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FISCAL POLICY AND ECONOMIC GROWTH: AN ANALYSIS OF CIVIL SERVICE SPENDING IN THE SMALLEST MUNICIPALITIES IN THE STATE OF SÃO PAULO

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SUMMARY

The aim of this study is to test the hypothesis that more public spending, specifically spending on civil servants, leads to higher tax collection and greater economic growth. To this end, public data and a brief analysis of the characteristics of the municipalities with the smallest populations in the state of São Paulo will be used to apply an econometric regression model. The population quartile method is used, considering the first quartile to define a small municipality. The response of the estimated value of the allocation of this revenue to spending on civil servant salaries in these smallest municipalities is intended to assist in the fiscal management of the federated entity. In the end, it will draw an empirical conclusion as to whether the municipalities in question, when it comes to spending more on civil servants, have a different impact on economic growth than large municipalities and whether such conduct brings greater tax revenue to their daily dynamics for carrying out public policies.

Keywords: Economic growth. Tax collection. Regression. Civil service. Municipal public management.
JEL: C33, H72, O49

SUMMARY

1. INTRODUCTION

Public management is the subject of debate in Brazil because of its complexity and the divergence of ideas. A recurring topic in this debate is the need to reduce government spending. "Few phrases have been repeated more often in Brazil over the last few decades than the old, worn-out jargon that 'public spending must be reduced'." (GIAMBIAGI; ALÈM, 2016, p. 34).

In view of this, this study aims to help municipal managers in small municipalities better understand the impact of their decisions. To this end, the study seeks to understand the correct approach in public administration in relation to how much spending on civil servants is indicated and the effects of this spending on the economy, especially in small municipalities.

This idea stems from the notion of the importance of sub-national spheres of government, because, as GIAMBIAGI (2016, p. 336) points out, local governments that provide better public services will attract a higher level of investment, generating more jobs and income.

It is well known that the basic idea being propagated today is that management that doesn't save on public spending is reprehensible. The maxim is that reductions in the payment of compulsory expenses do not harm growth (BENÍCIO, 2015, p. 21-23). But is this conduct valid for small municipalities?

The point here is not to demonstrate the best course of action, but to point out that the shape of current institutions are ideas, and these can be refined and improved, as history has shown (JONES, 2000, p. 130).

First of all, it should be made clear that this is not an application of Wagner's Law, but rather its inverse. It is known that Wagner's Law includes the need to increase public spending as there is greater economic growth and tax collection (PRADO; SILVA, 2018, p. 2).

The paper therefore assesses the impact on economic growth of government spending on civil servants in small municipalities. It also examines the effect of this policy on tax collection. Therefore, the questions to be answered are: does greater public spending on municipal payroll lead to greater economic growth in small towns? And what is the effect on tax collection?

The municipalities in the state of São Paulo were used to respond. The base is made up of the 645 municipalities in the state of São Paulo, including the capital.

Despite the fact that personnel expenses are significant and that this can inhibit the budget for capital investment (HARADA, 2020, p. 105), it is expected that, for small municipalities, a different reality occurs when private investment increases, which is affected by the emotional factor of "love" for the city and not just the rational one. This is because, for small towns, the

town hall itself ends up being the main employer (SANTOLIN; JAYME JUNIOR; REIS, 2009, p. 901).

And this hypothesis is not without reason. As we can see, Giambiagi (2016, p.88) reports that from 1950 to 1973, total public employment grew from 1 million to more than 3.5 million and, during this period, the Brazilian economic growth rate was higher than the world rate with strong state participation in the economy:

It is therefore important to differentiate the reality of small municipalities from that of large municipalities in order to understand economic growth and municipal tax collection (SANTOS; MOTTA; FARIA, 2020, p. 14).

2. VARIABLES IN THE REGRESSION MODEL

With regard to the database, there is more than one platform to check on the estimated number of variables from the public budget (tax collection, transfers and personnel costs), but the authors chose to prioritize just one, namely Finbra (Siconfi of the National Treasury).

In the composition of the variables, we followed the line of literature in which productive government spending is analyzed for economic growth (COLBANO, 2015, p. 88), which is tested here by the rubric of public wage increases. It should be noted that, empirically, only the omission of a variable in the model that has no impact on economic growth, i.e. neutral, reveals that the estimated coefficient does in fact reflect the effect of the estimated variable. However, this conclusion is contested by some authors because, although this situation is desirable, the hypothesis of the neutrality of an omitted variable is unlikely in empirical terms. The point is that the estimated coefficients should be read as the effect of a particular fiscal variable on growth, discounting the effect of the omitted variable (COLBANO, 2015, p. 90).

In other words, the omission of a non-neutral tax variable can lead to different results, but this should not be considered a lack of significance in the model, but rather a reflection of the different categories omitted (COLBANO, 2015, p. 91). This information is important when analyzing the results obtained.

In short, there is a wide range of results of fiscal policy on economic growth and this relationship depends on the characteristics of each economy and each period. However, some factors are relevant in the models: expenditure composition, tax structure and the government's budget constraint.

Furthermore, there are different effects on product growth for different types of public

spending, depending on whether they boost the production function of companies or the utility function of consumers (COLBANO, 2015, p. 101). Thus, the model found is expected to reveal the distinct effect of the inserted variable (personnel spending) on economic growth, using the pattern of relevant variables: share of expenditure (personnel spending); tax structure (collection) and budget (relevant net revenues and investments).

Since we want to analyze the effects of variables on economic growth and tax collection, we will use the following variables, with explanations for some of them highlighted.

For economic growth: Y = Bo + B1*X1 + B2*X2 + B3*X3 + B4*X4 + B5*X5 + B6*X6 + B7*X7 + B8*X8 + B9*X9 + u (error term)

For tax collection: Y = Bo + B1*X1 + B2*X2 + B3*X3 + B4*X4 + B6*X6 + B7*X7 + B8*X8 + B9*X9 + u (error term)

Y = Growth in GDP at Factor Price or the variable X5 replaces Y to analyze effects on tax collection: the monetary value variables have been divided by GDP at factor price, as this idea aims to eliminate autocorrelation problems. Therefore, when interpreting any correlation with this variable, you can see how much influence it has on the denominator of this variable.

X1 = GDP factor price per capita (in log) = l_pibpercapita~: to avoid perfect collinearity, log was used for the GDP per capita variable.

X2 = Investment per GDP at factor price = Investmentopo~: control variable.

X3 = Personnel Expenditure per GDP at Factor Price = Personnel Expenditure~: according to a study by IPEA (CAVALCANTI et al, 2020, p. 12), the expenditure of municipalities on personnel expenses has increased, however, most municipalities have the advantage of not having high expenditure on inactive workers because they follow the pension system of the General Regime (INSS). which relieves municipal public coffers. The survey reveals that, of the 5,568 municipalities, 3,444 opted for the General Regime.

X4 = Total Relevant Tax Revenue per GDP at Factor Price = TaxRevenue~: The data was transformed into indices on GDP, GDP at factor cost, i.e. without indirect taxes and subsi-

dies.

The relevant Total Tax Revenue of a Municipality was considered to be the sum of constitutional transfers (JARDIM, 2018, p. 89) - IPVA, ICMS, IPI, ITR and CIDE - and own collection (IPTU, ISS and ITBI), revenues that make up the municipal public budget, which the authors consider to be more relevant and have less political bias with other entities.

A few points of note regarding these taxes. With regard to the IPVA, since most of the collection goes to the municipality where the vehicle is registered, this was considered an important variable component in the model. This is because 50% of the IPVA collection is apportioned to the municipalities. To understand the importance of this transfer, using the municipality of Borá/SP as an example, in 2019, 44.3% of this amount of the municipal share of IPVA is made in the first months of the year (January to March), which reveals an important boost to the municipalities.

It is important to note that Finbra's database is annual and some analyses may be more relevant on a monthly basis. For this reason, the São Paulo Department of Finance and Planning's database is considered better, since it analyzes such revenue/revenues on a monthly basis.

As for the Rural Property Tax (ITR), although it is a federal responsibility, municipalities can choose to inspect and collect it. In this case, the federal government shares 100% of the tax revenue with the municipalities (SABBAG, 2012, p. 1096). For the sake of illustration, in 2019, 10% of the national ITR collection is made in small municipalities. This ITR collection represents 0.01% of the municipal GDP for the whole of 2019.

But if we analyze each municipality individually, the city of Altair/SP, for example, which, within the quartile of the smallest municipalities, is the one that collected the most ITR in 2019, and has around 2% of its GDP from ITR collection and 6% of all its main tax collection. As a curiosity, the capital São Paulo also has strong ITR representation, representing the fourth city in the state that collects the most ITR, behind only Barretos/SP, Guaíra/SP and Araraquara/SP.

Also, for ITR, until 2013, the budget headings did not identify the value of the municipal ITR itself, but only its share, while from 2013 onwards there is a differentiation between what is from the transfer of the share (50% transfer) and what is collected by the municipality (100%). However, it is understood that, despite the separation of the items, the amounts are totaled correctly.

With regard to income tax withheld at source (IRRF), the individual who earns income from the payment of a salary by the public authority has the municipal body withhold the tax

at source from the salary payment, making the paying body the tax collector. Thus, 100% of what is collected from these salaries ends up belonging to the municipality, under the terms of Article 158 of the Federal Constitution (BRASIL, 1988). Another part of income tax comes from constitutional transfers.

The municipality of Pontes Gestal/SP, which is at the bottom of the smallest municipalities in the state of São Paulo, with 2,577 inhabitants, collected the most IRRF in 2019, representing 5% of all its relevant current revenue and 1.4% of its annual GDP. Coincidentally, it is one of those that spends the most on salaries and staff costs in terms of population, ranking 5th out of the 162 smallest municipalities in the state. By way of comparison, the capital São Paulo, with 12.2 million inhabitants, in the same year of 2019, had a 6% IRRF collection of its total relevant current revenue and 0.4% of its annual GDP.

In terms of total revenue, most of it is generated by government transfers and not by their own collection, with inland municipalities depending more on these transfers (GIAMBIAGI, 2016, p. 357).

This component of current revenue in the budget of small municipalities reveals that, of all the transfer by the funds to the municipalities, 10% goes to small municipalities, i.e. 10% of everything that comes from the Fund goes to 162 of the 645 municipalities, or, in percentage terms, 10% goes to 25% of the municipalities in the state. The municipality that received the most in 2019 was Arapeí, which accounts for 79% of its relevant current revenue, as well as 39% of its GDP.

X5 = Population Growth = GrowthPop~: control variable.

X6 = land area per population = Areaterritoria~: The size of the municipality could affect the model and the inverted demographic density causes less bias in the estimators.

X7 = distance from the capital in Km = DistanceCap~: In terms of location, we see that the São José do Rio Preto mesoregion concentrates around 30% of the small municipalities. As the mesoregions bring together municipalities in a geographical region with economic and social similarities and as the small municipalities are, on average, 342 km away from the capital by road, there could be a bias in the sample due to geographical concentration and clusters, which is why the use of a dummy variable is justified.

X8 = small municipality dummie = small municipality dummie~: The Brazilian legal system does not define what a small municipality is. The institutions that could validate this division (IBGE, IPEA, among others) are also unclear about this concept.

The IBGE seems to divide between 7 size classes (i - up to 5,000 people; ii - from 5001 to 10,000; iii - from 10001 to 20,000; iv - from 20001 to 50,000; v - from 50001 to 100,000; vi - from 100001 to 500,000; and vii - above 500,000) (IBGE, 2017, p. 15), but this was just a subjective criterion of the person responsible for the study analyzed.

Art. 63 of Complementary Law No. 101, of May 4, 2000, known as the Fiscal Responsibility Law (BRASIL, 2000) also does not define or conceptualize what a small municipality is, but leads us to believe that there are 3 classes (up to 50 thousand people, between 50 and 100 thousand, over 100 thousand).

We also have a division in the 1988 Federal Constitution itself in Article 29-A (BRASIL, 1988), which also does not define what a small municipality is (up to 100,000; from 100 to 300,000; from 300,001 to 500,000; from 500,001 to 3,000,000; from 3,000,001 to 8,000,000; and above 8,000,001).

Thus, a concept of the variable was created using quantiles. This is because both the mean and the population standard deviation are not adequate measures to differentiate this group of small municipalities due to the extreme values and the lack of data symmetry between all the cities (MORETTIN; BUSSAB, 2013, p. 43).

As the population of all municipalities was adopted, there will be no problem in defining the first quartile (ANDERSON; SWEENEY; WILLIAMS, 2019, p. 96-97) as the criterion for defining a small municipality, which is close to the IBGE study, thus validating this quartile as synonymous with small municipality.

The reason for using this variable is that this division makes it possible to assess the impact of civil service in small municipalities, either by estimating it separately from other municipalities or by creating an interaction dummy.

Thus, of all the municipalities in the state of São Paulo (a total of 645), the first quartile (25%) is made up of 162 municipalities. As there is little variation in population over the period analyzed, in order to avoid several dummies, population data for 2019 was used as a reference. The first quartile includes a population of between 837 and 5,735 inhabitants.

One theoretical reason for differentiating a small municipality comes from the Solow model, where as not all countries have the same rates of investment and population growth or the

same technological levels, they cannot be expected to have the same steady state convergence (JONES, 2000, p. 57), which also applies to small municipalities.

X9 = small municipality interaction dummie with personnel costs = X9 * X3 = Dummiedeintera~: interaction variable.

3. METHODOLOGY

With regard to the period, it was decided to use the years from 2004 to 2019 and discard the years when the COVID pandemic broke out, from 2020 onwards, so as not to skew the data and understanding that it is a limitation of the work to analyze the effects of COVID, which could therefore be a continuation of this study. Also, as there are growth rate variables and the year 2003 is given as a base, data from this year was discarded.

Regarding the database, some fields or years are not reported by the municipalities in their accounts and the reason for this was not sought, as it would be beyond the scope of the work. However, in order to avoid an unbalanced statistical panel, these gaps were corrected with the average value of previous periods.

Gretl software version 2022a was used to estimate the models.

Regarding the best econometric model to adopt, two (2) academic articles on the subject were used as a basis.

In the first reference (SANTOLYN; JAYME JUNIOR; REIS, 2009, p. 910), he analyzes the impact of the Fiscal Responsibility Law on personnel spending in the municipalities of Minas Gerais and mentions the choice of using a dynamic panel and using all the covariates as endogenous to the model, considering that the legislation imposes, in a way, a direct relationship between spending and revenue.

For the use of GMM, an augmented estimator is indicated to include both the variables in first difference and the original equations in levels. The estimate improves the precision and reduces finite sample bias (ARELLANO; BOVER apud SARGAN apud SANTOLYN; JAYME JUNIOR; REIS, 2009, p. 911).

The specification of the model is measured by the Sargan test, which validates the overidentification restrictions in order to validate or not the exclusion of instruments (SANTOLYN; JAYME JUNIOR; REIS, 2009, p. 911).

The second literary reference analyzes the effects of human capital on economic growth

in Brazilian states. To this end, it understands that when a lagged dependent variable is used as an explanatory variable, this structure is called dynamic panel data and growth models, derived from Solow, are generally used with a dynamic panel and the System GMM technique (FERREIRA, 2018, p. 7).

It can be seen that the nature of economic growth and, by analogy, tax collection, is dynamic, that is, it tends to be correlated over time and the econometric model to be tested is: dynamic panel; GMM-system; 2-step estimation, 2 AR of the explained variable, asymptotic standard errors, DPD, collapsed instruments.

Given that we are looking for the best econometric model and, to this end, there is nothing better than making comparisons, we compared the use of grouped OLS, fixed effects and random effects to identify which is more efficient and whether it brings the same result as GMM, which is indicated by the literary reference mentioned above.

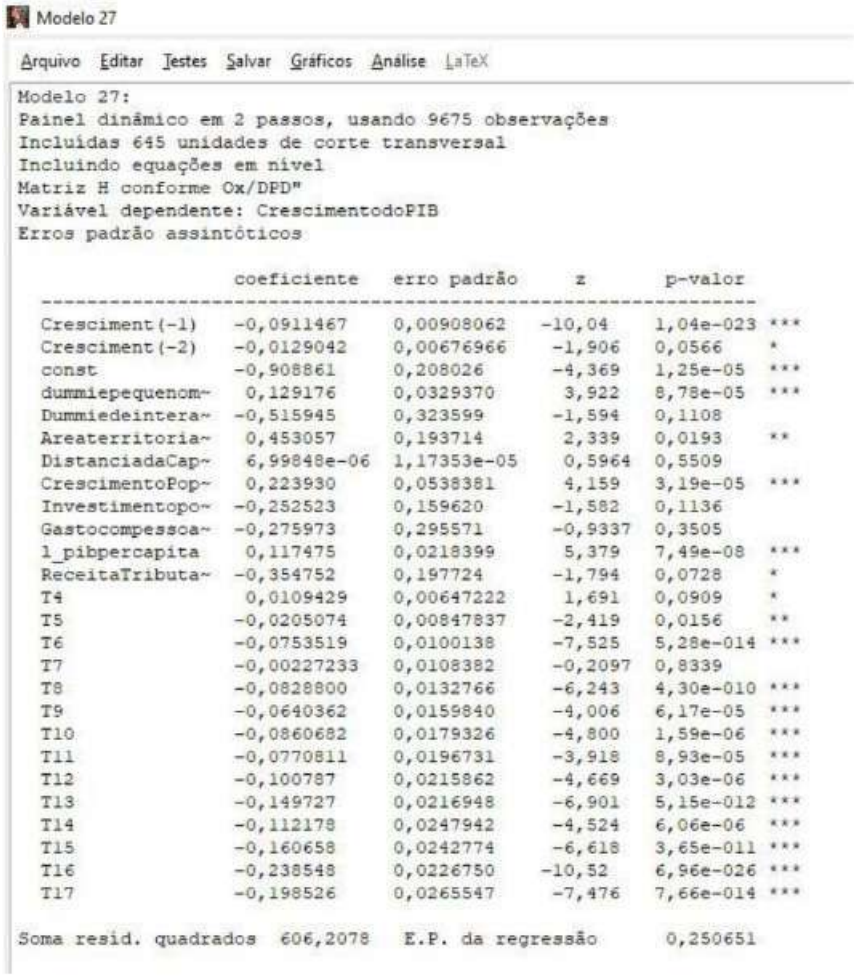
When it comes to fixed effects, data from small municipalities was used separately in one model and data from other municipalities in the other model.

4. RESULTS OF ESTIMATES

4.1. Y = GDP growth as explained variable - GMM

GMM-system, two-steps, dynamic panel, DPD, asymptotic standard errors, collapsed instruments, AR-2

Figure 1 - Gretl model 27



Modelo 27

Arquivo Editar Testes Salvar Gráficos Análise LaTeX

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Modelo 27:
Painel dinâmico em 2 passos, usando 9675 observações
Incluídas 645 unidades de corte transversal
Incluindo equações em nível
Matriz H conforme Ox/DPD"
Variável dependente: CrescimentodoPIB
Erros padrão assintóticos

                  coeficiente   erro padrão     z       p-valor
  ------------------------------------------------------------------
  Cresciment(-1)   -0,0911467   0,00908062   -10,04    1,04e-023 ***
  Cresciment(-2)   -0,0129042   0,00676966    -1,906   0,0566    *
  const            -0,908861    0,208026     -4,369   1,25e-05  ***
  dummiepequenom~   0,129176    0,0329370     3,922   8,78e-05  ***
  Dummiedeintera~  -0,515945    0,323599      -1,594   0,1108
  Areaterritoria~   0,453057    0,193714      2,339   0,0193    **
  DistanciadaCap~   6,99848e-06 1,17353e-05   0,5964  0,5509
  CrescimentoPop~   0,223930    0,0538381     4,159   3,19e-05  ***
  Investimentopo~  -0,252523    0,159620      -1,582   0,1136
  Gastocompessoa~  -0,275973    0,295571      -0,9337  0,3505
  l_pibpercapita    0,117475    0,0218399     5,379   7,49e-08  ***
  ReceitaTributa~  -0,354752    0,197724      -1,794   0,0728    *
  T4                0,0109429   0,00647222    1,691   0,0909    *
  T5               -0,0205074   0,00847837    -2,419  0,0156    **
  T6               -0,0753519   0,0100138     -7,525  5,28e-014 ***
  T7               -0,00227233  0,0108382     -0,2097 0,8339
  T8               -0,0828800   0,0132766     -6,243  4,30e-010 ***
  T9               -0,0640362   0,0159840     -4,006  6,17e-05  ***
  T10              -0,0860682   0,0179326     -4,800  1,59e-06  ***
  T11              -0,0770811   0,0196731     -3,918  8,93e-05  ***
  T12              -0,100787    0,0215862     -4,669  3,03e-06  ***
  T13              -0,149727    0,0216948     -6,901  5,15e-012 ***
  T14              -0,112178    0,0247942     -4,524  6,06e-06  ***
  T15              -0,160658    0,0242774     -6,618  3,65e-011 ***
  T16              -0,238548    0,0226750    -10,52   6,96e-026 ***
  T17              -0,198526    0,0265547     -7,476  7,66e-014 ***

Soma resid. quadrados  606,2078   E.P. da regressão      0,250651
```

Source: Gretl software. Authors' own elaboration.

For the GMM models, whether one-way or two-way, it can be seen from the Sargan test that the model is not well specified, rejecting the null hypothesis in both situations, i.e. the model would indicate that there is overidentification. However, it is very close to accepting the null hypothesis. Therefore, the model can be considered well specified (FERREIRA, 2018, p. 7-8).

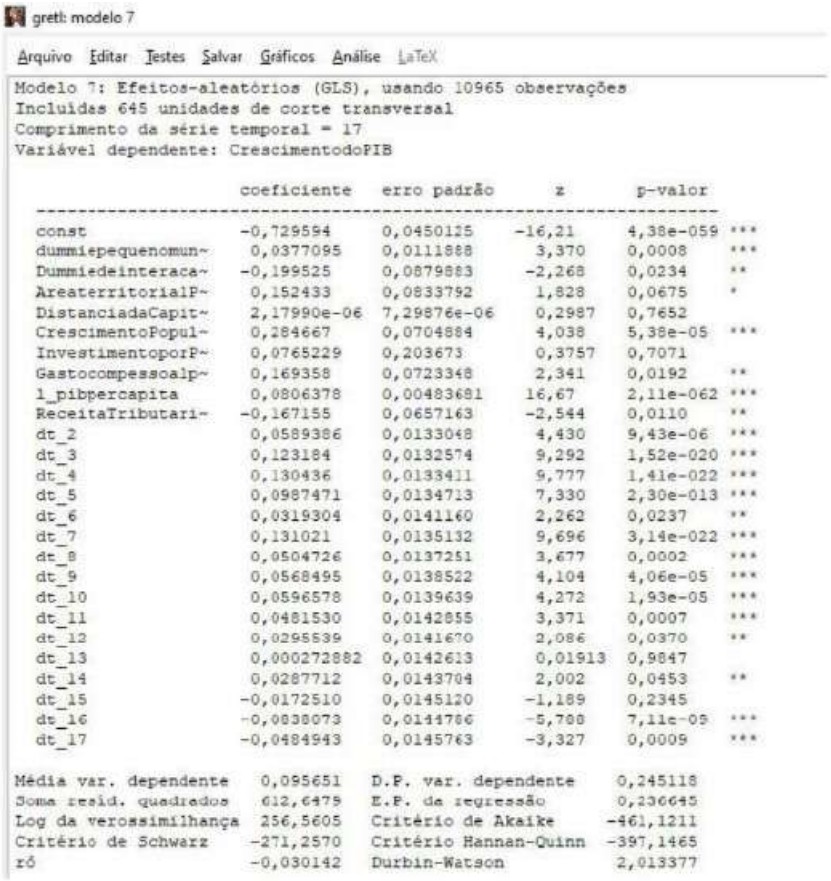
When the Wald test is carried out, both for the joint variables and for the omission of time variables, the null hypothesis that they are null is denied, i.e. there are time effects in the model and the variables are relevant, and the inclusion of time dummies in the model is indicated.

For the estimator to be consistent, it is recommended to reject the null hypothesis for the first order, AR (1), and not reject the null hypothesis for the higher order, AR (2) (FERREIRA, 2018, p. 8), which is what happens in the model presented.

The time lags show statistical significance of 1% in most years and a negative effect on the variables affecting economic growth, with only the fourth year being positive.

4.2. Y = GDP growth as explained variable - random effects:

Figure 2 - Gretl Model 7



gretl: modelo 7

Arquivo Editar Testes Salvar Gráficos Análise LaTeX

Modelo 7: Efeitos-aleatórios (GLS), usando 10965 observações
Incluídas 645 unidades de corte transversal
Comprimento da série temporal = 17
Variável dependente: CrescimentodoPIB

	coeficiente	erro padrão	z	p-valor	
const	-0,729594	0,0450125	-16,21	4,38e-059	***
dummiepequenomun~	0,0377095	0,0111888	3,370	0,0008	***
Dummiedeinteraca~	-0,199525	0,0879883	-2,268	0,0234	**
AreaterritorialP~	0,152433	0,0833792	1,828	0,0675	*
DistanciadaCapit~	2,17990e-06	7,29876e-06	0,2987	0,7652	
CrescimentoPopul~	0,284667	0,0704884	4,038	5,38e-05	***
InvestimentoporP~	0,0765229	0,203673	0,3757	0,7071	
Gastocompessoalp~	0,169358	0,0723348	2,341	0,0192	**
l_pibpercapita	0,0806378	0,00483681	16,67	2,11e-062	***
ReceitaTributari~	-0,167155	0,0657163	-2,544	0,0110	**
dt_2	0,0589386	0,0133048	4,430	9,43e-06	***
dt_3	0,123184	0,0132574	9,292	1,52e-020	***
dt_4	0,130436	0,0133411	9,777	1,41e-022	***
dt_5	0,0987471	0,0134713	7,330	2,30e-013	***
dt_6	0,0319304	0,0141160	2,262	0,0237	**
dt_7	0,131021	0,0135132	9,696	3,14e-022	***
dt_8	0,0504726	0,0137251	3,677	0,0002	***
dt_9	0,0568495	0,0138522	4,104	4,06e-05	***
dt_10	0,0596578	0,0139639	4,272	1,93e-05	***
dt_11	0,0481530	0,0142855	3,371	0,0007	***
dt_12	0,0295539	0,0141670	2,086	0,0370	**
dt_13	0,000272882	0,0142613	0,01913	0,9847	
dt_14	0,0287712	0,0143704	2,002	0,0453	**
dt_15	-0,0172510	0,0145120	-1,189	0,2345	
dt_16	-0,0830073	0,0144706	-5,736	7,11e-09	***
dt_17	-0,0484943	0,0145763	-3,327	0,0009	***

Média var. dependente	0,095651	D.P. var. dependente	0,245118
Soma resíd. quadrados	612,6479	E.P. da regressão	0,236645
Log da verossimilhança	256,5605	Critério de Akaike	-461,1211
Critério de Schwarz	-271,2570	Critério Hannan-Quinn	-397,1465
ró	-0,030142	Durbin-Watson	2,013377

Source: Gretl software. Authors' own elaboration

When the Wald test is carried out with the omission of time variables, the null hypothesis that these are null is denied, i.e. there are time effects in the model, and the bidirectional random effects model is the most appropriate among the MQOs presented, and this is due to the model presented above.

For the random effects models, whether one-way or two-way, it can be seen from the joint test of the designated regressors that it is a well-specified model, rejecting the null hypothesis in both situations, i.e. that the appropriate model would exclude one of the variables used. Thus, the variables are relevant.

The Breusch-Pagan test (Pooled MQO x Random Effects), whose null hypothesis is that MQO would be better than random effects, both for one-way and two-way.

At 1% significance, the null hypothesis would be rejected and OLS would be better, but at 5%, the random effect is more appropriate.

The Hausman test (Fixed Effects x Random Effects), whose null hypothesis is that ran-

dom effects are better than fixed effects, for both one-way and two-way, shows that the null hypothesis is rejected and fixed effects are better than random effects.

The Durbin-Watson test measures autocorrelation in residuals from a regression analysis and a test value of 2.01 indicates that there is no autocorrelation.

Most of the temporary dummies have a statistical significance of 1%, and only from the fifteenth year onwards do they have a negative impact on the estimators of the variables in the model.

4.3. Y = GDP growth as explained variable - fixed effects for small municipalities:

Figure 3 - Gretl model 11

gretl: modelo 11

Arquivo Editar Testes Salvar Gráficos Análise LaTeX

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Modelo 11: Efeitos-fixos, usando 2754 observações
Incluídas 162 unidades de corte transversal
Comprimento da série temporal = 17
Variável dependente: CrescimentodoPIB

                  coeficiente  erro padrão  razão-t    p-valor
  ------------------------------------------------------------
  const           -3,75071     0,205555    -18,25    4,82e-070 ***
  Areaterritoria~ -2,17010     0,874088     -2,483   0,0131    **
  CrescimentoPop~  0,242967    0,0986062     2,464   0,0138    **
  Investimentopo~  0,266688    0,286473      0,9309  0,3520
  Gastocompessoa~  0,147921    0,219992      0,6724  0,5014
  l_pibpercapita   0,440730    0,0226126    19,49    5,09e-079 ***
  ReceitaTributa~ -0,170386    0,208552     -0,8170  0,4140
  dt_2             0,0146342   0,0245142     0,5970  0,5506
  dt_3             0,0883558   0,0250980     3,520   0,0004    ***
  dt_4             0,0632560   0,0258836     2,444   0,0146    **
  dt_5            -0,0437785   0,0268193    -1,632   0,1027
  dt_6            -0,137540    0,0298136    -4,613   4,16e-06  ***
  dt_7            -0,0323587   0,0286798    -1,128   0,2593
  dt_8            -0,260528    0,0295820    -8,807   2,32e-018 ***
  dt_9            -0,224023    0,0316173    -7,085   1,78e-012 ***
  dt_10           -0,251050    0,0315872    -7,948   2,81e-015 ***
  dt_11           -0,266763    0,0326047    -8,182   4,35e-016 ***
  dt_12           -0,322959    0,0329770    -9,793   2,93e-022 ***
  dt_13           -0,313443    0,0338781    -9,252   4,49e-020 ***
  dt_14           -0,331039    0,0357501    -9,260   4,19e-020 ***
  dt_15           -0,449617    0,0358588   -12,54    4,77e-035 ***
  dt_16           -0,546088    0,0353844   -15,43    1,86e-051 ***
  dt_17           -0,482911    0,0362861   -13,31    3,96e-039 ***

Média var. dependente   0,095755   D.P. var. dependente     0,249871
Soma resid. quadrados   124,4480   E.P. da regressão        0,220053
R-quadrado LSDV         0,275978   Dentro de R-quadrado     0,244946
F(183, 2570) LSDV       5,353092   P-valor(F)               6,93e-88
Log da verossimilhança  356,7044   Critério de Akaike      -345,4087
Critério de Schwarz     744,0202   Critério Hannan-Quinn    48,16485
rô                     -0,054444   Durbin-Watson            2,050486
```

Source: Gretl software. Authors' own elaboration.

When the Wald test is carried out with the omission of time variables, the null hypothesis that they are null is denied, i.e. there are time effects in the model, and the bidirectional one is the most appropriate among the fixed effects presented.

For the fixed-effects models, whether one-way or two-way, for Y = GDP growth, the joint test of the designated regressors is well specified, rejecting the null hypothesis in both

situations, i.e. that the appropriate model would exclude one of the variables used. Thus, the variables are relevant.

From the test to differentiate group intercepts, we can see that the null hypothesis is that the vertical intercepts of the model are equal, which would make the Grouped MQO model better than the fixed effects model. As we have rejected the null hypothesis, the best model is the fixed effects model.

The Durbin-Watson test measures autocorrelation in residuals from a regression analysis and a test value of 2.05 indicates that there is none. The LSDV R square indicates that 28% of the variables used explain the variation in the explained variable.

Most of the temporary dummies have a statistical significance of 1%, and only from the fifth year onwards do they have a negative impact on the estimators of the variables in the model.

4.4. Y = GDP growth as explained variable - fixed effects for municipalities, except small ones:

Figure 4 - Gretl model 14

gretl: modelo 14

Arquivo Editar Testes Salvar Gráficos Análise LaTeX

```
Modelo 14: Efeitos-fixos, usando 8211 observações
Incluídas 483 unidades de corte transversal
Comprimento da série temporal = 17
Variável dependente: CrescimentodoPIB

                  coeficiente  erro padrão  razão-t    p-valor
  ------------------------------------------------------------
  const           -3,89243     0,155768    -24,99    1,38e-132 ***
  Areaterritoria~ -4,21445     0,853726     -4,937   8,12e-07  ***
  CrescimentoPop~  0,298713    0,107071      2,790   0,0053    ***
  Investimentopo~ -0,735603    0,351837     -2,091   0,0366    **
  Gastocompessoa~ -0,356897    0,203936     -1,750   0,0802    *
  l_pibpercapita   0,447919    0,0168264    26,62    1,94e-149 ***
  ReceitaTributa~ -0,0212381   0,0805784    -0,2636  0,7921
  dt_2             0,0525772   0,0147652     3,561   0,0004    ***
  dt_3             0,0567979   0,0147477     3,851   0,0001    ***
  dt_4             0,0158803   0,0152417     1,042   0,2975
  dt_5            -0,0519920   0,0163700    -3,176   0,0015    ***
  dt_6            -0,121677    0,0178599    -6,813   1,03e-011 ***
  dt_7            -0,103204    0,0174874    -5,902   3,75e-09  ***
  dt_8            -0,173270    0,0187784    -9,227   3,53e-020 ***
  dt_9            -0,224025    0,0200569   -11,17    9,56e-029 ***
  dt_10           -0,250256    0,0213187   -11,74    1,49e-031 ***
  dt_11           -0,302821    0,0227462   -13,31    5,36e-040 ***
  dt_12           -0,351550    0,0233570   -15,05    1,76e-050 ***
  dt_13           -0,417932    0,0239872   -17,42    1,03e-066 ***
  dt_14           -0,414210    0,0248419   -16,67    2,39e-061 ***
  dt_15           -0,465939    0,0256572   -18,16    3,37e-072 ***
  dt_16           -0,509693    0,0259568   -19,64    8,28e-084 ***
  dt_17           -0,499072    0,0266546   -18,72    1,56e-076 ***

Média var. dependente   0,095616   D.P. var. dependente     0,243518
Soma resid. quadrados   386,8797   E.P. da regressão        0,224065
R-quadrado LSDV         0,205361   Dentro de R-quadrado     0,162139
F(504, 7706) LSDV       3,951356   P-valor(F)               3,5e-149
Log da verossimilhança  891,8750   Critério de Akaike      -773,7500
Critério de Schwarz     2767,931   Critério Hannan-Quinn    436,9305
rô                     -0,025262   Durbin-Watson            2,006269
```

Source: Gretl software. Authors' own elaboration.

When the Wald test is carried out with the omission of time variables, the null hypothesis that they are null is denied, i.e. there are time effects in the model, and the bidirectional one is the most appropriate among the fixed effects presented.

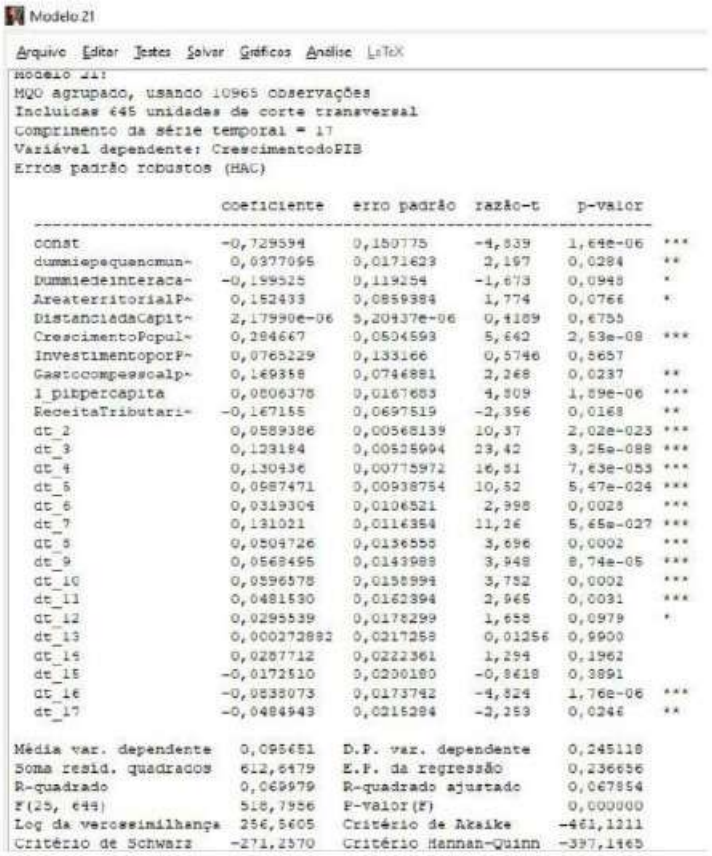
For the fixed effects models, whether one-way or two-way, the joint test of the designated regressors showed that the model is well specified, rejecting the null hypothesis in both situations, i.e. that the appropriate model excludes one of the variables used. Thus, the variables are relevant.

The test to differentiate group intercepts shows that the null hypothesis is that the vertical intercepts of the model are equal, which would make the Grouped MQO model better than fixed effects. As we rejected the null hypothesis, the best model is fixed effects. Most of the temporary dummies have a statistical significance of 1%, with the highlight being that only from the fifth year onwards do they have a negative effect on the variables in the model.

The Durbin-Watson test measures autocorrelation in residuals from a regression analysis and a test value of 2.00 indicates that there is no autocorrelation. The LSDV R square indicates that 21% of the variables used explain the variation in the explained variable.

4.5. Y = GDP growth as explained variable - OLS

Figure 5 – Gretl Model 21



Modelo 21

Arquivo Editar Testes Salvar Gráficos Análise LaTeX

Modelo 21:
MQO agrupado, usando 10965 observações
Incluídas 645 unidades de corte transversal
Comprimento da série temporal = 17
Variável dependente: CrescimentodoPIB
Erros padrão robustos (HAC)

	coeficiente	erro padrão	razão-t	p-valor	
const	−0,729594	0,150775	−4,839	1,64e−06	***
dummiepequencmun~	0,0377095	0,0171623	2,197	0,0284	**
Dummiedeinteraca~	−0,199525	0,119254	−1,673	0,0948	*
AreaterritorialP~	0,152433	0,0859384	1,774	0,0766	*
DistanciadaCapit~	2,17990e−06	5,20437e−06	0,4189	0,6755	
CrescimentoPopul~	0,284667	0,0504593	5,642	2,53e−08	***
InvestimentoporP~	0,0765229	0,133166	0,5746	0,8657	
Gastocompesscalp~	0,169358	0,0746881	2,268	0,0237	**
I_pibpercapita	0,0806378	0,0167683	4,809	1,59e−06	***
ReceitaTributari~	−0,167155	0,0697519	−2,396	0,0168	**
dt_2	0,0589386	0,00568139	10,37	2,02e−023	***
dt_3	0,123184	0,00525994	23,42	3,25e−088	***
dt_4	0,130436	0,00775972	16,81	7,63e−053	***
dt_5	0,0987471	0,00938754	10,52	5,47e−024	***
dt_6	0,0319304	0,0106521	2,998	0,0028	***
dt_7	0,131021	0,0114384	11,26	5,65e−027	***
dt_8	0,0509726	0,0136555	3,696	0,0002	***
dt_9	0,0568495	0,0143988	3,948	8,74e−05	***
dt_10	0,0596578	0,0158998	3,752	0,0002	***
dt_11	0,0481530	0,0162394	2,965	0,0031	***
dt_12	0,0295539	0,0178299	1,658	0,0979	*
dt_13	0,000272882	0,0217258	0,01256	0,9900	
dt_14	0,0287712	0,0222361	1,294	0,1962	
dt_15	−0,0172510	0,0200180	−0,8618	0,3891	
dt_16	−0,0838073	0,0173742	−4,824	1,76e−06	***
dt_17	−0,0484943	0,0215284	−2,253	0,0246	**

Média var. dependente	0,095651	D.P. var. dependente	0,245118
Soma resíd. quadrados	612,6479	E.P. da regressão	0,236656
R-quadrado	0,069979	R-quadrado ajustado	0,067854
F(25, 644)	518,7956	P-valor(F)	0,000000
Log da verossimilhança	256,5605	Critério de Akaike	−461,1211
Critério de Schwarz	−271,2570	Critério Hannan-Quinn	−387,1465

Source: Gretl software. Authors' own elaboration.

For MQO models with panel data, the pooled model is used and, whether one-way or two-way, the Ramsey test shows that it is well specified, rejecting the null hypothesis in both situations, i.e. the model rejects that the tested model is better than the original, which shows that the original is better.

The Jacque-Bera test, whose null hypothesis is that the residuals have a normal distribution, shows that the error residuals for both one-way and two-way OLS do not have a normal distribution.

White's test showed that there is a tendency towards heteroscedasticity, so the solution is to use robust errors in the OLS analysis to integrate heteroscedasticity into the model. The null hypothesis of the test was that there is heteroscedasticity, both for the two-way and the one-way, which is why the analysis is done with robust errors.

When performing the Wald test with omission of time variables, the null hypothesis that these are null is denied, i.e. there are time effects in the model, and the two-way clustered MQO with robust errors is the most appropriate.

The R2 indicates that the variables used explain 7% of the variable explained.

The Durbin-Watson test measures autocorrelation in residuals from a regression analysis and a test value of 2.05 indicates that there is no autocorrelation.

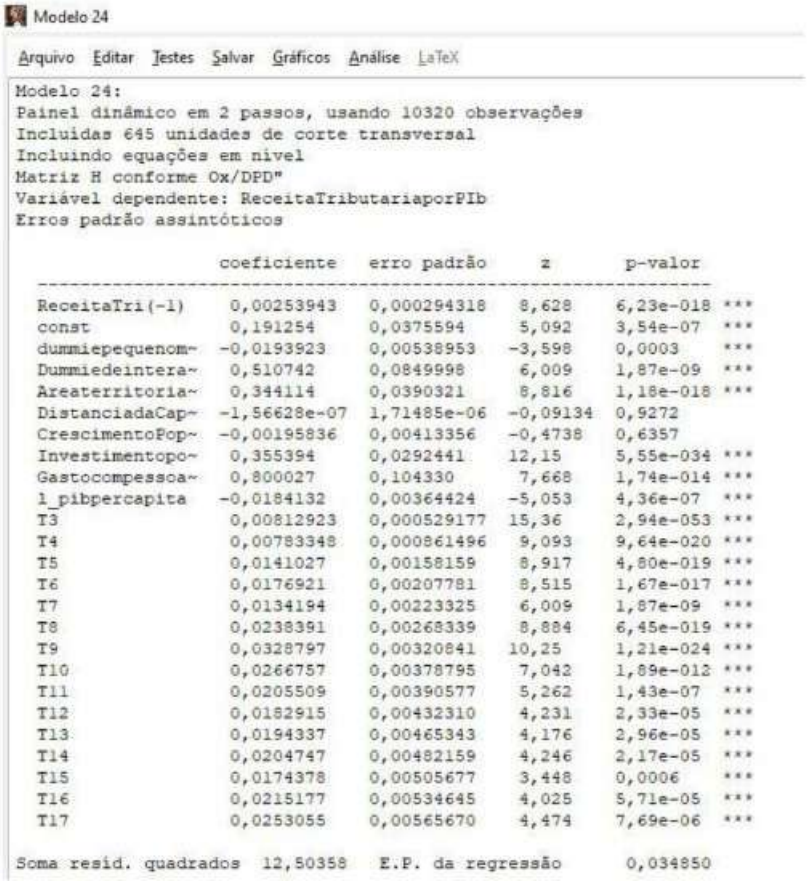
The F-test indicates that the entire explained part has no influence on the explained variable. As the null hypothesis of this test is rejected in the model, the variables used indicate that there is an influence on Y.

Most of the temporary dummies have a statistical significance of 1%, and only from the fifteenth year onwards do they have a negative impact on the estimators of the variables in the model.

4.6. Y = relevant tax revenue as explained variable - GMM

GMM-system, two-steps, dynamic panel, DPD, asymptotic standard errors, collapsed instruments, AR-2

Figure 6 – Gretl model 24



Modelo 24

Arquivo Editar Testes Salvar Gráficos Análise LaTeX

```
Modelo 24:
Painel dinâmico em 2 passos, usando 10320 observações
Incluídas 645 unidades de corte transversal
Incluindo equações em nível
Matriz H conforme Ox/DPD"
Variável dependente: ReceitaTributariaporPIb
Erros padrão assintóticos

                  coeficiente   erro padrão     z       p-valor
  ------------------------------------------------------------------
  ReceitaTri(-1)    0,00253943   0,000294318   8,628    6,23e-018 ***
  const             0,191254     0,0375594     5,092    3,54e-07  ***
  dummiepequenom~  -0,0193923    0,00538953   -3,598    0,0003    ***
  Dummiedeintera~   0,510742     0,0849998     6,009    1,87e-09  ***
  Areaterritoria~   0,344114     0,0390321     8,816    1,18e-018 ***
  DistanciadaCap~  -1,56628e-07  1,71485e-06  -0,09134  0,9272
  CrescimentoPop~  -0,00195836   0,00413356   -0,4738   0,6357
  Investimentopo~   0,355394     0,0292441    12,15     5,55e-034 ***
  Gastocompessoa~   0,800027     0,104330      7,668    1,74e-014 ***
  l_pibpercapita   -0,0184132    0,00364424   -5,053    4,36e-07  ***
  T3                0,00812923   0,000529177  15,36     2,94e-053 ***
  T4                0,00783348   0,000861496   9,093    9,64e-020 ***
  T5                0,0141027    0,00158159    8,917    4,80e-019 ***
  T6                0,0176921    0,00207781    8,515    1,67e-017 ***
  T7                0,0134194    0,00223325    6,009    1,87e-09  ***
  T8                0,0238391    0,00268339    8,884    6,45e-019 ***
  T9                0,0328797    0,00320841   10,25     1,21e-024 ***
  T10               0,0266757    0,00378795    7,042    1,89e-012 ***
  T11               0,0205509    0,00390577    5,262    1,43e-07  ***
  T12               0,0182915    0,00432310    4,231    2,33e-05  ***
  T13               0,0194337    0,00465343    4,176    2,96e-05  ***
  T14               0,0204747    0,00482159    4,246    2,17e-05  ***
  T15               0,0174378    0,00505677    3,448    0,0006    ***
  T16               0,0215177    0,00534645    4,025    5,71e-05  ***
  T17               0,0253055    0,00565670    4,474    7,69e-06  ***

Soma resid. quadrados  12,50358   E.P. da regressão      0,034850
```

Source: Gretl software. Authors' own elaboration.

For GMM models, whether one-way or two-way, the Sargan test showed that it is not well

specified, rejecting the null hypothesis, i.e. the model indicates that there is overidentification (FERREIRA, 2018, p. 7).

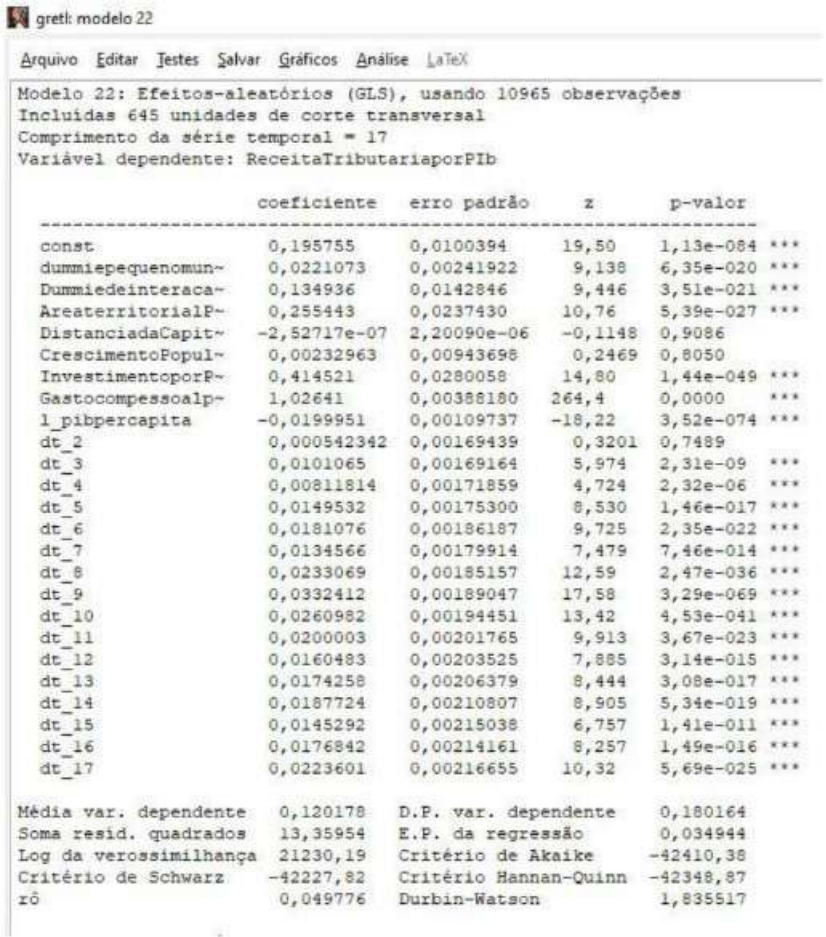
When the Wald test is carried out, both for the joint variables and for the omission of time variables, the null hypothesis that they are null is denied, i.e. there are time effects in the model and the variables are relevant, and the inclusion of time dummies in the model is indicated.

The time lags show statistical significance of 1% in all the years and a positive impact on the variables that affect the total relevant tax revenue, with an increase in the last 2 years of the period.

For the estimator to be consistent, it is recommended to reject the null hypothesis for the first order, AR (1), and not reject the null hypothesis for the higher order, AR (2) (FERREIRA, 2018, p. 8), which is not the case in the model presented, as none is rejected.

4.7. Y = relevant tax revenue as explained variable - random effects

Figure 7 – Gretl Model 22



gretl: modelo 22

Arquivo Editar Testes Salvar Gráficos Análise LaTeX

```
Modelo 22: Efeitos-aleatórios (GLS), usando 10965 observações
Incluídas 645 unidades de corte transversal
Comprimento da série temporal = 17
Variável dependente: ReceitaTributariaporPIb

                     coeficiente   erro padrão     z       p-valor
  ------------------------------------------------------------------
  const               0,195755     0,0100394     19,50    1,13e-084 ***
  dummiepequenomun~   0,0221073    0,00241922     9,138   6,35e-020 ***
  Dummiedeinteraca~   0,134936     0,0142846      9,446   3,51e-021 ***
  AreaterritorialP~   0,255443     0,0237430     10,76    5,39e-027 ***
  DistanciadaCapit~  -2,52717e-07  2,20090e-06   -0,1148  0,9086
  CrescimentoPopul~   0,00232963   0,00943698     0,2469  0,8050
  InvestimentoporP~   0,414521     0,0280058     14,80    1,44e-049 ***
  Gastocompessoalp~   1,02641      0,00386180   264,4     0,0000    ***
  l_pibpercapita     -0,0199951    0,00109737   -18,22    3,52e-074 ***
  dt_2                0,000542342  0,00169439     0,3201  0,7489
  dt_3                0,0101065    0,00169164     5,974   2,31e-09  ***
  dt_4                0,00811814   0,00171859     4,724   2,32e-06  ***
  dt_5                0,0149532    0,00175300     8,530   1,46e-017 ***
  dt_6                0,0181076    0,00186187     9,725   2,35e-022 ***
  dt_7                0,0134566    0,00179914     7,479   7,46e-014 ***
  dt_8                0,0233069    0,00185157    12,59    2,47e-036 ***
  dt_9                0,0332412    0,00189047    17,58    3,29e-069 ***
  dt_10               0,0260982    0,00194451    13,42    4,53e-041 ***
  dt_11               0,0200003    0,00201765     9,913   3,67e-023 ***
  dt_12               0,0160483    0,00203525     7,885   3,14e-015 ***
  dt_13               0,0174258    0,00206379     8,444   3,08e-017 ***
  dt_14               0,0187724    0,00210807     8,905   5,34e-019 ***
  dt_15               0,0145292    0,00215038     6,757   1,41e-011 ***
  dt_16               0,0176842    0,00214161     8,257   1,49e-016 ***
  dt_17               0,0223601    0,00216655    10,32    5,69e-025 ***

Média var. dependente   0,120178   D.P. var. dependente    0,180164
Soma resid. quadrados   13,35954   E.P. da regressão       0,034944
Log da verossimilhança  21230,19   Critério de Akaike     -42410,38
Critério de Schwarz    -42227,82   Critério Hannan-Quinn  -42348,87
rô                      0,049776   Durbin-Watson           1,835517
```

Source: Gretl software. Authors' own elaboration.

For the random effects models, whether one-way or two-way, it can be seen from the joint test of the designated regressors that it is well specified, rejecting the null hypothesis in both situations, i.e. that the appropriate model excludes one of the variables used. Thus, the variables are relevant.

The Breusch-Pagan test (Pooled MQO x Random Effects), whose null hypothesis is that MQO would be better than random effects, both for one-way and two-way, shows that the null hypothesis is rejected and, in this case, random effects would be better.

The Hausman test (Fixed Effects x Random Effects), whose null hypothesis is that random effects are better than fixed effects, for both one-way and two-way, shows that the null hypothesis is rejected and fixed effects are better than random effects.

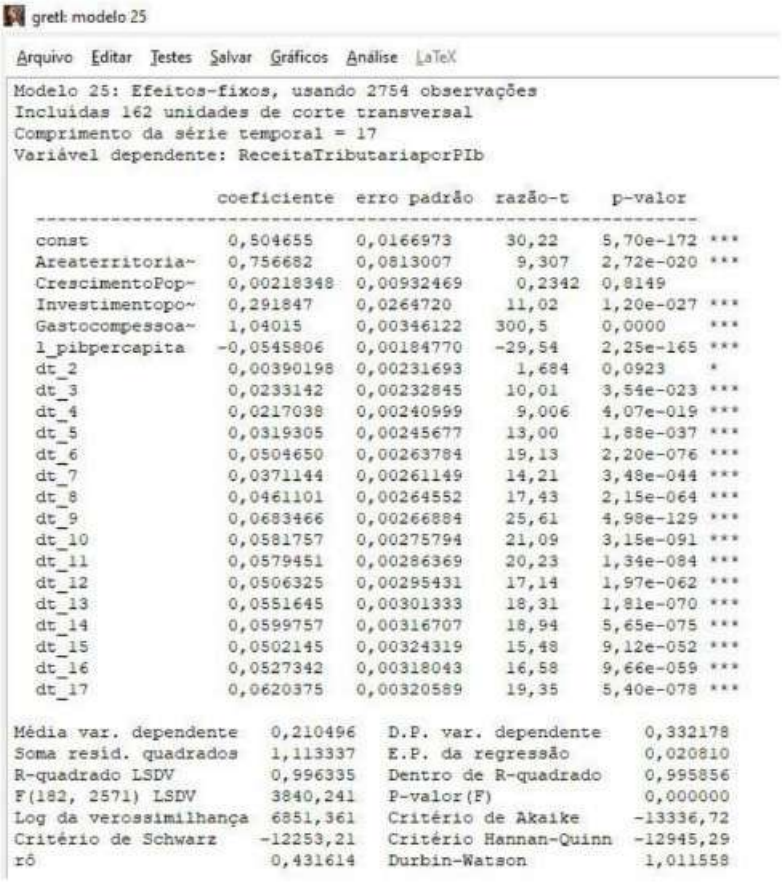
When the Wald test with omission of time variables is carried out, the null hypothesis that these are null is denied, i.e. there are time effects in the model, and two-way random effects are the most appropriate.

The time dummies were statistically significant at 1% in all the years, positively affecting the variables in the model.

The Durbin-Watson test measures autocorrelation in residuals from a regression analysis and the test value of 1.83 indicates that there is almost no autocorrelation.

4.8. Y = relevant tax revenue as explained variable - fixed effects for small municipalities

Figure 8 – Gretl model 25



gretl: modelo 25

Arquivo Editar Testes Salvar Gráficos Análise LaTeX

```
Modelo 25: Efeitos-fixos, usando 2754 observações
Incluídas 162 unidades de corte transversal
Comprimento da série temporal = 17
Variável dependente: ReceitaTributariaporPIb

                  coeficiente  erro padrão  razão-t    p-valor
  ------------------------------------------------------------
  const            0,504655    0,0166973     30,22    5,70e-172 ***
  Areaterritoria~  0,756682    0,0813007      9,307   2,72e-020 ***
  CrescimentoPop~  0,00218348  0,00932469     0,2342  0,8149
  Investimentopo~  0,291847    0,0264720     11,02    1,20e-027 ***
  Gastocompessoa~  1,04015     0,00346122   300,5     0,0000    ***
  l_pibpercapita  -0,0545806   0,00184770   -29,54    2,25e-165 ***
  dt_2             0,00390198  0,00231693     1,684   0,0923    *
  dt_3             0,0233142   0,00232845    10,01    3,54e-023 ***
  dt_4             0,0217038   0,00240999     9,006   4,07e-019 ***
  dt_5             0,0319305   0,00245677    13,00    1,88e-037 ***
  dt_6             0,0504650   0,00263784    19,13    2,20e-076 ***
  dt_7             0,0371144   0,00261149    14,21    3,48e-044 ***
  dt_8             0,0461101   0,00264552    17,43    2,15e-064 ***
  dt_9             0,0683466   0,00266884    25,61    4,98e-129 ***
  dt_10            0,0581757   0,00275794    21,09    3,15e-091 ***
  dt_11            0,0579451   0,00286369    20,23    1,34e-084 ***
  dt_12            0,0506325   0,00295431    17,14    1,97e-062 ***
  dt_13            0,0551645   0,00301333    18,31    1,81e-070 ***
  dt_14            0,0599757   0,00316707    18,94    5,65e-075 ***
  dt_15            0,0502145   0,00324319    15,48    9,12e-052 ***
  dt_16            0,0527342   0,00318043    16,58    9,66e-059 ***
  dt_17            0,0620375   0,00320589    19,35    5,40e-078 ***

Média var. dependente   0,210496   D.P. var. dependente     0,332178
Soma resid. quadrados   1,113337   E.P. da regressão        0,020810
R-quadrado LSDV         0,996335   Dentro de R-quadrado     0,995856
F(182, 2571) LSDV       3840,241   P-valor(F)               0,000000
Log da verossimilhança  6851,361   Critério de Akaike      -13336,72
Critério de Schwarz    -12253,21   Critério Hannan-Quinn   -12945,29
rô                      0,431614   Durbin-Watson            1,011558
```

Source: Gretl software. Authors' own elaboration.

For the fixed effects models, whether one-way or two-way, the joint test of the designated regressors is well specified, rejecting the null hypothesis in both situations, i.e. that the appropriate model excludes one of the variables used. Thus, the variables are relevant.

The test to differentiate group intercepts shows that the null hypothesis is that the vertical intercepts of the model are equal, which would make the Grouped MQO model better than fixed effects. As we rejected the null hypothesis, the best model is fixed effects.

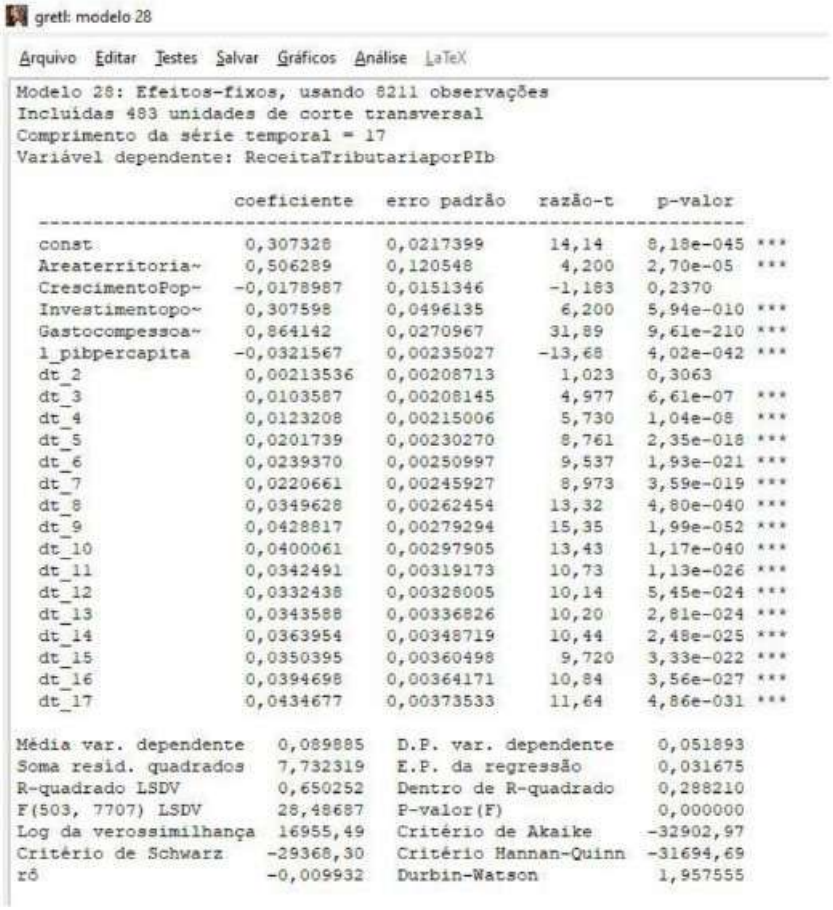
When the Wald test with omission of time variables is carried out, the null hypothesis that these are null is denied, i.e. there are time effects in the model, and two-way random effects are the most appropriate.

The temporary dummies have a statistical significance of 1% in all periods with a positive impact on the estimators of the variables in the model.

The Durbin-Watson test measures autocorrelation in residuals from a regression analysis and a test value of 1.01 indicates that there is positive autocorrelation. The LSDV R square indicates that 99.63% of the variables used explain the variation in the explained variable.

4.9. Y = relevant tax revenue as explained variable - fixed effects for municipalities except small ones

Figure 9 – Gretl model 28



gretl: modelo 28

Arquivo Editar Testes Salvar Gráficos Análise LaTeX

```
Modelo 28: Efeitos-fixos, usando 8211 observações
Incluídas 483 unidades de corte transversal
Comprimento da série temporal = 17
Variável dependente: ReceitaTributariaporPIb

                  coeficiente   erro padrão   razão-t    p-valor
  ------------------------------------------------------------
  const            0,307328     0,0217399     14,14    8,18e-045 ***
  Areaterritoria~  0,506289     0,120548       4,200   2,70e-05  ***
  CrescimentoPop~ -0,0178987    0,0151346     -1,183   0,2370
  Investimentopo~  0,307598     0,0496135      6,200   5,94e-010 ***
  Gastocompessoa~  0,864142     0,0270967     31,89    9,61e-210 ***
  l_pibpercapita  -0,0321567    0,00235027   -13,68    4,02e-042 ***
  dt_2             0,00213536   0,00208713     1,023   0,3063
  dt_3             0,0103587    0,00208145     4,977   6,61e-07  ***
  dt_4             0,0123208    0,00215006     5,730   1,04e-08  ***
  dt_5             0,0201739    0,00230270     8,761   2,35e-018 ***
  dt_6             0,0239370    0,00250997     9,537   1,93e-021 ***
  dt_7             0,0220661    0,00245927     8,973   3,59e-019 ***
  dt_8             0,0349628    0,00262454    13,32    4,80e-040 ***
  dt_9             0,0428817    0,00279294    15,35    1,99e-052 ***
  dt_10            0,0400061    0,00297905    13,43    1,17e-040 ***
  dt_11            0,0342491    0,00319173    10,73    1,13e-026 ***
  dt_12            0,0332438    0,00328005    10,14    5,45e-024 ***
  dt_13            0,0343588    0,00336826    10,20    2,81e-024 ***
  dt_14            0,0363954    0,00348719    10,44    2,48e-025 ***
  dt_15            0,0350395    0,00360498     9,720   3,33e-022 ***
  dt_16            0,0394698    0,00364171    10,84    3,56e-027 ***
  dt_17            0,0434677    0,00373533    11,64    4,86e-031 ***

Média var. dependente   0,089885   D.P. var. dependente    0,051893
Soma resid. quadrados   7,732319   E.P. da regressão       0,031675
R-quadrado LSDV         0,650252   Dentro de R-quadrado    0,288210
F(503, 7707) LSDV       28,48687   P-valor(F)              0,000000
Log da verossimilhança  16955,49   Critério de Akaike     -32902,97
Critério de Schwarz     -29368,30  Critério Hannan-Quinn  -31694,69
rô                      -0,009932  Durbin-Watson           1,957555
```

Source: Gretl software. Authors' own elaboration.

For the fixed-effects models, whether one-way or two-way, the joint test of the designated regressors showed that it is well specified, rejecting the null hypothesis in both situations, i.e. that the appropriate model excludes one of the variables used. Thus, the variables are relevant.

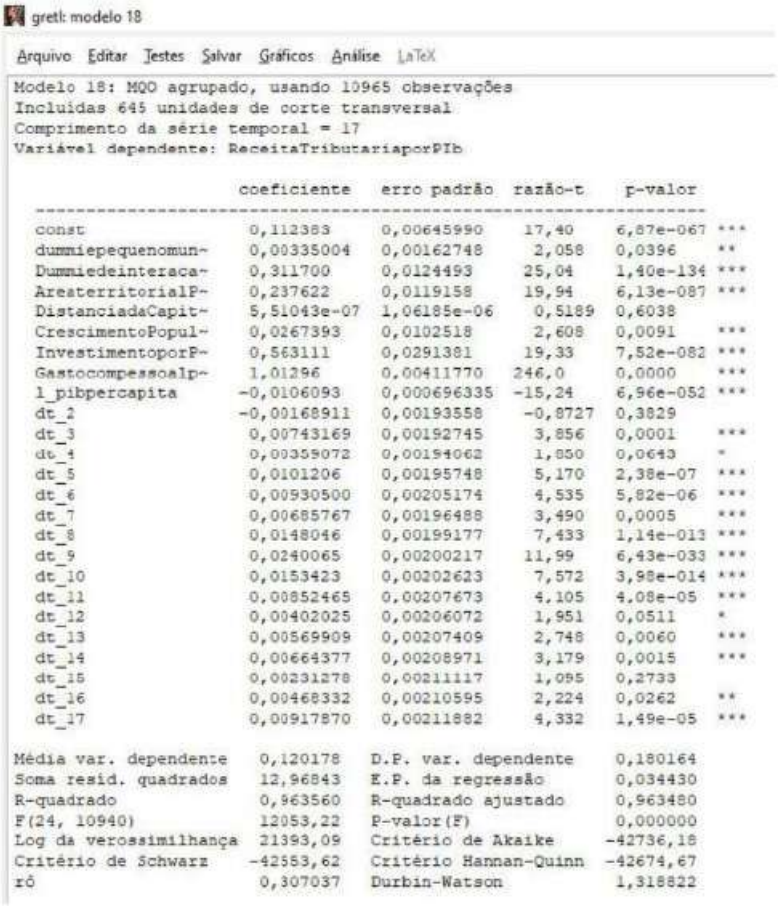
The test to differentiate group intercepts shows that the null hypothesis is that the vertical intercepts of the model are equal, which would make the Grouped MQO model better than fixed effects. Since we rejected the null hypothesis, the best model is fixed effects. When performing the Wald test with omitted time variables, we see that the null hypothesis of these being null is denied, i.e. there are time effects in the model, with the effects being bidirectional randomization is the most suitable.

The time dummies are statistically significant at 1% in all years, except the second year, and have a positive effect on the variables in the model.

The Durbin-Watson test measures autocorrelation in residuals from a regression analysis. The test value of 1.96 indicates that there is almost no autocorrelation. The LSDV R square indicates that 65.02% of the variables used explain the variation in the explained variable.

4.10. Y = relevant tax revenue as explained variable - OLS

Figure 10 – Gretl Model 18



gretl: modelo 18

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Modelo 18: MQO agrupado, usando 10965 observações
Incluídas 645 unidades de corte transversal
Comprimento da série temporal = 17
Variável dependente: ReceitaTributariaporPIb

	coeficiente	erro padrão	razão-t	p-valor	
const	0,112383	0,00645990	17,40	6,87e-067	***
dummiepequenomun~	0,00335004	0,00162748	2,058	0,0396	**
Dummiedeinteraca~	0,311700	0,0124493	25,04	1,40e-134	***
AreaterritorialP~	0,237622	0,0119158	19,94	6,13e-087	***
DistanciadaCapit~	5,51043e-07	1,06185e-06	0,5189	0,6038	
CrescimentoPopul~	0,0267393	0,0102518	2,608	0,0091	***
InvestimentoporP~	0,563111	0,0291381	19,33	7,52e-082	***
Gastocompessoalp~	1,01296	0,00411770	246,0	0,0000	***
l_pibpercapita	-0,0106093	0,000696335	-15,24	6,96e-052	***
dt_2	-0,00168911	0,00193558	-0,8727	0,3829	
dt_3	0,00743169	0,00192745	3,856	0,0001	***
dt_4	0,00359072	0,00194062	1,850	0,0643	*
dt_5	0,0101206	0,00195748	5,170	2,38e-07	***
dt_6	0,00930500	0,00205174	4,535	5,82e-06	***
dt_7	0,00685767	0,00196488	3,490	0,0005	***
dt_8	0,0148046	0,00199177	7,433	1,14e-013	***
dt_9	0,0240065	0,00200217	11,99	6,43e-033	***
dt_10	0,0153423	0,00202623	7,572	3,98e-014	***
dt_11	0,00852465	0,00207673	4,105	4,08e-05	***
dt_12	0,00402025	0,00206072	1,951	0,0511	*
dt_13	0,00569909	0,00207409	2,748	0,0060	***
dt_14	0,00664377	0,00208971	3,179	0,0015	***
dt_15	0,00231278	0,00211117	1,095	0,2733	
dt_16	0,00468332	0,00210595	2,224	0,0262	**
dt_17	0,00917870	0,00211882	4,332	1,49e-05	***

Média var. dependente	0,120178	D.P. var. dependente	0,180164
Soma resid. quadrados	12,96843	E.P. da regressão	0,034430
R-quadrado	0,963560	R-quadrado ajustado	0,963480
F(24, 10940)	12053,22	P-valor(F)	0,000000
Log da verossimilhança	21393,09	Critério de Akaike	-42736,18
Critério de Schwarz	-42583,62	Critério Hannan-Quinn	-42674,67
rô	0,307037	Durbin-Watson	1,318822

Source: Gretl software. Authors' own elaboration.

When the Wald test is carried out with the omission of time variables in the model, the null hypothesis that they are null is denied, i.e. there are time effects in the model, and the two--way pooled MQO is the most appropriate.

For the pooled variable OLS models, whether one-way or two-way, the Ramsey test shows that it is well specified, rejecting the null hypothesis in both situations, i.e. the model rejects that the tested model is better than the original, which shows that the original is better.

The Jacque-Bera test, whose null hypothesis is that the residuals have a normal distribution, shows that the error residuals for both one-way and two-way OLS have a normal distri-

bution.

According to White's test, the null hypothesis of the test is that there is no heteroscedasticity, both for the two-way and one-way tests, which is why no analysis is carried out with robust errors.

The time dummies are statistically significant at 1% in all years, except the second year, and have a positive effect on the variables in the model.

The R2 indicates that the variables used explain only 96.35% of the variable explained.

The Durbin-Watson test measures autocorrelation in residuals from a regression analysis and the test value of 1.32 indicates that there is almost no autocorrelation.

The F test indicates that the entire explained part has no influence on the explained variable. As the null hypothesis of the model is rejected, the variables used influence the Y adopted.

4.11. Summary of results

Table 1 – Summary spreadsheet of estimates with Y = GDP growth

Statistical significance: 1% = *; 5% = ** and 10% = ***					
variable	**GMM**	**fixed effects small municipalities**	**fixed effects other municipalities**	**random effects**	**OLS**
GDP factor price per capita (in log)	0,1175***	0,4407***	0,4479***	0,0806***	0,0806***
Investment by GDP Price factors	-0,2525	0,2667	-0,7356**	0,0765	0,0765
Personnel costs per GDP factor price	-0,2760	0,1479	-0,3569*	0,1694**	0,1694**
Relevant Total Tax Revenue per GDP Factor price	-0,3548*	-0,1704	-0,0212	-0,1672**	-0,1672**
Population growth	0,2239***	0,2430**	0,2987***	0,2847***	0,2847***
territorial area by population	0,4531**	-2,1701**	-4,2144***	0,1524*	0,1524*
distance from the capital in Km	0	not applicable	not applicable	0	0
small town dummie	0,1292***	not applicable	not applicable	0,0377***	0,0377***
small municipality interaction dummie * personnel costs = X9*X3	-0,5159	not applicable	not applicable	-0,1995**	-0,1995**
time dummies	not applicable	positive only for the next 3 years and then negative	positive only for the next 3 years and then negative	positive for 14 years and then negative	positive for 15 years and then negative
lag	Negative, only positive in the fourth year	not applicable	not applicable	not applicable	not applicable

Source: Authors' own elaboration

Table 2 – Summary spreadsheet of estimates with Y = tax collection

Statistical significance: 1% = *; 5% = ** and 10% = ***					
variable	**GMM**	**fixed effects small municipalities**	**fixed effects other municipalities**	**random effects**	**OLS**
GDP factor price per capita (in log)	0,0184***	-0,0546***	-0,0322***	0,0200***	-0,0106***
Investment per GDP Factor price	0,3554***	0,2918***	0,3076***	0,4145***	0,5631***
Personnel costs per GDP factor price	0,8000***	1,0401***	0,8641***	1,0264***	1,0130***
Population growth	-0,0020	0,0022	-0,0179	0,0023	0,0267***
territorial area by population	0,3441***	0,7567***	0,5063***	0,2554***	0,2376***
distance from the capital in Km	0	not applicable	not applicable	0	0
small town dummie	-0,0194***	not applicable	not applicable	0,0221***	0,0033**
small municipality interaction dummie * personnel costs = X9*X3	0,5107***	not applicable	not applicable	0,1349***	0,3117***
time dummies	not applicable	positive	positive	positive	positive
lag	positive	not applicable	not applicable	not applicable	not applicable

Source: Authors' own elaboration.

5. FINAL CONSIDERATIONS

As we have seen, depending on the model used, the estimators will differ and in some cases even the sign of the correlation will change.

In principle, the GMM model would be the best one to adopt, based on the references in the literature. However, the fixed and random effects and OLS models were also consistent and there is a slight chance of overidentification in the GMM models presented, which is why the fixed effects models, run separately for the small municipality base and the large municipality base, were better defined by the comparative method between these models. However, the scenario of all the estimators in the different models adopted would help to adopt interpretations and administrative measures on the results.

Based on this, if we look at the civil service expenditure variable for the fixed effects model for small municipalities, we see that, as a small municipality, each public expenditure on personnel has a positive effect on the economic growth of a small municipality, although this variable does not have statistical significance. However, the time dummies show positive varia-

bility up to the fourth year and statistical significance in the third (1%) and fourth (5%) years, which may reveal a positive effect of public spending on personnel up to the fourth year. When we look at the GMM model, weighting the

In this last model, and with a significance level of 1%, we see that a small municipality represents a positive correction in the general economic growth of municipalities. On the other hand, still in the GMM model, the interaction dummy would reveal that public spending would not be the explanatory factor for this because it is negative, however, it also has no statistical significance. Similarly, in this last model, in the fourth year there is a positive variation to be added to the coefficients of the variables.

It can be seen that the time dummies in the fixed-effect model indicate that there is a good positive relationship between spending more on civil servants in the first 5 years for small municipalities, but that after that, it negatively affects economic growth. Therefore, models without permanent civil service exams, aimed at temporary contracts, can be better controlled by municipalities in monitoring this growth and it is recommended to re-analyze them after 5 years.

In the random model and MQO, both show the same correlation values and signs for the small municipality dummy (0.0377 with significance at 1% and 5%, respectively) and the interaction dummy (-0.1995 with significance at 5% and 10%, respectively) and personnel costs (0. 1694 with significance at 5% in both),1694 with significance of 5% in both), which may indicate, especially by analyzing the time dummies, that over the years, for at least 14 years, the tendency is for the interaction dummie to continue to have a negative impact on growth, but with a lesser impact as the years go by.

As for the other variables, all the models used did not show that a municipality's distance from the capital affects its economic growth. On the other hand, the fact that the population is growing has a more positive effect in large municipalities than in small municipalities, and with statistical significance in all the models, perhaps explained by the multiplier effect of a more populous area than in a small municipality.

The same is true for an increase in the variable GDP at factor prices per capita (in log), where the effect is greater in a large municipality.

As for the land area per population (population density) variable, in all the models it had a positive effect on economic growth, except for the fixed effects model, which had a high negative correlation with statistical significance. This may suggest that highly populated areas lead to lower economic growth. However, the negative effect in a small municipality is almost half

that of a negative effect in a large municipality.

As for the explained variable tax revenue, we see that only the population growth variable is not statistically significant.

Furthermore, the increase in spending on civil servants has a positive effect on the increase in municipal tax collection in any of the models presented, with a difference, at least in the GMM and fixed effects model, that is greater in small municipalities than in large ones, i.e. spending more on civil servants in a small municipality tends to have a greater positive effect than the same expenditure in a large municipality in terms of the result of the increase in tax collection.

As for the other variables, we can see that having a lot of uninhabited land is not recommended if the municipality's intention is to increase tax collection. In small municipalities, as can be seen from the analysis of the fixed effects model, tax collection is higher than in large municipalities when the population density variable is increased.

Distance, as in the analysis of economic growth, also did not prove to be a relevant variable in the model.

The control variable, GDP per capita (log), shows that economic growth increases more as GDP per capita increases, but this relationship is inverse and negative for tax collection. This could indicate greater tax planning in line with greater wealth in the economy, a greater exodus of residents, more savings by families who avoid consumption and tax collections on trade, among other possible explanations. These correlations are slightly different between small and large municipalities, with small municipalities faring worse in this respect.

Well then, the work had the relevant role of consolidating what is understood to be relevant in a municipality's budget and which depends only, or largely, on its efforts to improve, given that some changes in these adopted variables depend on changes in the Constitution, which presents strong rigidity for its alteration and inhibits a frustration in a municipal economic project.

As another consequence of the work, it also consolidated a concept of what a small municipality is in Brazil and a methodological way of arriving at a sample base in this sense (first quartile).

It is hoped that other sequential studies can emerge with databases from other states or corrections to the authors' analyses, or even a theoretical renewal of the general concept of what efficient spending in public management would be for small municipalities in order to achieve greater economic growth, as well as being useful for legislative adaptations governing the sub-

ject, such as the fiscal responsibility law.

Finally, the research reveals that, regardless of the model adopted, there are different statistics between a small municipality and a large municipality and they should be treated differently in macroeconomic calculations with the help of the small municipality concept adopted in the work. The fact that spending on civil servants is affected differently in a small municipality than in a large municipality is notorious, but it is inconclusive as to whether this is a determining variable for the economic growth of a small municipality, but, on the other hand, it proved to be an important variable for increasing municipal tax collection.

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