a}_1 lny_t+(\ldots)ln(P_t/P_{t-1})+\acute{a}_3 ln(P_t)+\tilde{a}_t$ in which μ is the stochastic trend, γ is the seasonality and T is the relevant revenue. That is, the model above differs from Hernández's model on the side because it *i)* assumes that $\acute{a}_1$ is variable; *ii)* includes the level of prices beyond inflation as an explanatory variable; and *iii)* has to address seasonal issues (since it is quarterly). The trend and the seasonality have the following functional specifications: $i_t = i_{t-1} + \hat{a}_{t-1} + i'_t$; $\hat{a}_t = \hat{a}_{t-1} + \ddot{a}'_t$; e $\tilde{a}_t = -\sum^{(i=1\ldots4)} \tilde{a}_{t-j} + \dot{u}'_t$; in which i'_t, $\ddot{a}_t$ and $\dot{u}_t$ are all white noises.	$Z_t = F(Y_t, Il_t) = A_t Y_t^{\beta_1} Il_t^{\beta_2}$ or, applying logs of the two sides: $ln(Z_t)=ln(A_t)+\alpha' ln(y_t)+\beta' ln(Il_t)$ which would be a basic log-linear model (in which Z_t is the relevant tax measured in real terms) if it were not for the fact that both the term contained above [log(A)] and the inflation coefficient (β) are modelled as variables, along time, i.e., as order (1) autoregressive models with errors that are not self-correlated and that are not correlated with one another. Model MA (6) for the "Other net current revenues"

Prepared by the authors.

Regarding the "atheoretical" models, it should be noted that we designate in this way those models that use strictly statistical approaches – notably the one proposed by Box and Jenkins (1970) – in order to forecast the future path of a certain variable (some type of tax or contribution or aggregation of the two) based on data on its recent past path. Note that the application of these methods dispenses with theoretical considerations on other variables that might affect both the past and future dynamics of the variable that one wishes to forecast. Thus, the "atheoretical" models do not seem relevant in terms of policy implications. Examples of models of this type appear in Melo (2001), Siqueira (2002), Guaranga and Mello (2002).

Starting with Guaranga and Mello's text (2002), we notice that the core of the study is the presentation of a method to estimate ICMS revenue for the state of Rio Grande do Sul. In the second part of the work, however, the authors

13. That is, the "Other gross current revenues" minus the "Other transfer expenditures".

also present forecasts for eleven other states of the federation and for Brazil as a whole. What makes the text peculiar is the fact that it adopts statistical procedures (descriptive, that is, without any stochastic component) that are dominated by the proposals of Box and Jenkins (SIQUEIRA, 2002). In this sense, Melo's text (2001) is more "modern", so to speak. Indeed, in the first two parts of the text, Melo presents a competent and useful summary of the basic techniques associated with the use of Box and Jenkins's approach (1970) and of the "method of the indicators" historically used by the Federal Revenue Secretariat to forecast the total revenue from a series of taxes and contributions. In the third part, Melo criticizes the "method of the indicators", for being a particular case of a non-estimated one order autoregressive model [or AR(1)], discusses several measures of "accuracy" in forecasts and shows that the use of Box and Jenkins's approach, separately or combined with other statistical methods, leads to much better results than the "method of the indicators" in the case of a particular tax, the Income Tax.

Siqueira's text (2002) is perhaps the most important of this literature. The author initiates the text by noting that Box and Jenkins's approach (1970) not only evolves from a long succession of simpler deterministic and/or stochastic forecast methods, but can be significantly improved with the introduction of the technique of "calendar variations". In the second part of the text, Siqueira (2002) uses Box and Jenkins's approach with and without calendar variations, depending on the case, with a view to presenting forecasts for a long list of taxes, contributions and their respective disaggregations "under the control of the Federal Revenue Secretariat", in addition to the ICMS. As one would expect, the results obtained by Siqueira proved to be superior than those of Guaranga and Melo, in the case of the ICMS, and of Melo, in the case of the Income Tax.

Albeit useful as forecast instruments, atheoretical models are not very promising to explain, in economic terms, the behaviour of the different revenue items. On the other hand, neither are conventional Keynesian models such as the ones discussed above – with their two or three basic explanatory variables – completely satisfactory as explanations of public sector revenues (even though they are useful in the identification of structural breaks) and, consequently, to measure policy implications. A third family of models that help "assemble the puzzle", so to speak, is composed of "intertemporal" models.

By "intertemporal" models we mean models that seek to explain the dynamics of the flows of current expenditures and revenues of the government on the basis of considerations on the dynamic implications of these flows – notably on the indebtedness or accumulation of net assets by the public sector – in longer time frames. Issler and Lima's text (2000) presents a good

example of this type of model. The starting point of the text is the so-called condition of sustainability of the public debt, understood as the condition that the public debt today is equal to the present value of the sum of future primary surpluses. This condition of sustainability, in turn, is understood as a condition of long-term balance (or, in the statistical version of the expression, as a "co-integration equation"), that is, as a condition that "joins" along the time the series of current revenues and expenditures. This fact makes any shocks in any of these variables, say, in government expenditures, for example, lead to other shocks in the future, whether in government revenue or expenditure, in order to correct the initial shock (or "error"), thus ensuring the intertemporal balance of public accounts. This story, with some variations, is told in the first part of the work. Moreover, the authors notice that: *i* the seigniorage revenue is usually not computed in accounting definitions of public sector current revenues; and *ii)* the nominal interests of the public accounts have to undergo some ad-hoc adjustments in order to become the "real interests" of the theory.

The results of Issler and Lima (with data on the national accounts, annually from 1947 to 1992) indicate that there was, in fact, co-integration between the revenues and the current expenditures of the government in the period in question, a resulted corroborated by the "debt sustainability" literature.

What makes the work more interesting than other texts of this literature is the fact that it estimates the error correction model associated with the co-integration equation obtained. This procedure allows the authors to conclude that:

> (...) [the] results for budgetary balance depend on the generating source of the deficit (surplus). When the imbalance of the public accounts is generated by changes in the taxes, what is adjusted is always the present value of the taxes (...). When the imbalance factor is public expenditure, the adjustment is made by increasing the present value of the taxes and decreasing the present value of expenditures by 60% and 40%, respectively. (...) A possible interpretation for the reversion of 40% of the initial expenses is that the Treasury is unable to get the Central Bank to accomodates 100% of the increases of expenditures, being that 40% of the increases, on average, are not accomodated. This set of evidences places Brazilian public finances in the spend-and-tax model, and rejects the tax-and-spend model. Finally, it should be noted that, in Brazil, seigniorage was very important in the attainment of intertemporal budgetary balance, since, if we exclude seigniorage revenues from the total government revenue, the public debt will no longer be sustainable in econometric tests (ISSLER LIMA: 2000, p. 3-4).

In an analysis also based on the government's intertemporal budgetary restriction, Mello (2005) estimated a fiscal reaction function using monthly data from the 1995-2004 period. The results indicated a significant reaction of the primary surplus to indebtedness, especially as of 1999. Moreover, in relation

to the central government's revenues and expenditures, Mello used a similar procedure to the one used by Issler and Lima (2000) to infer the tax policy model. The evidences were in favour of the spend-and-tax model with two thirds of the changes in the expenditures being covered by an increase of revenues in the long run.

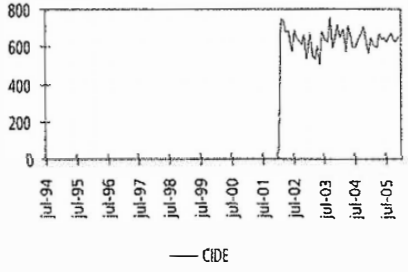
3 SOME NEW RESULTS

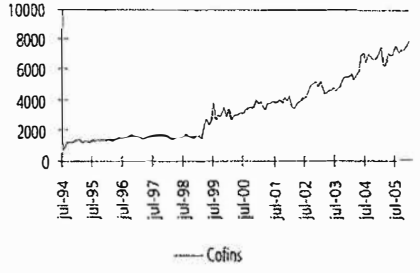
Although still in a preliminary stage, our effort to model current revenues under the control of the Federal Revenue Secretariat seems to corroborate the conventional econometric wisdom on their behaviour. As suggested by the examples below, our results indicate that *i)* the precise composition of federal current revenues presents varied structural breaks and its study is, in fact, crucial to understand the aggregated dynamics; despite this, *ii)* atheoretical models are useful in efforts towards short-term forecasting of these revenues; and *iii)* the behaviour of the real GDP, in fact, seems to explain to a large extent the behaviour of those revenues (when, for example, they are deflated by the Expanded Consumer Price Index – IPCA).

3.1 Structural breaks and the composition of current revenues under the control of the Federal Revenue Secretariat

Graphs 1 to 8, showing a disaggregation of federal current revenues (such as measured by the Central Bank, in billions of R$, with monthly data after the Real Plan – July/1994 to December/2005), give an idea of the extension of the structural shocks and breaks that affect the aggregated series.

GRAPHS 1 TO 8





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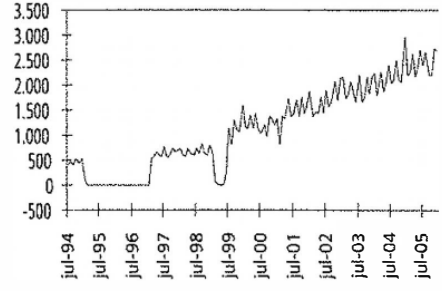
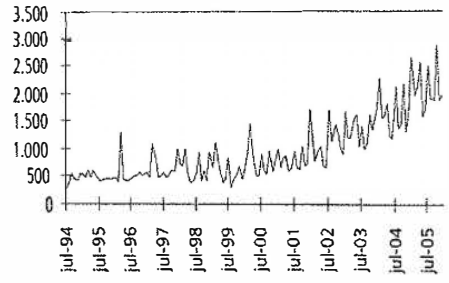


— CPMF



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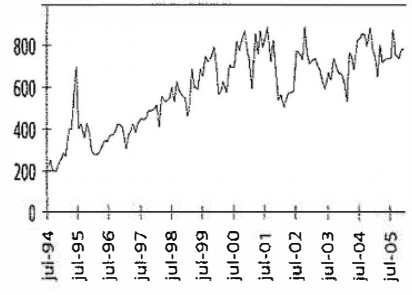
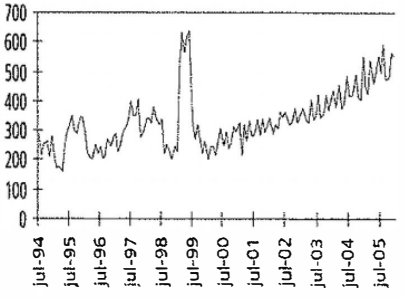
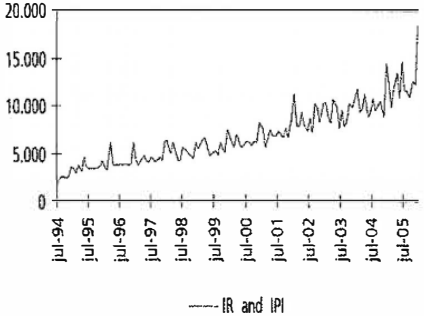


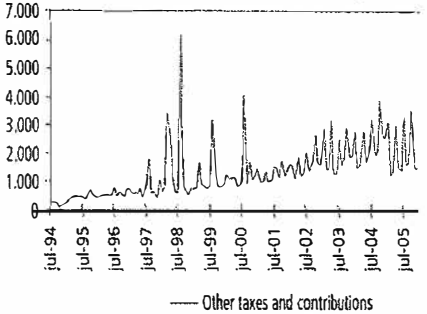
— Import taxes



— IOF



— IR and IPI



— Other taxes and contributions

Source: Brazilian Central Bank.
Prepared by Ipea/Dirur/CFP.

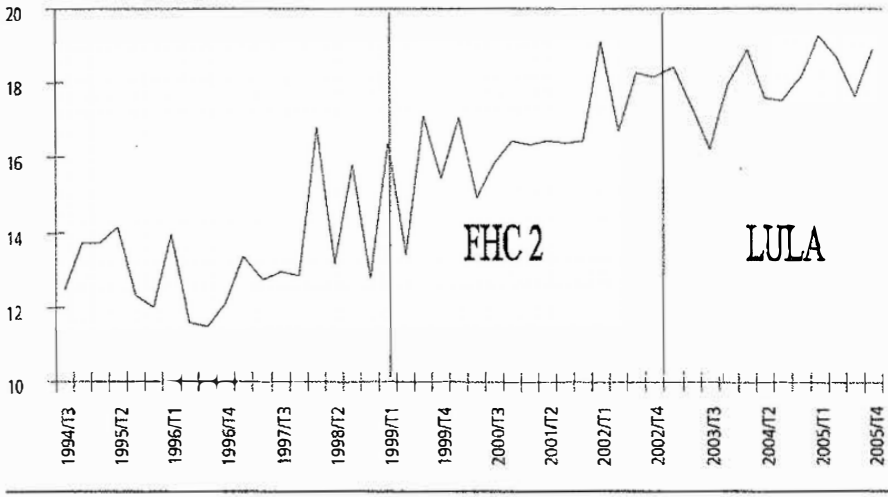
Taken together, the graphs above tell us a simple story. About two thirds of the federal revenues collected were obtained through the Income Tax, the IPI (about 42%) and Cofins (about 24%). Moreover, the years that mark the beginning of government (1999 and 2003) show clear (positive) inflections in the inclination of the series. Finally, discrepant observations (or "outliers" in

the econometric jargon) were endemic in the period. Not only were contributions created (the Contribution for Intervention in the Economic Domain (CIDE), in January 2002), cancelled (such as the CPMF in January 1995 and February 1999) and recreated (as the CPMF itself in February 1997 and June 1999), but in a given month – August 1998, for example – there were extraordinary revenues of the order of 60% of the normal revenues.[14]

3.2 A simple exercise of forecast of current revenues under the control of the Federal Revenue Secretariat measured as percentage of the GDP

Graph 9 describes quarterly data of the total of federal revenues collected (as measured by the Central Bank) as percentage of the GDP in the period beginning with the Real Plan. In exercises involving the construction of scenarios, one often wishes to formulate hypotheses on the future behaviour of this variable. Table 2 presents the results of the estimate of an atheoretical model that has been useful in forecast exercises of this type.

GRAPH 9



Prepared by the authors.

14. In this case, "revenues of concession of telecommunication services".

TABLE 1

Results of the estimate of an atheoretical model for the total of federal revenues collected

Dependant variable measured as percentage of GDP. Sample adjusted for 1996:3-2005:4 period (38 observations).[15] AR = autoregressive and MA = moving averages.

Variable	Coefficient	Standard deviation	Statistic-t	Prob.
C	20,336	1,0445	1,946	0,0000
D_{3trim}	-1,445	0,233	-6,194	0,0000
$D_{1999:3}$	1,923	0,714	2,701	0,0111
$D_{1998:1}$	1,265	0,733	1,726	0,0943
AR(4)	-0,268	0,162	-1,654	0,1082
AR(2)	1,201	0,172	6,996	0,0000
MA(2)	-0,995	0,0000186	-53418,90	0,0000

Prepared by the authors.

Even though it lacks economic content, the estimated model is well adjusted to the data, stable (when re-estimated for smaller samples, for example) and useful in forecast exercises. Indeed, the performance of the model is significantly higher than that achieved through "pocket rules" (generally adaptive) usually used in models based on the "method of the indicators". This point is obvious in table 3, which shows the forecast errors that would have been made by the model if it had been estimated in the last four quarters (with different results, on account of different samples, on each one of the occasions). The dynamic forecasts of the model proved to be much more efficient than those obtained, for example, with the (adaptive) hypothesis that the amount of federal revenues collected as percentage of GDP in a given quarter would be equal to that of the previous quarter. Of course, this result is even clearer in the case of static forecasts.

TABLE 2

Forecast errors for 2005: model A – theoretical *versus* adaptive expectations
(As % of GDP)

	2005:1	2005: 2	2005: 3	2005: 4
2004:4 (mod)	-.163	-.092	.298	-.13
2004:4 (adap)	-.4	-1.1	-.14	-.737
2004:1 (mod)	-	.12	.69	.13
2004:1 (adap)	-	1.1	.14	.737
2004:2 (mod)	-	-	.63	.177
2004:2 (adap)	-	-	.14	.737
2004:3 (mod)	-	-	-	.066
2004:3 (adap)	-	-	-	.737

Prepared by the authors.

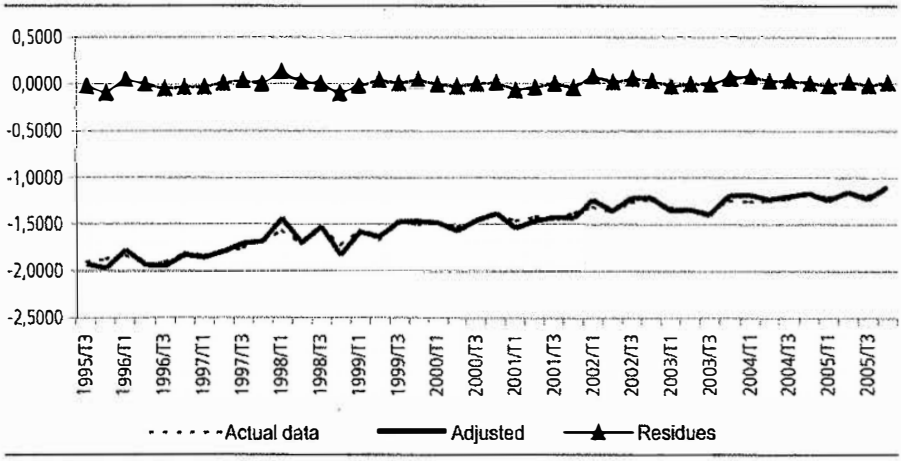
15. The adjusted R2 of this equation is 0,91. The errors are stationary, normal and homoscedastic. Some evidence – not definitive – of self-correlation was found.

3.3 GDP as determining factor in the dynamics of current revenues under the control of the Federal Revenue Secretariat

As mentioned previously, atheoretical models have the disadvantage of not helping in the task of explaining "why things happen". Historical analyses on the basis of disaggregated data, such as Giambiagi's (2006), seem much better for this end, besides having the advantage of being fully compatible with the econometric method (or providing hypotheses to be tested by econometricians or being based on these tests).

In particular, the main underlying hypothesis to these studies – namely, the Keynesian hypothesis that the dynamics of current revenues is to a large extent determined by GDP dynamics, albeit with precise specifications that are variable and dependant on the historical context – seems perfectly compatible with the data. The results of the estimate of a conventional Keynesian model for the total of federal revenues collected, with which we have been working and that seem to corroborate this view, are presented in graph 10.

GRAPH 10
Degree of adjustment of the Keynesian model



Prepared by the authors.

Besides corroborating the intuitions that federal current revenues "follow" the GDP and that there was a qualitative change in Fernando Henrique Cardoso's second administration, the model ("autoregressive of distributed imbalances") above – obtained with the use of the "general to specific" methodology (Hendry, 1995) – is reasonably well adjusted to the data (see

graph 10) and stable (when re-estimated for smaller samples, for example). The fact that some evidence of heteroscedasticity was found makes it impossible for us to eliminate the hypothesis of parametric variability - a topic currently under study in the CFP/Dirur/Ipea.

4 FINAL NOTES

The present text had two objectives. Initially, it described the main types of models and databases used by Brazilian economists concerned with studying the dynamic behaviour of public revenues in Brazil. Secondly, new empirical evidences were presented that corroborate some of the main qualitative conclusions of the literature.

Even though our results reflect a preliminary stage of the modelling effort currently undertaken by CFP-Dirur-Ipea, they seem compatible with conventional wisdom that no model is capable of explaining and forecasting the behaviour of public revenues in a modern economy. The informed and careful use of the various types of models outlined above seem to us the best way to move forward, given the current state of the arts.