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ECONOMIC INDICATORS FOR THE PUBLIC TRANSPORTATION AGGREGATE DEMAND ESTIMATION IN SÃO PAULO

Daniel A. Pamplona[1*] and Alessandro V. M. Oliveira[2]

[1]*Department of Civil Engineering, Aeronautics Institute of Technology, Brazil*
[2]*Department of Civil Engineering, Aeronautics Institute of Technology, Brazil*

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Abstract: This article investigates the application of economic indicators for the parametric estimation of public transportation aggregate demand. Since the transportation sector plays a vital role in a city infrastructure, the objective is to present a method of selecting economic indicators that assist in the study of urban public transport demand, taking as a case study the Metropolitan Region of São Paulo (MRSP). Using econometric modelling, it was estimated the effect of variables explaining total traffic in the transport system, and more specifically examine the role of fares and the employment and wage indicators. Statistical tests were performed to check the validity of the analyzed models and develop a rank of indicators according to their performance as regressors. The subset of indicators that were representative of industrial activity and more related to the local economy had the best performance as a forecasting tool.

Keywords: Economic indicators; public transportation; aggregate demand

* Correspondence to: Daniel A. Pamplona, Tel.: +55 12 98116 1800.
E-mail: pamplonadefesa@hotmail.com

INTRODUCTION

In the process of properly planning and implementing transport policy in modern days, managers all over the world have increasingly been required to collect great amounts of quantitative information related to socioeconomic indicators. This data collection is nowadays crucial for the proper support of the decision-making process in any public and private organization. Planners rely on instruments that are capable of indicate the trends of the variables studied and enable them to better design plans and management strategies given the information gathered. Due to the impact in the population's quality of life, public transport planning is a field that has received great attention from the administration in last decade.

The main objective of this work is to present a method of selecting economic indicators that assist in the study of urban public transport demand, taking as a case study the Metropolitan Region of São Paulo (MRSP). Using an econometric model of aggregate demand, it is quantified the variables effect of the total number of passengers in the public transport. The independent variables of the study were fare, job indicators, income e production.

Public planners use economic indicators because they allow understanding the environment and evaluating alternative strategies. These indicators are constituted by statistical data of economic situations in a specific market or in an economic sector. They are used as a tool to assist in the analyses of a particularly moment. Time series analyses and economic methodology behind every index allow to better forecast. The main problem is that economic indicators can contradict themselves or not permit a correct trend analyses.

Baumohl (2012) analyzing the use of indicators for trend analyses, lists some important characteristics: (a) **Accuracy:** the quality of information. It is an important attribute to consider when choosing an indicator. There are indicators that go through several corrections and revisions and suffer the influence of seasonality, creating uncertainty and bias. (b) **Temporality:** be available in constant periods. For the forecasts realization, the indicators should be the most updated. Similarly, should be made available as close as possible to its consolidation. (c) **Cyclical business stage:** the emphasis on an indicator may face changes due to business period. (d) **Predictive capacity:** the indicator's ability to assist in economic forecasting is very important for the prognosis of achievements. (e) **Degree of relevance and interest:** indicators may have different levels of significance at different economies.

The demand for transport is considered a derived demand, where goods and people move not with the simple goal to move, but to add value to the relocation in space. The public transport plays the role of integrating the diverse urban spaces and connecting the places of work and leisure, promoting consumption in the regions of operation. Thus, the level and type of service provided affect the development of the various economic and social activities.

Despite advances in the past decades in vehicle technology, road infrastructure, public administration management tools and the upgrading of operating companies, public transport in the metropolitan region of São Paulo still faces problems that compromise their quality. Among these enormous challenges, which are part of the daily routine of millions of São Paulo and visitors who pass through the city, one that can be cite is the growing number of cars in the system.

This leads to congestion and compromise the average travel time, the productivity on urban activities, to the poor spatial distribution of economic activities, affects the performance of transport operations, and the pace below expectations in investments needed to improve public transport, causing reduction in the level and sustainability of the service.

During the last decades, the concept and planning process of the urban transportation has changed because of social, economic and environmental changes experienced by society. In this scope, the National Association of Public Transport (ANTP) (1997) defines the transportation planning as the activity that sets the necessary infrastructure to ensure the movement of people and goods. It is also responsible for organizing the transport systems that are subject to public regulation, including the technology and the level of service offered - public transportation, taxi and special transportation.

This paper aims to contribute to a better methodology for the selection of indicators of economic conditions suitable for correct dimensioning of demand for urban public transport so that ultimately may contribute to the macro planning of the sector. Econometric models and the analysis of demand indicators can be extremely useful tools of quantitative basis to transportation planning, giving a better estimation of future scenarios and allowing the correct adjustment by the public planner.

The paper is organized as follows: Section 2 presents the Metropolitan Region of São Paulo (MRSP); Section 3 presents the public transportation system in the MRSP; Section 4 performs the methodological development of the article, with details of the econometric modeling used, the presentation and discussion of the results of the estimations; Section 5 presents the selection of economic indicators for urban public transport demand; Finally, the concluding section, summarizes the key points and shows work limitations.

THE METROPOLITAN REGION OF SÃO PAULO (MRSP)

The Metropolitan Region of São Paulo consists of 39 municipalities in the state of São Paulo in Brazil and comprises a total area of approximately 7963.31 km. **Figure 1** shows in yellow municipalities that make up the metropolitan area and in the bottom the state of São Paulo with the region where it is located.

Currently, the region has an estimated population of 20,935,204 inhabitants. The population was in the period 2011 to 2014 an average growth rate of 1.8%, with a peak 4.1%, as shown in **Fig. 2**.

Looking at the wealth of the region, the GDP of the metropolitan area in 2011 was 760 044 million and represented 56% of the total state of São Paulo. When

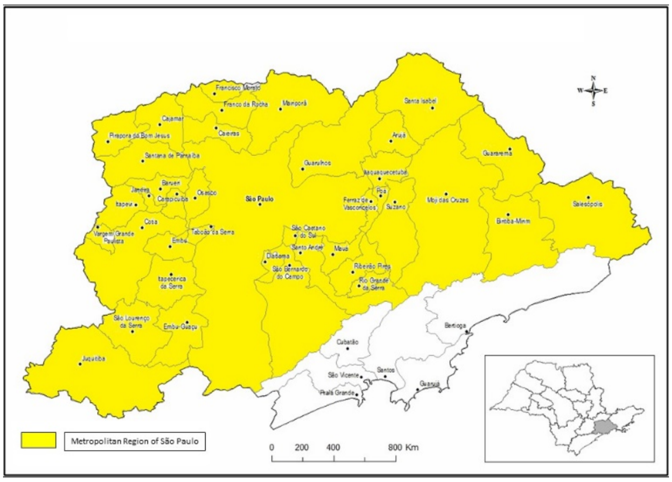

Fig. 1 Municipalities of the Metropolitan Region of São Paulo

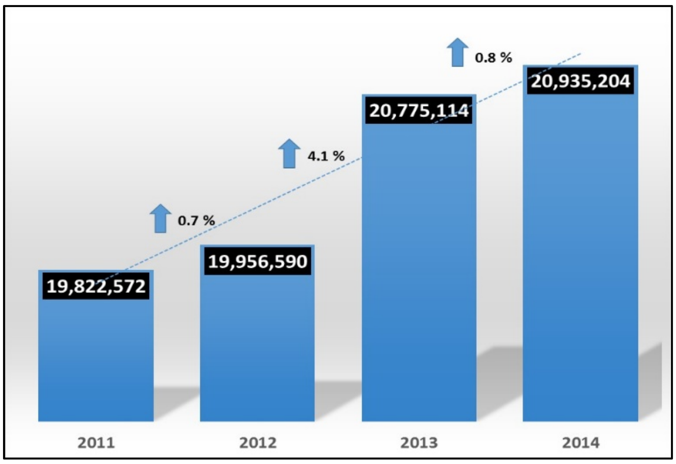

Fig. 2 Population and growth taxes of the Metropolitan Region of São Paulo

analyzed in relation to Brazil, represented 18.5% of the country's wealth. It is a region noted for its high amount of industries, Brazil's financial center and polo wealth generator.

Within this context, a large network of public transport was organized to meet the needs of all passengers who wish to get around by public transportation.

PUBLIC TRANSPORT SYSTEM IN THE MRSP

Public transport is an important way of locomotion in large cities. Due to the increasing need for mobility and inappropriate amount of infrastructure investments, motorization is a huge force in economic growth, but when not done with proper planning, it brings congestion and increased pollution. Inserted in this context is the MRSP.

According to São Paulo Transporte SA (SPTrans) (2014), the city of São Paulo serves an average demand of 6 million passengers per working day, with the bus lines being operated by private companies. SPTrans manages the system, in a system of lines operated by 16 consortium formed by enterprises and co-responsible for the operation of 15 million vehicles in more than 1300 lines, which operates about 55% of motorized trips to the metropolitan area.

In addition to the system managed by SPTrans, operates the Companhia do Metropolitano (Metrô) responsible for the administration of the subway system and Companhia Paulista de Trens Metropolitanos (CPTM) responsible for the administration of the metropolitan trains system. Finally, operates in the city the Empresa Metropolitana de Transportes Urbanos (EMTU) who plays the role of connecting the capital cities of the metropolitan region by bus.

Table 1 shows the growth in passenger traffic of urban transportation of MRSP, disaggregating the values in "System under Tires" (public bus, operated by SPTrans and the EMTU) and "System under rails" (subway-railroad operated by the Company of Metropolitan ViaQuatro and EMTU).

Table 1. Recent developments in passenger traffic in the metropolitan area of São Paulo

Year	(1) System under Tires (SPTrans + EMTU)		(2) System under Trails (Metrô + Via4 + CPTM)		(1) + (2) Total Systems	
	pax/year (billion)	pax/day (million)	pax/year (billion)	pax/day (million)	pax/year (billion)	pax/day (million)
2009	3..39	9.29	1.56	4.28	4.95	13.57
2010	3.46	9.48	1.69	4.62	5.15	14.10
2011	3.50	9.60	1.84	5.04	5.34	14.64
2012	3.49	9.56	2.03	5.57	5.52	15.13
2013	3.50	9.60	2.09	5.73	5.59	15.33

Table 1 shows that the "System under Tires" met 3.5 billion passengers in 2013, equivalent to almost 10 million passengers daily. This represented an increase of 3.3% compared to 2009. At the same time, the subway-railroad system reached a total traffic of 2.09 billion passengers in 2013, in a much more accelerated growth of around 34.0% in the same period. CPTM and Metro transported on average 5.73 million people per day in 2013. In total computation of the two systems, 15 million passengers in 2012 were transported, reaching 15.33 million per day in 2013, representing 5.6 billion total passengers - an increase of 12.9% compared to 2009. For a discussion of transport in the MRSP, see Cardoso (2011 and 2013).

ECONOMETRIC MODELING FOR TRANSPORT AGGREGATE DEMAND

The demand study includes a quantitative analysis of the database available and the development of econometric model of demand for urban travel in public transport. One of the great advantages of using econometric models is the ability to analyze the relations of cause between the dependent variable in the case of the study the amount of daily passengers in the MRSP, and the independent variable, the factors that can influence the passenger demand.

Database and model configuration

The data collection procedure encompassed researching to websites of institutions responsible for the transportation sector in São Paulo and in the state of São Paulo. Research were made to the following data sources: SPTrans, EMTU, CTPM, CET, subway, SEADE, ViaQuatro. The main data and statistics used in the study were obtained from the SPTrans page and with the Secretariat of Metropolitan Transport (SMT) through the Integrated Information System for Citizen of the State of São Paulo. At the end of the collection and processing of data procedure, we obtained a sample of 168 sample points. The data frequency is monthly, covering the period from January 2000 to December 2013. **Equation (1)** presents the econometric model used at work.

$$daily\ pax\ sp = \beta_0 + \beta_1\ economic\ indicator + \beta_2\ av.fare + \sum_k Yk\ \ sazonality\ month\ k + u \quad (1)$$

where the variables used are as follows:

Daily pax sp Total number of daily public transportation of passengers in the Metropolitan Region of São Paulo (Source: SPTrans and Secretary of Metropolitan Transport and own calculations). The calculation of total passenger traffic are not included in the intra-municipal public transport passengers of the MRSP cities, but only the city of São Paulo (Source: SPTrans).

Average fare Index of the average rate of the MRSP for public transport in constant values of January 2014 (Source: Brazilian Institute of Geography and Statistics, IBGE). The base of the index is 100, set at the average value of 2000. In calculating this variable, it was used data collected in the database of IBGE Automatic Recovery System (SIDRA), available at sidra.ibge.gov.br. On basis concerning the National Index of Consumer Price (IPCA), were collected monthly data of price variation in the MRSP for the items of municipal bus, interstate transport, subway and metropolitan train fares. Built up an average index of these items, pondering for its share of traffic by month, based on data collected from SPTrans and the Secretariat of Metropolitan Transport. For the setting procedure at constant currency values in order to purge the inflationary effect, we used the general IPCA inflation for the MRSP.

Wage It represents the average nominal wage rate in the São Paulo State industry, brought to constant values of January 2014 by the IPCA / IBGE (see procedure of the above rates). (Source: Federation and Center of Industries of São Paulo (Fiesp), Monthly Survey, and were collected in Ipeadata Portal).

Employment It represents the employment index level of the industry in the State of São Paulo. (Source: Federation and Center of Industries of São Paulo (Fiesp), Monthly Survey, and were collected in Ipeadata Portal).

Wage mass It represents the total wage index paid to the employees of the local unit, in the reference month of the survey. (Source: National Confederation of Industry (CNI) and were collected in Ipeadata Portal).

Occupied population It is the index of the number of people in the MRSP who were working in the reference week the National Research by Household Sample (PNAD/IBGE), estimated from the microdata research. (Source: Applied Economic Research Institute (IPEA) and were collected in Ipeadata Portal).

Economically active population It is the index number of people in the MRSP considered active in the labor market, a group that includes all those aged 10 or older who were seeking employment or working in the reference week of the National Sample Survey of Households (PNAD/IBGE), estimated from the microdata research. (Source: Applied Economic Research Institute (IPEA) and were collected in Ipeadata Portal).

Activity It is the index of the activity rate of persons 10 years or older, by metropolitan areas. (Source: Brazilian Institute of Geography and Statistics (IBGE) and were collected in Ipeadata Portal).

Retail sales It represents the index of the nominal rate of retail sales. (Source: Brazilian Institute of Geography and Statistics (IBGE) and were collected in Ipeadata Portal).

Industry sales It represents the nominal index rate of industry sales. (Source: Federation and Center of Industries of São Paulo (Fiesp) and were collected in Ipeadata Portal).

Industry capacity It is the index utilization rate of the installed capacity in the industry. (Source: National Confederation of Industry (CNI) and were collected in Ipeadata Portal).

ICMS collection It represents the tax collection rate index on operations related to goods and on transport services rendered interstate and intramunicipal and communications. (Source: Ministry of Finance and were collected in Ipeadata Portal).

GDP São Paulo It represents the rate index of Gross Domestic Product of the State of São Paulo. (Source: Brazilian Central Bank and were collected in Ipeadata Portal).

GDP Brazil It represents the rate index of Gross Domestic Product of Brazil. (Source: Brazilian Central Bank and were collected in Ipeadata Portal).

Table 2 below shows the descriptive statistics of the variables used in the econometric model. The following chart shows the evolution over time of the main indicators of economic conditions used for the demand study by public transportation, shown in **Fig. 1**.

Figure 1 shows the correlation study between the various indicators and the amount of daily collective passenger transport. To carry out the work, 12 economic indicators were chosen. These indicators are recognized as thermometers of the economic situation at large. It is intended by means of estimates and econometric tests to see how they behave when used specifically for the prognosis of public transport.

Estimation results

We present below the results of the estimation of the econometric model of demand for urban trips of urban transportation in the metropolitan region of São Paulo expressed in **Eq. (2)** and using the data collected and discussed in 3.1. In order to make clearer the analysis of the impacts of regression variables x in the dependent variable daily pax sp, chose to display the estimated elasticity of passenger demand with respect to the respective regressor x. It is designated demand elasticity of $\eta_x^{daily\ pax\ sp}$. The display of elasticity makes the results of the dimensionless coefficients estimated (ie, independent of the adopted scale model variables). Elasticity of demand can be defined as follows:

$$\eta_x^{daily\ pax\ sp} = \frac{\partial \text{ daily pax sp}}{\partial \text{ regressor } x} \cdot \frac{\text{average regressor sample } x}{\text{average sample daily sample sp}} \quad (2)$$

Elasticity results of the resulting coefficient estimated by the regression model are shown in Table 3. The estimator used was the OLS estimator (Ordinary Least Squares).

Table 2. Descriptive statistics

Variable	Unity	Average	Standard Deviation	Min.	Max.
daily pax sp	millions pax	11.63	2.83	6.50	16.52
average fare	index 2010 = 100	113.85	8.23	96.14	128.85
wage	index 2010 = 100	87.55	12.98	64.83	110.43
employment	index 2010 = 100	95.13	6.61	81.13	106.11
wage mass	index 2010 = 100	83.88	17.09	56.30	109.16
occupied pop.	index 2010 = 100	94.15	7.93	77.89	106.47
economically active pop.	index 2010 = 100	96.36	5.40	82.56	104.44
activity	index 2010 = 100	99.77	1.51	93.83	103.23
retail sales	index 2010 = 100	81.90	21.58	55.48	157.24
industry sales	index 2010 = 100	87.40	15.28	53.82	118.36
industry capacity	index 2010 = 100	99.00	2.69	90.50	103.22
ICMS collection	index 2010 = 100	81.10	18.78	51.28	138.23
GDP São Paulo	index 2010 = 100	99.66	7.20	82.77	121.37
GDP Brazil	index 2010 = 100	80.90	18.03	52.34	115.23
tendency	sequential	102.50	59.03	1.00	204.00
tendency broke	sequential x dummy	92.93	70.46	0.00	204.00
seasonality month 1	dummy	0.08	0.28	0.00	1.00
seasonality month 2	dummy	0.08	0.28	0.00	1.00
seasonality month 3	dummy	0.08	0.28	0.00	1.00
seasonality month 4	dummy	0.08	0.28	0.00	1.00
seasonality month 5	dummy	0.08	0.28	0.00	1.00
seasonality month 6	dummy	0.08	0.28	0.00	1.00
seasonality month 7	dummy	0.08	0.28	0.00	1.00
seasonality month 8	dummy	0.08	0.28	0.00	1.00
seasonality month 9	dummy	0.08	0.28	0.00	1.00
seasonality month 10	dummy	0.08	0.28	0.00	1.00
seasonality month 11	dummy	0.08	0.28	0.00	1.00
seasonality month 12	dummy	0.08	0.28	0.00	1.00

Tables 3–5 shows the estimation results by using the indicators for specifying economic conditions used separately. The stars shown are indicative of hypothesis testing as to the invalidity of the elasticity at a given level of significance (***, ** and * indicates 1%, 5% or 10%, respectively). The absence of stars indicates that the variable was not statistically significant in the estimated econometric model.

First, it was verified if the indicator and the average fare showed statistical significance. The statistical significance is an important guide when dealing with samples and working with hypotheses. The higher the significance of the independent variable, the closer to 0%, better to reject the null hypothesis, which in the study is that the variable has no effect in the model, with its coefficient of zero.

Table 3. Results of the regression model (dependent variable: daily pax sp)

	(I) *wage*	(II) *employment*	(III) *wage mass*	(IV) *occupied pop.*
wage	0.6359***			
employment		0.5646*		
wage mass			0.5676***	
occupied pop.				2.1246 ***
average fare	-0.2458	-0.6586**	-0.4977***	-0.3414
seasonality month 2	0.0071***	0.0074***	0.0072***	0.0075***
seasonality month 3	0.0102***	0.0102***	0.0100***	0.0115***
seasonality month 4	0.0074***	0.0078***	0.0067***	0.0101***
seasonality month 5	0.0085***	0.0088***	0.0075***	0.0104***
seasonality month 6	0.0069***	0.0074***	0.0060***	0.0085***
seasonality month 7	0.0020*	0.0026	0.0010	0.0034***
seasonality month 8	0.0111***	0.0110***	0.0100***	0.0112***
seasonality month 9	0.0089***	0.0088***	0.0076***	0.0090***
seasonality month 10	0.0100***	0.0100***	0.0085***	0.0099 ***
seasonality month 11	0.0056***	0.0076***	0.0046***	0.0069 ***
seasonality month 12	0.0038***	0.0059***	0.0040***	0.0038 **
R^2	0.9638	0.9560	0.9674	0.9631
RMSE	0.5649	0.6228	0.5359	0.5674
F Test (Statistics)	194.4178	174.7246	285.7414	386.2805
F Test (P-Value)	0.0000	0.0000	0.0000	0.0000
RESET	2.5956	5.7862	0.2651	4.0420
RESET_P-Value	0.1072	0.0162	0.6066	0.0444

Notes: (1) ***, **, * indicates statistically significant at 1%, 5% and 10%, respectively. (2) Standard errors of estimates omitted. These were corrected to be robust to the presence of heteroskedasticity and 18-order autocorrelation (indicated in hypothesis testing). The correction adopted was the Newey-West procedure (see Baum, 2006 and Wooldridge, 2002). (3) Presented results reflect the elasticity from the respective coefficients.

Table 4. Results of the regression model (dependent variable: daily pax sp)

	(V) *economically active pop.*	(VI) *activity*	(VII) *retail sales*	(VIII) *industry sales*
economically active pop.	0.8401**			
activity		0.5951		
retail sales			0.0281	
industry sales				0.5791***
average fare	-0.1908	-0.1651	-0.4121	-0.2932
seasonality month 2	0.0066***	0.0066***	0.0075***	0.0070***
seasonality month 3	0.0100***	0.0101***	0.0102***	0.0034
seasonality month 4	0.0085***	0.0086***	0.0085***	0.0053**
seasonality month 5	0.0095***	0.0095***	0.0098***	0.0040*
seasonality month 6	0.0080***	0.0081***	0.0084***	0.0024
seasonality month 7	0.0035**	0.0036**	0.0038***	-0.0023
seasonality month 8	0.0116***	0.0117***	0.0122***	0.0030
seasonality month 9	0.0101***	0.0103***	0.0103***	0.0009
seasonality month 10	0.0113***	0.0115***	0.0115***	0.0018
seasonality month 11	0.0089***	0.0090***	0.0089***	0.0012
seasonality month 12	0.0064***	0.0064***	0.0052**	0.0002
R^2	0.9543	0.9530	0.9504	0.9633
RMSE	0.6316	0.6407	0.6610	0.5684
F Test (Statistics)	212.9847	175.5394	148.3166	251.3735
F Test (P-Value)	0.0000	0.0000	0.0000	0.0000
RESET	7.1044	8.8856	1.1623	0.0041
RESET_P-Value	0.0077	0.0029	0.2810	0.9493

Notes: (1) ***, **, * indicates statistically significant at 1%, 5% and 10%, respectively. (2) Standard errors of estimates omitted. These were corrected to be robust to the presence of heteroskedasticity and 18-order autocorrelation (indicated in hypothesis testing). The correction adopted was the Newey-West procedure (see Baum, 2006 and Wooldridge, 2002). (3) Presented results reflect the elasticity from the respective coefficients.

The average fare is the main economic indicator to verify transport demand. Every decision on demand analysis, on which transport to use, the average fare must be present. In the event of a price increase, the quantity demanded will decrease, a fact demonstrated by the negative sign of the regression. The statistical significance of 1% for average fare was achieved only with the use of wage mass index. The 5% with employment and industry capacity, and 10% with ICMS collection and GDP Brazil. In the other indices, the average rate was not statistically significant.

Analyzing the significance of the index, wage, wage mass, occupied population, industry sales, industry capacity and GDP Brazil showed significant 1%. Economically active population and ICMS collection presented significance of 5%; employment showed significant 10% and the others were not statistically significant.

Table 5. Results of the regression model (dependent variable: daily pax sp)

	(IX) industry capacity	(X) ICMS collection	(XI) GDP São Paulo	(XII) GDP Brazil
industry capacity	1.5274 ***			
ICMS collection		0.1583**		
GDP São Paulo			0.1194	
GDP Brazil				0.3826***
average fare	-0.4132**	-0.4198*	-0.1195	-0.4051*
seasonality month 2	0.0059***	0.0081***	0.0068***	0.0086***
seasonality month 3	0.0065**	0.0107***	0.0093***	0.0105***
seasonality month 4	0.0052**	0.0085***	0.0080***	0.0084***
seasonality month 5	0.0046	0.0099***	0.0086***	0.0085***
seasonality month 6	0.0037*	0.0080***	0.0073***	0.0069***
seasonality month 7	-0.0012	0.0038***	0.0026**	0.0027**
seasonality month 8	0.0060*	0.0122***	0.0105***	0.0110***
seasonality month 9	0.0046	0.0097***	0.0094***	0.0100***
seasonality month 10	0.0057**	0.0106***	0.0105***	0.0097***
seasonality month 11	0.0042**	0.0083***	0.0083***	0.0068***
seasonality month 12	0.0066***	0.0053***	0.0053***	0.0046***
R2	0.9623	0.9542	0.9532	0.9537
RMSE	0.5761	0.6355	0.6455	0.6388
F Test (Statistics)	169.5205	249.6348	163.4837	216.7733
F Test (P-Value)	0.0000	0.0000	0.0000	0.0000
RESET	0.0014	1.0882	6.9748	1.0809
RESET_P-Value	0.9700	0.2969	0.0083	0.2985

Notes: (1) ***, **, * indicates statistically significant at 1%, 5% and 10%, respectively. (2) Standard errors of estimates omitted. These were corrected to be robust to the presence of heteroskedasticity and 18-order autocorrelation (indicated in hypothesis testing). The correction adopted was the Newey-West procedure (see Baum, 2006 and Wooldridge, 2002). (3) Presented results reflect the elasticity from the respective coefficients.

Concerning the synthesis statistics of the estimated regression model, the coefficient of determination (R^2) was above 90%, indicating an adequate fit of the data to the model. The F test is used to test the overall significance of a multiple regression, by checking that all angular coefficients are simultaneously equal to zero (null hypothesis). If at least one of the coefficients is nonzero, we can reject the null hypothesis. The lower the test p-value F, more easily we can reject the null hypothesis. All models presented test p-value F statistically significant at 1%, indicating that at least one of the coefficients is not zero, and the model has the explanatory power of this phenomenon.

Finally, we have the RESET test, whose null hypothesis that there is some underspecification model, measured by polynomials included in the regression. To increase the power of the hypothesis test, the test p-value should be greater than 25%. The present indicators in columns III, VII, VIII, IX, X and XII did not reject the null hypothesis, showing no underspecification system and other models presenting underspecification. In the next section will be held the classification of indicators.

CLASSIFICATION OF ECONOMIC INDICATORS

To compare the indicators, as shown in **Table 5**, was used the following statistical indicators to verify the accuracy: RMSE, MAPE and RESET test, along with the statistical significance of the coefficients. After analyzing the parameters, was performed a rating scheme ranging from 0 to 5, with 5 assigned to the best estimates. The score was obtained as the total sum of scores for each criterion. For the RMSE, RESET and MAPE criteria scored the five smallest indicators. For the coefficients 1 and 2 scored those with statistical significance. The RMSE is the square root of the error mean and MAPE is the mean absolute percentage error and are defined as:

Table 5. Growth rates used in the forecast scenarios

Model	*Variable*	*RMSE*		*RESET*		*MAPE*		*Coef. 1*	*Coef. 2*	*Score*
I	wage	0.565	†	0.082		0.051		-0.2458*	0.6359***	3
II	employment	0.623		0.016		0.043	†	-0.6586**	0.5646*	3
III	wage mass	0.536	†	0.607	‡	0.034	†	-0.4977***	0.5676***	5
IV	occupied pop.	0.567	†	0.041		0.045	†	-0.3414	2.1246***	3
V	economically active pop.	0.632		0.008		0.066		-0.1908	0.8401***	1
VI	activity	0.641		0.002		0.069		-0.1651	0.5951	0
VII	retail sales	0.661		0.277	‡	0.064		-0.4121	0.0281	1
VIII	industry sales	0.568	†	0.947	‡	0.049	†	-0.2932*	0.5791***	5
IX	industry capacity	0.576	†	0.970	‡	0.045	†	-0.4132**	1.5274***	5
X	ICMS collection	0.636		0.274	‡	0.061		-0.4198*	0.1583**	3
XI	GDP São Paulo	0.646		0.009		0.070		-0.1195	0.1194	0
XII	GDP Brazil	0.639		0.281	‡	0.057		-0.4051*	0.3826***	3

Note: † indicates selection between 5 minors; ‡ indicates that not reject the null hypothesis test at 25% significance level (the higher the significance more conservative); ***, **, * Indicates statistically significant at 1%, 5% and 10%, respectively

$$\text{RMSE} = \sqrt{\frac{\sum u_i^2}{n}} \text{ e } \text{MAPE} = \frac{\sum |e_i|/Y_t}{n} \quad (3)$$

where u: the regression error term; n: number of observations; and: forecast error in period t; Y_t: true value in period t.

The wage mass, industry sales and industry capacity index proved to be the best indicators. Most workers use public transport as a means of locomotion, including being guaranteed by the Brazilian law the aid for transport. In the event of reduction of the workforce, the demand for public transport will decrease. However, as employment and wage index proved to be the worst indicators.

We can analyze the wage mass and industry capacity are measured locally, while wages and employment are measured in the state of São Paulo. The geographically specificity produced better indicators. The activity and GDP Sao Paulo index appeared to be the worst indicators, due not only to enter the industry numbers but the other sectors of the economy. The best rates are those directly related to the industry and measured locally, showing the correlation between workers and public transport.

CONCLUSIONS

The planning of urban public transport in large cities has received the attention of rulers. The use of reliable economic indicators for demand studies will allow better planning and projection of the necessary infrastructure needs to ensure the movement of people and goods. This need in the case of transport demand is evident, due to its derivative feature, where the displacements occur, to add value and generate wealth.

Through econometric and statistical analysis tests, in this paper was conducted the analysis of passenger demand and its relationship with economic indicators. The indicators linked to the industry and locally measured proved to be the best indicators, while wealth indicators that include other sectors of the economy and measured regionally produced no significant results.

Future studies should be conducted on the possible use of other indicators, how will behave indicators of workers by income, and should be examined educational indicators to measure the strength of students from public and private schools in the public transportation.

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