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Study of the changes in urban mobility of the Brazilian middle class, brought about by the population's increased income, and the ensuing impact on urban mass transit.

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Abstract

Since 2003, Brazil has shown strong economic growth, accompanied by improved income distribution. This has brought changes in consumption patterns and within the country's different production chains, with considerable impact on urban mobility. The economic boom led to increased travel and the enhanced ability to purchase consumer durables brought changes in the way people traveled. The result has been the adoption of an unsustainable consumption pattern, with a reduction in public transport usage and increased automobile use. Reversing this trend will mean identifying the population groups that would be most likely to go back to using public transport, following the implementation of suitable public policies. The purpose of this article is to identify and define this population segment and then to look into what the most suitable measures and policies would be for reversing the present trend and ensuring the sustainability of urban travel.

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1. Introduction

Since 2003 there has been significant growth and improved distribution of income for the Brazilian population, which has been reflected in a swelling of the numbers of people in the economic classes that have greater purchasing power and a reduction in the economic classes that have less purchasing power. This has brought about changes in

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consumption patterns that have affected all the Brazilian production chains, as well as having a significant impact on urban mobility.

During this same period, the demand for urban mass transit in Brazil underwent a steady decline, saw a turnaround that led to a slight improvement, and now the number of passengers carried has stabilized. In contrast, public policies have benefited individual transport, with new vehicle and fuel costs rising more slowly than inflation. The result has been increased spending on private transportation by all income groups, while spending on public transportation has only increased among the lower income brackets and has diminished among the higher income groups.

In this article we examine this migration away from mass transit to individual transportation for getting around in Brazilian urban centers, identify the population segment that should be the primary focus of action to improve the public transport systems and outline the most suitable measures and policies for reversing the present trend. In this analysis we have used the 2003 and 2009 Household Budget Surveys (*POF - Pesquisas de Orçamento Familiar*) and the 2001 and 2012 Household Origin and Destination Surveys for the Belo Horizonte metropolitan area.

2. Income and urban mobility in Brazil

In Figure 1, one can see the period of economic growth combined with improved income distribution. During the years 1992 to 2003 there was modest economic growth, while during the years 2003 to 2011 there was a significant decline in the numbers within the social classes that have less purchasing power, the Lower Classes (Classes D and E), accompanied by expansion of the social classes that have greater purchasing power, the Middle Class (Class C) and Upper Classes (Classes A and B). During this latter period, the population classified as Middle Class grew by an annual average of 7.3%, compared to 3.1% p.a. during the earlier period. In absolute terms, that means a total of 40 million people was added to the Middle Class in just eight years. Meanwhile, the Upper Classes grew by 9.8 million during the latter period, representing an average annual growth rate of 8.9%, compared to 5.9% p.a. during the earlier period. In stark contrast, the population numbers in the Lower Classes, following an initial increase of 0.2% p.a., declined by an average of 4.4% p.a., with the result that there were 34.7 million fewer Brazilians in the lowest economic classes by 2011.

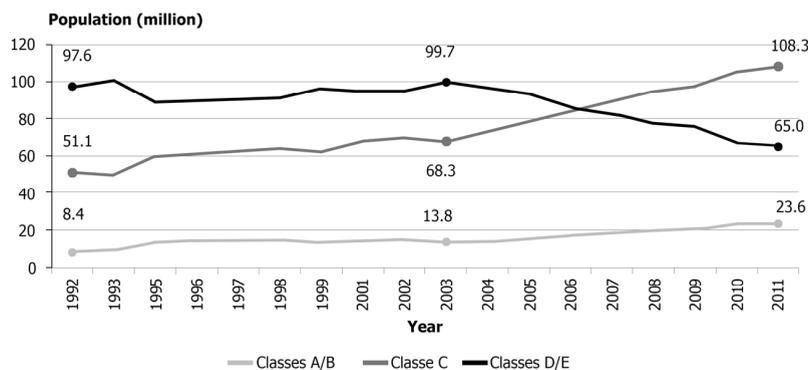


Figure 1: Brazilian population change by social class

Source: Prepared by the authors, based on Neri (2010) and Neri (2012).

Analyzing the changes in the number of passengers carried per month in the urban bus - the main public transport mode in Brazilian cities - network over the aforementioned period, **¡Error! No se encuentra el origen de la referencia.** Figure 2 shows a sharp decline in the number of passengers carried on buses. This can be broken up into five distinct periods. The first period, between 1995 and 2000, saw a sharp reduction in demand, with a loss of 26.5% over the period, equivalent to an average of 5.3% p.a. or approximately 25 million monthly passengers per year. The next two years (2000-2002) saw the demand stabilize, with a slight increase of 1%. However, this short-lived stability was merely a rest before a further sharp drop in demand between 2002 and 2004. Over those two

years, the urban bus network lost 6.5% of its passenger numbers each year, equivalent to 22.8 million monthly passengers per year.

In the fourth period, the situation changed and there was a steady rise in demand, which was up by 10.3% between 2004 and 2008, at an average of 2.6% p.a. or 8 million monthly passengers per year. The final period began in 2008 and shows a flattening off of demand, with a slight downward trend in passenger volume, by -0.7% to 2012. The level of demand for the bus network in 2012 is similar to that of 2000 and there is concern over the oscillations in demand over the last four years and uncertainty as to what passenger numbers will be like in the next few years.

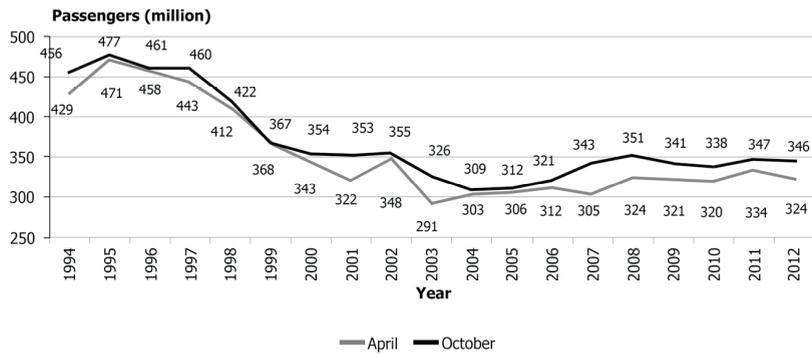


Figure 2: Changes in the monthly number of passengers carried in the urban bus system of 9 Brazilian state capitals (Belo Horizonte, Curitiba, Fortaleza, Goiânia, Porto Alegre, Recife, Rio de Janeiro, Salvador and São Paulo). Source: NTU (National Association of Urban Transport Companies) 2008.

Every six years, the IBGE (Brazilian Institute for Geography and Statistics) conducts a Household Budget Survey (POF - Pesquisa de Orçamentos Familiares). This is an important source of data on the consumption patterns and income of Brazilian households and includes spending on urban transport, the object of our study. The 2003 and 2009 POFs mark, respectively, the stages before and after Brazil’s recent rapid economic growth and are therefore essential to any analysis of the changes in spending on urban travel by the Brazilian population. Carvalho & Pereira (2012) take advantage of these two studies to analyze those changes and we have used some of their charts to assess the scenario of Brazilian urban mobility in recent years.

The percentage changes in the number of households and the proportion of their incomes devoted to urban transport between 2003 and 2009 (Figure 3 and Figure 4) show the increased use of private transport and reduced use of public transport, with different behaviors revealed by analysis according to income level.

The changes in the number of households spending their money on urban transport, shown in Figure 3, do not reveal an increased share of private transport at all income levels. Indeed, the use of public transportation has increased among households up to the 4th decile, then decreases as from the 5th decile.

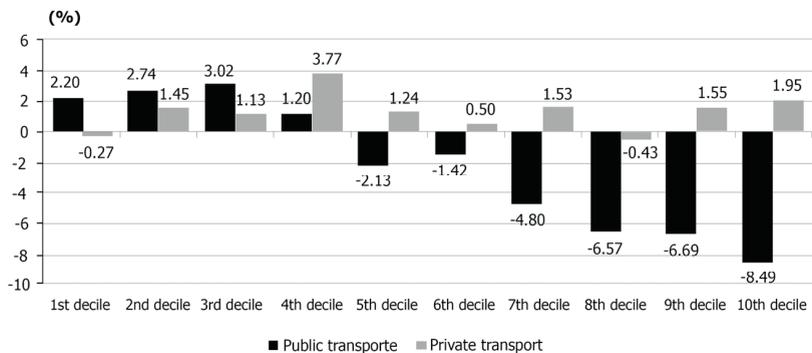


Figure 3: Change in the number of households with spending on urban transport, in per capita income deciles (2003-2009)
Source: Carvalho & Pereira (2012), from the 2003 and 2009 POFs (Household Budget Surveys).

Figure 4 shows increased income being devoted to private transportation, up to the 5th decile, and a reduction in relation to public transport for all income groups, but with the highest percentages among the lower-income groups, up to the 6th decile. Carvalho & Pereira (2012) believe that the increase in the number of households and the greater income devoted to private transport is related to the releasing of suppressed demand among the groups with lower purchasing power, as rising incomes and easier access to such modes of transport have led to increased spending. The impact of the incentive programs that have facilitated automobile acquisition and helped to keep the prices down, as well as that of fuel, has also been reflected among the groups with higher purchasing power, who have been able to reduce their spending, because they already owned and had already been using this consumer durable.

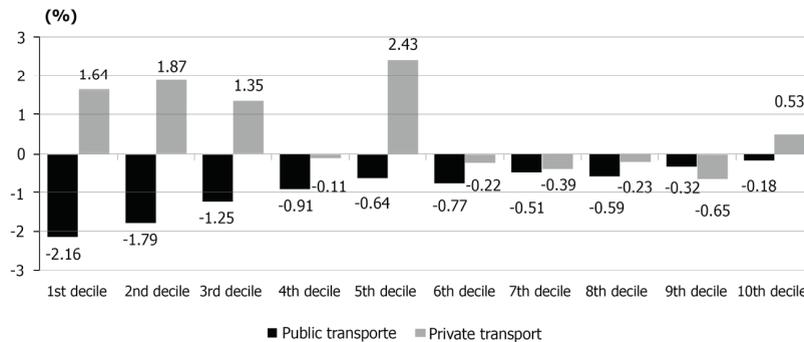


Figure 4: Change in household income devoted to spending on urban transport, in per capita income deciles (2003-2009)
Source: Carvalho & Pereira (2012), from the 2003 and 2009 POFs (Household Budget Surveys).

It is interesting to see how these government incentive programs have affected urban transport costs during this period and clarify what we said earlier. From Figure 5, one can see that public transport fares increased at a much faster rate than inflation, as measured by the IPCA index (63.2% against 41.8%). In contrast, the increases in the price of a new vehicle (19%) and in gasoline prices (27.5%) were both well below the inflation rate (41.8%). So there were savings gains to be made when using private transport instead of public transport, once the vehicle had been acquired, which also involved a price reduction.

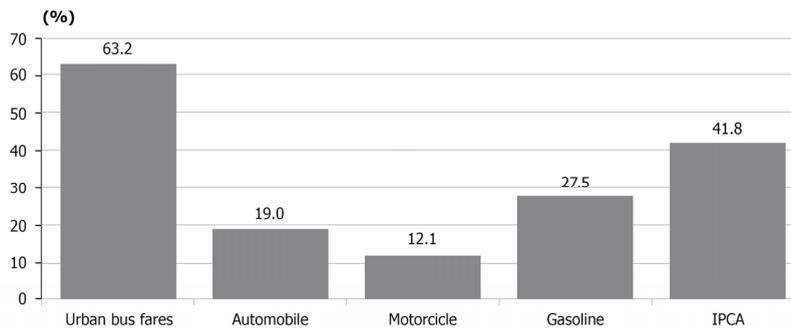


Figure 5: Accumulated changes in urban bus fares, the cost of a new car or motorcycle, gasoline prices and the IPCA inflation index (2003-2009).
Source: Carvalho & Pereira (2012), from the 2003 and 2009 POFs (Household Budget Surveys).

Further useful information is obtained when one analyzes the spending of these households on urban transport at those two different times and in the light of the different income levels (

Table 1). In this context, it is important to note the high level of spending on private transport as from the 6th decile, from which one may presume that private transport is given enhanced importance among the top five deciles. It is also interesting to note that, although there was an overall reduction in spending on public transport, a significant reduction only occurs as from the 8th decile, and one should also acknowledge the significant increase in average per capita income among the 1st to 4th deciles, plus the sizeable gains in the 5th to 7th deciles.

Analyzing all the previous data, one can see that the recovery in demand for public transport takes place during the period of rapid economic growth and improved income distribution amongst the Brazilian population, despite an increased share of spending going to private transport and a transfer of spending from public transport to private transportation by the middle and higher-income population. This means that the increased spending on public transport by the population with lower purchasing power has ensured the stability of demand, replacing the higher income level passengers.

Table 1: Average monthly household spending on urban transport, in income deciles (2003-2009)

Per capita household income (in deciles)	Urban transport spending			Private transport spending			Public transport spending			Average monthly income (R\$)		
	2003	2009	Change (%)	2003	2009	Change (%)	2003	2009	Change (%)	2003	2009	Change (%)
1st decile	94.73	116.16	22.62	41.91	61.34	46.38	52.82	54.82	3.78	423.90	532.03	25.51
2nd decile	128.52	161.90	25.97	63.80	97.14	52.25	64.71	64.75	0.06	731.55	917.20	25.38
3rd decile	154.81	189.77	22.58	84.58	118.74	40.39	70.23	71.03	1.14	956.49	1165.42	21.84
4th decile	211.73	248.54	17.38	133.53	164.72	23.36	78.20	83.82	7.18	1,196.63	1,490.95	24.60
5th decile	224.30	296.63	32.25	145.12	213.93	47.42	79.18	82.69	4.44	1,461.68	1,730.79	18.41
6th decile	316.47	350.30	10.69	227.64	262.23	15.20	88.83	88.07	-0.85	1,793.03	2,102.56	17.26
7th decile	400.92	439.92	9.73	312.04	350.45	12.31	88.88	89.47	0.67	2,227.85	2,573.93	15.53
8th decile	524.44	541.14	3.18	426.95	454.56	6.47	97.49	86.57	-11.20	2,988.64	3,237.67	8.33
9th decile	824.25	810.59	-1.66	730.79	727.52	-0.45	93.46	83.07	-11.12	4,503.41	4,669.59	3.69
10th decile	1,421.94	1,503.45	5.73	1,328.52	1,426.78	7.40	93.42	76.66	-17.94	10,550.82	10,872.28	3.05
Total	478.72	506.33	5.77	396.22	427.44	7.88	82.50	78.89	-4.38	3,015.66	3,211.25	6.49

Source: Carvalho & Pereira (2012), from the 2003 and 2009 POFs (Household Budget Surveys).
 Authors' note: Values in R\$ for January 2009 are adjusted according to the IPCA inflation index.

A look at the regional database for the 2009 POF, involving the nine most important Brazilian metropolitan areas, shown in Figure 6 and Figure 7, reveals that spending on private transport increases sharply as from the 7th decile. At the same time, one can see steady growth in spending on public transport between the 1st and 7th income deciles, after which it drops off sharply.

So, the public transport characteristics must be sensitive to perceived quality for the population in the 4th to 7th income deciles. And if one wants to make the most of policies to favor public transport, one must focus on the demands of the population within this income range. By giving due importance to the demands of this income range, one will find the population within the 1st to 3rd income deciles automatically adopting public transport, leading to a potential increase in revenue.

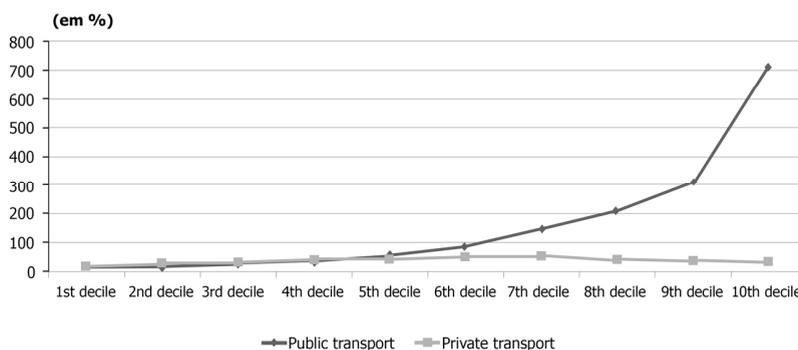


Figure 6: Per capita spending on urban mass and individual transport by urban households in the nine original¹ metropolitan areas with effective spending on urban transport, in income deciles (2009)

Source: Carvalho & Pereira (2012), from the 2003 and 2009 POFs (Household Budget Surveys).

¹ Belém, Belo Horizonte, Curitiba, Fortaleza, Porto Alegre, Recife, Rio de Janeiro, Salvador and São Paulo.

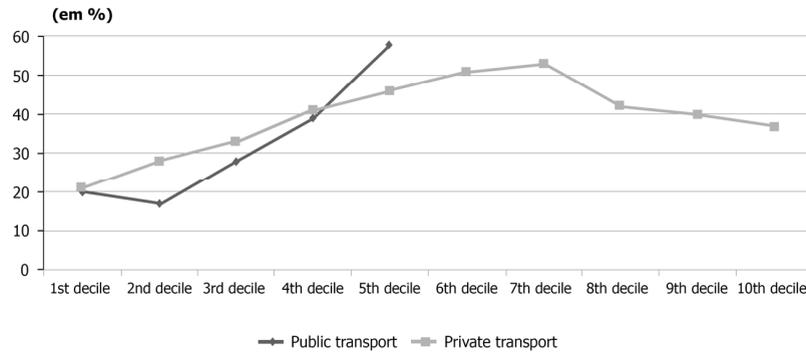


Figure 7: Per capita spending on urban mass and individual transport by urban households in the nine original¹ metropolitan areas with effective spending on urban transport, in income deciles (2009)

Source: Carvalho & Pereira (2012), from the 2003 and 2009 POFs (Household Budget Surveys).

¹ Belém, Belo Horizonte, Curitiba, Fortaleza, Porto Alegre, Recife, Rio de Janeiro, Salvador and São Paulo.

3. Urban mobility in the Belo Horizonte metropolitan area

The Household Origin and Destination Survey (OD) has been carried out every ten years in the Belo Horizonte Metropolitan Area (RMBH) since 1972, with the aim of determining and defining the population's urban journeys. The 2001 and 2012 ODs determined the urban mobility in the RMBH at the stages before and after the rapid Brazilian economic growth, making them an essential tool for analyzing the changes in urban journeys and adding valuable information to that analyzed in the POFs.

The RMBH is the third largest Brazilian urban agglomeration, covering an area of 9.5 million km² and with a population of 5.4 million, according to the most recent IBGE population census. The area contains 34 municipalities, of which only 13 form a conurbation, while just five of them contain 80% of the population. During the 1990s, Belo Horizonte grew at a rate of 1.1% p.a., while the RMBH grew at 3.9% p.a.. During the 2000s the population growth of the state capital declined to 0.6% p.a. and in the RMBH it was 1.9% p.a.. It should be noted that the rate of population growth decreases every year and is concentrated in the peripheral municipalities, thus reducing Belo Horizonte's share.

The general data on urban mobility in the RMBH, shown in Figure 8, reveal that in the last ten years the population increased by 18.9%, while the automobile and motorcycle fleets grew by 112% and 278%, respectively, representing an increase of 92.7% in motor vehicle ownership. During the same period, the number of journeys made by the inhabitants increased by 57%, mainly driven by the increase in automobile and motorcycle journeys, which were up by 174%. Overall analysis indicates that increased vehicle ownership in the RMBH has led to increased travel without causing a reduction in the demand for urban public transport, which has remained constant during the period. Analysis of the specific years and by income level should help us to better understand the population behavior.

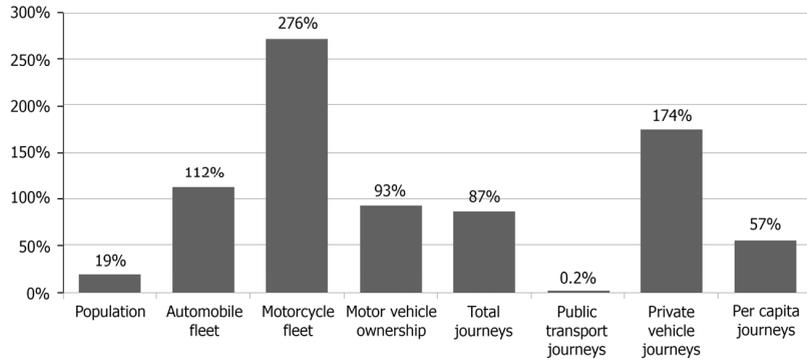


Figure 8: Changes in the population and mobility indicators (2002-2012).

Source: Prepared by the authors, based on the 2001 and 2012 ODs; IBGE 2000 and 2010 Censuses.

The number of vehicles per capita grows exponentially with increased income. In Figure 9, the 2001 automobile curve shows a steepening from the 7th decile, while in 2012 the steeper slope is from the 8th decile, and there is increased vehicle ownership in all the income groups. The increased income and economic stability has enabled the population with lower purchasing power to buy consumer durables and Figure 10 shows that, in terms of urban mobility, this has led to increased motor vehicle ownership. This has been most accentuated among the population with lower purchasing power, between the 1st and 3rd deciles, where the average increase was 140%, while in the 4th to 7th deciles it was 77% and in the 8th to 10th deciles it was 21%. Motorcycles, because of their relatively lower purchase price and running cost, showed much higher percentage variations. The similarity between the groups of income deciles enabled us to analyze the urban mobility using the three income groups mentioned above.

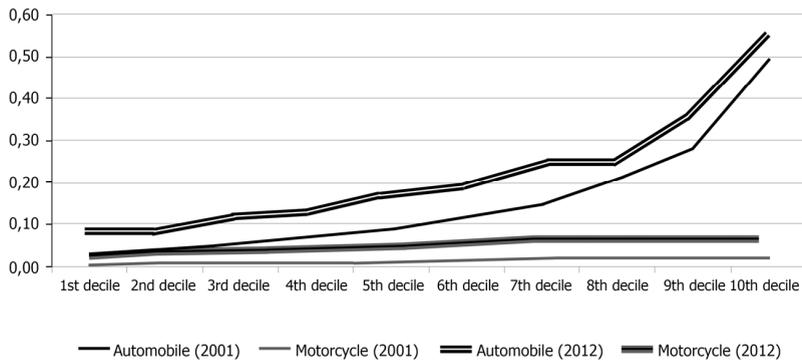


Figure 9: Vehicle fleet per capita, in per capita income deciles (2001 – 2012)

Source: Prepared by the authors, based on the 2001 and 2012 ODs.

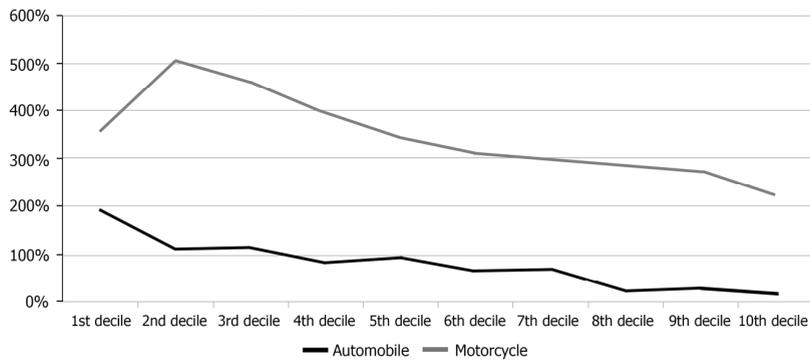


Figure 10: Change in vehicle fleet per capita, in per capita income deciles (2001 – 2012)
Source: Prepared by the authors, based on the 2001 and 2012 ODs.

The number of journeys in 2001 and 2012, shown in Table 2, broken down by transport mode and reason, shows that automobile and motorcycle journeys increased by 203% and, along with traveling on foot, account for 84% of the increase in urban travel. Public transport by bus, unlike the other modes of transport, suffered a year on year decline of 4.1% and the stable overall demand for the mass transit network is due to the increased demand for subway services, which for the users represent greater quality and reliability. Nevertheless, the mass transit network lost market share in the travel matrix. In 2001, it was the main means of transport, accounting for 66% of motor vehicle journeys (currently down to 39%), while the individual modes that accounted for 27% have increased to 48%, thereby establishing themselves as the principal means of transport. From the point of view of the sustainability of urban mobility, the loss of mass transit market share in the overall travel matrix and the increasing number of journeys by individual motor vehicle transportation (automobiles and motorcycles) is worrying.

All the different reasons underlying the journeys showed growth during the period, except for stopovers. Study is particularly worth mentioning, showing growth of 141.29%, while Personal Services (Leisure, Shopping, Personal Matters and Health) grew by 264%. Both of these were well above average. So, people are traveling more, particularly by means of individual transportation and for personal reasons.

Transport mode	Urban journeys			Reason for journey	Urban journeys		
	2001	2012	Change (%)		2001	2012	Change (%)
Mass transit	3380382	4100807	21.3	Home	3530885	6181049	75.1
Bus	3048404	2923826	-4.1	Work	1496364	2749515	83.7
Subway	76834	206259	168.4	Study	770761	1859800	141.3
School bus	158374	679912	329.3	Stopover	708563	52275	-92.6
Chartered transport	96769	290810	200.5	Leisure/Visit/Religious	127108	438064	244.6
Individual	1330324	3999630	200.7	Personal Matter	116897	299322	156.1
Automobile (driver)	859450	2278429	165.1	Health	76059	308676	305.8
Automobile (passenger)	359799	1068235	196.9	Shopping	65680	359012	446.6
Motorcycle	63282	547185	764.7	Others	109622	812006	640.7
Taxi	27642	87530	216.7	Total	7001939	13059719	86.5
Truck	20151	18251	-9.4				
No Motor Vehicle	2281269	4939276	116.5				
On foot	2213546	4809512	117.3				
Bicycle	67723	129764	91.6				
Other	9964	20005	100.8				
Others	9964	20005	100.8				
Total	7001939	13059719	86.5				

Table 2: Daily urban travel, by mode of transport and motive (2001 – 2012)
Source: Prepared by the authors, based on the 2001 and 2012 ODs.

The increase in the number of journeys is not evenly distributed among the different income deciles, as can be seen in Figure 11. The higher income deciles (8th to 10th) did not show any significant change in the number of journeys per capita, while the lower income deciles (1st to 3rd) showed a 31% increase in the number of journeys per capita and the intermediate deciles (4th to 7th) showed an average increase of 9%. In other words, the lower income classes (1st to 3rd decile) and middle class (4th to 7th decile) are responsible for the increase in urban travel by the various different transport modes.

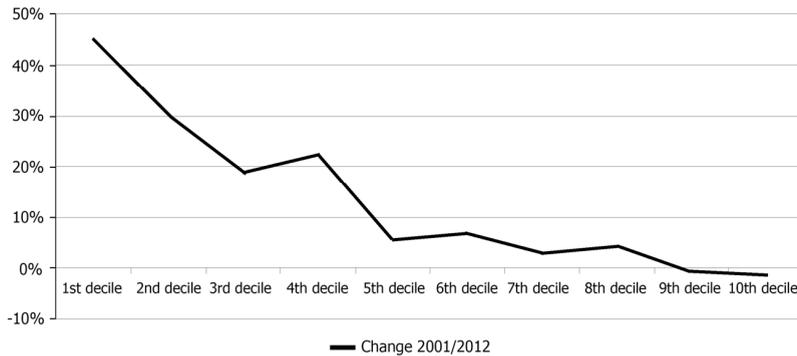


Figure 11: Change in per capita urban travel, in per capita income deciles (2001 – 2012)
 Source: Prepared by the authors, based on the 2001 and 2012 ODs.

The distribution of households according to the modes of transport used in 2001, shown in Figure 12, reveals a strong increase in travel by individual modes, as from the 7th decile, and a reduction in the exclusive use of public modes, as from the 4th decile. These data strengthen the conclusions drawn from the spending analyses that indicated households in the income range between the 4th and 7th deciles as the ones that are most likely to change their mode of transportation with increased income. Figure 13 shows the equivalent data for 2012, revealing a reduction in the number of households that only use public transport right across all the income deciles. One can also perceive an increase in the number of households between the 1st and 7th deciles that use both public and individual modes, while there is a reduction in all the other deciles. And there has been an increase in the exclusive use of individual transport in all the deciles, but most notably in the 1st to 7th deciles. These changes show that among the households in the 4th to 7th income deciles there was a migration to the individual transport modes, to the detriment of the public transport modes.

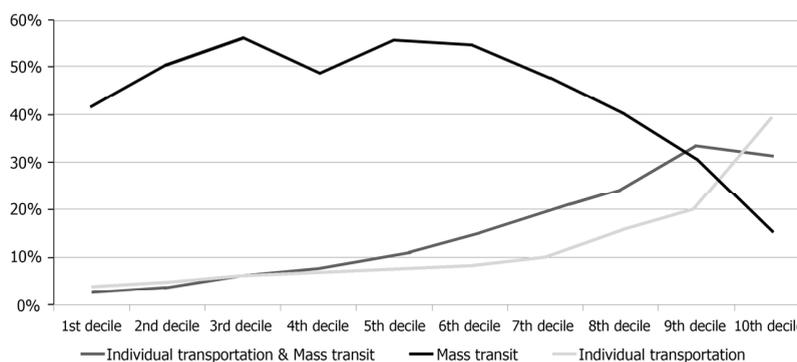


Figure 12: Different means of urban travel, in per capita income deciles (2001)
 Source: Prepared by the authors, based on the 2001 OD.

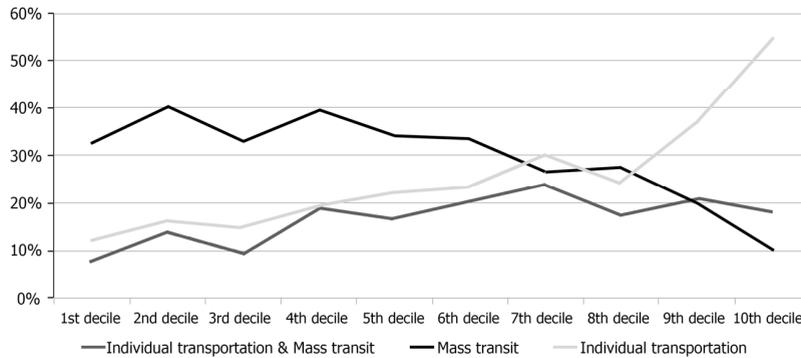


Figure 13: Different means of urban travel, in per capita income deciles (2012)

Source: Prepared by the authors, based on the 2012 OD.

4. Conclusions

Improved income distribution coupled with economic growth and low inflation brought about profound changes in the urban travel matrix, modifying the reasons to travel and the transport mode utilized. The consequences were increased travel by car, making this the primary urban transport mode, and a reduction in journeys by public transport. The population's choice of this unsustainable urban mobility model can lead to a serious loss of quality of life in Brazil's cities.

Reversing this choice and progressing towards a sustainable model of transportation is essential and requires the adoption of new public policies for urban transport that safeguard mass transit and focus on the 4th to 7th income deciles, which are rapidly migrating to individual modes of transport.

These new policies need to discourage the use of individual transportation and parking in urban centers, while improving the quality of the urban public transport, providing enhanced speed and comfort, implementing exclusive lanes for buses, expanding the subway networks and designing infrastructure that provides full integration between the different transport modes, including motor vehicles and other ways of getting around.

Any furthering of this study should focus on increasing understanding of urban travel by the population segment in the 4th to 7th income deciles, along with their needs and desires, as well as following up the study, so as to deepen the analysis of the most suitable public policies for ensuring sustainable urban mobility.

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