前　言

近年来，中国汽车产业持续保持高速发展态势，汽车产销和保有量连续多年快速增长，2010 年汽车产销量突破 1800 万辆，成为世界第一大汽车产销国，民用汽车保有量突破 7800 万辆；由汽车消耗的燃料总量不断攀升，连续多年成为中国新增石油消耗的主体。

为应对汽车保有量不断增长所引起的能源和环境问题，实现中国汽车产业可持续、健康发展，中国从 2002 年开始先后制定实施了《乘用车燃料消耗量限值》、《轻型商用车辆燃料消耗量限值》、《轻型汽车燃料消耗量标识》等汽车节能领域的重要标准，建立起相对完善的轻型汽车燃料经济性标准体系。在汽车节能管理方面，工业和信息化部于 2008 年发布实施《轻型汽车燃料消耗量标示管理规定》，在我国首次建立了以服务消费者为目的的燃料消耗量标示和通告制度，自 2010 年 1 月 1 日起通过工信部网站每月向社会公开发布轻型汽车燃料消耗量信息，通过准确的燃料消耗量信息引导消费者购买低油耗节能汽车。

受工业和信息化部委托，中国汽车技术研究中心将以汽车燃料消耗量标识备案信息为基础，定期对我国汽车产品的技术状态、燃料消耗量水平及其发展趋势进行客观分析，对汽车燃料消耗量限值标准的实施效果进行评估，为政府部门决策、企业产品开发及科学研究提供参考。

作为尝试，我们首先从乘用车开始，依据 2010 年乘用车燃料消耗量备案数据，对车辆主要特征参数、车型燃料消耗量及其相互关系进行统计和交叉分析；梳理统计各类节能技术在乘用车上的应用情况，简要分析节能技术的应用效果；结合节能汽车（1.6 升及以下乘用车）推广政策实施情况，对比分析节能汽车技术状态和燃料消耗量水平；计算分析我国主要乘用车生产企业平均燃料消耗量、全国平均燃料消耗量和不同技术来源平均燃料消耗量。

本报告是在工业和信息化部的指导和能源基金会的支持下、由中国汽车技术研究中心编写完成的。本报告由金约夫负责，王兆、保翔执笔；编写组成员包括金约夫、王兆、保翔、郑天雷。

这是我们首次对中国乘用车产品技术状态和燃料消耗量进行综合分析。受基础数据历史积累不够所限，部分研究分析不够系统和深入，报告可能会存在不足和疏漏之处。希望关心汽车节能工作的领导、专家和社会各界提出指导和批评意见，以便我们在后续的工作中改进和提高。

二零一一年十一月

Foreword

During the recent years, the Chinese automobile industry has kept its roaring growth, with the production, sales, and population of motor vehicles rising rapidly in many successive years; in the year2010, both auto production and sales outstripped 18 million sets, making China rank number one around the globe, and with the population of private vehicles exceeding 78 million sets; the total fuel consumption attributable to automobiles has remained increase, and the automotive sector has become, in many years, the new big petroleum consumer in China.

For finding a solution to the energy and environmental issues arising from vehicle population and promoting the development of the Chinese auto industry in a sustainable, healthy manner, China has begun, since 2002, formulating and putting into effect some key standards with respect to automotive energy saving, including, among others, “Limits of fuel consumption for passenger cars”, “Limits of fuel consumption for light duty commercial vehicles”, and “Fuel consumption label for light vehicle”; consequently, a relatively complete system of standards has been set up for fuel economy of light-duty vehicles. As for the administration over automotive energy saving, Ministry of Industry and Information Technology (MIIT) promulgated and implemented, in 2008, the “Regulations for Fuel Consumption Label of Light-duty Vehicles”, establishing, for the first time, the fuel consumption labeling and publicity system in China for the purpose of serving the consumers; after January 1, 2010, the official website of MIIT has monthly made public the fuel consumption information of light-duty vehicles, such that the accurate information could guide the consumers in purchasing the energy-saving vehicles featuring a low fuel consumption.

As engaged by MIIT, China Automotive Technology and Research Center (CATARC) will unfold objective analysis to the technical state, fuel consumption level and its trends of the local auto products in a periodic manner based on the record information of automotive fuel consumption label, in addition to the assessment on the implementation efficacy of the fuel consumption limit standards for motor vehicles, thus providing references for the policy making of governmental authorities, the product R&D of manufacturers, and scientific researches.

As an attempt, we begin with passenger cars: based on the record data of fuel consumption of passenger cars in 2010, statistics and cross analysis are conducted to vehicles’ main characteristic parameters, fuel consumption of vehicle type, and their interrelations; based on the collation and statistics of the application of various energy-saving technologies in passenger cars, a brief analysis is conducted to the application results of the energy-saving technologies; in combination with the execution of the popularization policies concerning energy-saving vehicles (passenger cars ≤ 1.6 liter), comparative analysis is unfolded to the technical state and fuel consumption level of the energy-saving vehicles; and calculations and analysis are carried out as to the company average fuel consumption (CAFC) of the local main passenger car makers, national average fuel consumption (NAFC), and average fuel consumption of technical source (TSAFC).

This report is formulated by CATARC under the guidance of MIIT and supported by Energy Foundation. As led by Jin Yuefu, it is written by Wang Zhao and Bao Xiang; and the compilation team constitutes Jin Yuefu, Wang Zhao, Bao Xiang, and Zheng Tianlei.

This report represents our first all-round analysis to the technical status and fuel consumption of the passenger car products in China. Whereas the historically accumulated fundamental data are not quite sufficient and some researches and analysis are not quite systematic and deep-going, weak points and omissionswould be inevitable in this report. It is expected that the officials, experts and various social circles who care about the auto energy-saving could put forward guidance and criticism opinions, so as to encourage our improvement in the subsequent work.

November, 2011

目　录

CONTENT

1 数据来源和数据处理

为准确、客观地反映我国乘用车产品的技术状态及燃料消耗量水平，本章简要介绍了报告中所用数据的来源以及对数据进行前期处理的方法。

1.1 数据来源

本报告数据全部来源于国产车生产企业及进口车经销商按照《轻型汽车燃料消耗量标示管理》提交并经工业和信息化部确认的汽车燃料消耗量标识备案信息。数据截止至 2010 年 12 月 30 日，仅涵盖乘用车备案数据，共计 10,653 条，对应 4486 个车辆型号[1]。

1.2 数据处理

按照《轻型汽车燃料消耗量标示管理规定》、“汽车燃料消耗量标识备案信息”及其填写说明的要求：对同一型号的车辆，如果整车整备质量、最大设计总质量、额定载客人数、前/后轴距、轮胎规格、燃料消耗量等任何车辆参数具有不同数值或不同配置的应分别单独备案；对已备案车型的车辆参数或燃料消耗量进行更改的，按如下原则进行处理：

已备案车型除燃料消耗量以外的其它参数发生变化的，按照新增数据发布；

已备案车型的燃料消耗量变化但其余参数不作调整的，需要企业提供相应文件及证明，对申请燃料消耗量变化情况予以说明。

基于上述原因，在汽车燃料消耗量标识备案数据库中存在一个车型对应多条数据的情况。

为方便后续分析，对照《乘用车燃料消耗量限值》标准并根据数据分析需要，将 1）生产企业、2）车辆型号、3）是否越野车、4）发动机型号、5）燃料类型、6）排量、7）座椅排数、8）驱动型式、9）变速器型式、11）档位数、12）综合工况燃料消耗量和 13）整车整备质量所处的质量段等 13 项参数作为表征车辆技术状态和燃料消耗量水平的主要参数。对上述参数全部相同的数据进行合并；对上述参数中任何一项存在差别的，则作为单独的有效数据予以保留。

如表 1 所示，依照上述原则，将 2010 年 12 月及以前的 10,653 条备案信息，简化合并为 5,726 条有效数据（为方便描述，以下将“有效数据”称为“车型”），涵盖了国内外共 131 家生产企业和制造商，其中包括 90 家国内生产企业和 41 家国外制造商（涉及 27 家进口经销商）。

表 1 本报告所用数据概览

数据条数			企业数		
国内	国外	合计	国内	国外	合计
5073	653	5726	90	41	131

1. Data Sources and Processing

In order to correctly, objectively reflect the technical status and fuel consumption level of the local passenger cars, this Chapter introduces the sources of the data employed herein and the pre-stage processing methods of these data.

1.1. Data source

All the data of this report comes from the filed information of fuel consumption label of motor vehicles as furnished by the local vehicle manufacturers and the dealers of imported vehicles as per the "Regulations for Fuel Consumption Label of Light-duty Vehicles" and confirmed by MIIT. The data are up to Dec. 30, 2010, merely involving the filed data of passenger cars (in total 10,653 data pieces, with 4468 vehicle models) [1].

1.2. Data processing

According to the requirements of the "Regulations for Fuel Consumption Label of Light-duty Vehicles", the "Filed Information of Fuel Consumption Label of Motor Vehicles" and its fill-out instructions: for a same model of vehicles, separate filing is required if any vehicle parameter (e.g., curb mass, gross vehicle weight, authorized number of passengers, Front/rear wheel base, tyre size, etc.) presents different values or the configurations are different; if an already filed vehicle type involves any change in vehicle parameter or fuel consumption, the following principles shall be followed for the processing:

If an already filed vehicle type involves change in any parameter other than fuel consumption, it shall be made public as newly added data;

If an already filed vehicle type involves change in fuel consumption only (without regard to any other parameter), manufacturer shall furnish related documents and certificates, explaining the conditions as to the change of fuel consumption.

Due to the aforesaid facts, one vehicle type may correspond to several pieces of data in the database of the filed information of fuel consumption label of motor vehicles.

For the convenience of subsequent analysis, with reference to the standard of "Limits of fuel consumption limits for passenger cars", and in consideration of the demands for data analysis, the following 12 parameters are picked as the main variables in characterizing the technical status of vehicles and the level of fuel consumption: 1) manufacturer; 2) vehicle model; 3) off-road vehicle or not; 4) engine model; 5) fuel type; 6) engine displacement; 7) number of seat rows; 8) type of drive model; 9) type of transmission; 10) number of gear ratios; 11) fuel consumption in combined mode; and 12) segment of curb mass. The data with totally identical parameters mentioned above are combined together; if any parameter above is different, the data will be retained as separate, effective data.

As shown in Table 1, the 10,653 data pieces field till up to Dec. 2010 are simplified and combined into 5,726 pieces of effective data according to the principles above (for the convenience of depiction, the "effective data" is called "vehicle type"), involving 131 local and foreign manufacturers, i.e., 90 local ones and 41 foreign ones (27 dealers of imported vehicles).

Table 1 Overview of data used in this report

Number of data pieces			Number of manufacturers		
Local	Foreign	Total	Local	Foreign	Total
5,073	653	5,726	90	41	131

2　车辆技术状态

车辆质量、燃料类型、发动机排量和功率、驱动型式及变速器型式是表征车辆技术状态的重要特征参数，与车辆燃料消耗量水平密切相关。为全面客观评价车辆技术状态，本章对这些关键技术参数及其相互关系进行了分析和比较。

2.1　排量分布

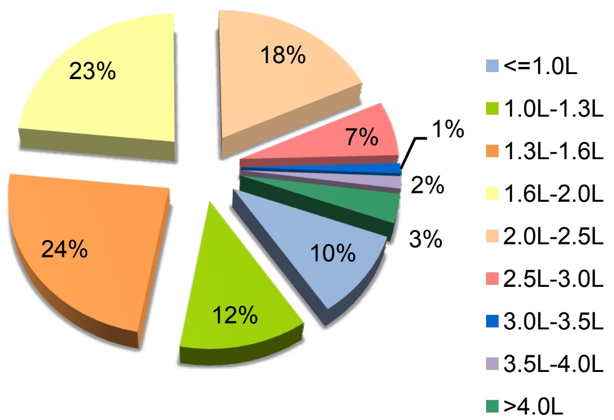


图 1 排量段分布

如图所示，对照我国小汽车消费税率设置将乘用车划分为 9 个不同的排量段，其中，1.0 L-1.6 L 进一步细分为 1.0 L-1.3 L、1.3 L-1.6 L 两个排量段。

我国乘用车发动机排量呈现较为明显的橄榄形分布，大约 65.2%的车型集中在 1.3 L-1.6 L、1.6 L-2.0 L 和 2.0 L-2.5 L 这三个排量段，其车型数量分别占车型总数的 23.8%、23.1%和 18.3%；排量在 1.0 L 以下、1.0 L-1.3 L 以及 2.5 L 以上车型分别占车型总数的 10.1%、12.2%和 12.5%。

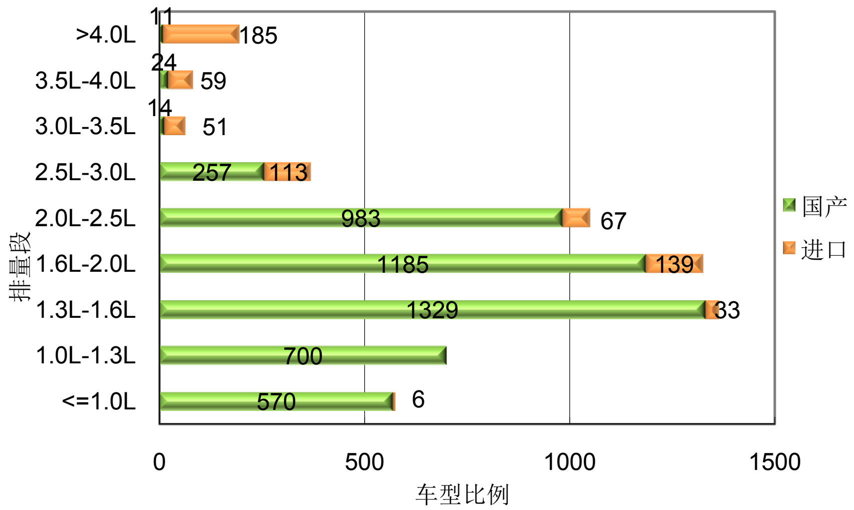


图 2 各排量段车型分布

如图 2 所示，从产地分布来看，国产车和进口车在 1.6 L 以下和 2.5 L 以上分化明显。

2. Technical Status of Passenger Cars

Vehicle mass, fuel type, engine displacement and power, type of drive model, and type of transmission are the main characteristic parameters utilized to depict the technical state of a vehicle, immediately correlated with the vehicle's fuel consumption level. For the purpose of assessing vehicle's technical state in a comprehensive, objective manner, this Chapter analyzes and compares these critical technical parameters and their interrelations.

2.1. Distribution of engine displacement

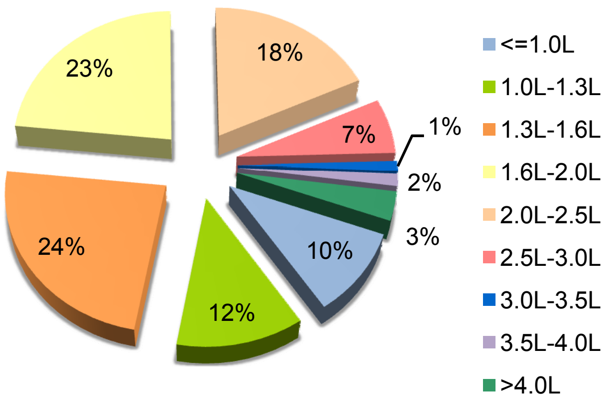


Figure 1 Distribution of engine displacement segments

With reference to the set-up of consumption tax rates for small motor vehicles in China, the passenger cars are classified into 9 different segments of engine displacement; see Figure 1. Concretely, the segment of 1.0 L ~ 1.6 L is further divided into two sub-segments, i.e., 1.0 L ~ 1.3 L, and 1.3 L ~ 1.6 L.

Clearly, the engine displacements of the local passenger cars are distributed in olive shape; roughly 65.2% vehicle types are concentrated in three segments, namely, 1.3 L ~ 1.6 L, 1.6 ~ 2.0 L and 2.0 L ~ 2.5 L, taking up 23.8%, 23.1% and 18.3%, respectively, of the total quantity; the vehicle types with engine displacement below 1.0 L, within 1.0 L ~ 1.3 L and above 2.5 L are 10.1%, 12.2% and 12.5% respectively.

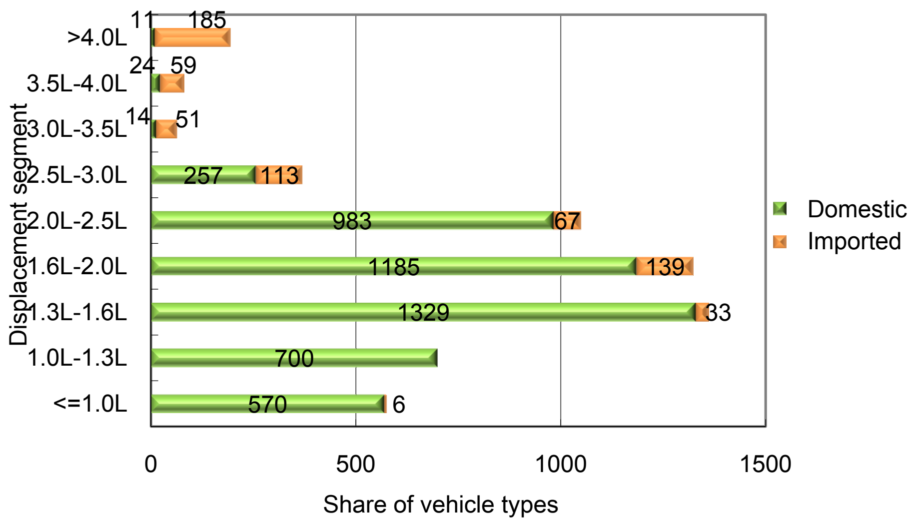


Figure 2 Distribution of vehicle types in each segment of engine displacement

As shown in Figure 2, in view of place of origin, the domestic vehicles differ from their imported counterparts

国产车发动机排量在 2.5 L 以上的车型只有 306 个，占国产车车型总数的 6%；94%的车型发动机排量在 2.5 L 及以下，其中，发动机排量在 1.0 L 及以下的车型和 1.0 L-1.3 L 的车型分别为 577 和 700 个，占国产车车型总数的 11.2%和 13.8%。进口车发动机排量分布恰好相反，94%的车型发动机排量在 1.6 L 以上，其中，发动机排量在 4.0 L 以上的车型数量为 185 个，占进口车车型数量的 28.3%；而在 1.6 L 及以下车型比例只有 39 个，仅占 6%，特别是在 1.3 L 及以下总共只有 6 个车型，全部集中在 1.0 L 及以下排量段，分别是戴姆勒股份公司的 Fortwo（四个车型）和通用大宇科技公司的 Spark（两个车型）。

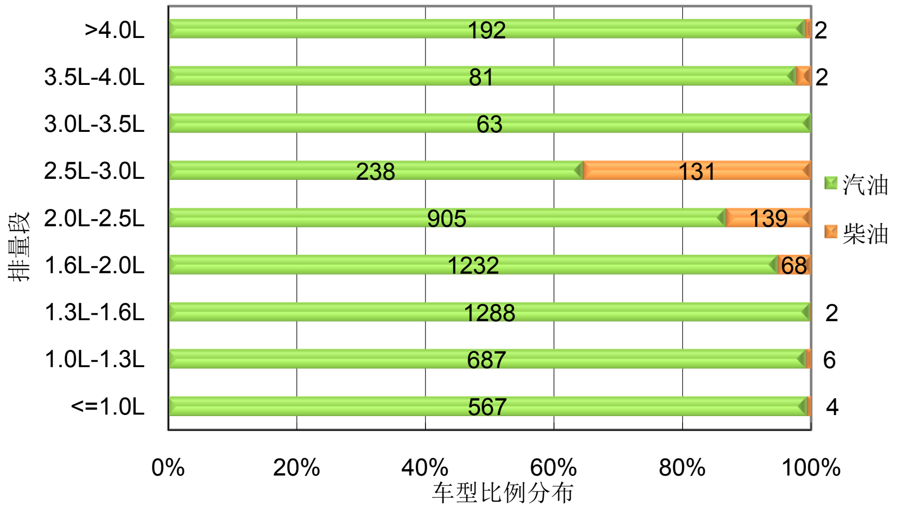


图 3 各排量段燃料类型分布

如图 3 所述，95.5%的柴油燃料车型集中分布在 1.6 L-2.0 L、2.0 L-2.5 L、2.5 L-3.0 L 三个排量段，只有个别车型零星分布在其它排量段。

为方便分析，按照我国消费者习惯，将发动机排量以“升”表示并取 1 位小数，对全部车型排量的分布频率进行统计。

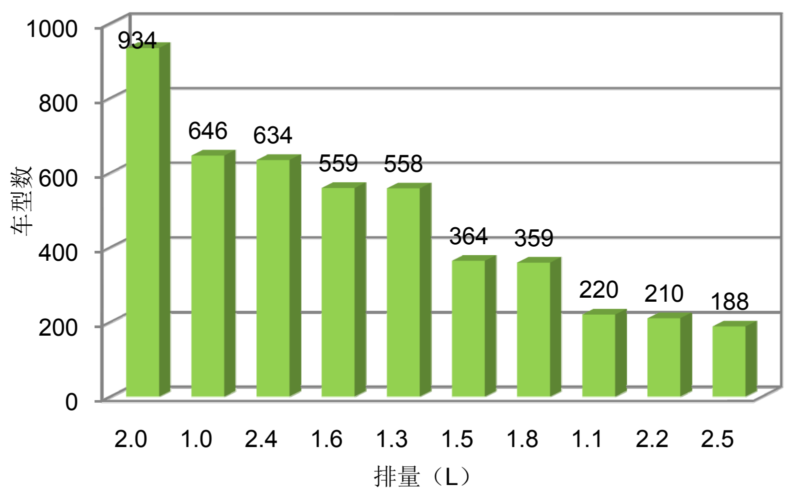


图 4 不同排量车型分布

in thesegments below 1.6 L and those above 2.5 L. As for domestic vehicles, only 306 vehicle types have the engine displacement above 2.5 L, occupying 6% of the total domestic vehicle types; 94% vehicle types have the engine displacement not exceeding 2.5 L; concretely, 577 and 700 vehicle types have the engine displacement not exceeding 1.0 L and within 1.0 L ~ 1.3 L, respectively, occupying 11.2% and 13.8% of the total domestic vehicle types. The situation of imported vehicles is just the opposite: 94% vehicle types have the engine displacement above 1.6 L; concretely, 185 vehicle types present the engine displacement above 4.0 L, occupying 28.3% of the total imported vehicle types; merely 39 ones have the value at 1.6 L or lower, only occupying 6% thereof; in particular, accumulatively only 6 vehicle types have the value not exceeding 1.3 L types, which are totally concentrated at the segment of 1.0 L and below, physically represented by Daimler's Fortwo (four vehicle types) and GM Daewoo's Spark (two vehicle types).

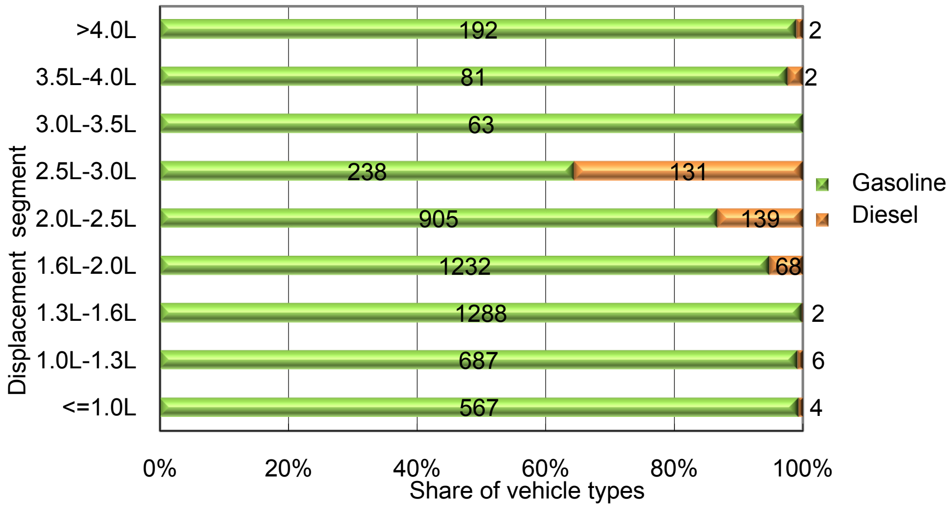


Figure 3 Distribution of fuel types for each engine displacement segment

As shown in Figure3, 95.5% diesel-engine vehicle types are concentrated in the three segments of 1.6 ~ 2.0 L, 2.0 ~ 2.5 L, and 2.5 ~ 3.0 L; other segments merely accommodate quite few vehicle types.

For the convenience of analysis and in consideration of the habits of the local consumers, engine displacement is expressed in "liter (L)" and rounded off to 0.1. Statistics is conducted to the distribution frequency of all vehicle types in view of engine displacement.

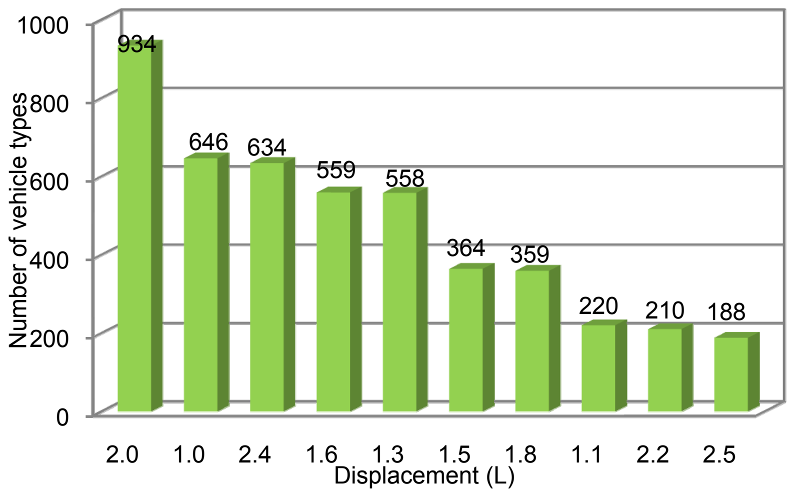


Figure 4 Distribution of vehicle types with respect to engine displacement

由图 4 看出，按车型数量从高到低排在前五位的发动机排量依次为 2.0 L、1 L、2.4 L、1.6 L 和 1.3 L，对应车型总数的比例依次为 16.3%、11.3%、11.1%、9.8%和 9.7%；上述 5 种排量的车型数量共计 3332 个，占车型总数的 58%。

2.2　变速器型式及档位分布

根据我国乘用车变速器产品技术及装车应用情况，轻型汽车燃料消耗量标识备案时将变速器分为手动变速器（MT）、自动变速器（AT）、手自一体变速器（AMT）、无级变速器（CVT）和双离合变速器（DCT）等五种不同的型式，将新型变速器技术列入“其它”型式。在列入分析的车型中，只有菲亚特采用的“智能双模变速器（Dualogic Transmission）”和海马汽车 ASG 变速器申请按照“其它”变速器型式备案，但上述两种变速器型式实际仍属于手自一体变速器（AMT），因此，在数据处理时仍作为手自一体（AMT）变速器处理。

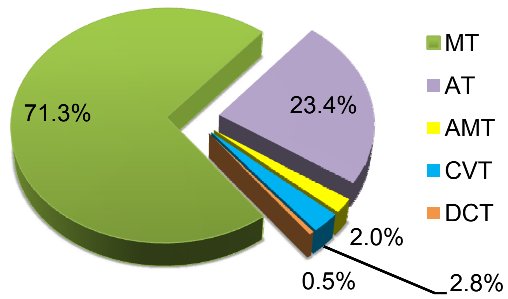


图 5 变速器型式分布

从统计数据来看，我国乘用车变速器仍以手动档（MT）、自动档（AT）为主，采用上述两类变速器型式的车型分别占车型总量的 72%和 23%；采用手自一体变速器（AMT）、无级变速器（CVT）和双离合变速器（DCT）的车型只分别有 114 个、160 个和 28 个，分别占车型总量的 2.0%、2.8%和 0.5%。

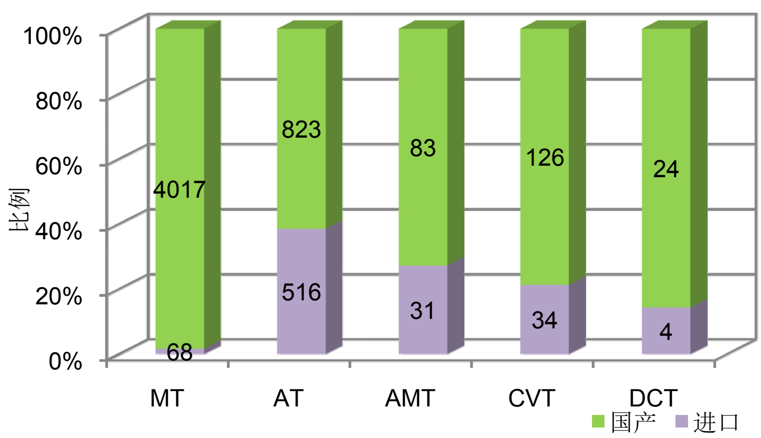


图 6 国产/进口车变速器型式分布

According to Figure 4, the top five engine displacements, as ranked with respect to the number of vehicle types, are 2.0 L, 1 L, 2.4 L, 1.6 L and 1.3 L, in sequence, with the corresponding proportions (in the total number of vehicle types) being 16.3%, 11.3%, 11.1%, 9.8% and 9.7%, respectively; in total, 3,332 vehicle types present the 5 engine displacements above, representing 58% of the total vehicle types.

2.2. Distribution with respect to type of transmission and number of gear ratios

Based on the technologies of transmission products for passenger cars and their application onboard vehicles in China, for the filing purpose of fuel consumption label the transmissions are grouped into five types: manual transmission (MT), automatic transmission (AT), automated mechanical transmission (AMT), and continuously variable transmission (CVT) and dual clutch transmission（DCT）; while any innovative transmission technology is divided into the "other" type. For the vehicle types involved in the analysis, only Fiat's "Dualogic Transmission" and Hainan Mazda's ASG transmission are filed as "other" type; in actuality, these two transmissions are of the type of AMT; therefore, they are regarded as AMT for the purpose of data processing.

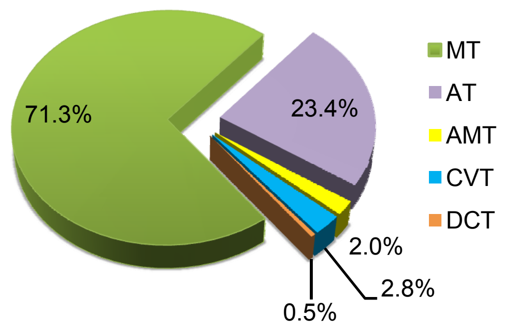


Figure 5 Distribution with respect to type of transmission

According to the statistics, the transmission of local passenger cars is mainly represented by MT and AT, and the vehicle types employing these two types are 72% and 23%, respectively, of the total vehicle types; only 114, 160 and 28 vehicle types employ the AMT, CVT, and dual clutch transmission (DCT), respectively, occupying 2.0%, 2.8% and 0.5% of the total ones.

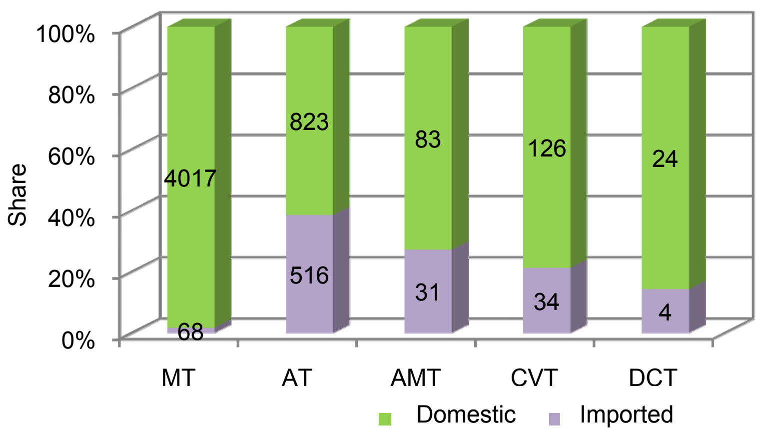


Figure 6 Distribution of domestic/imported vehicle types with respect to the type of transmission

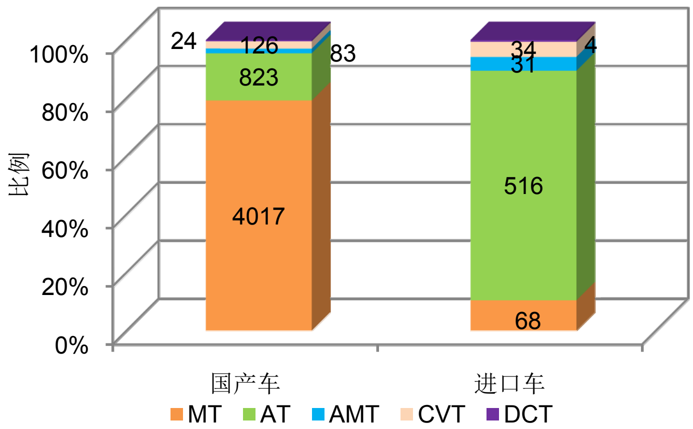


图 7 国产/进口车变速器型式

如图 7 所示，与国产车以手动变速器（MT）为主不同，进口车采用手动变速器（MT）的车型只有 10.4%，采用自动变速器（AT）的车型比例高达 79%。采用手自一体变速器（AMT）、无级变速器（CVT）和双离合变速器（DCT）的车型比例分别为 4.7%、5.2%和 0.6%，略高于国产车。

表 2 国产/进口车手动变速器档位分布

MT	国产车		进口车		全部	
	车型数量	比例，%	车型数量	比例，%	车型数量	比例，%
3	6	0.1%	/	/	6	0.1%
4	17	0.4%	/	/	17	0.4%
5	3887	96.8%	40	58.8%	3927	96.1%
6	95	2.4%	28	41.2%	123	3.0%
9	12	0.3%	/	/	12	0.3%
合计	4017	100%	68	100%	4085	100%

在列入分析的车型中，采用手动档变速器的车型为 4085 个，其中，国产车型共计 4017 个，进口车型仅有 68 个。在国产车型中，采用 5 档变速器的车型数量为 3887 个，占 96.8%，采用 6 档变速器的车型有 95 个，占 2.4%，其余档位的车型所占比例不足 1%。采用手动变速器的进口车型全部采用 5 档或 6 档变速器，其中，采用 5 档变速器的车型数为 40 个，占 58.8%，采用 6 档变速器的车型数为 28 个，占 41.2%。

表 3 国产/进口车自动变速器档位分布

AT	国产车		进口车	
	车型数量	比例，%	车型数量	比例，%
4	481	58.4%	72	14.0%
5	153	18.6%	67	13.0%
6	169	20.5%	246	47.7%
7	8	1.0%	105	20.3%
8	6	0.7%	26	5.0%
9	6	0.7%	/	0.0%
合计	823	100%	516	100%

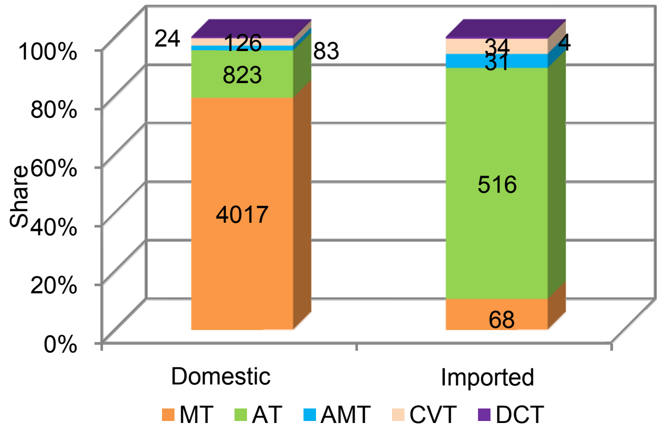


Figure 7　Type of transmission of domestic/imported vehicles

As shown in Figure 7, unlike the situation of domestic vehicles mainly employing MT, only 10.4% imported vehicles adopt such type of transmission, while those employing AT occupy a high share of 79%. The ones employing AMT, CVT and DCT are 4.7%, 5.2% and 0.6%, respectively, slightly higher than the respective case of the domestic vehicles.

Table 2　Distribution of domestic/imported vehicle types with respect to the number of gear ratios of MT

MT	Domestic vehicles		Imported vehicle types		All	
	Number of vehicle types	Share, %	Number of vehicle types	Share, %	Number of vehicle types	Share, %
3	6	0.1%	/	/	6	0.1%
4	17	0.4%	/	/	17	0.4%
5	3,887	96.8%	40	58.8%	3,927	96.1%
6	95	2.4%	28	41.2%	123	3.0%
9	12	0.3%	/	/	12	0.3%
Total	4,017	100%	68	100%	4,085	100%

As for all the vehicle types involved by the analysis, 4,085 ones employ MT, including 4,017 domestic and 68 imported ones. Of the domestic vehicle types, 3,887 ones employ the 5-gear transmission, occupying 96.8%,; 95 ones employ 6-gear transmission, occupying 2.4%; and the ones employ other number of gear ratios only occupy a share lower than 1%. All the imported MT vehicle types employ the 5- or 6-gear transmission; concretely, 40 vehicle types employ the 5-gear transmission, occupying 58.8%, and 28 ones employ the 6-gear transmission, occupying 41.2%.

Table 3　Distribution of domestic/imported vehicle types with respect to the number of gear ratios of AT

AT	Domestic vehicles		Imported vehicle types	
	Number of vehicle types	Share, %	Number of vehicle types	Share, %
4	481	58.4%	72	14.0%
5	153	18.6%	67	13.0%
6	169	20.5%	246	47.7%
7	8	1.0%	105	20.3%
8	6	0.7%	26	5.0%
9	6	0.7%	/	0.0%
Total	823	100%	516	100%

采用自动变速器的车型共计 1339 个，其中，国产车型 823 个，进口车型 516 个；进口车型所占比例达到 38.5%，明显高于手动变速的车型，从档位分布来看，国产车中采用 4 档变速器的车型数量最多，占 58.4%；采用 6 档变速器的车型比例为 20.5%；变速器档位数在 6 档以下的车型占 77%，采用 6 档以上变速器的车型比例仅为 2.4%。进口车多档变速器应用比例明显高于国产车，只有 26.9%的车型采用了 4 档或 5 档变速器，采用 6 档及以上变速器的进口车型比例达到 77.3%；其中，47.7%的车型采用了 6 档变速器，采用 7 档、8 档变速器的车型比例分别达到了 20.3%、5%。

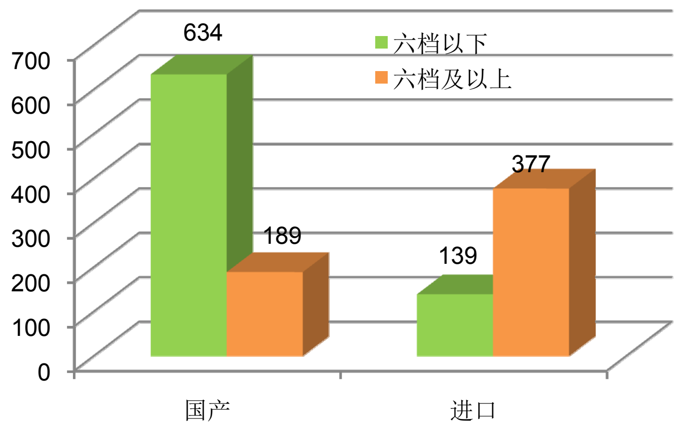


图 8 国产/进口车自动档变速器档位分布

2.3 驱动型式分布

按照“汽车燃料消耗量标识备案信息”及其填写说明的要求，在对车辆驱动型式进行分类时，仅区分前轮驱动、后轮驱动和全时全轮驱动三种型式；对实时全轮驱动、分时全轮驱动的车辆，根据其在非全轮驱动状态的驱动轮位置，分别划归前轮驱动或后轮驱动。

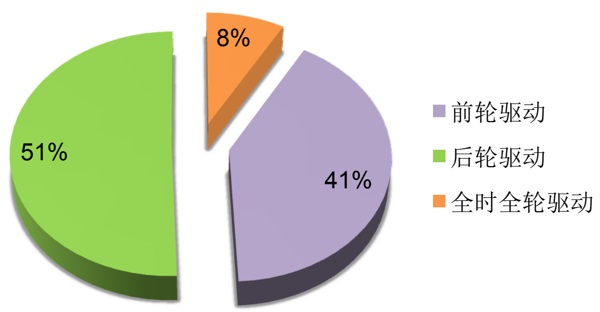


图 9 驱动型式分布

In total, 1,339 vehicle types employ AT, including 823 domestic and 516 imported ones; the imported vehicle types occupy a share of 38.5%, evidently higher than that of the case of MT vehicle types. In view of number of gear ratios, the domestic vehicles employing 4-gear transmission occupy the biggest share, i.e., 58.4%; those employing 6-gear transmission occupy a share of 20.5%; 77% vehicle types employ the transmission with 5 or lower gear ratios, while those employing more than 6 gear ratios take up 2.4% only. In terms of the imported vehicle types, the multi-gear transmission is applied more extensively: only 26.9% vehicle types employ the 4- or 5-gear transmission, while those employ 6- or more gear ratios are as high as 77.3%; concretely, 47.7% vehicle types employ the 6-gear transmission, while those employ 7- and 8-gear transmission are 20.3% and 5%, respectively.

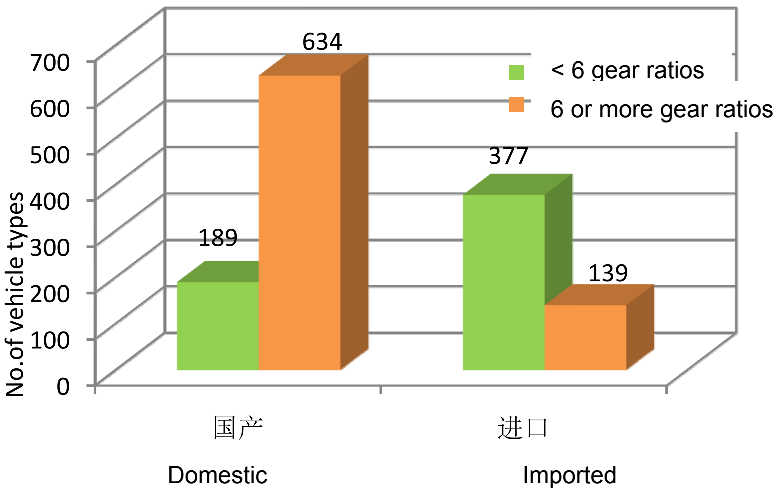


Figure 8 Distribution of domestic/imported vehicle types with respect to the number of gear ratios of AT

2.3. Distribution with respect to type of drive model

According to the "Filed Information of Fuel Consumption Label of Light-duty Vehicles" and its fill-out instructions, the drive models of vehicles are merely divided into three types, namely, front-wheel drive, rear-wheel drive, and all-wheel drive; and, thus, the vehicles adopting full-time all-wheel drive and part-time all-wheel drive are classified into front-wheel or rear-wheel drive type based on the position of driving wheels under the state of non all-wheel drive.

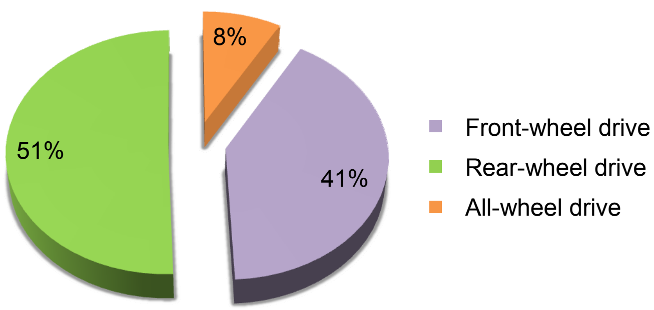


Figure 9 Distribution with respect to the type of drive model

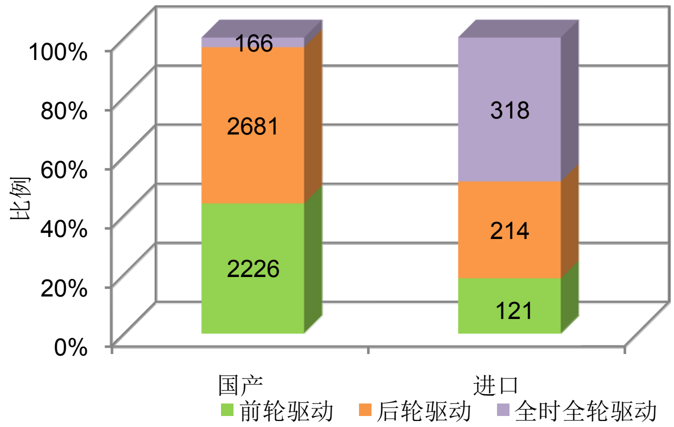


图 10 国产/进口车驱动型式分布 I

从驱动形式分布来看，共有 2895 个车型采用了后轮驱动，占全部车型总数的 51%；采用前轮驱动、全时全轮驱动的车型数量分别为 2347、484 个，所占比例分别为 41%、8%(见图 9)。如图 10 所示，国产车主要为前轮驱动或后轮驱动，采用全时全轮驱动的车型仅占 3.3%。进口车中，采用全时全轮驱动的车型比例高达 48.7%，另有 32.8%的车型采用后轮驱动，采用前轮驱动的车型比例仅为 18.5%。

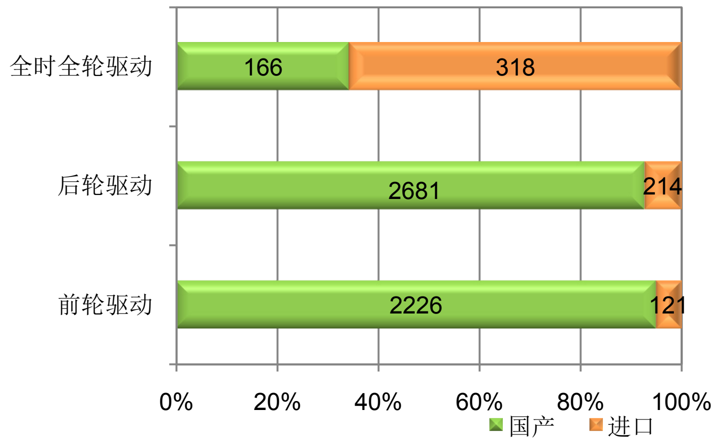


图 11 国产/进口车驱动型式分布 II

对不同驱动型式车辆的产地分析发现，在前轮和后轮驱动车辆中，国产车所占比例均在 90%以上，进口车所占比例不足 10%，这与国产和进口车车型比例基本一致；而采用全时全轮驱动的车型中，约有 66%的车型为进口车。这从一定程度上反映了我国进口车构成以越野车辆为主的现状；如果将采用实时全轮驱动、分时全轮驱动的车型考虑在内，这一比例还会更高。

2.4 燃料及动力型式分布

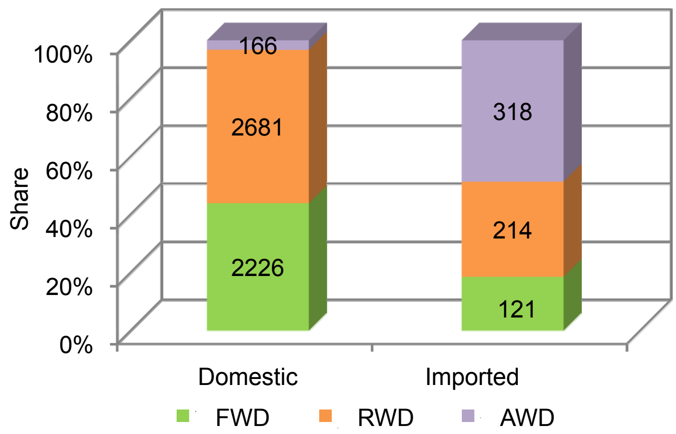


Figure 10 Distribution of domestic/imported vehicle types with respect to the type of drive model (I)

In view of type of drive model, in total 2,895 vehicle types employ the rear-wheel drive, occupying 51% of the total vehicle types; 2,347 and 484 ones respectively adopt the Front-wheel drive and all-wheel drive, occupying 41% and 8% respectively (see Figure 9). As indicated in Figure 10, the domestic vehicles are mainly of Front-or rear-wheel drive, and those employing all-wheel drive are only of 3.3%. As for imported vehicle types, those employing all-wheel drive take up a share of 48.7%, 32.8% vehicle types adopt the rear-wheel drive, and those adopting Front-wheel drive are only of 18.5%.

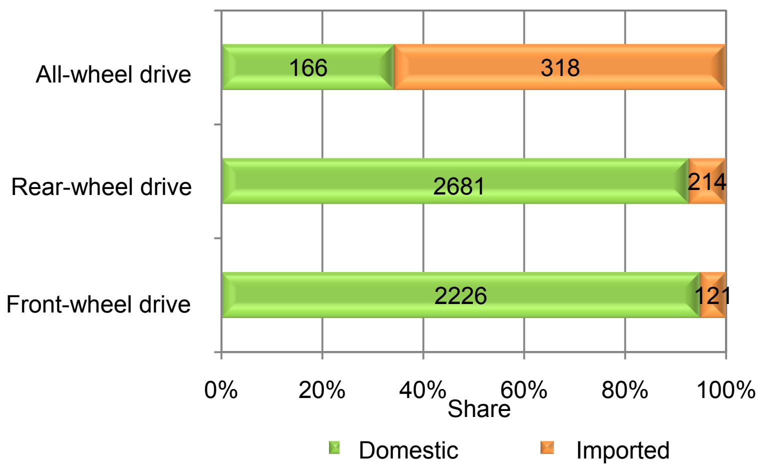


Figure 11 Distribution of domestic/imported vehicle types with respect to the type of drive model (II)

As analyzed to the place of origin of the vehicles employing different types of drive model, more than 90% Front- or rear-wheel drive vehicle types are domestic, while no more than 10% are imported ones, basically running consistent with the shares of domestic and imported vehicle types; as for the vehicle types employing all-wheel drive, about 66% are of imported vehicle types. It reflects, to a certain extent, the current situation where the imported vehicles in China are mainly of the off-road vehicle types; given the combination of the vehicles types employing real-time and part-time all-wheel drive, such a ratio would be much higher.

2.4. Distribution with respect to type of fuel and power-train

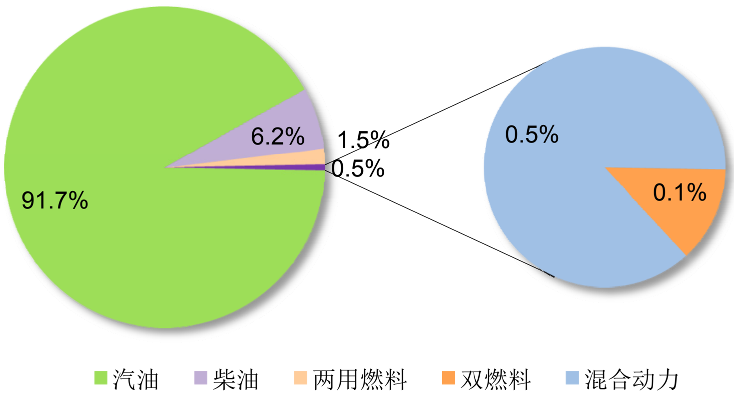


图 12 燃料及动力型式分布

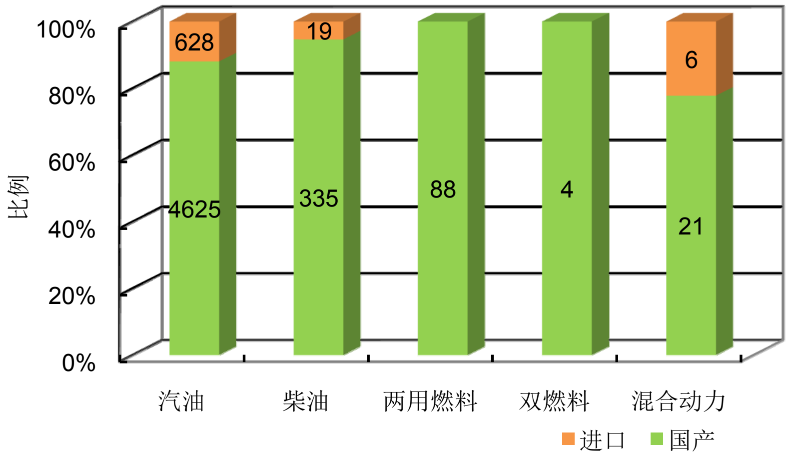


图 13 燃料及动力型式

如图 12 所示，我国乘用车仍以汽油和柴油燃料为主，其中，汽油车型所占比例约为 91.7%，柴油车型比例约为 6.2%，采用其它燃料及动力型式的车型仅占 2%。除进口车没有采用两用燃料和双燃料外，国产和进口车型的燃料及动力形式基本类似（见图 13）。

2.5 功率分布

2.5.1 额定功率与净功率

发动机功率是表征车辆动力性能的重要技术参数，长期以来，我国发动机行业主要采用额定功率，而国际上通行的做法是用净功率。按照 GB/T 18297-2001《汽车发动机性能试验方法》中的定义，发动机的额定功率是指制造厂根据发动机具体用途，在规定的额定转速下所输出的总功率；净功率是指发动机带全套附件时所输出的校正有效功率（所带附件在标准中亦有规定）。按照轻型汽车燃料消耗量标识备案管理文件的要求，企业需要同时申报发动机额定功率和净功率数据，额定功率需按照 GB/T 18297 规定的试验方法进行测量，净功率则按照 GB/T 17692《汽车用发动机净功率测试方法》的规定进行测量。对于仅测定了额定功

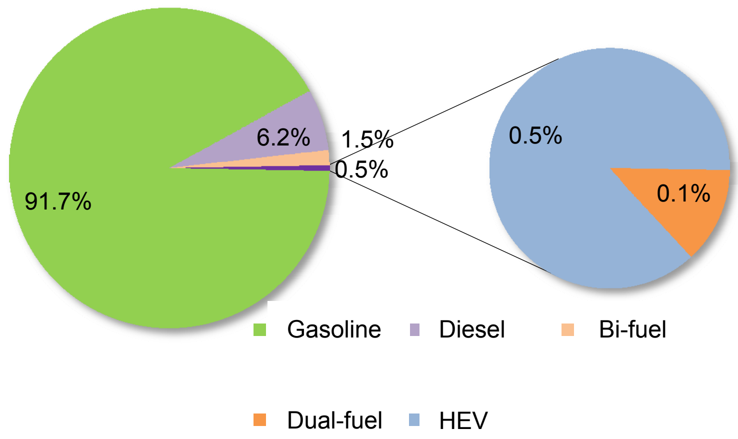


Figure 12 Distribution with respect to the type of fuel and power-train

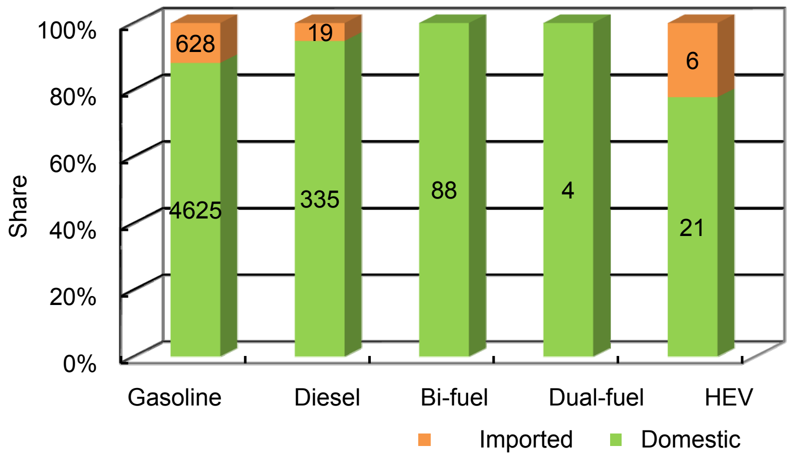


Figure 13 Type of fuel and power-train

As shown in Figure 12, the Chinese passenger cars are still principally powered by gasoline and diesel fuel; concretely, the gasoline vehicle types occupy 91.7% or so, the diesel ones, about 6.2%, and those employing other fuel and power-train types, 2%. In this regard, the domestic vehicle types are basically identical to the imported ones, except that the latter involves no bi-fuel and dual-fuel types (see Figure 13).

2.5. Distribution with respect to power

2.5.1. Rated power vs. net power

Engine power is a key parameter used to characterize the power performance of vehicle. For long, the local engine industry has been adopting rated power, while internationally the general practice is to use net power. As defined in GB/T 18297-2001"Performance test code for vehicle engines", rated engine power means the total output power under a prescribed rotational speed as designed by manufacturer in consideration of the actual purpose of the engine; net power means the corrected, valid output power of an engine operating with the full set of accessories (such accessories are set out in the standard). As required by the document for the administration over filing of fuel consumption label of light-duty vehicles, manufacturer needs to simultaneously declare the engine data as to rated power and net power, with rated power to be measured as per the test procedures of GB/T 18297, and net power, as per GB/T 17692"Measrement methods of net power for automotive engines". As for an engine merely with the measurement of rated power, GB 7258-2004"Safety specifications for power-driven vehicles operating on roads"

率的发动机，GB 7258-2004《机动车运行安全技术条件》中提出可以通过换算系数将额定功率乘以系数 0.9 的方法得到该发动机净功率的估算值，即：

$$净功率=额定功率\times 0.9$$

在燃料消耗量标识备案过程中，国内企业提供的主要是发动机额定功率信息，而进口经销商则是净功率。通过对标识备案数据库中企业申报的额定功率和净功率分析发现，有相当一部分申报数据的额定功率与净功率相等或额定功率仅比净功率高 1 kW-2 kW，显然是不合理的。对于此类数据，其额定功率与净功率在分析过程中均作了删除处理。

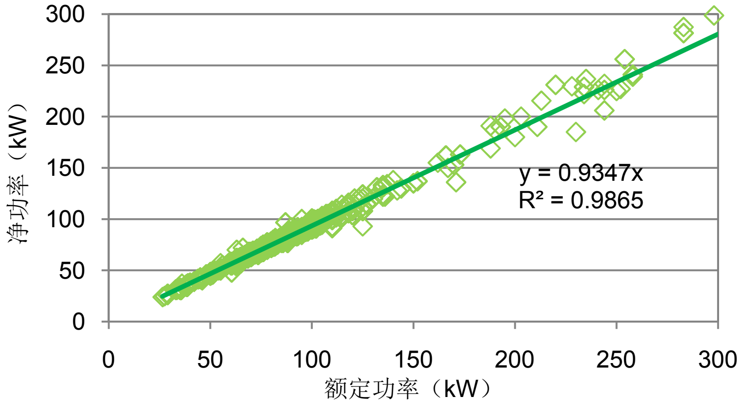


图 14 额定功率与净功率

从图 14 中可以看出，保留下来用作分析的数据中，额定功率与净功率之间的换算系数大约为 0.93，也高于 GB 7258-2004 中的推荐的换算系数 0.9。这意味着对未在试验台架上进行净功率测定的发动机，企业并未按照上述标准中的规定申报净功率，申报的净功率与实际值相比偏大，上文所提及净功率与额定功率仅相差 1 kW-2 kW 的情形也印证了这一点。

2.5.2 不同产地的额定功率分布

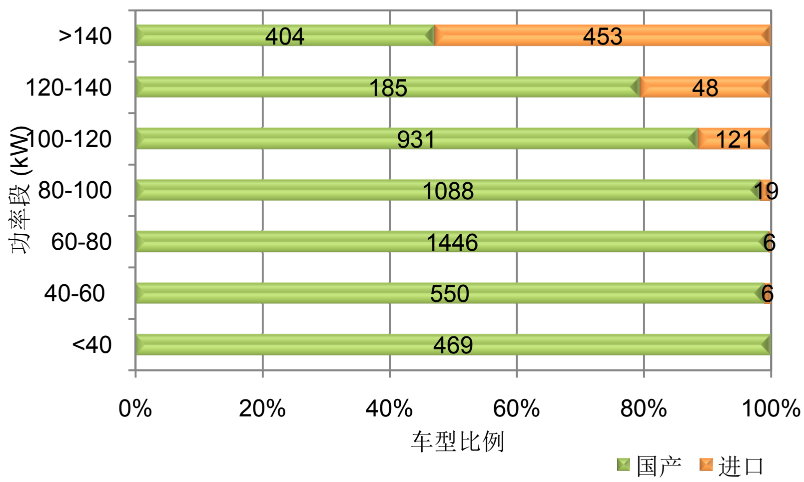


图 15 国产/进口车额定功率分布 I

proposes that the estimated net power of the engine may be converted by multiplying the rated power with a factor of 0.9, that is:

$$\text{Net power} = \text{rated power} \times 0.9$$

For the filing of fuel consumption label, local manufacturers have mainly furnished the information of rated engine power, while the imported vehicle types have been provided with net power. According to the analysis made to the manufacturers' declared rated power and net power in the label filing database, for a large portion of declared data, the rated power is identical to the net power or the rated power exceeds the net power only by 1 kW ~ 2 kW, which situation is evidently irrational. For such data, both rated power and net power are ignored for the analysis purpose.

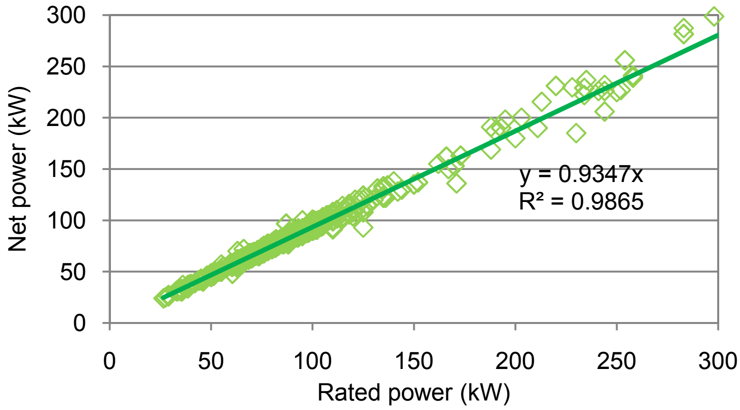


Figure 14 Rated power vs. net power

As shown in Figure 14, for the data retained for analysis, the conversion factor between rated and net power is roughly 0.93, higher than that recommended in GB 7258-2004, i.e., 0.9. It means that the manufacturers which didn't measure the net engine power on test bench failed to declare the net power as per the provisions of the standard above, and subsequently the declared net power is relatively bigger than the actual one; this is also proved by the fact mentioned above that the difference between net and rated power is just 1 kW ~ 2 kW.

2.5.2. Distribution with respect to rated power for different places of origin

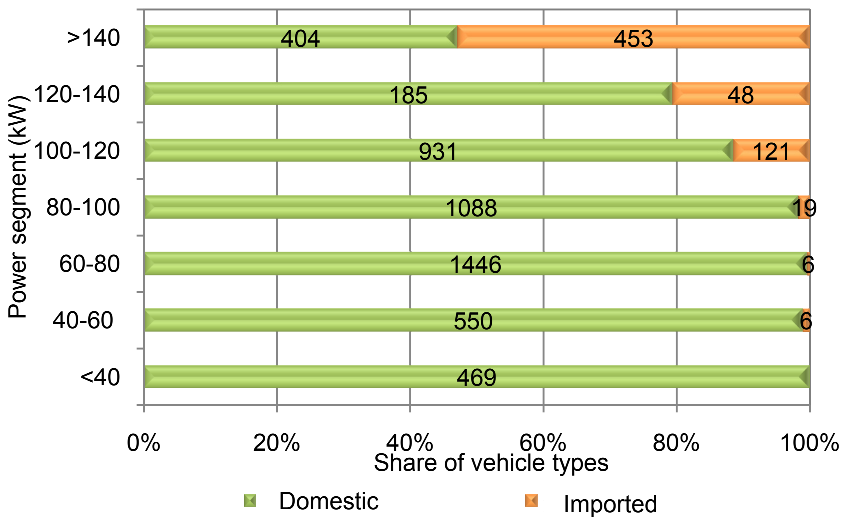


Figure 15 Distribution of domestic/imported vehicle types with respect to rated power (I)

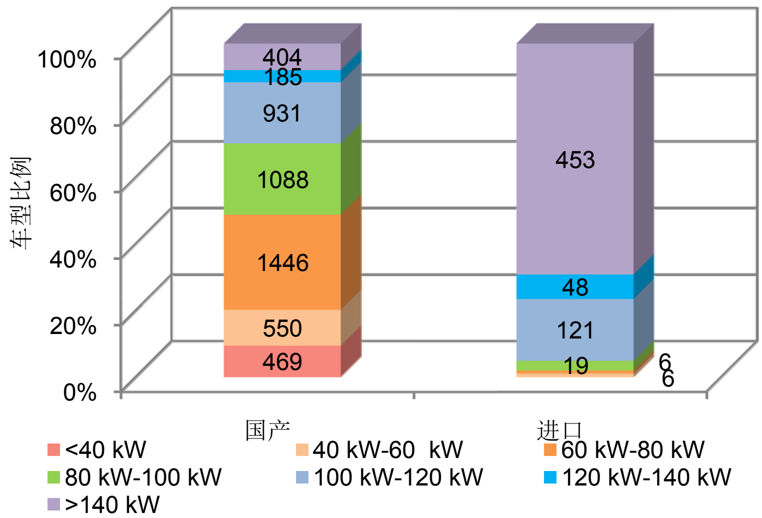


图 16 国产/进口车额定功率分布 II

如图 15、图 16 所示，按照额定功率大小分为≤40 kW、40 kW-60 kW、60 kW-80 kW、80 kW-100 kW、100 kW-120 kW、120 kW-140 kW、>140 kW 共 7 个不同的分组。从额定功率的车型分布来看，60 kW-80 kW、80 kW-100 kW、100 kW-120 kW 的车型较多，车型数量分别为 1452、1107、1052 个，占全部车型总数的 25.4%、19.3%、18.4%。在后四个功率段中，进口车所占的比例逐渐增大；在超过 140 kW 的功率段内进口车为 52.8%所占比例最高，也是所占比例唯一超过国产车的功率段。另一个显著特征是，国产车主要分布在中间功率段，在大功率段和小功率段车型分布较少，而进口车有约 70%的车型都分布在 140 kW 以上的大功率段，100 kW 以下的进口车型仅有 31 个，占全部进口车的 4.7%，小于 40 kW 的功率段没有进口车型分布。

2.5.3 不同燃料类型的额定功率分布

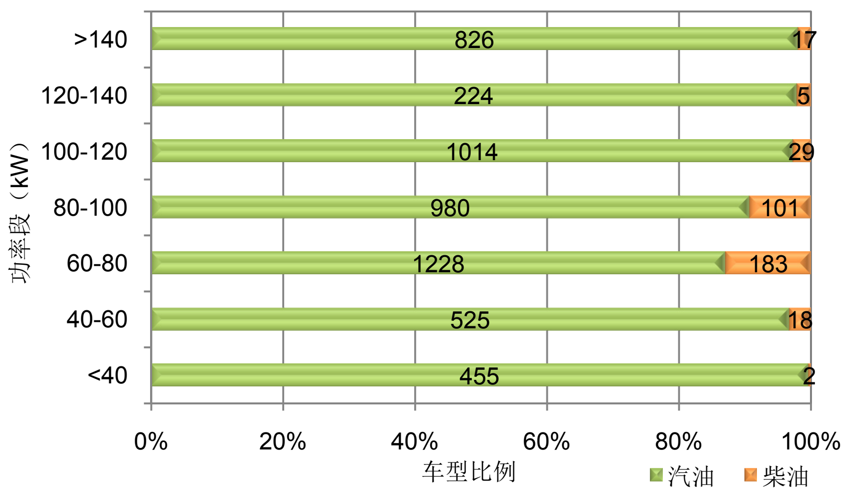


图 17 汽油/柴油车额定功率分布 I

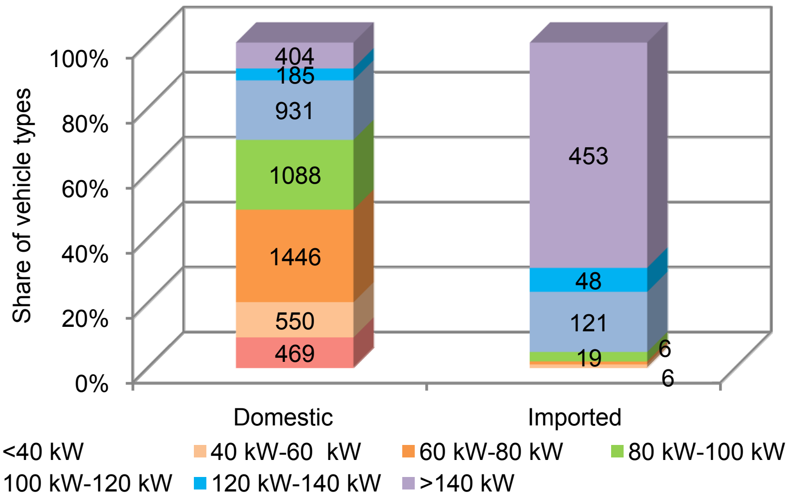


Figure 16 Distribution of domestic/imported vehicle types with respect to rated power (II)

As shown in Figure 15 and Figure 16, 7 segments of rated power are grouped as ≤40 kW, 40 kW ~ 60 kW, 60 kW ~ 80 kW, 80 kW ~ 100 kW, 100 kW ~ 120 kW, 120 kW ~ 140 kW, and > 140 kW. A majority of vehicle types are distributed in the segments of 60 kW ~ 80 kW, 80 kW ~ 100 kW, and 100 kW ~ 120 kW, and the numbers of vehicle types are respectively 1,452, 1,107, and 1,052, occupying 25.4%, 19.3%, and 18.4% respectively of the total. In the final four segments, the share of imported vehicle types escalate progressively; for the segment of > 140 kW, the share of imported vehicle types is 52.8% (i.e., the highest proportion), which represents the sole segment where the share exceeds that of the domestic vehicles. Plus, another notable characteristic cannot be denied, that is, the domestic vehicles are concentrated in the middle segments, and the share in the big and small segments is less. In contrast, 70% imported vehicle types are present in the big power segment > 140 kW; below 100 kW, there are only 31 imported vehicle types, occupying 4.7% of the total; and for the segment below 40 kW, no imported vehicle type exists at al.

2.5.3. Distribution of vehicle types of different fuel types with respect to rated power

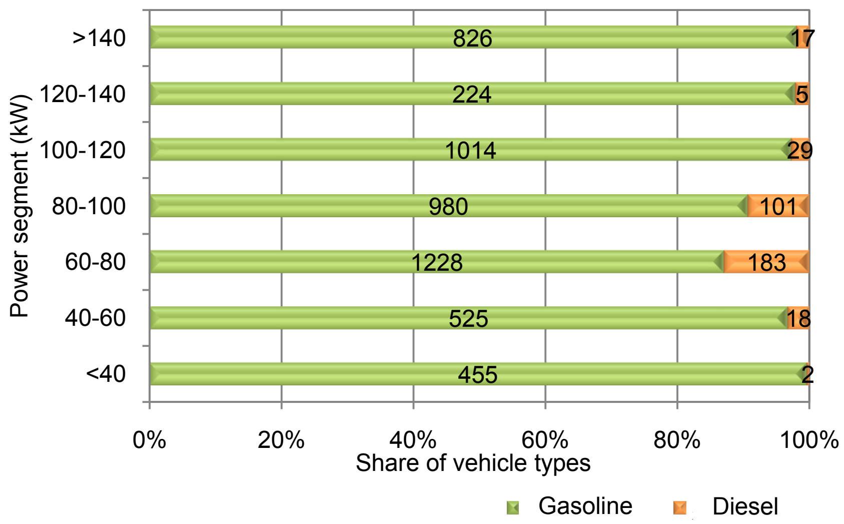


Figure 17 Distribution of gasoline/diesel vehicle types with respect to rated power (I)

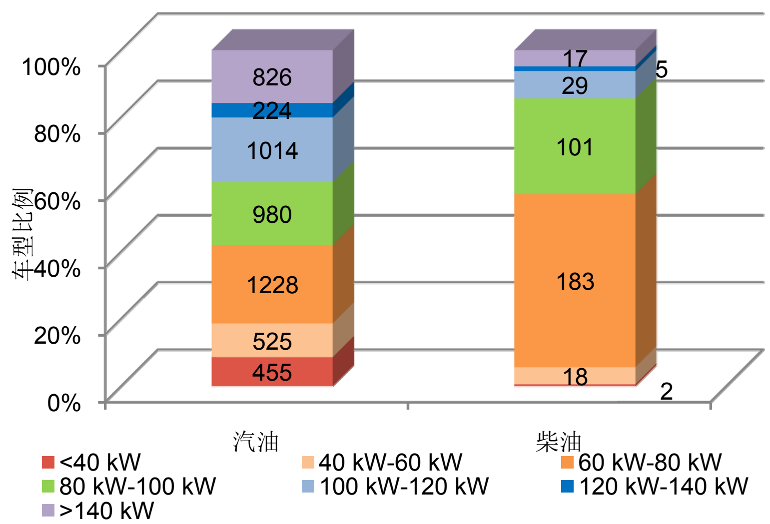


图 18 汽油/柴油车额定功率分布 II

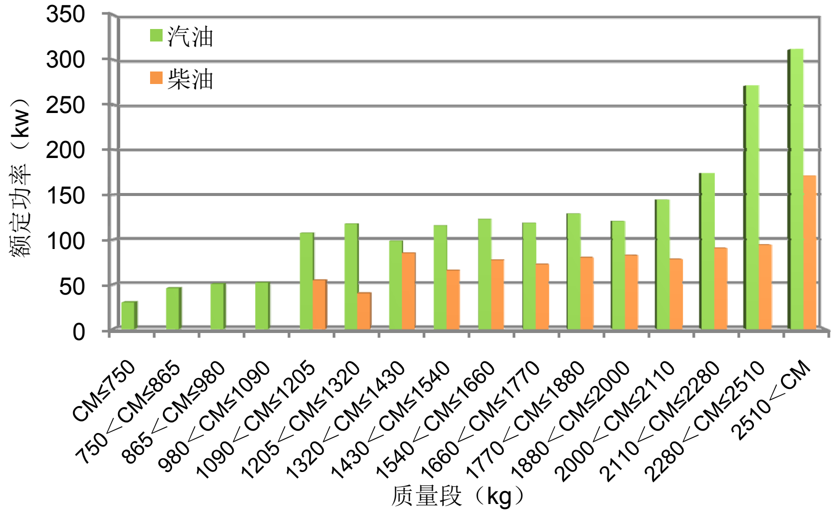


图 19 不同质量段不同燃料类型功率比较

不同燃料类型的功率分布表明汽油车与柴油车的功率分布并无显著差异，大部分车型都集中在中间功率段，大功率段和小功率段的汽油车和柴油车均比较少。60 kW-80 kW 是汽油车和柴油车分布车型最多的功率段，也是目前我国乘用车车型分布最集中的功率段。

如图 19 所示，在目前已有的数据量下，同一质量段内汽油车的额定功率明显高于柴油车，在大质量段，由于进口汽油车所占比例较高且进口车的额定功率较大，因此其额定功率与柴油车的差距更为明显。

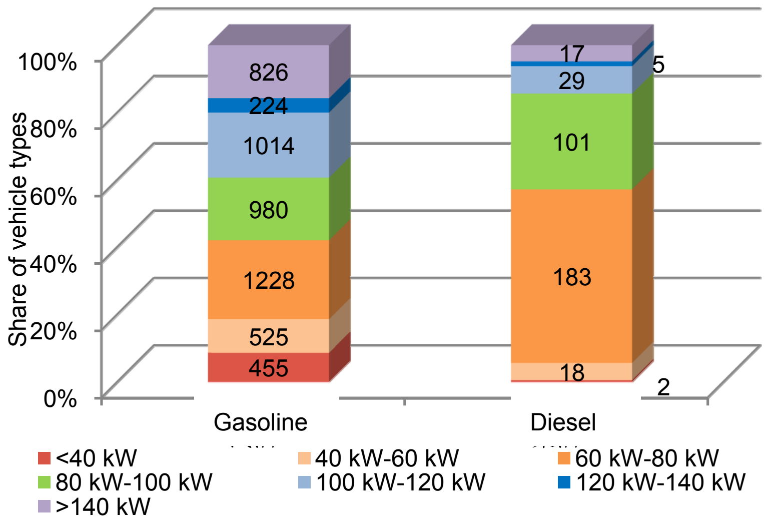


Figure 18 Distribution of gasoline/diesel vehicle types with respect to rated power (II)

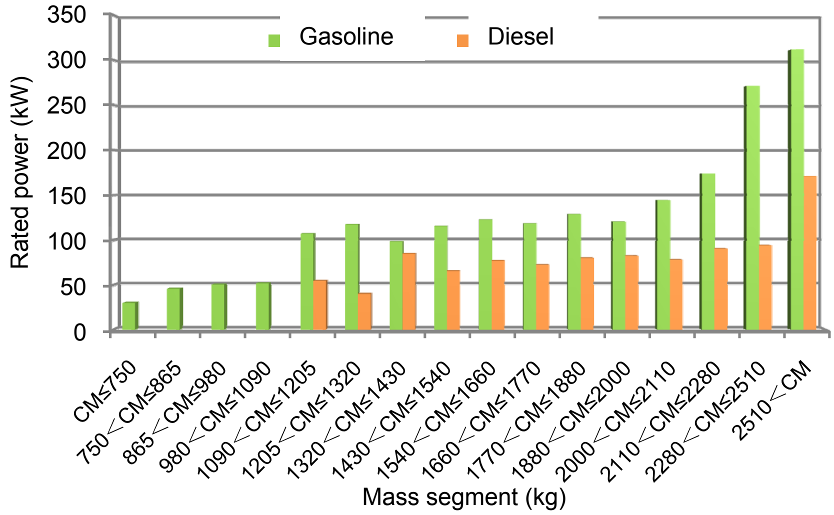


Figure 19 Comparison of power between fuel types in different mass segments

No notable difference exists between gasoline and diesel vehicles with respect to power; with a majority of vehicle types concentrated in the middle segments, and, irrespectively of gasoline or diesel vehicles, the number of vehicle types is small in the large and small segments. 60 kW ~ 80 kW represents the power segment where accommodates the most gasoline and diesel vehicles and where the distribution of the local vehicle types of passenger cars are most concentrated.

According to Figure 19, under the presently available database, for a same mass segment the rated power of gasoline vehicles is saliently higher than that of their diesel peers; for the big mass segments, such a difference becomes more highlighted since the imported gasoline vehicles take up a big share and the rated power of the imported vehicle types is larger.

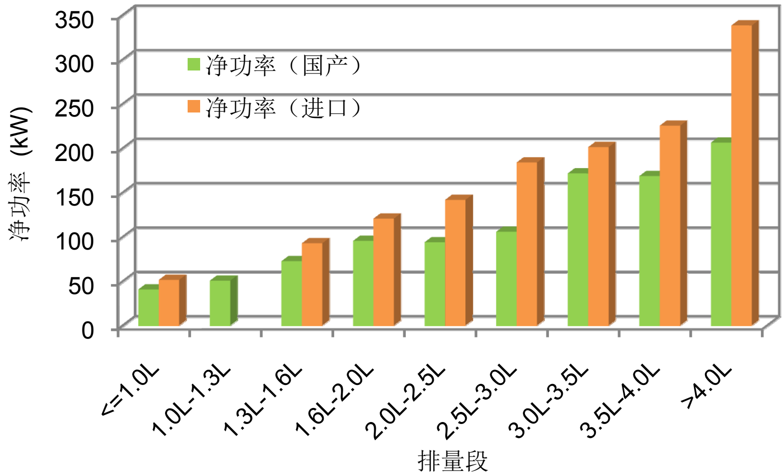


图 20 各排量段净功率分布

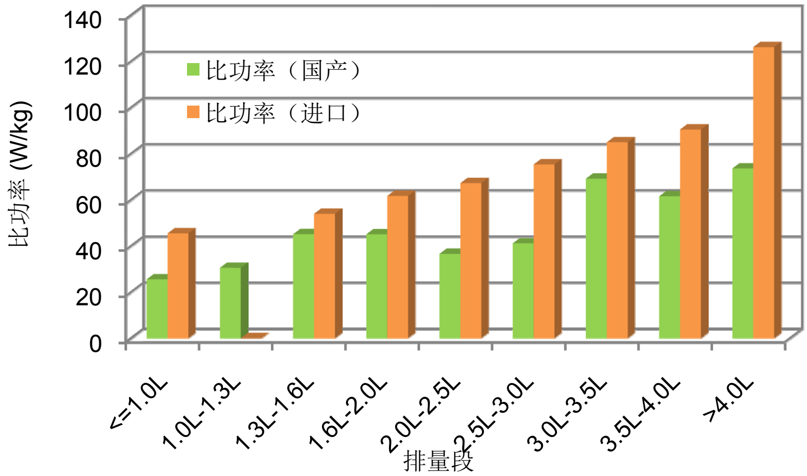


图 21 各排量段比功率分布

比功率是衡量汽车动力性能的一个综合指标，具体是指汽车发动机净功率与汽车最大设计总质量之比,单位为 W/kg。一般来讲，对同类型汽车而言，比功率越大，汽车的动力性越好。

如图 20、图 21 所示，国产车与进口车比功率的差距也十分明显，在每个排量段内进口车比功率的平均值均大于国产车；特别是在 2.0 L-2.5 L 的排量段，进口车比功率的平均值甚至比国产车大 83%，即使在差距最小的 1.3 L-1.6 L 的排量段，进口车的比功率均值也比国产车大 19%。

综合比较净功率与比功率，可以看出目前国产车与进口车动力性相比还存在很大的差距。

2.6　最高设计车速分布

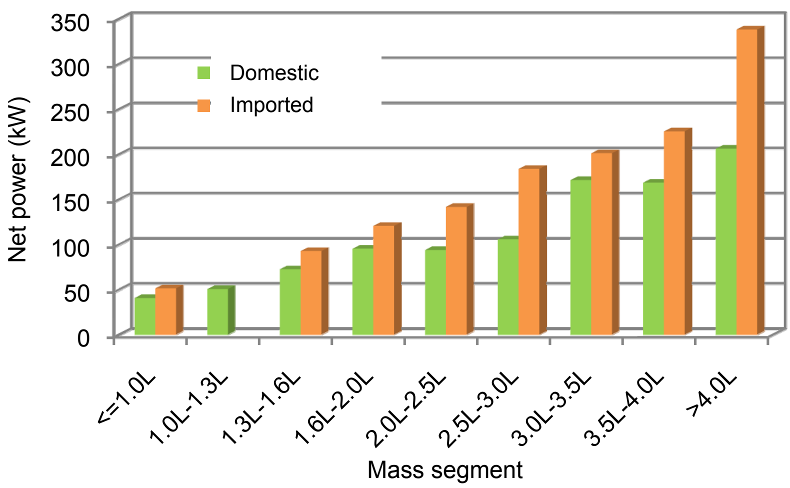


Figure 20 Distribution of net power in each engine displacement segment

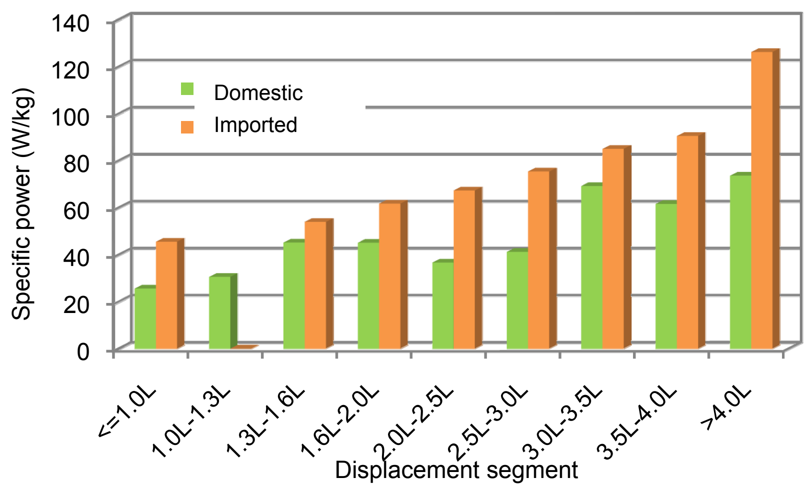


Figure 21 Distribution of specific power in each engine displacement segment

As a comprehensive criterion measuring vehicle's power performance, specific power refers to the ratio between the net engine power and the gross vehicle weight, expressed in W/kg. Generally speaking, for vehicles of a same category, the bigger the specific power is, the better the power performance.

As shown in Figure 20 and Figure 21, a quite clear indent exists between domestic vehicles and their imported counterparts with respect to specific power; in each segment of engine displacement, the average specific power of the imported vehicle types is bigger than that of domestic ones; especially in the segment of 2.0 ~ 2.5 L, the former is larger, by 83%, than the latter; and even in the segment with the least difference (i.e., 1.3 L ~ 1.6 L), the difference reaches 19%.

Based on the comprehensive comparison between net power and specific power, it is clear that a big gap cannot be denied between domestic vehicles and imported ones with respect to the power performance.

2.6. Distribution with respect to max. designed vehicle speed

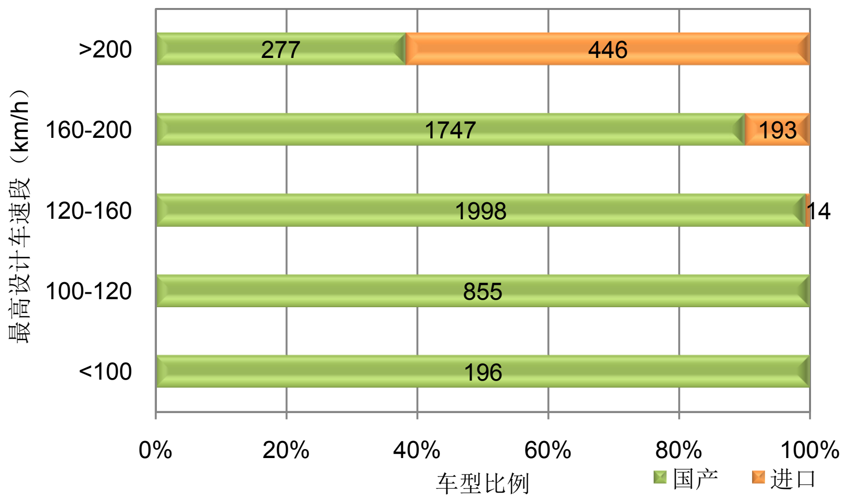


图 22 国产/进口车最高设计车速分布

如图 22 所示，将车型的最高设计车速分为≤100 km/h，100 km/h-120 km/h、120 km/h-160 km/h、160 km/h-200 km/h 和>200 km/h 共 5 个最高设计车速段。从图中可以看出，我国乘用车最高设计车速主要集中在 120 km/h-160 km/h、160 km/h-180 km/h 这两个速度段。

不同产地的车型的最高设计车速的分布情况与功率分布情况类似，国产车中 90%以上的车型分布在最高设计车速为 100 km/h-200 km/h 的区间，最高设计车速在 120 km/h 以下的车型共 1051 个，全部为国产车。进口车最高设计车速全部集中在在 120 km/h 以上；其中，最高设计车速在 200 km/h 以上的车型中，进口车的比例则高达 61.7%。

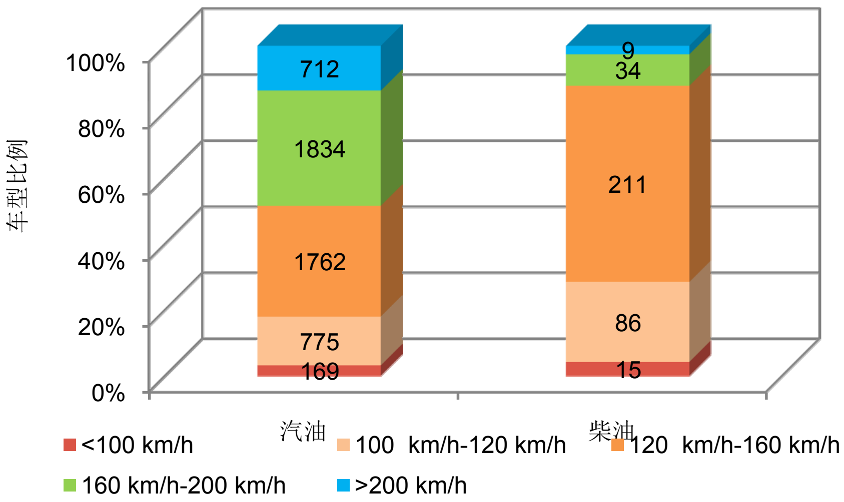


图 23 汽油/柴油车最高设计车速车型分布

如图 23 所示，汽油车最高设计车速明显高于柴油车。在柴油车中，只有略超过 10%的车型最高设计车速在 160 km/h 以上，对汽油车这一比例则接近 50%。

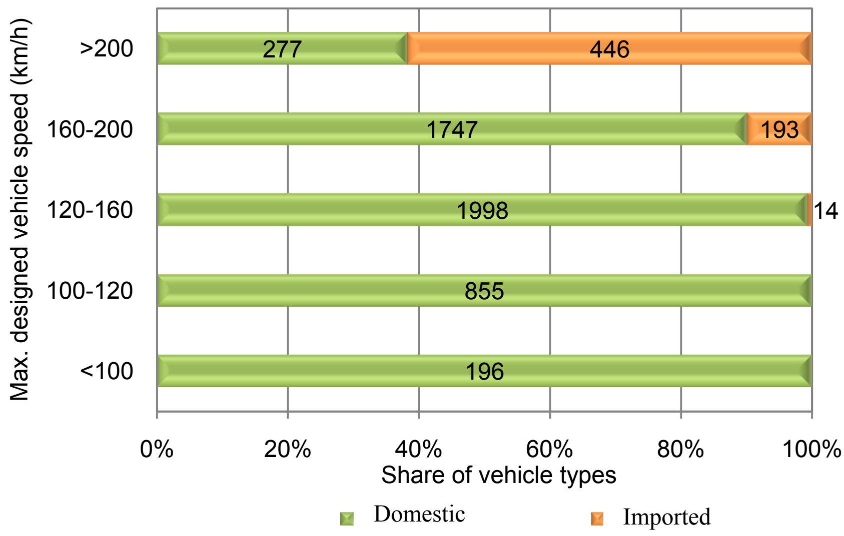


Figure 22 Distribution of domestic/imported vehicle types with respect to max. designed vehicle speed

According to Figure 22, 5 segments of max. designed vehicle speed are grouped, i.e., ≤100 km/h, 100 km/h ~ 120 km/h, 120 km/h ~ 160 km/h, 160 km/h ~ 200 km/h, and > 200 km/h. As shown in the figure, the local passenger cars are mainly distributed in two speed segments, namely, 120 km/h ~ 160 km/h, and 160 km/h ~ 180 km/h.

For different places of origin, the distribution of vehicle types with respect to max. designed vehicle speed is similar to that with respect to power. Over 90% domestic vehicle types fall within the range of 100 km/h ~ 200 km/h; in total 1,051 vehicle types have the max. designed vehicle speed below 120 km/h, totally represented by domestic vehicles. All the imported vehicle types are concentrated in the segments of more than 120 km/h; concretely, amongst the vehicle types with max. designed vehicle speed exceeding 200 km/h, the share of imported vehicle types is high as 61.7%.

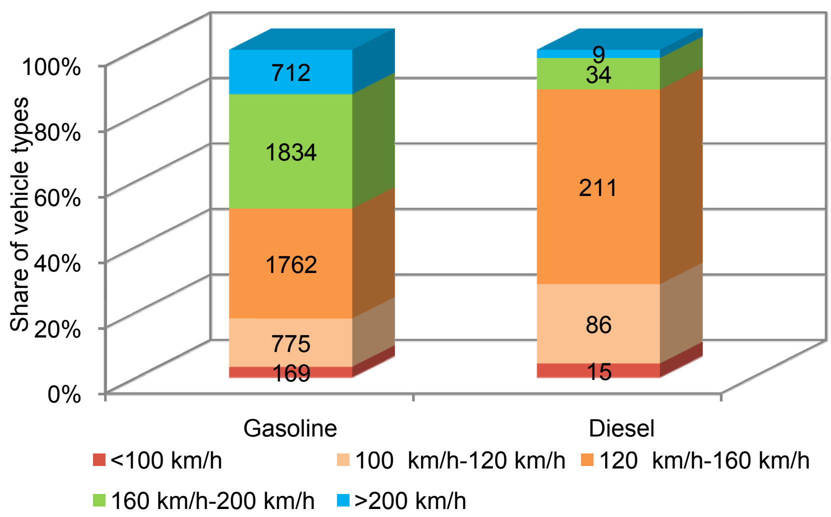


Figure 23 Distribution of gasoline/diesel vehicle types with respect to max. designed vehicle speed

As shown in Figure 23, the gasoline vehicles have a clearly higher max. designed vehicle speed than that of diesel ones. For diesel vehicles, slightly more than 10% vehicle types have the max. designed vehicle speed exceeding 160 km/h; in the case of gasoline vehicles, this proportion approaches 50%.

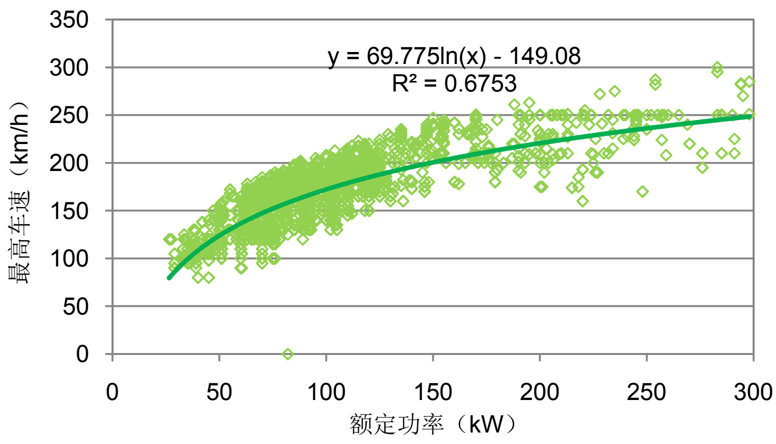


图 24 额定功率与最高设计车速

在上述分析中，车辆最高设计车速分布与额定功率分布规律类似，这在一定程度上反映了二者之间存在某种联系；进一步分析表明发动机的额定功率与最高设计车速存在明显的指数分布关系。如图 24 所示，最高设计车速整体上随额定功率增加而增大，但增长幅度则随着额定功率的增加而趋于平稳，这是因为绝大部分配置较大额定功率发动机的乘用车整备质量或最大设计总质量较大，大功率发动机主要被设计用来提高乘用车的加速性能而不是最高设计车速，并且从产品开发角度来看，无限制提高最高设计车速对乘用车而言，意义并不显著。

2.7 可比燃料消耗量因子分布

为对汽车动力性、燃料经济性、舒适性及驾驶性等进行综合全面评价，中国汽车技术研究中心提出了“FEDC 因子”的概念，即“基于动力性和舒适性的燃料消耗量因子”。该值越小说明汽车的节能性能越好，舒适性越高。FEDC 因子的优点是在考虑车辆动力性、舒适型的前提下对不同车辆的燃料消耗量进行横向对比，因此也称为“可比燃料消耗因子”。目前，已被《乘用车节能产品认证技术要求》采用作为乘用车节能产品评价的技术指标，中国汽车工业协会 2008 年公布的汽车产品节能评价办法也采用了这一方法。

可比燃料消耗因子的计算公式如下：

可比燃料消耗因子=（燃料消耗量/比功率）×（燃料消耗量/脚印面积）

其中，比功率是指发动机净功率（或 0.9 倍的发动机额定功率）与车辆的整车整备质量的比（W /kg）；脚印面积是指前轮距和轴距的乘积（m^2）。

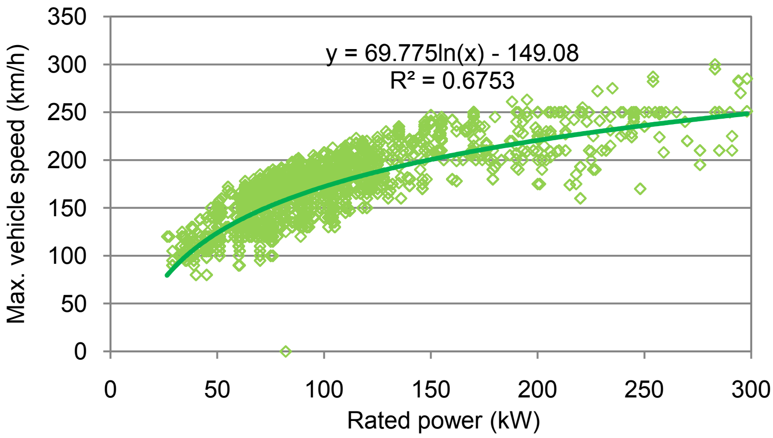


Figure 24 Rated power vs. max. designed vehicle speed

According to the analysis above, the distribution with respect to max. designed vehicle speed is similar to that with respect to rated power, which, to a certain extent, signals that some correlation exists between them; according to further analysis, a clear exponential distribution relation exists between rated engine power and max. designed vehicle speed. As shown in Figure 24, the max. designed vehicle speed generally increases along with rated power, and the extent in rise becomes stabilized with the increase in rated power, on the grounds that a great majority of passenger cars equipped with big-rated-power engine have a larger curb mass or gross vehicle weight and the big-power engine is used mainly to improve the acceleration property of passenger cars (other than to uplift the max. designed vehicle speed); additionally, in the perspective of product development, unlimited improvement of the max. designed vehicle speed would be of no clear significance for passenger cars.

2.7. Distribution with respect to FEDC factor

For the comprehensive, all-round assessment over power performance, fuel economy, comfort and controllability of motor vehicles, CATARC puts forward the concept of “FEDC factor”, that is, “fuel consumption factor based on dynamic characteristic and comfort”. The smaller the value is, the better the energy-saving performance and the higher the comfort. The advantages of FEDC factor rests with that transverse comparison could be conducted to the fuel consumption of different vehicles under the prerequisite that vehicles’ power performance and comfort are taken into account; in this sense, it is also called “FEDC factor”. Now, the “Specifications for Certification of Energy-saving Passenger Car Products” regards it a technical index intended for assessing the energy-saving passenger car products; in the energy-saving appraisal methods for auto products as released by CAAM (China Association of Automobile Manufacturers) in 2008, such an index is also employed.

The formula of the FEDC factor is as follows:

FEDC factor = (fuel consumption/specific power) × (fuel consumption/footprint)

Where, specific power refers to the ratio between net engine power (or 0.9 time of rated engine power) and curb mass (W/kg); and footprint refers to the product between the front wheel base and axle base (m^2).

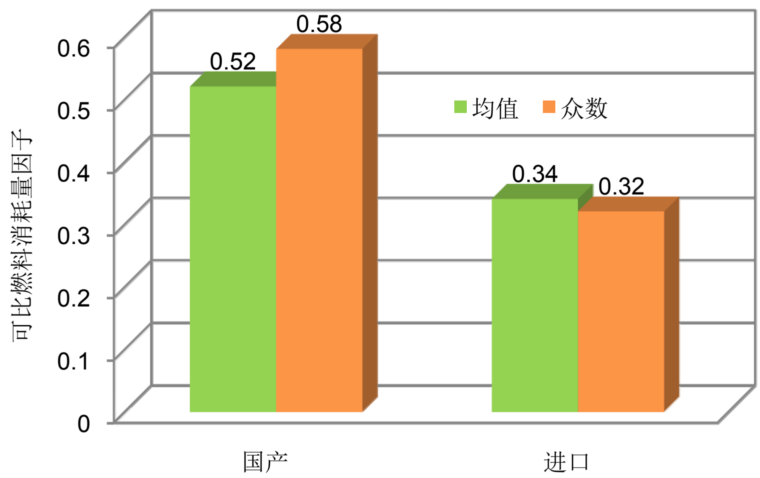


图 25 国产/进口车可比燃料消耗量因子比较

如图 25 所示，对国产车和进口车的 FEDC 因子进行对比分析可以发现，进口车的 FEDC 因子明显小于国产车。这意味着尽管国产车的燃料消耗量水平低于进口车，但这主要是由于国产车和进口车的质量差异造成的，在综合考虑动力性、舒适性和燃料经济性的前提下，国产车的整体技术水平和性能指标仍与进口车存在较大的差距。

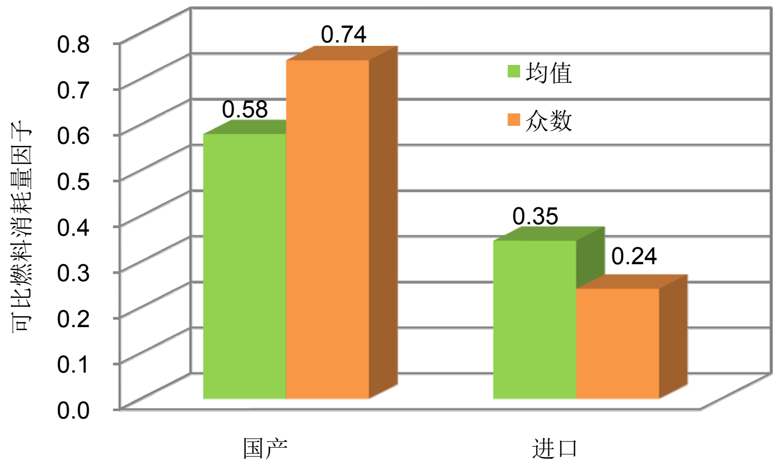


图 26 国产/进口越野车可比燃料消耗量因子比较

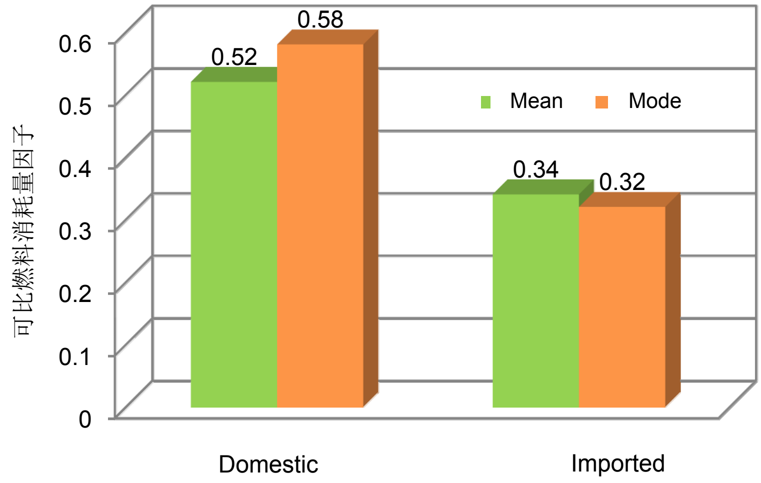


Figure 25 Comparison between domestic and imported vehicle types with respect to FEDC factor

Figure 25 illustrates the comparison between domestic and imported vehicle types with respect to FEDC factor; clearly, the imported vehicle types have a largely smaller FEDC factor than their domestic peers. It means that, despite the domestic vehicles present a fuel consumption level lower than that of their imported counterparts, the difference is mainly resulted from the quality indent between them; given all-round consideration of power performance, comfort and fuel economy, a big indent still exists for the domestic vehicles as to the overall technical proficiency and performance indices when compared to the imported ones.

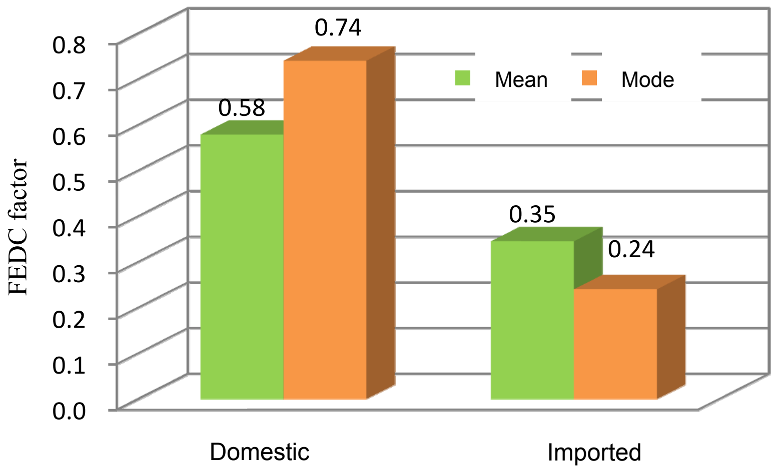


Figure 26 Comparison between domestic and imported off-road vehicles with respect to FEDC factor

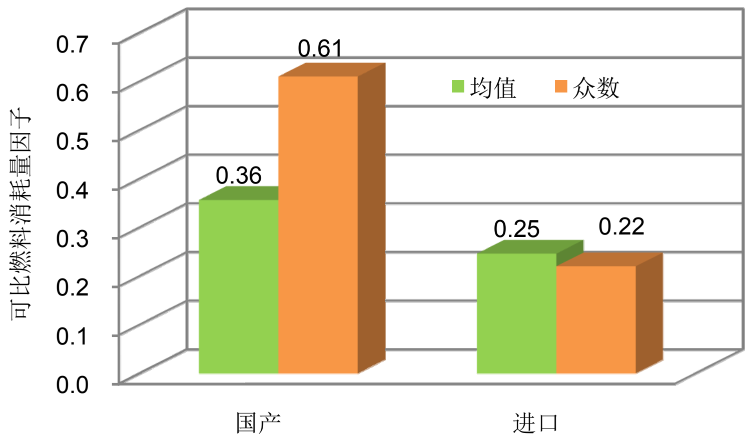


图 27 非越野车可比燃料消耗量因子产地分布

从图 26、图 27 中可以看出，国产越野车或非越野车的可比燃料消耗量因子均高于进口车。

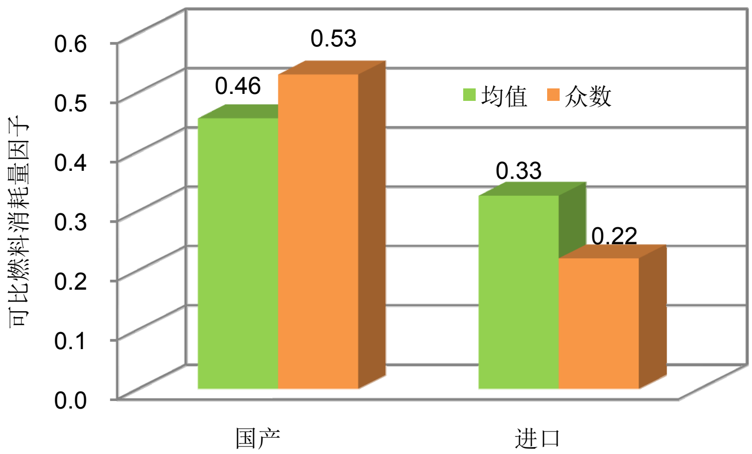


图 28 国产/进口五座以上非越野车可比燃料消耗量因子比较

图 28 所示为 2010 年我国不同产地的 5 座以上（三排及以上座椅）非越野车（本报告中将其归类为微型客车）的可比燃料消耗量因子的分布情况。可以看出，此类进口车辆的可比燃料消耗量因子与进口越野车相当，此类国产车的可比燃料消耗量因子则优于越野车，而劣于 5 座及以下的普通车辆。

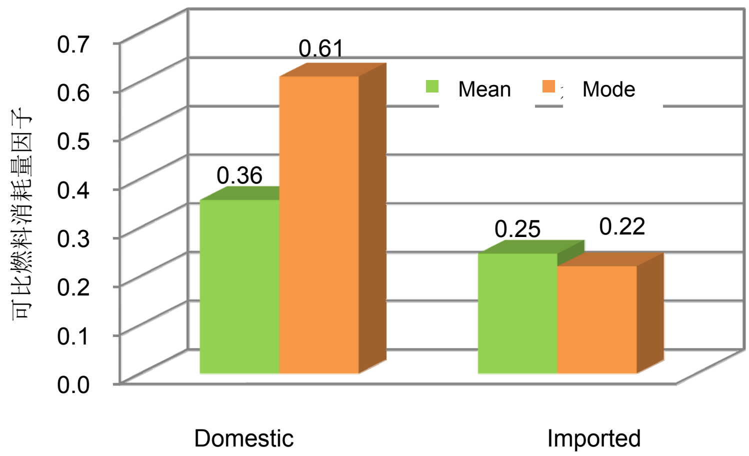


Figure 27 Distribution of non off-road vehicle types with respect to FEDC factor and place of origin

As shown in Figure 26 and Figure 27, the domestic off-road and non off-road vehicles have a FEDC factor higher than that of the imported vehicle types.

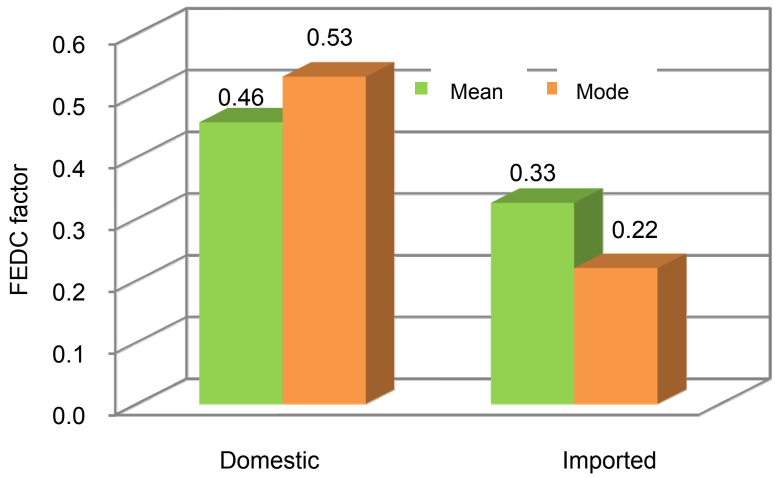


Figure 28 Comparison between domestic and imported non off-road vehicle types having more than 5 seats with respect to FEDC factor

Figure 28 shows the distribution of non off-road vehicle types (may be deemed as mini vans) of different places of origin having more than 5 seats (three or more rows of seats) with respect to FEDC factor in China in the year 2010. Evidently, the imported vehicle types of this category have a FEDC factor equivalent to that of imported off-road vehicles; while for the domestic vehicles, their FEDC factor is superior to that of the off-road vehicles, but inferior to that of the common vehicles having 5 or less seats.

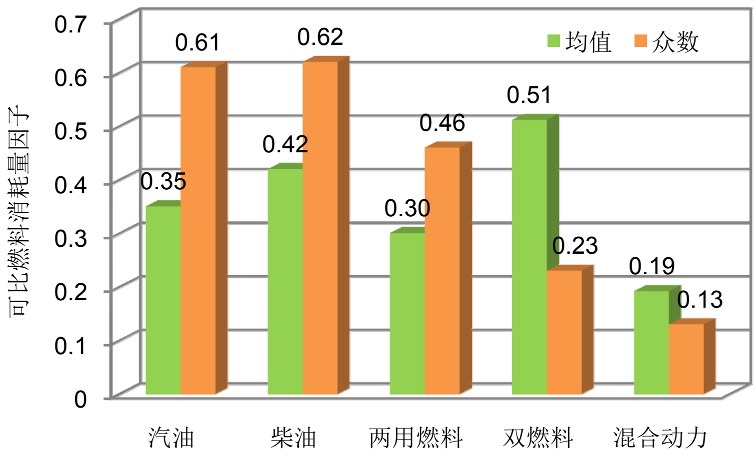


图 29 不同燃料类型可比燃料消耗量因子分布

如图 29 所示，在对不同燃料类型车辆的可比燃料消耗量因子进行统计分析时发现，双燃料车辆的可比燃料消耗量因子均值在所有燃料类型车辆中最高。这说明与传统燃料相比，现有的双燃料车辆在提高车辆经济性的同时却也损失了其动力性。同时，混合动力车辆的可比燃料消耗量因子在所有燃料类型中最小，说明在综合考评汽车动力性、燃料经济性、舒适性等指标时，混合动力车辆与采用其余燃料类型的车辆相比具有比较明显的优势。

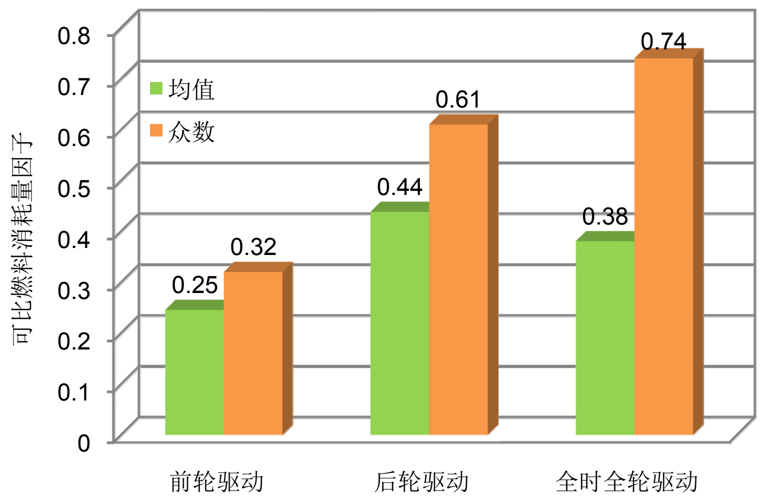


图 30 不同驱动型式可比燃料消耗量因子比较

如图 30 所示，采用前轮驱动的多为质量轻、较为经济的中小型车，因此燃料消耗量因子最小，而采用后轮驱动车辆质量跨度大，车型复杂，其燃料消耗量因子相对较大，全时全轮驱动车辆虽然多为质量大、燃料消耗量较高的豪华车，但其优异的动力性与舒适性使得其燃料消耗量因子均值介于前轮驱动与后轮驱动车型之间。

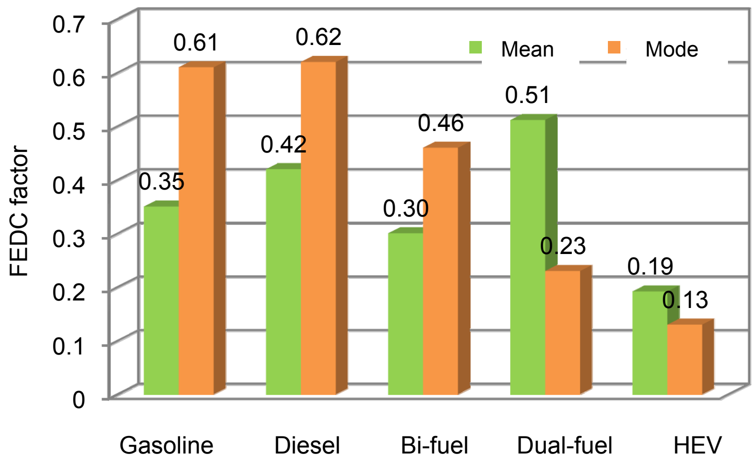


Figure 29 Distribution of different fuel types with respect to FEDC factor

As shown in Figure 29, statistics are conducted to the FEDC factor of vehicles of different fuel types; clearly, the FEDC factor of dual-fuel vehicles is the highest. It means that, as compared to conventional fuels, the existing dual-fuel vehicles are improved in their economy, but at the cost of power performance. Meanwhile, the hybrid electric vehicles (HEVs) present the lowest FEDC factor, indicating that, upon comprehensive appraisal of vehicles' power performance, fuel economy, and comfort, HEVs enjoy apparent superiority as compared to the vehicles of other fuel types.

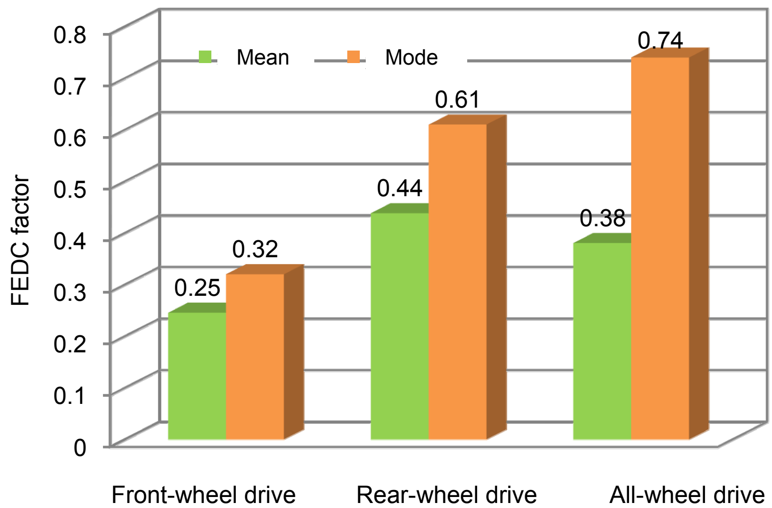


Figure 30 Comparison among different types of drive model with respect to FEDC factor

As shown in Figure 30，the vehicle type of front-wheel drive are mostly lightweight and economical, so the FEDC is smaller; the type distribution of rear-wheel drive vehicle is complex, the FEDC is much more higher than the others, though all-wheel drive vehicles are mostly have higher fuel consumption, large quality, its power performance and comfort making its FEDC between the front-wheel drive and rear-wheel-drive models..

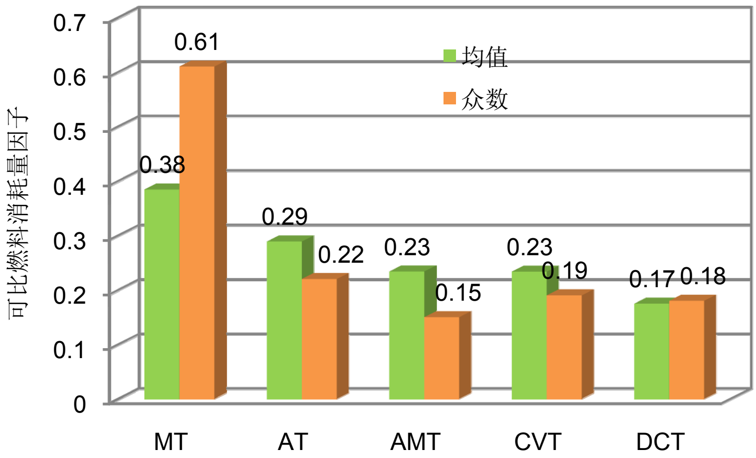


图 31 不同变速器型式可比燃料消耗量因子比较

由于目前市场上配置(AMT)、(CVT)、(DCT)等新型变速器的乘用车通常都是技术较为先进的新车，其可比燃料消耗量因子普遍低于配置(MT)的乘用车。

2.8 质量分布

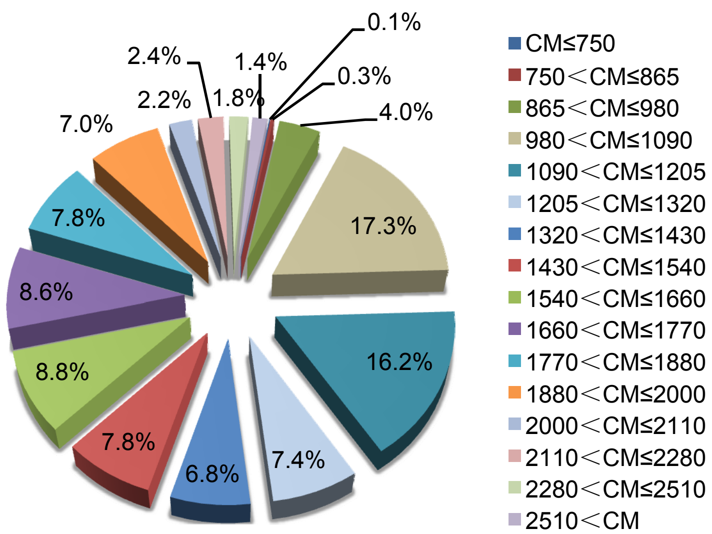


图 32 质量段分布

《乘用车燃料消耗量限值》(GB 19578-2004)中采用了基于整车整备质量的单车燃料消耗量评价体系。对应标准将乘用车的整车整备质量分为 16 个质量段，各质量段中车型分布如图 32 所示，约有 34%的车型集中在 980 kg-1090 kg 和 1090 kg-1205 kg 这两个质量段，其车型数量分别为 992 和 997 个，占全部车型数量比例分别为 17.3%和 16.2%，整备质量在 865 kg 以下的车型所占比例极小：分布在 750-865 kg 质量段的车型有 18 个，占全部车型总数的 0.3%，而 750 kg 及以下的车型只有 4 个，所占比例不足 0.1%。2000 kg-2110 kg、2110 kg-2280 kg、2280 kg-2510 kg 和 2510 kg 以上这四个质量段的车型数分别为 125、140、103 和 81 个，占

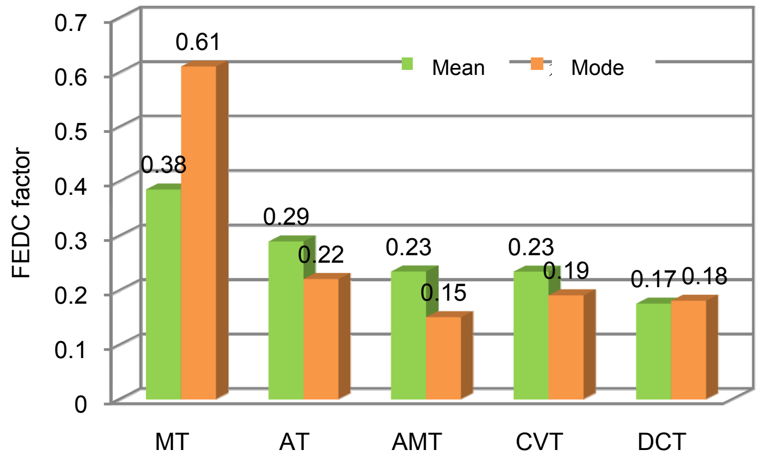


Figure 31 Comparison among different types of transmission with respect to FEDC factor

Whereas the present passenger cars fitted with AMT, CVT, DCT, or other innovative types of transmission are usually the technically-advanced new vehicles, their FEDC factor is generally lower than the MT passenger cars.

2.8. Distribution with respect to mass

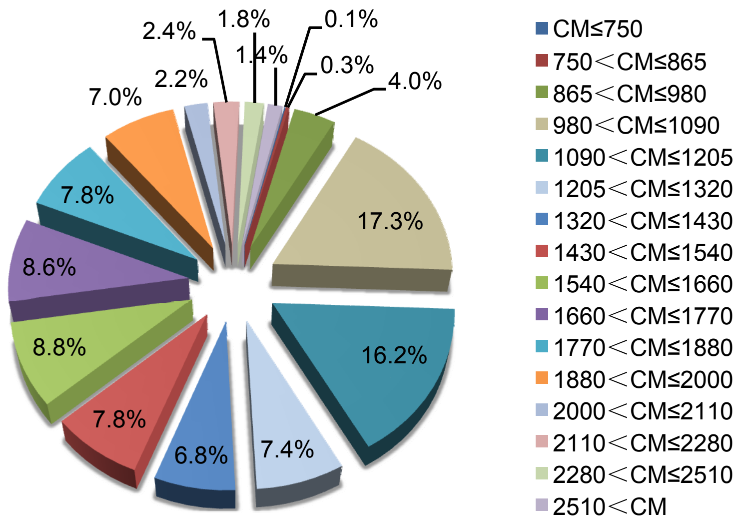


Figure 32 Distribution of mass segments

GB 19578-2004 "Limits of fuel consumption limits for passenger cars" employs the single-vehicle fuel consumption assessment system based on curb mass. In correspondence to the standard, passenger cars are divided into 16 segments of curb mass; for the distribution of vehicle types in each mass segment, see Figure; about 34% vehicle types are concentrated in the following two segments, i.e., 980 kg ~ 1,090 kg and 1,090 kg ~ 1,205 kg, which respectively accommodate 992 and 997 vehicle types, occupying 17.3% and 16.2% accordingly of the total vehicle types. The vehicle types with the curb mass below 865 kg take up a tiny share: 18 vehicle types fall within the segment of 750 ~ 865 kg, occupying 0.3% of the total, and 4 vehicle types are at 750 kg or below, occupying less than 0.1%. For the four segments of 2,000 kg ~ 2,110 kg, 2,110 kg ~ 2,280 kg, 2,280 kg ~ 2,510 kg, and above 2,510 kg, the numbers of vehicle

全部车型的比例均在 2%左右，分别为 2.2%、2.4%、1.8%和 1.4%；其余各质量段车型分布比较平均，车型数量所占全部车型的比例在 8%左右。

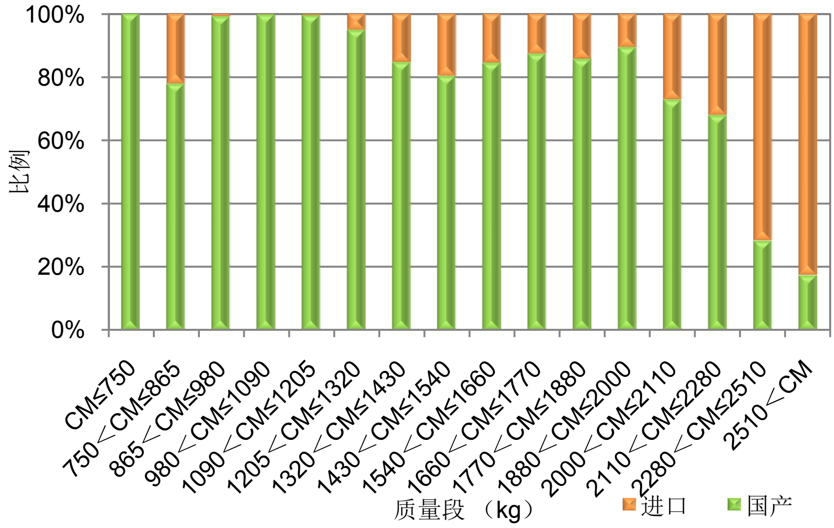


图 33 各质量段产地分布

如图 33 所示，在车型最集中的 980 kg-1090 kg 和 1090 kg-1205 kg 这两个质量段，国产车车型数量分别为 989、922 个，占总车型数的比例超过 99%，进口车在这两个质量段分别只有 3 个和 5 个车型，所占比例不足 1%；在 750 kg 以下质量段没有进口车型。而在超过 2280 kg 的质量段中，进口车与国产车的车型数量分别为 141 个和 43 个，进口车车型数量比例远高于国产车。这是因为进口车市场主要定位在利润高、质量大的中高级车辆上。

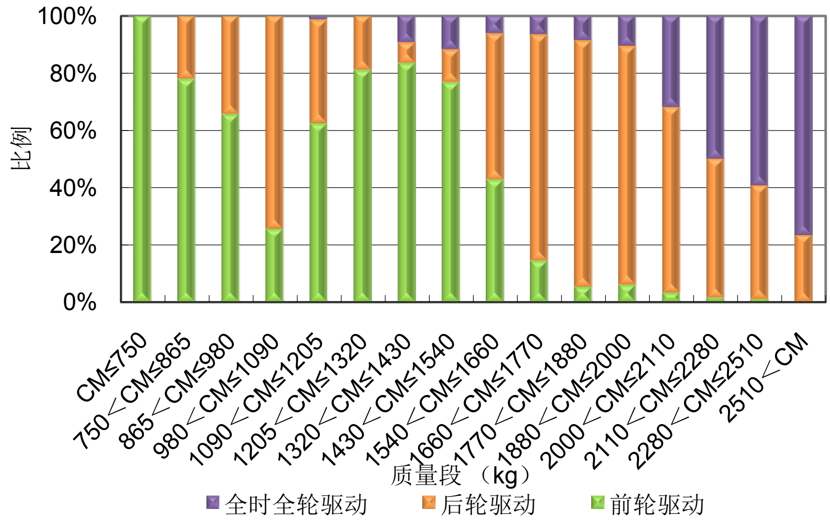


图 34 各质量段驱动型式分布

如图 34 所示，前轮驱动、后轮驱动仍然是我国乘用车的主要驱动方式。在列入统计的车型中，采用前轮驱动和后轮驱动的车型数量分别为 2347 和 2895 个，占车型总数的 91.5%；采用全时全轮驱动的车型比例仅为 8.5%，主要分布在中高质量段，特别是在 2000 kg 以上的车辆中，采用全时全轮驱动的车型比例超过 50%。而在整车整备质量小于 1430 kg 的车型中，

types are respectively 125, 140, 103 and 81, occupying roughly2% each (concretely, 2.2%, 2.4%, 1.8% and 1.4% respectively). For the rest segments, the distribution of vehicle types is quite uniform, with the share being at about 8% each of the total.

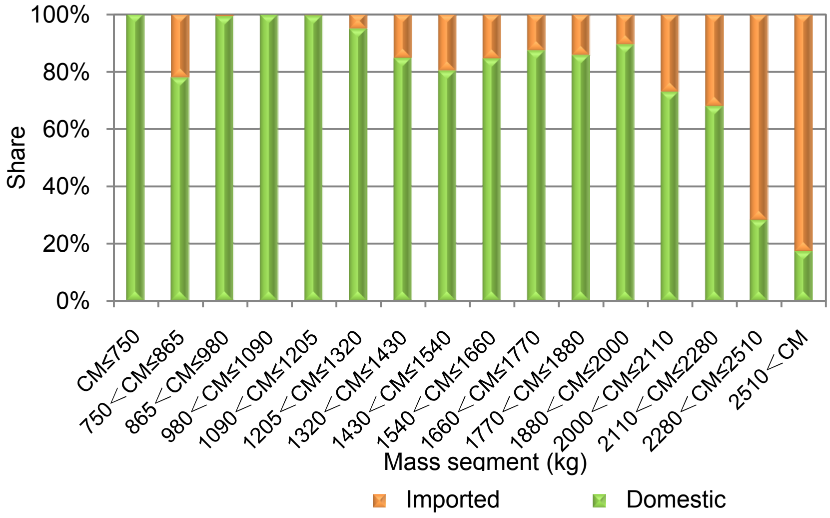


Figure 33 Distribution of places of origin in each mass segment

As shown in Figure 33, in the two mass segments where vehicle types are most concentrated (i.e., 980 kg ~ 1,090 kg and 1,090 kg ~ 1,205 kg), there are 989 and 922 domestic vehicle types respectively, occupying, when combined, more than 99% of the total; in contrast, there are merely 3 and 5 imported vehicle types in these two segments respectively, with the combined share not reaching 1%; and for the mass segment below 750 kg, no imported vehicle type is seen at all. In the segments above 2,280 kg, there are 141 imported vehicle types and 43 domestic ones, with the number of imported vehicle types far outstripping that of the domestic peers. The reason is quite clear: the imported vehicle types place a close eye on the market of intermediate- and high-grade vehicles featuring big mass and high profit margin.

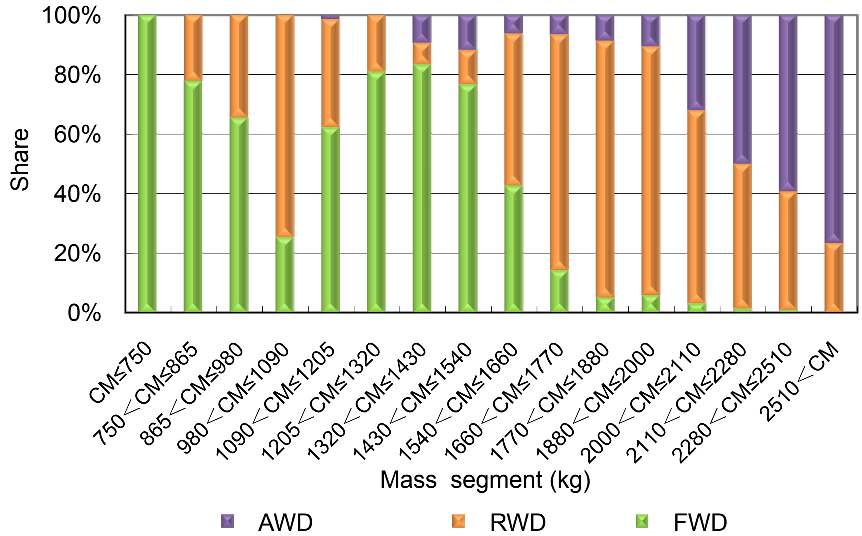


Figure 34 Distribution of types of drive model in each mass segment

As shown in Figure 34, Front- and rear-wheel drives are still the mainstream of the local passenger cars. Amongst the vehicle types involved for the statistics, 2,347 and 2,895vehicle types employ the Front- and rear-wheel drives respectively, occupying, when combined, 91.5% of the total; only 8.5% vehicle types employ the all-wheel drive, which are mainly distributed in the medium and high mass segments; especially in terms of the vehicles above 2,000 kg, over 50% vehicle types are of all-wheel drive. In contrast, as for the vehicle types with curb mass less than 1,430 kg, quite

仅有个别车型采用了全时全轮驱动。此外，980 kg-1090 kg 的车型采用后轮驱动的比例显著高于相邻质量段；在对这一质量段的车型进行分析后发现，造成这一现象的主要原因是目前绝大部分微型客车采用的驱动方式为后轮驱动（见表 4）。如图 35 所示，微型客车在该质量段所占的比例远高于相邻质量段。除此以外，整备质量在 1540 kg 以下的车型主要是前轮驱动。

表 4 微型客车驱动型式分布

	前轮驱动	后轮驱动	全时全轮驱动
车型数	179	1563	13

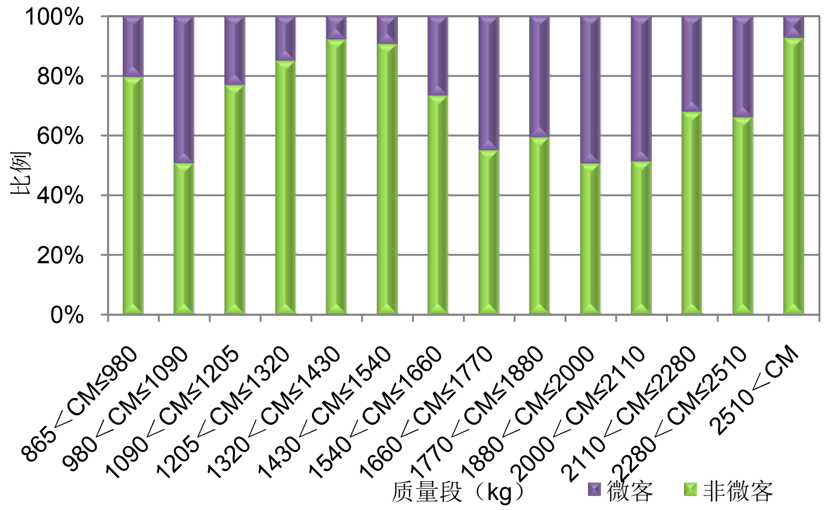


图 35 微型客车分布比例

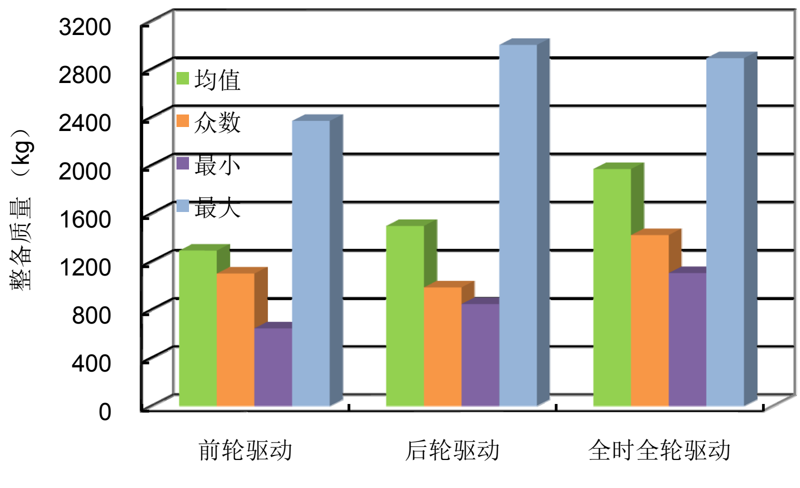


图 36 不同驱动型式质量分布

如图 36 所示，采用全时全轮驱动汽车的整备质量要普遍高于单独采用前轮驱动或后轮驱动汽车的整备质量。根据统计，采用前轮驱动和后轮驱动的车辆的平均整车整备质量分别为 1291 kg、1496 kg，采用全时全轮驱动的车辆整备质量平均值为 1969 kg，分别比前轮驱动和后轮驱动的车辆高 52.5%和 31.6%。另外一个显著的特点是，由于后轮驱动车辆车型覆盖

few vehicle types employ the all-wheel drive. Moreover, the vehicle types within 980 kg ~ 1,090 kg are much more inclined to adopt rear-wheel drive when compared to the adjacent mass segments; according to the analysis conducted to the vehicle types within such a segment, it is found that the main reason lies in that presently a great majority of mini vans employs rear-wheel drive (see Table 4). According to Figure 35, the share of mini vans in this mass segment is far higher than that of each adjacent segment. Moreover, the vehicle types with curb mass below 1,540 kg principally employ front-wheel drive.

Table 4 Distribution of types of drive model for mini vans

	Front-wheel drive	Rear-wheel drive	All-wheel drive
Number of vehicle types	179	1,563	13

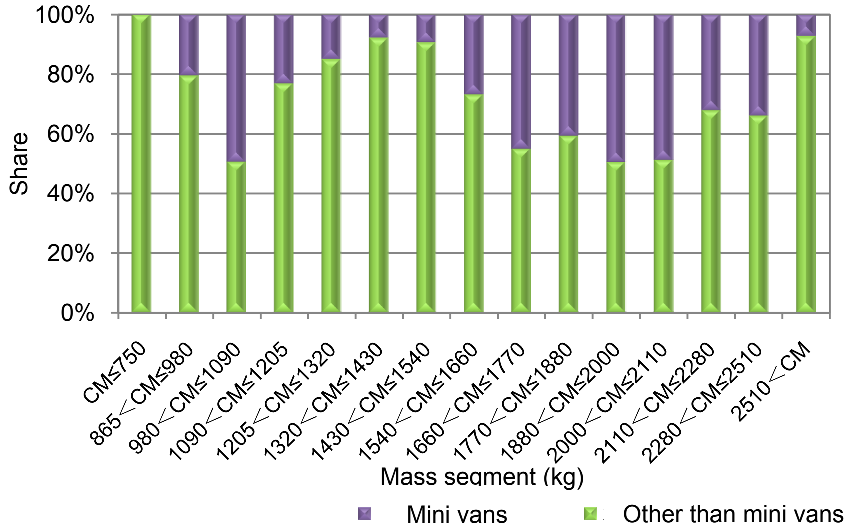


Figure 35 Distribution shares of mini vans

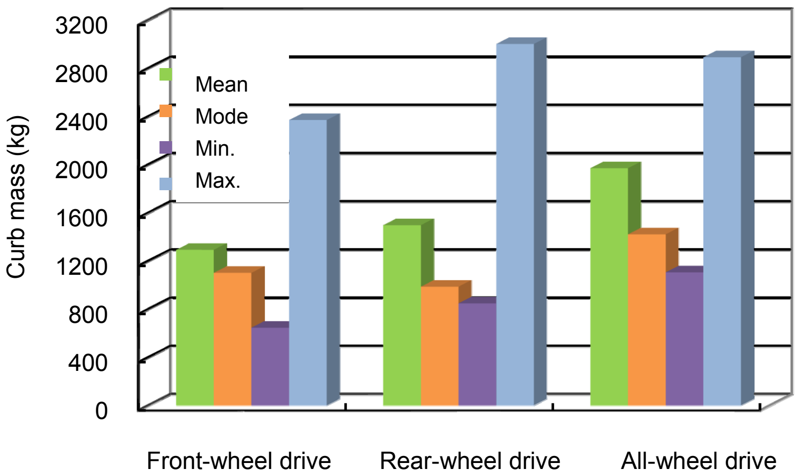


Figure 36 Distribution of different types of drive model with respect to mass

According to Figure 36, it is a general situation that the all-wheel drive vehicles have a higher curb mass than the vehicles separately employing Front- or rear-wheel drive. As indicated by the statistics, the average curb mass of the vehicles employing Front- and rear-wheel drives is 1,291 kg and 1,496 kg respectively, while that of all-wheel drive vehicles is 1,969 kg, 52.5% and 31.6% highly than the Front- and rear-wheel drive vehicles respectively. Another salient

面广，其质量跨度明显大于其它两种驱动型式，最大与最小整备质量之差高达 2153 kg。

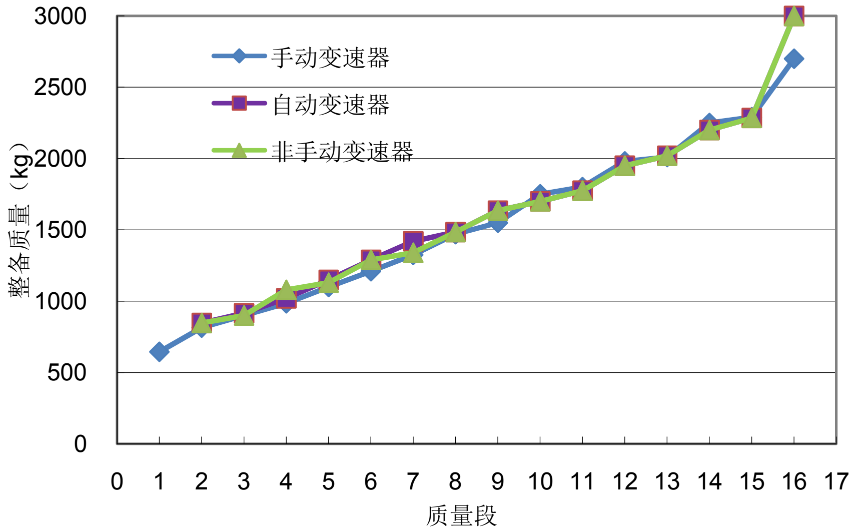


图 37 不同变速器型式质量分布

对各质量段内采用不同变速器型式的车型分析表明，变速器型式对同一质量段间车辆质量的影响并不明显，或者说变速器型式并不是造成车辆质量差异的关键因素。

如图 38 所示，图中左侧为质量段质量下限，右侧为质量段的质量上限。绿色与橙色相交的地方为整备质量众数在该质量段的位置，可以看出每个质量段的车型最多采用的整备质量都趋近于质量段的上限。

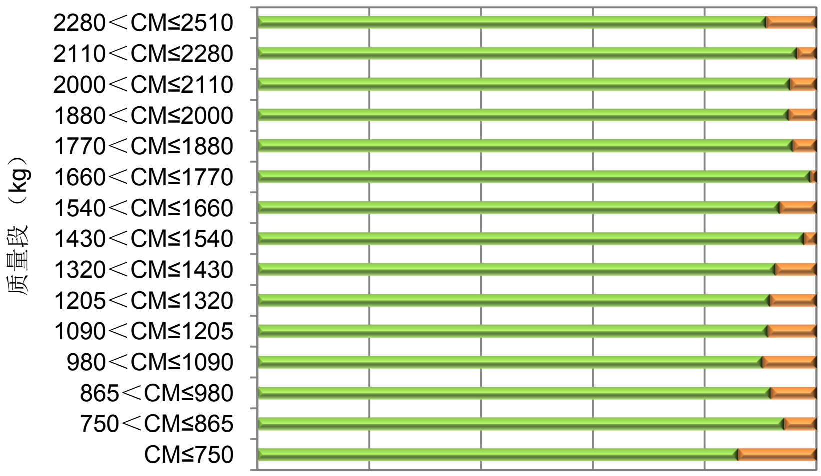


图 38 质量众数在各质量段中的位置

characteristic can not be disregarded: whereas the rear-wheel drive vehicles present a large coverage, their mass span is clearly bigger than that of the other two types of drive model, with the spread between max. and min. curb mass arriving at 2,153 kg.

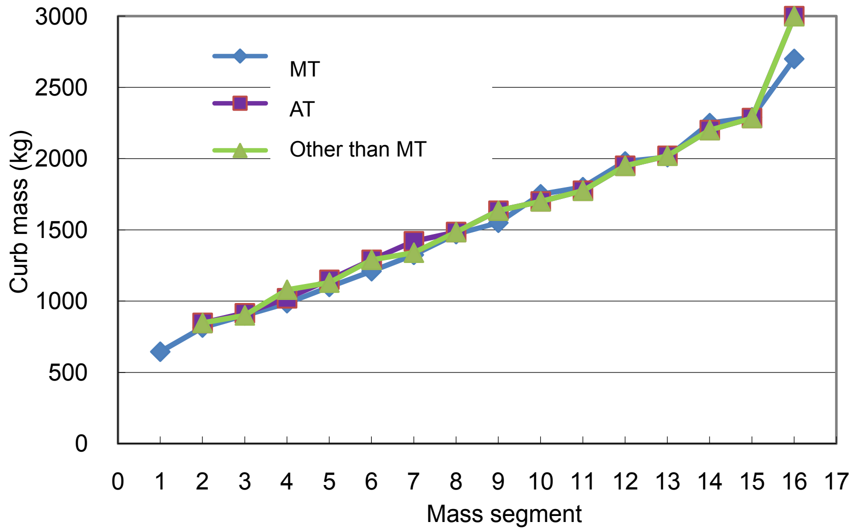


Figure 37 Distribution of different types of transmission with respect to mass

According to the analysis on the vehicle types employing different types of transmission in each mass segment, the type of transmission has no large impact on the vehicle mass within one segment; or, to put it directly, the type of transmission is not the critical factor resulting in vehicle mass difference.

As indicated in Figure 38, the left hand side of the figure gives the lower mass limit of the segment, while the right hand side, the upper limit. The intersection between green and orange colors indicate the position where the mode of the curb mass resides for the segment; clearly, for each mass segment the most employed curb mass approaches, without exception, to the upper limit of the segment concerned.

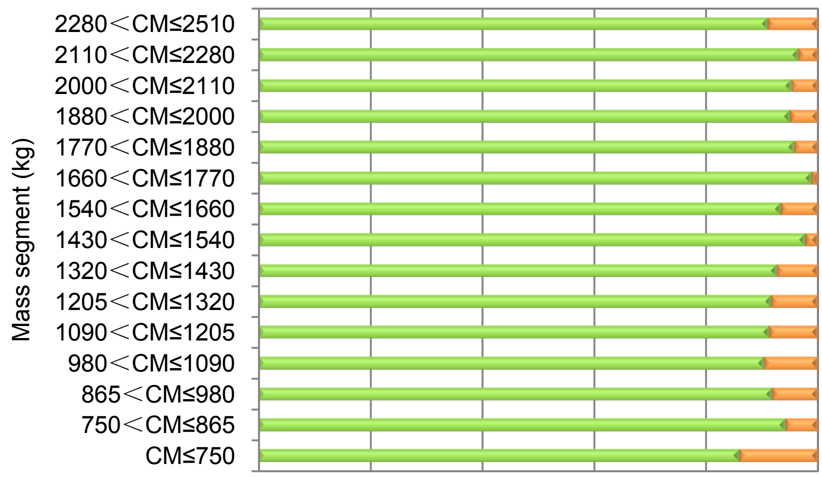


Figure 38 Mass mode for each mass segment

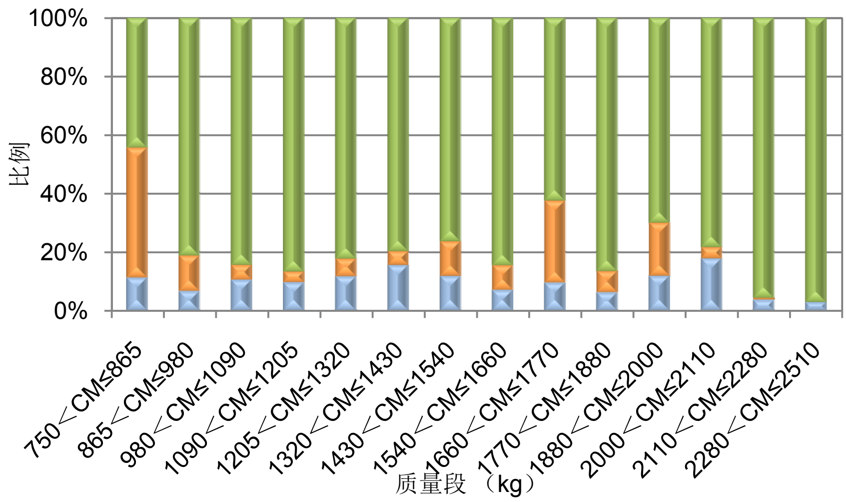


图 39 整备质量与质量上限差值分布

表 5 各排量段与质量段车型分布情况

	<=1.0	1.0-1.3	1.3-1.6	1.6-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	>4.0	合计
CM≤750	3	1								4
750＜CM≤865	18									18
865＜CM≤980	118	44	67							229
980＜CM≤1090	356	373	259	4						992
1090＜CM≤1205	76	231	595	25						927
1205＜CM≤1320	4	44	278	98						424
1320＜CM≤1430		7	126	251	4	2				390
1430＜CM≤1540			27	349	51	12	4		2	445
1540＜CM≤1660	1		10	252	172	49	5	8	9	506
1660＜CM≤1770				188	212	62	12	10	11	495
1770＜CM≤1880				69	279	54	8	9	26	445
1880＜CM≤2000				78	209	81	13	8	13	402
2000＜CM≤2110				9	52	33	10	11	10	125
2110＜CM≤2280					47	45	8	20	20	140
2280＜CM≤2510				1	20	22	5	11	44	103
2510＜CM					4	10		6	61	81
合计	576	700	1362	1324	1050	370	65	83	196	5726

质量段（纵）单位：kg 排量段（横）单位： L

注：表示横向极值，即与该质量段对应的车型数量最多的排量段；
表示纵向极值，即与该排量段对应的车型数量最多的质量段；
表示横向极值与纵向极值相同。

从上表中可以看出排量在 1.6 L-2.0 L 的车型质量跨度最大，覆盖了从 980 kg-2280 kg 之间的 11 个质量段，整备质量在 1540 kg-1660 kg 质量段内的车型排量段分布最广，覆盖了从 1.3 L 到 4.0 L 以上的 7 个排量段。在被统计的所有数据中，排量为 1.3 L-1.6 L 之间、整备质量在 1090 kg-1205 kg 之间的车型数量最多，为 595 个，占全部车型总数的 10.4%。

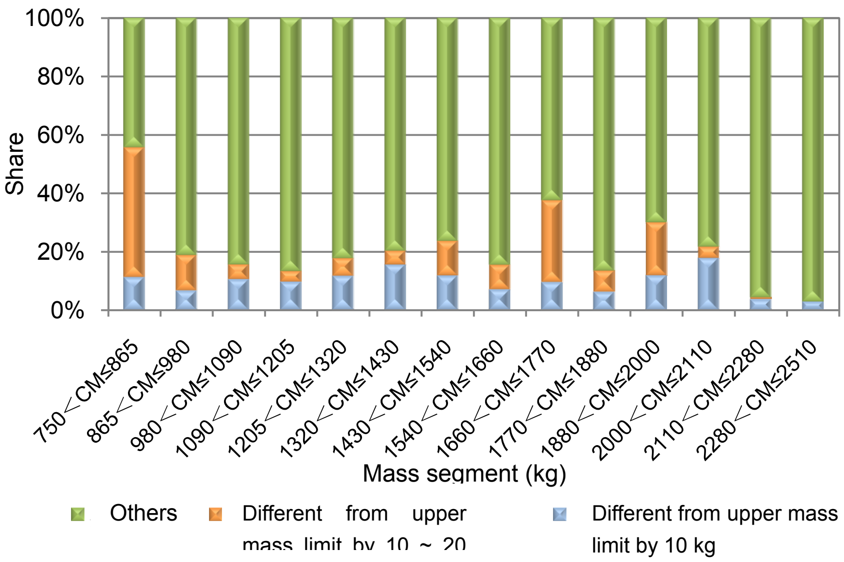


Figure 39 Difference distribution between curb mass and upper mass limit

Table 5 Distribution of vehicle types in each engine displacement segment and each mass segment

	<=1.0	1.0-1.3	1.3-1.6	1.6-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	>4.0	Total
CM ≤ 750	3	1								4
750 ＜ CM ≤ 865	18									18
865 ＜ CM ≤ 980	118	44	67							229
980 ＜ CM ≤ 1,090	356	373	259	4						992
1,090 ＜ CM ≤ 1,205	76	231	595	25						927
1,205 ＜ CM ≤ 1,320	4	44	278	98						424
1,320 ＜ CM ≤ 1,430		7	126	251	4	2				390
1,430 ＜ CM ≤ 1,540			27	349	51	12	4		2	445
1,540 ＜ CM ≤ 1,660	1		10	252	172	49	5	8	9	506
1,660 ＜ CM ≤ 1,770				188	212	62	12	10	11	495
1,770 ＜ CM ≤ 1,880				69	279	54	8	9	26	445
1,880 ＜ CM ≤ 2,000				78	209	81	13	8	13	402
2,000 ＜ CM ≤ 2,110				9	52	33	10	11	10	125
2,110 ＜ CM ≤ 2,280					47	45	8	20	20	140
2,280 ＜ CM ≤ 2,510				1	20	22	5	11	44	103
2,510 ＜ CM					4	10		6	61	81
Total	576	700	1,362	1,324	1,050	370	65	83	196	5,726

Mass segment (longitudinal) in kg; engine displacement segment (transverse) in L

Notes: Represent the transverse extreme, i.e., the engine displacement segment with the most vehicle types corresponding to the mass segment concerned;

Represent the longitudinal extreme, i.e., the mass segment with the most vehicles types corresponding to the engine displacement segment concerned;

Represent the equality of transverse and longitudinal extremes.

From the table above it can be seen that the vehicle types having the engine displacement falling within 1.6 ~ 2.0 L present the biggest span of masses, covering 11 mass segments from 980 kg up to 2,280 kg; the vehicle types in the curb mass segment of 1,540 kg ~ 1,660 kg present the most extensively distributed engine displacement, involving 7 segments from 1.3 L up to > 4.0 L. In view of all the data involved by the statistics, the engine displacement segment of 1.3 L ~ 1.6 L and the curb mass segment of 1,090 kg ~ 1,205 kg have the most vehicle types, i.e., 595, occupying 10.4% of the total.

2.9 脚印面积分布

为遏制 SUV 数量快速增长造成的燃料经济性水平的下降，美国于 2006 年 4 月对 CAFE 标准进行了重大改革，首次采用基于车辆“脚印面积”的燃料经济性评价体系，根据不同的“脚印面积”设定不同的燃料经济性目标值。其中，脚印面积的计算公式为：

脚印面积=前轮距×轴距（m^2）

之所以采用“脚印面积”作为评价车辆燃料经济性水平的基准参数是为了鼓励轻量化技术和材料的应用，同时又不影响汽车产品市场的多样性。另外一个重要的原因是，车辆的轮距、轴距一旦确定则不易做出较大的改变，标准的执行力更高。在基于车辆尺寸的燃料经济性评价体系下，通过轻量化技术可帮助汽车企业达到标准要求，但减少车辆尺寸大小则不能，因为一旦减小车辆尺寸，车辆面对的标准会更加严格[2]。

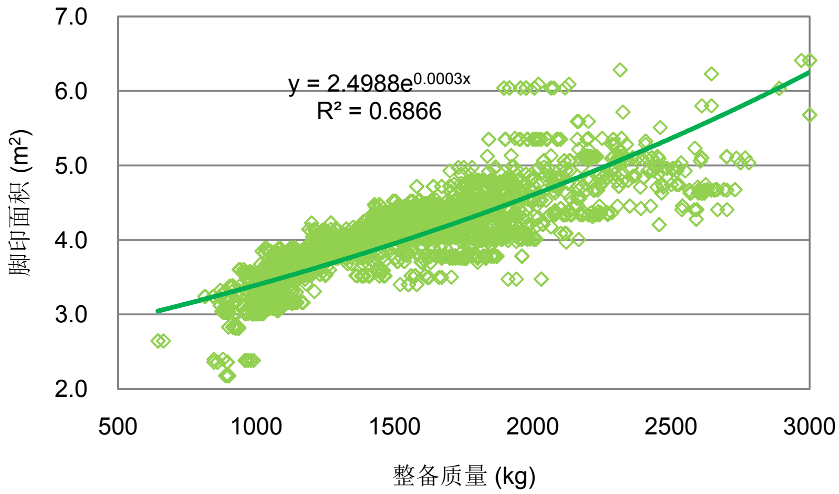


图 40 整备质量与脚印面积

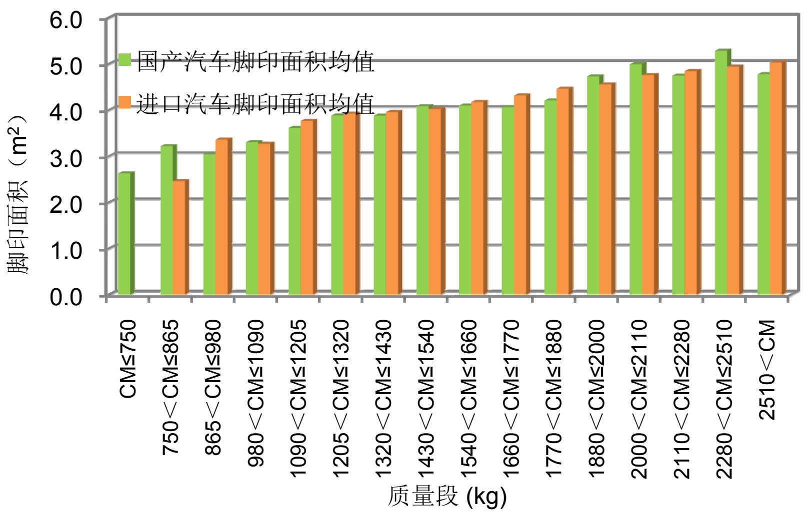


图 41 各质量段国产/进口车脚印面积

从图 40 中可以看出，我国汽车的脚印面积整体上随整备质量的增加而增加，但是在同

2.9. Distribution with respect to footprint

In order to hold rein of the reduction in fuel economy arising from the rapid rise in quantity of SUVs, the United States largely altered the CAFE standard in Apr. 2006, introducing, for the first time, the fuel economy appraisal system based on vehicle "footprint" and establishing separate fuel economy target value for each "footprint". To this end, footprint is calculated as follows:

$$\text{Footprint} = \text{Front wheel base} \times \text{axle base } (m^2)$$

The use of "footprint" as the reference parameter for the assessment of vehicle's fuel economy level is to encourage the application of light-weight technology and materials, without impairing the diversity of the auto product market. Another key reason cannot be denied: once established, vehicle's wheel base and wheelbase are hard to be largely altered, and the standard would subsequently be executed more effectively. Under the fuel consumption assessment framework based on vehicle dimensions, light-weight technology may help the auto makers in complying with the standard; in contrast, the diminishing of vehicle dimensions cannot reach such a goal, since that, given reduced vehicle dimensions, the vehicle would face much stricter standard [2].

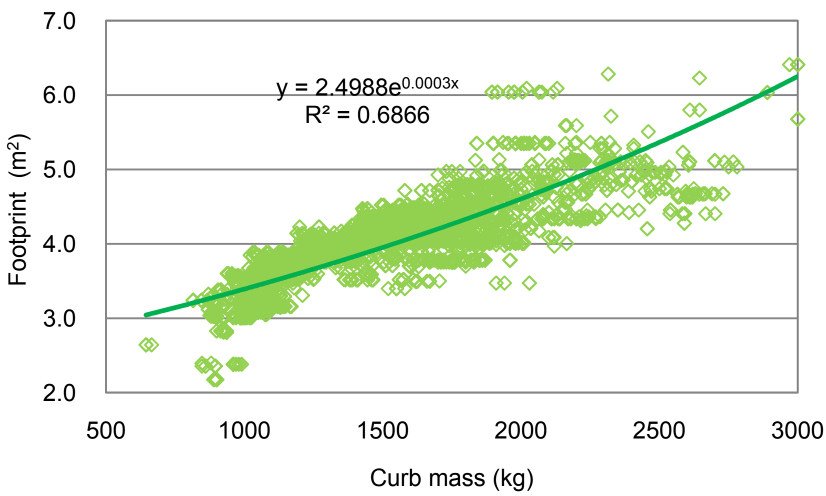


Figure 40 Curb mass vs. footprint

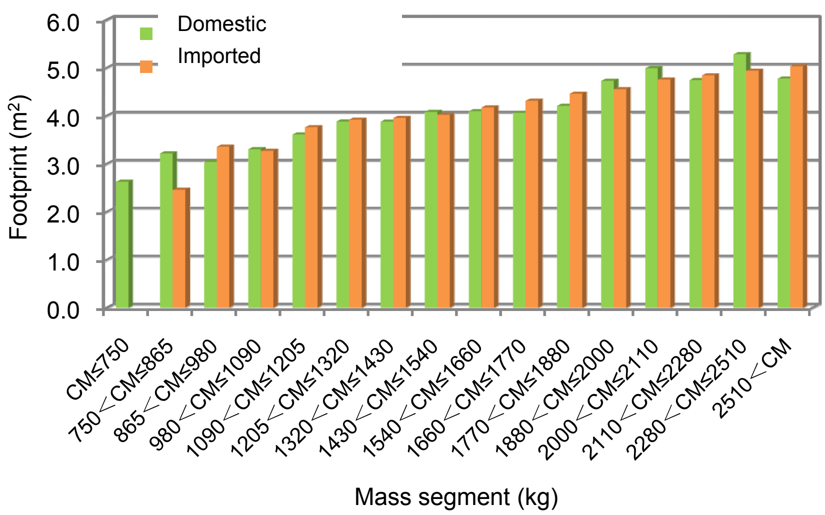


Figure 41 Footprint of domestic/imported vehicle types in each mass segment

As shown in Figure 40, the local vehicles follows the basic rule that footprint increases with curb mass; nevertheless, a same footprint would involve a large mass span, and the bigger the curb mass is, the larger the

一脚印面积下会有较大的质量跨度，并且在整备质量越大，脚印面积对应的质量跨度也越大。另外，如图 41 所示,在各质量段,国产车与进口车的脚印面积并无显著差别。

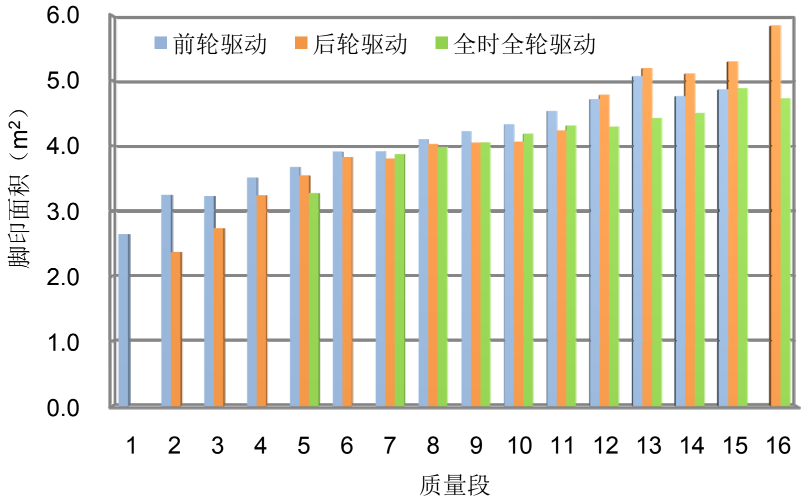


图 42 各质量段不同驱动型式脚印面积

如图 42 所示，分析了不同驱动型式车辆脚印面积的均值后发现，在中小质量段（≤1880 kg），前轮驱动汽车的脚印面积大于后轮驱动汽车，全时全轮驱动汽车的脚印面积则介于二者之间；而在大质量段（>1880 kg），后轮驱动汽车的脚印面积最大，其次是前轮驱动，全时全轮驱动汽车的脚印面积则最小。

3 乘用车燃料消耗量总体分析

随着我国汽车保有量的不断增加和国际油价的持续攀升，汽车作为石油燃料的消耗主体，降低其燃料消耗量，提高能源利用效率显得非常重要和迫切。影响汽车燃料消耗量的因素很多，本章归纳和分析了乘用车燃料消耗量与整备质量、排量等主要技术参数的关系和分布情况，以及汽柴油车燃料消耗量水平的差异和汽柴油燃料消耗量与 CO_2 排放量之间的关系，希望能为了解我国乘用车市场的燃料消耗量的水平和制定下一阶段节能减排计划提供参考。

3.1 乘用车燃料消耗量限值标准概况

我国现行《乘用车燃料消耗量限值》（GB 19578-2004）于 2004 年发布，是我国控制汽车燃料消耗量的第一项强制性国家标准。该标准采用基于整车整备质量的燃料消耗量评价体系，按照整车整备质量将车辆分为 16 个不同的质量段，对每个质量段内的所有车辆分别设定统一的最高燃料消耗量限值。考虑到某些特殊结构或用途对燃料消耗量的不利影响，该标准对 M_1G 类车辆（即越野车）、具有三排及以上座椅的车辆或采用自动变速器的车辆限值相应放松 6%左右，见表 6、表 7。标准采取分阶段实施的策略，分别从 2005 年 7 月 1 日和 2009 年 1 月 1 日开始对新认证车辆实施第一阶段限值要求，在生产车的实施日期相应推迟一年；

mass span corresponding to the footprint. Moreover, as indicated in Figure 41, for each mass segment no notable difference between the domestic vehicles and the imported ones.

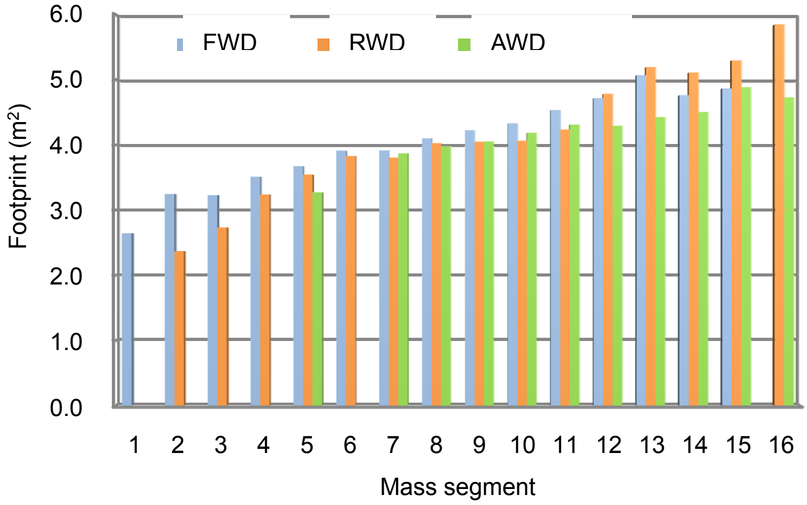


Figure 42 Footprint of different types of drive model for each mass segment

As shown in Figure 42, analysis is conducted to the mean value of footprints for each type of drive model; it is subsequently found that, in the small and medium mass segments (≤ 1,880 kg), the Front-wheel drive vehicles have a bigger footprint than that of the rear-wheel drive ones, and that of the all-wheel drive vehicles fall between them; while in the big mass segments (>1,880 kg), the rear-wheel drive vehicles present the largest footprint, followed by the Front-wheel drive ones, and the all-wheel drive ones present the least.

3. Overall Analysis of Fuel Consumption of Passenger Cars

Along with the continual rise of vehicle population in China and the steady price increase of oil on the global market, it is a quite important and pressing task to reduce the automotive fuel consumption and improve the energy efficiency; after all, motor vehicles have been a giant consumer of fossil fuels. A cluster of factors would impact fuel consumption of motor vehicles; this Chapter sums up and analyzes the correlations of passenger car fuel consumption with such main technical variables as curb mass, engine displacement, etc., the distributions, the difference between gasoline and diesel vehicles in terms of fuel consumption level, and the interrelation between fuel consumption and CO_2 emissions, with the hope to provide references for getting more knowledge of the fuel consumption of the local passenger car sector and working out the next-stage energy-saving and emission-reduction plan.

3.1. Highlights of the limits standard of fuel consumption for passenger cars

GB 19578-2004 “Limits of fuel consumption limits for passenger cars” was released in 2004, featuring the first compulsory national standard for controlling automotive fuel consumption in China. Employing the fuel consumption appraisal system based on curb mass, this standard classifies 16 segments of curb mass; for each mass segment, unitary max. fuel consumption limit is established for all the vehicles concerned. In consideration of the adverse effects of certain special constructions or uses on fuel consumption, this standard applies a relaxed (by 6% or so) limit for the vehicles of category M_1G (i.e., off-road vehicles), the vehicles with three or more rows of seats, and the AT vehicles; see Table 6 and Table 7. The standard follows the in-phase implementation strategy: the Phase I limits shall apply.

目前，该标准第二阶段限值要求已经全面实施。

按照国务院“关于进一步加强节油节电工作的通知”要求，全国汽车标准化技术委员会于 2010 年制定完成了更加严格的《乘用车燃料消耗量评价方法与指标》标准（即所谓的“第三阶段标准”），继续沿用按质量分组的车型燃料消耗量评价体系，并用车型燃料消耗量目标值取代限值要求；同时，根据政府管理和行业需求，提出了企业平均燃料消耗量评价体系。

与《乘用车燃料消耗量限值》类似，《乘用车燃料消耗量评价方法与指标》在设定目标值时考虑了特殊结构对燃料经济性的不利影响，对装有自动变速器（AT）、具有三排或三排以上座椅的车辆目标值适当放宽，如表 7 所示。需要特别说明的是，根据政府管理部门的指导意见，M_1G 类车辆不再作为特殊结构车辆享受放松的燃料消耗量要求，而视作普通车辆。

但在数据分析过程中发现，M_1G 类车辆燃料消耗量主要集中在非特殊结构第二阶段限值附近，这高于《乘用车燃料消耗量评价方法与指标》规定的车型燃料消耗量目标值，其次，此类车型共有 348 个，约占全部车型的 6%，因此在分析 M_1G 类车辆燃料消耗量与三阶段的符合性时，将其作为特殊结构的车辆处理对分析结果影响不大。

表 6 乘用车燃料消耗量限值（非特殊结构）

整车整备质量（CM）， kg	第一阶段，L/100km	第二阶段，L/100km	第三阶段，L/100km
CM≤750	7.2	6.2	5.2
750＜CM≤865	7.2	6.5	5.5
865＜CM≤980	7.7	7.0	5.8
980＜CM≤1090	8.3	7.5	6.1
1090＜CM≤1205	8.9	8.1	6.5
1205＜CM≤1320	9.5	8.6	6.9
1320＜CM≤1430	10.1	9.2	7.3
1430＜CM≤1540	10.7	9.7	7.7
1540＜CM≤1660	11.3	10.2	8.1
1660＜CM≤1770	11.9	10.7	8.5
1770＜CM≤1880	12.4	11.1	8.9
1880＜CM≤2000	12.8	11.5	9.3
2000＜CM≤2110	13.2	11.9	9.7
2110＜CM≤2280	13.7	12.3	10.1
2280＜CM≤2510	14.6	13.1	10.8
2510＜CM	15.5	13.9	11.5

表 7 乘用车燃料消耗量限值（特殊结构）

整车整备质量（CM）， kg	第一阶段，L/100km	第二阶段，L/100km	第三阶段，L/100km
CM≤750	7.6	6.6	5.6
750＜CM≤865	7.6	6.9	5.9
865＜CM≤980	8.2	7.4	6.2
980＜CM≤1090	8.8	8.0	6.5
1090＜CM≤1205	9.4	8.6	6.8

to the vehicles newly applying for certification from July 1st 2005 and Jan. 1st 2009 respectively, and the effective date for the in-production vehicles shall be postponed by one year; up to now, the Phase II limit requirements of the standard have been extensively put into effect.

According to the requirements of “The Notice of State Council on Further Strengthening the work of energy-saving”, National Automotive Standardization Technical Committee (SAC/TC 114) formulated, in 2010, the stricter standard “Fuel consumption evaluation method and targets for passenger cars” (i.e., the so-called “Phase III standard”), which continues using the fuel consumption appraisal system for vehicle type based on mass segments and substituting the target value of fuel consumption of vehicle type for the limits; meanwhile, CAFC appraisal system is put forward to cater for the governmental administration and industrial demands.

Like the case of “Limits of fuel consumption limits for passenger cars”, the standard “Fuel consumption evaluation method and targets for passenger cars” takes into account, upon setting target values, the adverse effects of special constructions on fuel economy, and properly relaxed target values are proposed for the vehicles fitted with AT or with three or more rows of seats; see Table 7. Especially it shall be noted that, in consideration of the guidance opinions of the competent authority, category M_1G vehicles are no longer regarded as the special construction vehicles for applying the relaxed requirements as to fuel consumption; that is, they are deemed common vehicles in this regard.

According to data analysis, however, the fuel consumption of category M_1G vehicles are mainly concentrated around the Phase II limit for the vehicles other than of special construction, which is higher than the target value of fuel consumption of vehicle type as established in the standard “Fuel consumption evaluation method and targets for passenger cars”; in addition, there are in total 348 such vehicle types, roughly occupying 6% of the total. Therefore, for the purpose of analyzing the conformity of the category M_1G vehicles with the Phase III fuel consumption requirements, no big effect would be brought forth when these vehicles are deemed as vehicles of special construction.

Table 6 Limits of fuel consumption limits for passenger cars (other than special construction)

curb mass(CM), kg	Phase I, L/100km	Phase II, L/100km	Phase III, L/100km
CM ≤ 750	7.2	6.2	5.2
750 < CM ≤ 865	7.2	6.5	5.5
865 < CM ≤ 980	7.7	7.0	5.8
980 < CM ≤ 1,090	8.3	7.5	6.1
1,090 < CM ≤ 1,205	8.9	8.1	6.5
1,205 < CM ≤ 1,320	9.5	8.6	6.9
1,320 < CM ≤ 1,430	10.1	9.2	7.3
1,430 < CM ≤ 1,540	10.7	9.7	7.7
1,540 < CM ≤ 1,660	11.3	10.2	8.1
1,660 < CM ≤ 1,770	11.9	10.7	8.5
1,770 < CM ≤ 1,880	12.4	11.1	8.9
1,880 < CM ≤ 2,000	12.8	11.5	9.3
2,000 < CM ≤ 2,110	13.2	11.9	9.7
2,110 < CM ≤ 2,280	13.7	12.3	10.1
2,280 < CM ≤ 2,510	14.6	13.1	10.8
2,510 < CM	15.5	13.9	11.5

Table 7Limits of fuel consumption limits for passenger cars (special construction)

curb mass (CM), kg	Phase I, L/100km	Phase II, L/100km	Phase III, L/100km
CM ≤ 750	7.6	6.6	5.6
750 < CM ≤ 865	7.6	6.9	5.9
865 < CM ≤ 980	8.2	7.4	6.2
980 < CM ≤ 1,090	8.8	8.0	6.5
1,090 < CM ≤ 1,205	9.4	8.6	6.8

1205＜CM≤1320	10.1	9.1	7.2
1320＜CM≤1430	10.7	9.8	7.6
1430＜CM≤1540	11.3	10.3	8.0
1540＜CM≤1660	12.0	10.8	8.4
1660＜CM≤1770	12.6	11.3	8.8
1770＜CM≤1880	13.1	11.8	9.2
1880＜CM≤2000	13.6	12.2	9.6
2000＜CM≤2110	14.0	12.6	10.1
2110＜CM≤2280	14.5	13.0	10.6
2280＜CM≤2510	15.5	13.9	11.2
2510＜CM	16.4	14.7	11.9

3.2 燃料消耗量与技术参数

3.2.1 排量与燃料消耗量

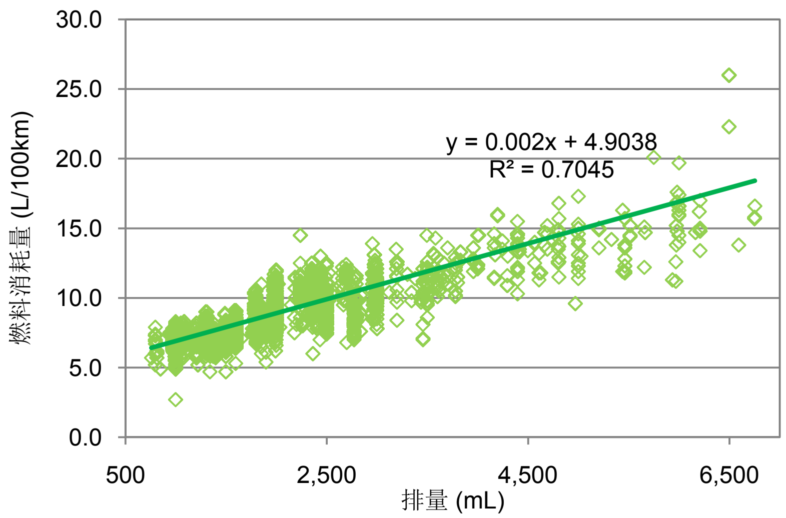


图 43 排量与燃料消耗量

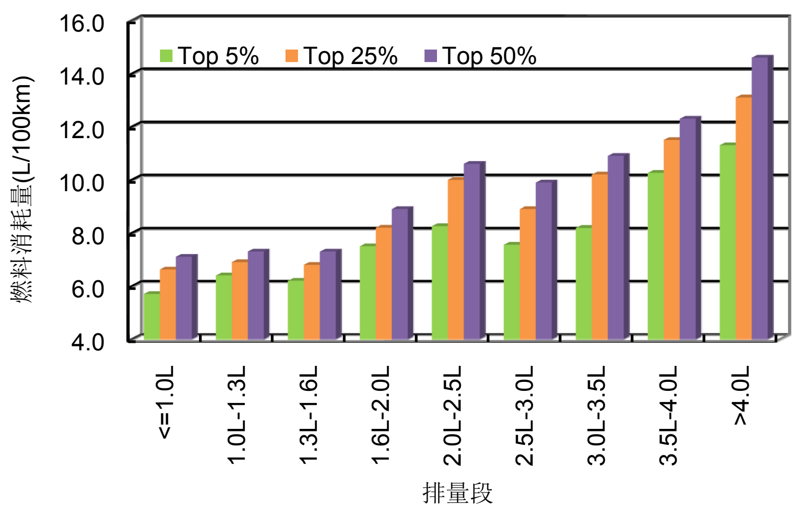


图 44 各排量段燃料消耗量分布

1,205 < CM ≤ 1,320	10.1	9.1	7.2
1,320 < CM ≤ 1,430	10.7	9.8	7.6
1,430 < CM ≤ 1,540	11.3	10.3	8.0
1,540 < CM ≤ 1,660	12.0	10.8	8.4
1,660 < CM ≤ 1,770	12.6	11.3	8.8
1,770 < CM ≤ 1,880	13.1	11.8	9.2
1,880 < CM ≤ 2,000	13.6	12.2	9.6
2,000 < CM ≤ 2,110	14.0	12.6	10.1
2,110 < CM ≤ 2,280	14.5	13.0	10.6
2,280 < CM ≤ 2,510	15.5	13.9	11.2
2,510 < CM	16.4	14.7	11.9

3.2. Fuel consumption vs. technical parameters

3.2.1. Engine displacement vs. fuel consumption

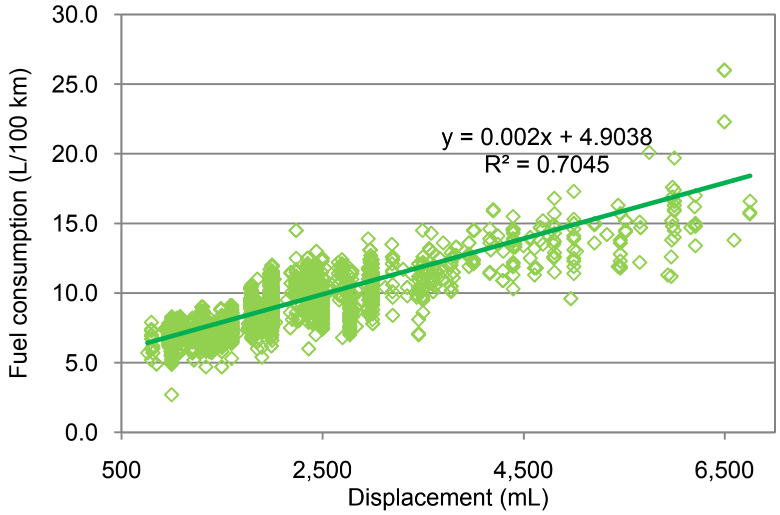


Figure 43 Engine displacement vs. fuel consumption

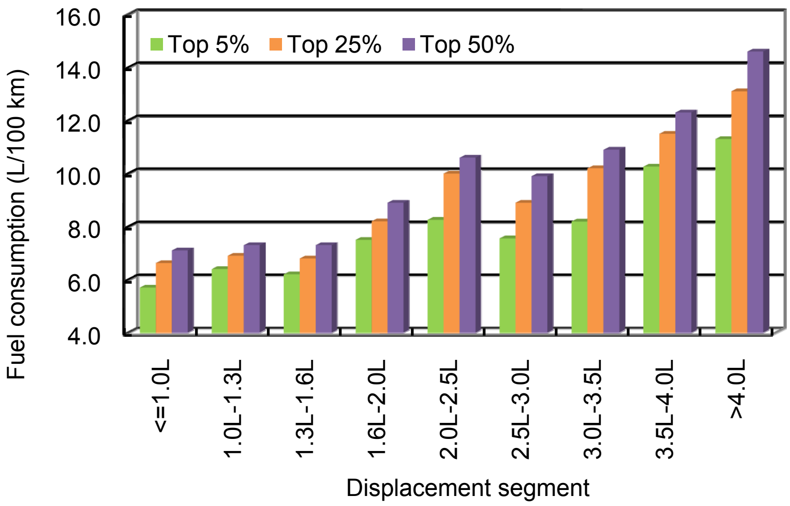


Figure 44 Distribution of fuel consumption in each segment of engine displacement

从图 43 中可以看出，汽车燃料消耗量水平总体趋势是随发动机排量增大而增加的。按照第 2.1.1 节中排量的分组方法分析不同排量段乘用车燃料消耗量的水平，如图 44 所示，就统计的数据来看，乘用车的燃料消耗量水平可按排量段分为三组：1）排量小于 1.6 L 的车型，其燃料消耗量水平比较接近，大约为 7.2 L/100km； 2) 排量在 1.6 L-3.0 L 之间的车型燃料消耗量处于 9.8 L/100km 的水平；3）排量大于 3 L 的车型，其燃料消耗量随排量增大而增加的趋势十分明显，平均燃料消耗量约为 12.6 L/100km。

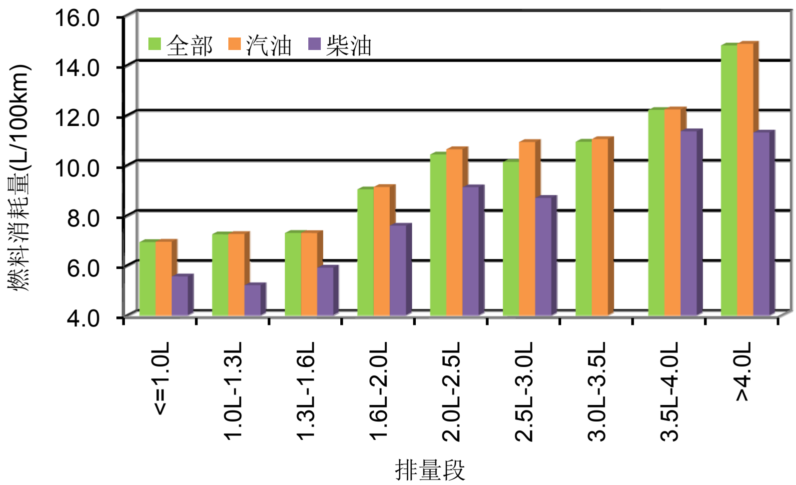


图 45 各排量段不同燃料类型车型的燃料消耗量分布

如图 45 所示，除在 3.0 L-3.5 L 没有柴油车型燃料消耗量数据外，其余各排量段汽油车的燃料消耗量均高于柴油车。

3.2.2 脚印面积与燃料消耗量

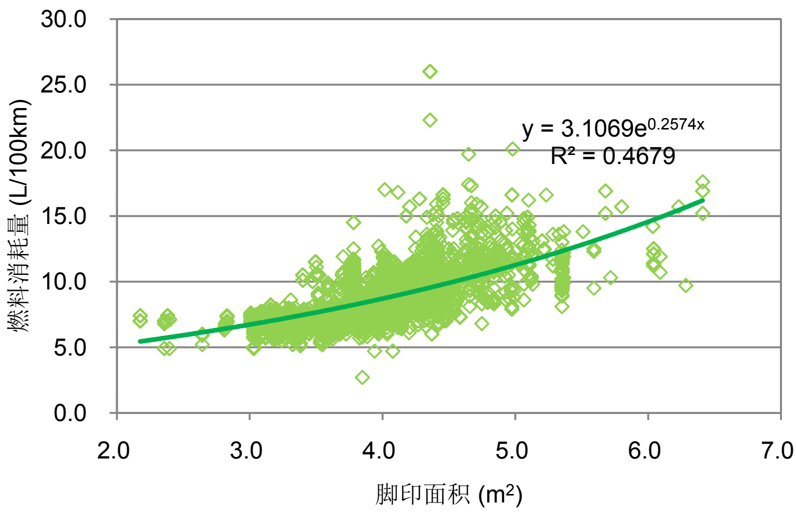


图 46 脚印面积与燃料消耗量 I

As indicated in Figure 43, it is a general trend that fuel consumption increases along with engine displacement. As per the grouping method of engine displacement stated in 2.1.1, analysis is conducted to the fuel consumption level of passenger cars in different segments of engine displacement; see Figure 44; in view of the statistical data, the fuel consumption level of passenger cars may be divided into three groups based on engine displacement: 1) the vehicle types with engine displacement less than 1.6 L present a similar fuel consumption level, roughly 7.2 L/100 km; 2) those with engine displacement between 1.6 and 3.0 L are at the level of 9.8 L/100 km; 3) those with engine displacement exceeding 3 L present a quite apparent trend where fuel consumption rises with engine displacement, with the mean fuel consumption around 12.6 L/100 km.

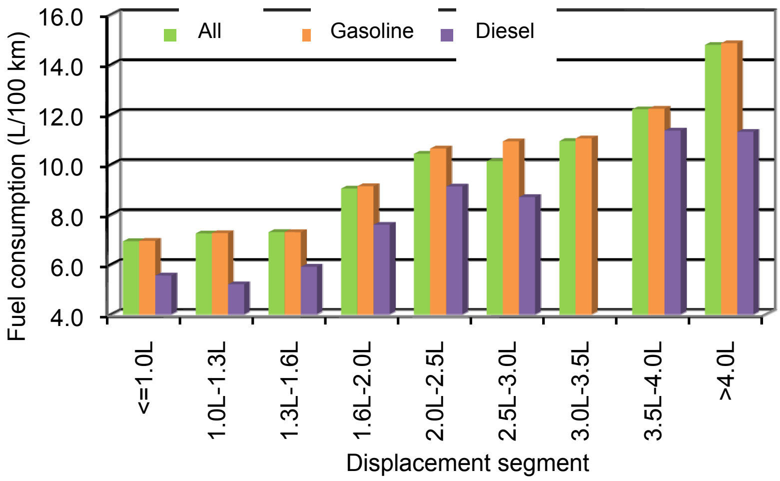


Figure 45 Distribution of vehicle types (by fuel type) in each segment of engine displacement

As shown in Figure 45, in each segment of engine displacement (except that of 3.0 ~ 3.5 L where there is no fuel consumption data of diesel vehicle types), the fuel consumption of gasoline vehicles is higher than that of diesel ones.

3.2.2. Footprint vs. fuel consumption

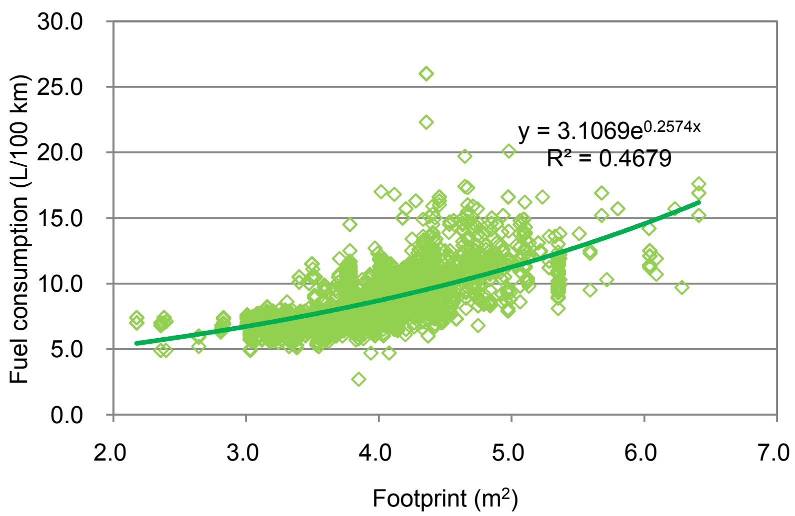


Figure 46 Footprint vs. fuel consumption (I)

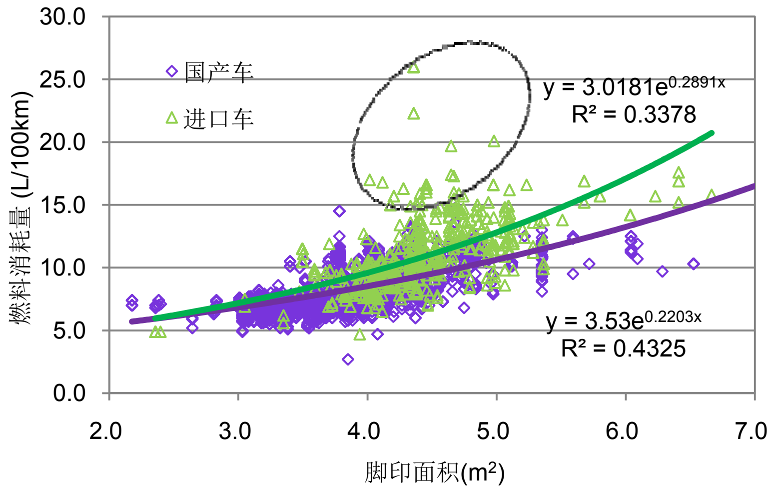


图 47 脚印面积与燃料消耗量 II

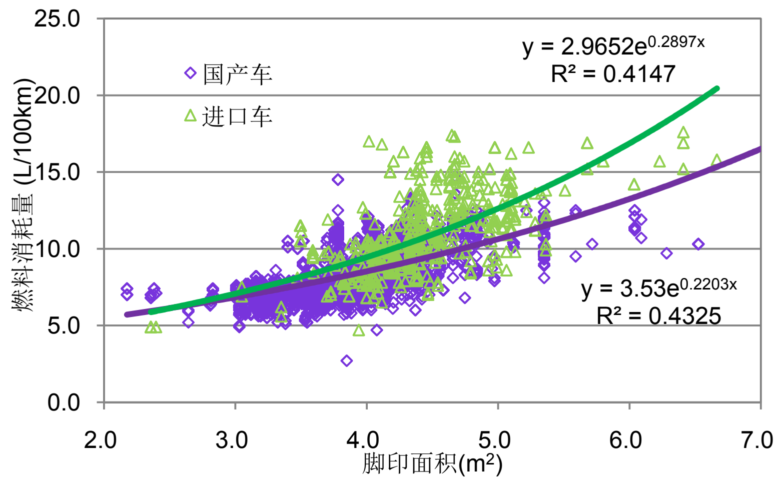


图 48 脚印面积与燃料消耗量 III

如图 46 所示，车辆燃料消耗量随脚印面积变化的整体趋势与整备质量类似，燃料消耗量随着脚印面积的增大而增加。从图 47 中可以看出，进口车的燃料消耗量随着脚印面积增大而增加的速度比国产车更快。(图 48 为剔除圈内所示异常数据点后的图形。)

3.2.3 质量与燃料消耗量

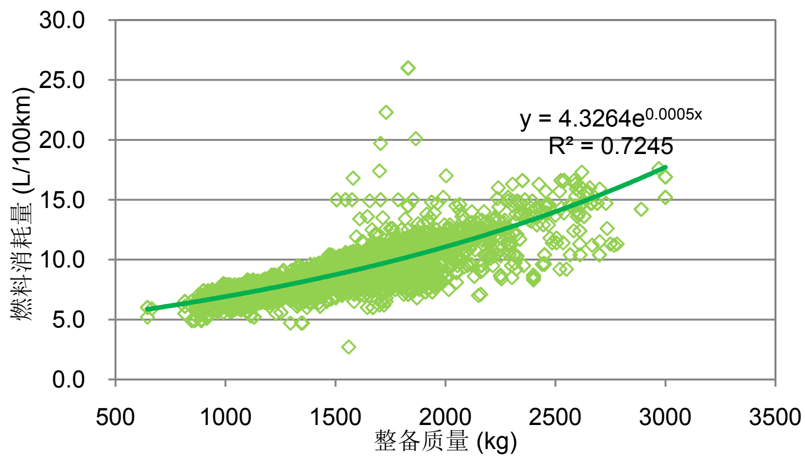


图 49 整备质量与燃料消耗量 I

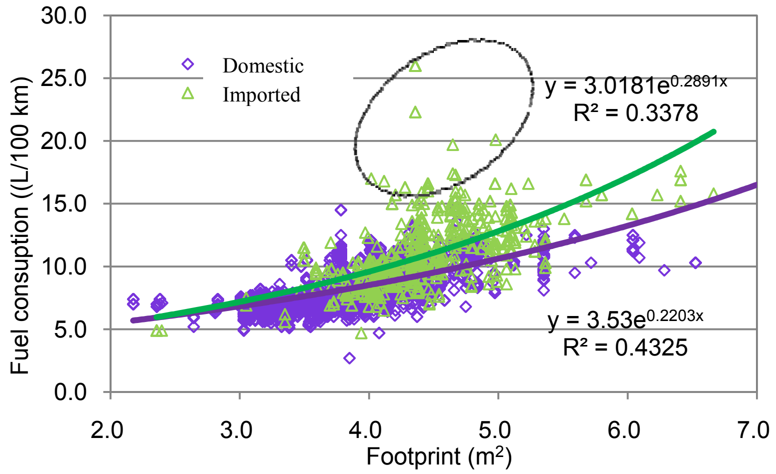


Figure 47 Footprint vs. fuel consumption (II)

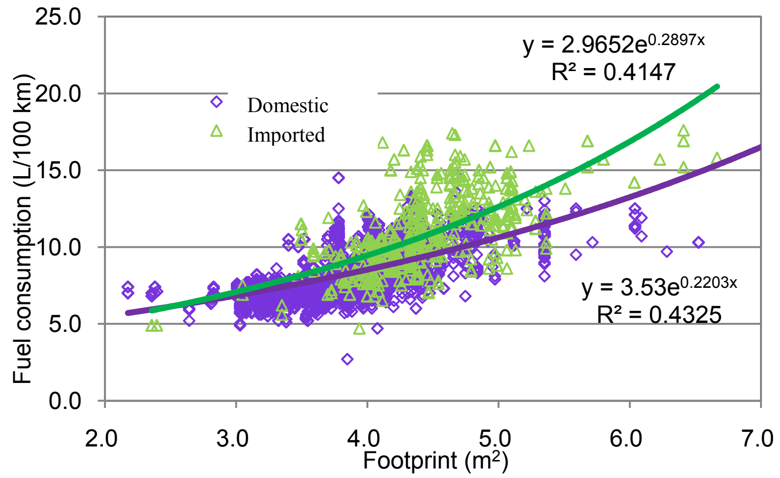


Figure 48 Footprint vs. fuel consumption (III)

As indicated in Figure 46, the overall correlation between fuel consumption and footprint is similar to the case of curb mass, i.e., fuel consumption increases with footprint. As shown in Figure 47, for imported vehicle types, fuel consumption increases with footprint at a higher rate than that of the domestic vehicles. (Figure 48 is a graph where the abnormal data points in the circle are already eliminated.)

3.2.3. Mass vs. fuel consumption

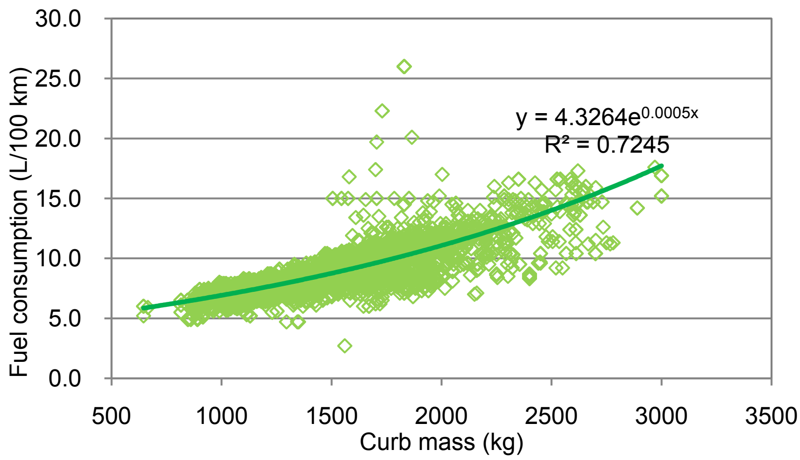


Figure 49 Curb mass vs. fuel consumption (I)

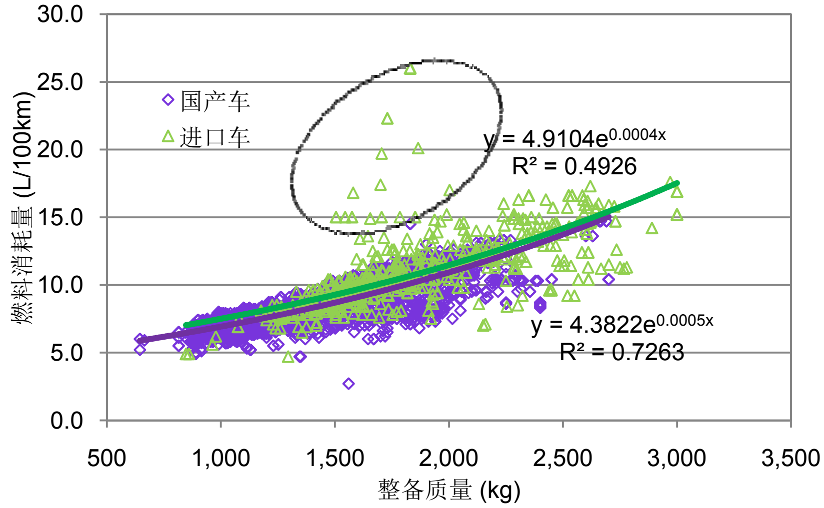


图 50 整备质量与燃料消耗量 II

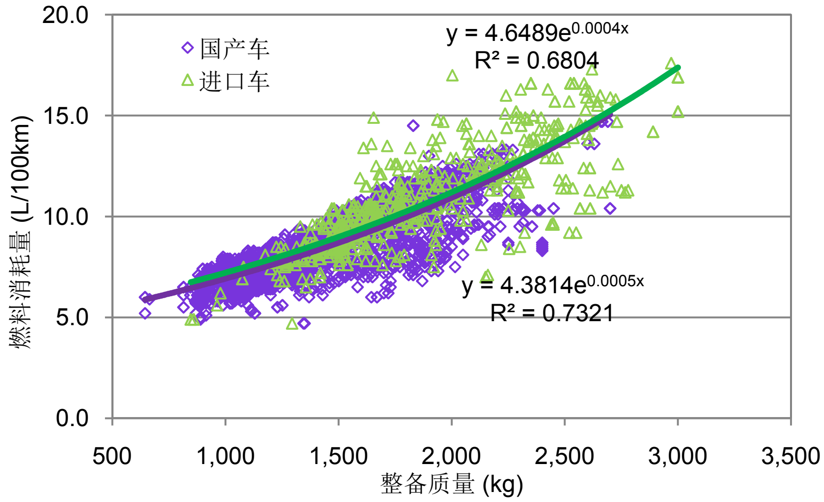


图 51 整备质量与燃料消耗量 III

如图 49–图 51 所示为车辆燃料消耗量随整备质量变化的情况，与图 46 相比，燃料消耗量与整备质量的相关性要高于脚印面积，同时还可以看出，进口车和国产车的燃料消耗量随着整备质量变化的趋势与随脚印面积变化的趋势有明显不同。进口车与国产车的燃料消耗量随整备质量变化的趋势线基本重合，说明在各质量段同样质量的进口车与国产车，其燃料消耗量水平基本相当。(图 51 为剔除圈内所示异常数据点后的图形，未影响趋势线的走向)。但无论选择脚印面积还是整备质量作为基准参数，进口车的燃料消耗量均高于国产车。

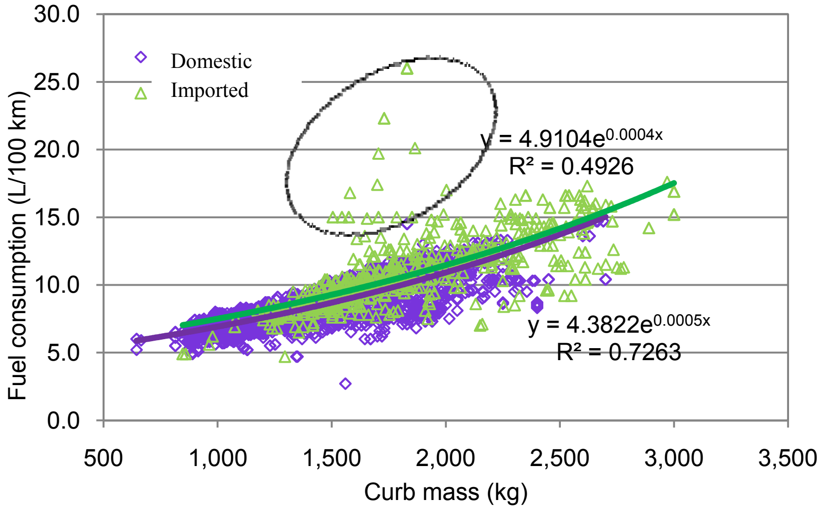


Figure 50 Curb mass vs. fuel consumption (II)

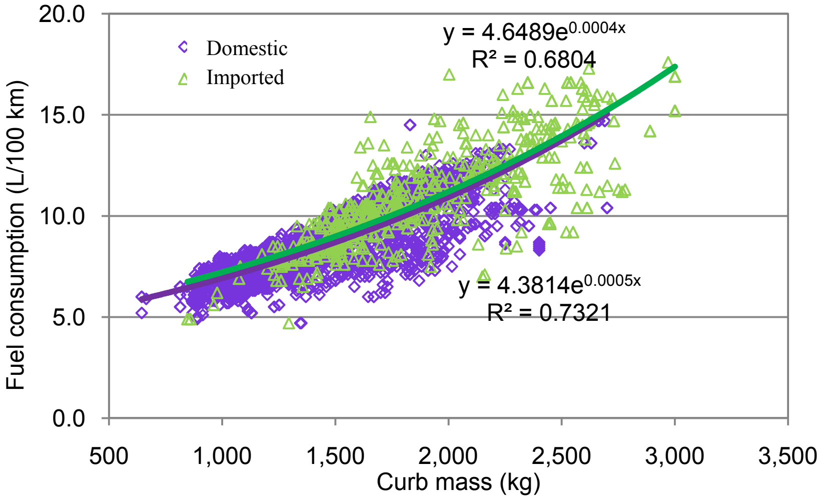


Figure 51 Curb mass vs. fuel consumption (III)

As shown in Figure 49 ~ Figure 51, fuel consumption varies with curb mass. As compared to Figure 46, the correlation between fuel consumption and curb mass is higher than that case of footprint; in addition, the correlation between fuel consumption and curb mass is largely different from the case of footprint, irrespective of imported or domestic vehicles. The imported vehicle types basically coincide with the domestic ones as to the correlation curve between fuel consumption and curb mass, indicating that, in each mass segment, the imported vehicle types and the domestic ones of the same mass present a basically equivalent level of fuel consumption. (Figure 51 is a graph where the abnormal data points in the circle are already eliminated, which has no effect on the orientation of the trend line). Nevertheless, the fuel consumption of imported vehicle types is higher than that of the domestic ones, no matter either footprint or curb mass is picked as the reference parameter.

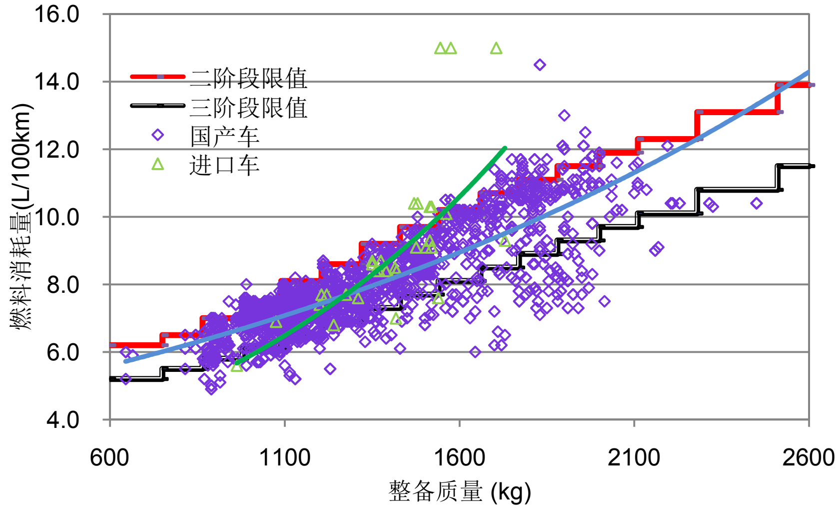


图 52 乘用车燃料消耗量分布（非特殊结构）

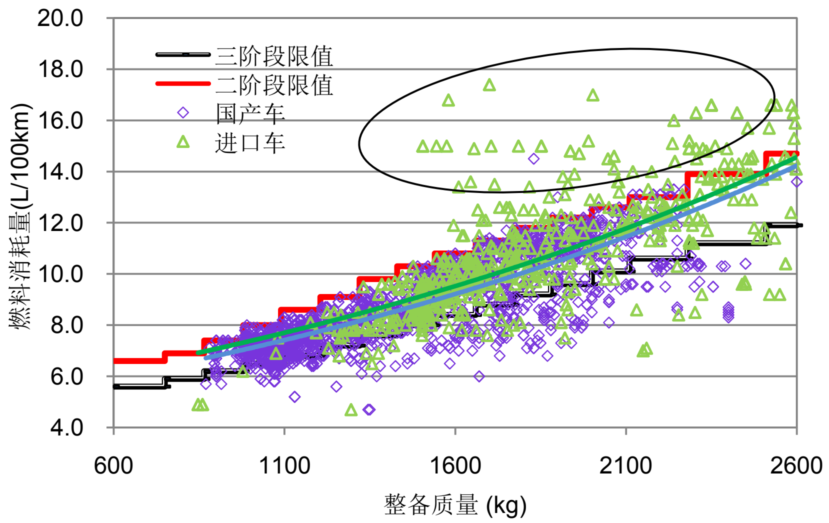


图 53 乘用车燃料消耗量分布（特殊结构）

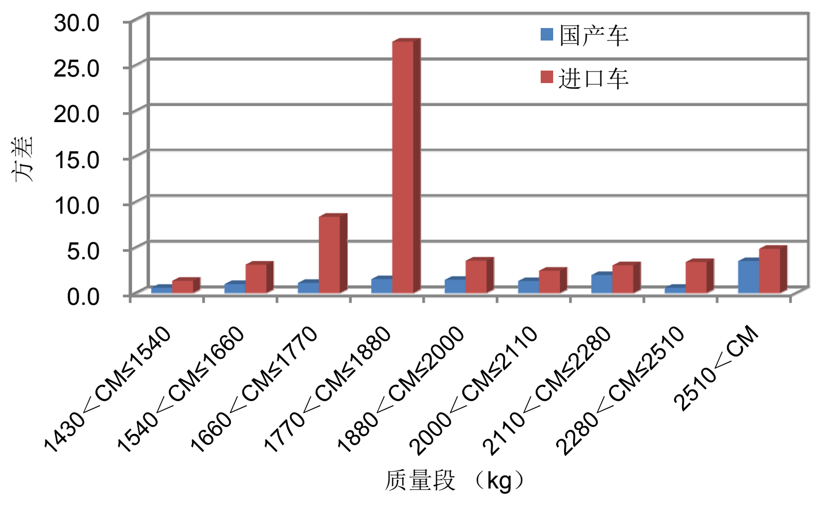


图 54 燃料消耗量离散程度

如图 53，按照乘用车燃料消耗量限值的规定，大部分进口车都属于特殊结构车辆，虽

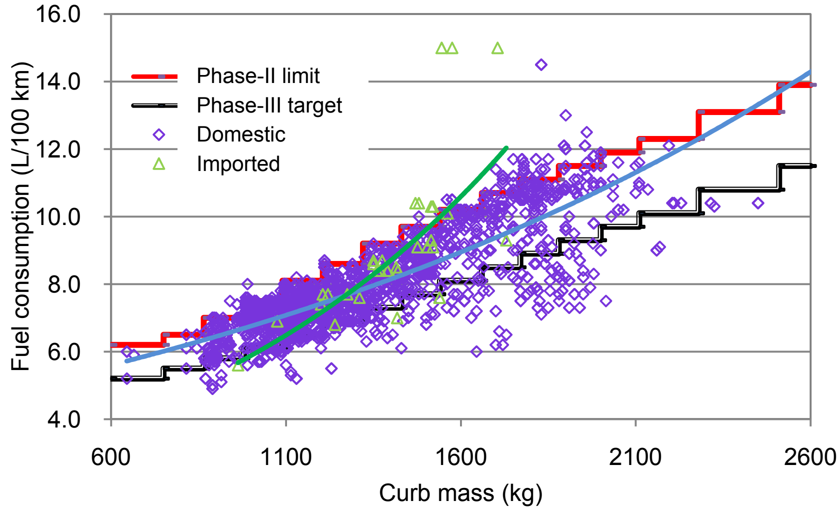


Figure 52 Distribution of fuel consumption of passenger cars (other than special construction)

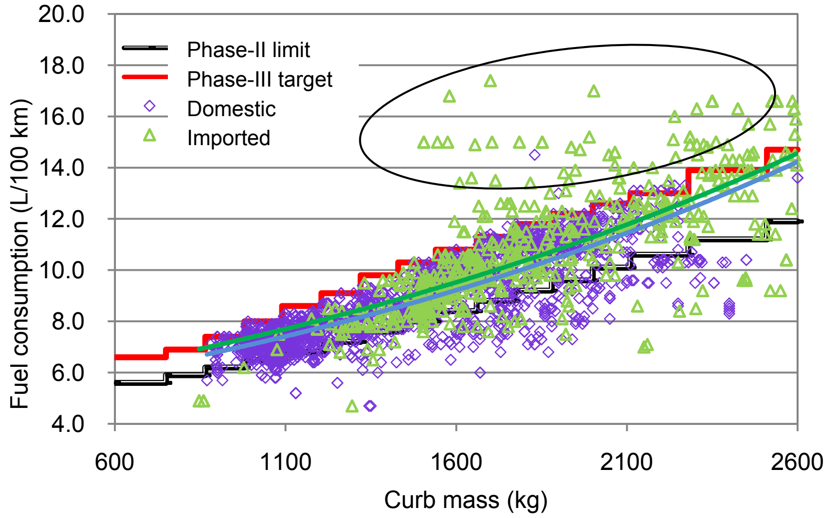


Figure 53 Distribution of fuel consumption of passenger cars (special construction)

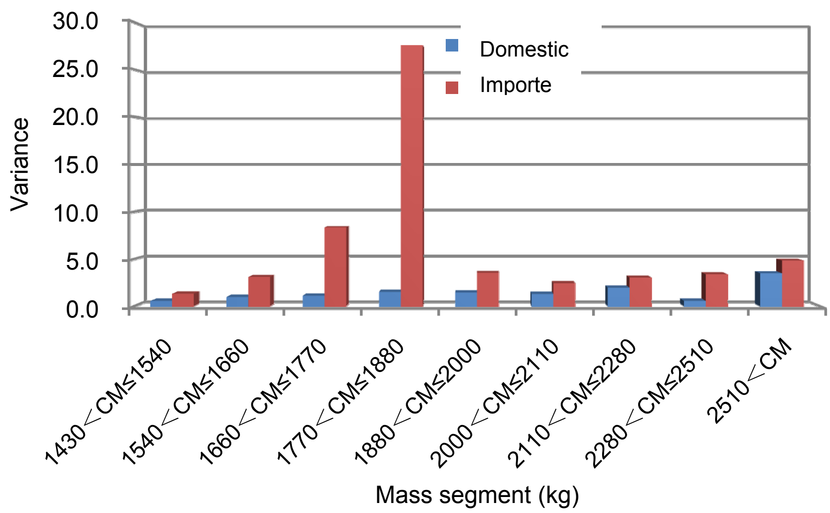


Figure 54 Discrete extent of fuel consumption

As shown in Figure 53, a majority of imported vehicle types, according to the provisions of the standard "Limits of fuel

然从图中的统计曲线看出特殊结构进口车的燃料消耗量仅略高于国产车，但是进口车燃料消耗量的离散程度要远大于国产车（图 54），目前还有三分之一左右的进口车未满足二阶段限值的要求（图 53 黑框内的数据点）。而国产车在限值标准的约束下,其燃料消耗量基本都被控制在二阶段限值为上限的范围内，离散度较低。

表 8 国产/进口车燃料消耗量的限值符合情况

		总车型数	满足三阶段限值	
			车型数	所占比例
国产车	特殊结构	2782	466	16.8%
	非特殊结构	2291	414	18.1%
	合计	5073	880	17.3%
进口车	特殊结构	608	69	11.3%
	非特殊结构	45	5	11.1%
	合计	653	74	11.3%
合计		5726	954	16.7%

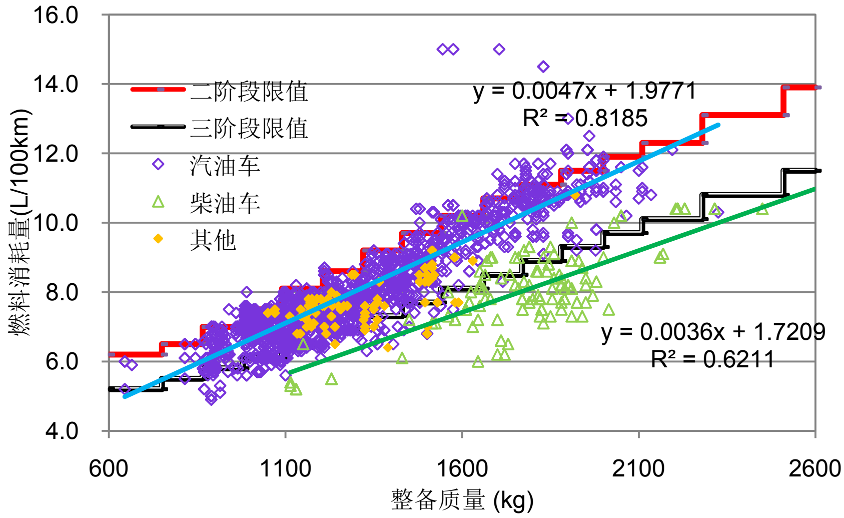


图 55 不同燃料乘用车燃料消耗量分布（非特殊结构）

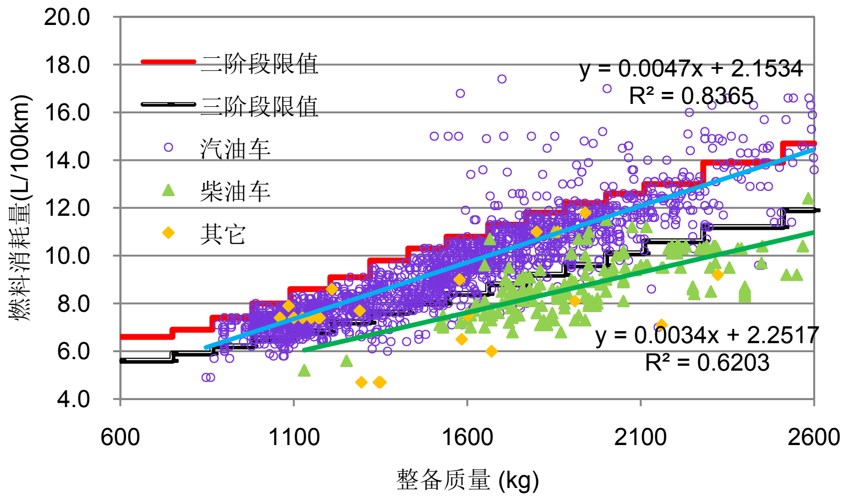


图 56 不同燃料乘用车燃料消耗量分布（特殊结构）

consumption limits for passenger cars", belong to vehicles of special construction; from the statistical curves in the graph, it can be seen that the fuel consumption of imported vehicle types of special construction is slightly higher than that of the domestic vehicles; however, the discrete extent of the fuel consumption of imported vehicle types is far higher than that of the domestic vehicles (Figure 54); at present, about one third imported vehicle types fail to satisfy the Phase II limit requirements (data points in the black box of Figure 53). Under the binding effect of the limit standard, the fuel consumption of domestic vehicles is basically controlled within the scope where the upper boundary is represented by the Phase II limit, with a lower discrete extent.

Table 8 Conformity of domestic/imported vehicle types with fuel consumption limits

		Total number of vehicle types	Conformity with Phase III target	
			Number of vehicle types	Share
Domestic vehicles	Special construction	2,782	466	16.8%
	Other than special construction	2,291	414	18.1%
	Total	5,073	880	17.3%
Imported vehicle types	Special construction	608	69	11.3%
	Other than special construction	45	5	11.1%
	Total	653	74	11.3%
Total		5726	954	16.7%

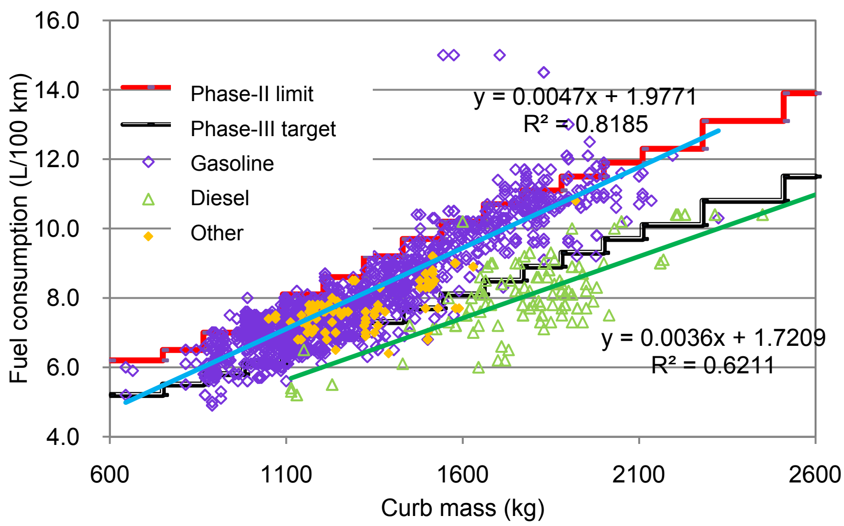


Figure 55 Fuel consumption distribution of passenger cars of different fuel types (other than special construction)

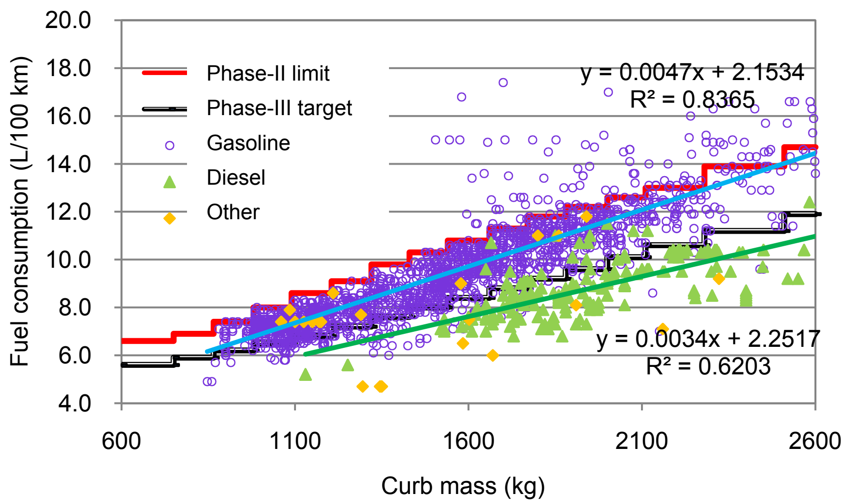


Figure 56 Fuel consumption distribution of passenger cars of different fuel types (special construction)

柴油与汽油相比有较高的燃料能量密度，并且柴油发动机的压缩比大于汽油发动机，其热效率大约为汽油机的 1.2 倍[3]，因此柴油车的燃料消耗量要明显低于汽油车（图 55、图 56）。

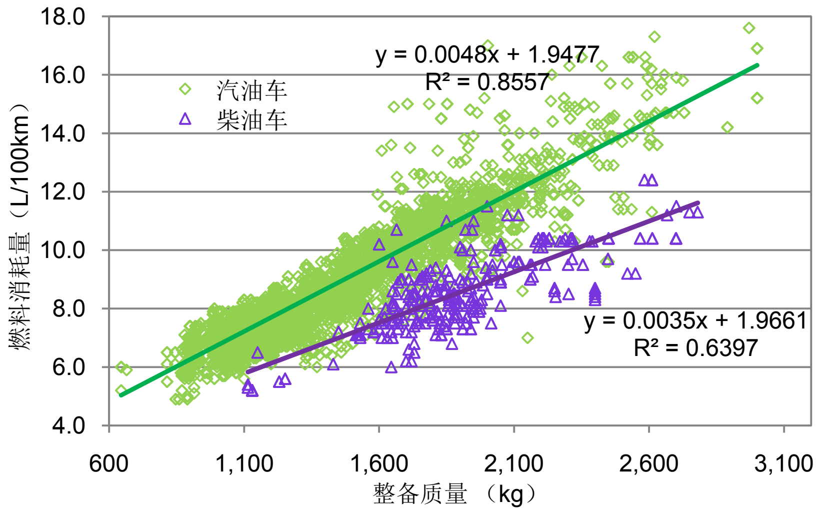


图 57 不同燃料乘用车燃料消耗量分布

为分析汽油车与柴油车燃料消耗量水平差异，将所有结构的燃料消耗量数据绘制在一张图上，并剔除了图 50 中圆圈内所示的异常点。可令汽油车与柴油车的燃料消耗量分别为 FC_G 和 FC_D，整车整备质量为 M，根据图 57 中拟合出的公式可得：

$$FC_G = 0.0048 \times M + 1.9477 \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (1)$$

$$FC_D = 0.0035 \times M + 1.9661 \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (2)$$

设柴油车燃料消耗量低于汽油车的幅度为 a，则：

$$a = 1 - \frac{FC_D}{FC_G} = 1 - \frac{0.0035 \times M + 1.9661}{0.0048 \times M + 1.9477} \cdots\cdots \quad (3)$$

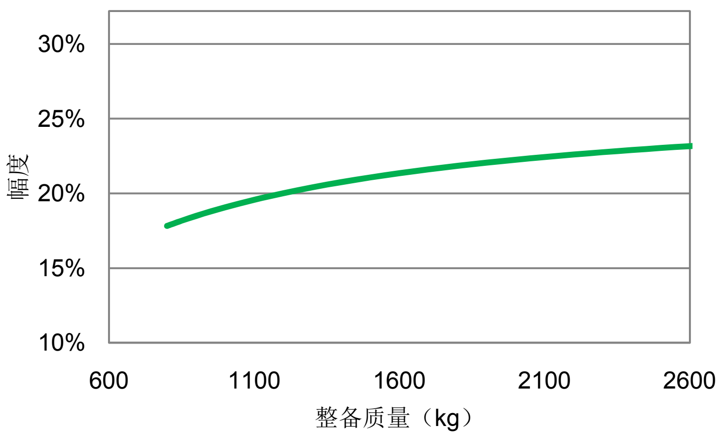


图 58 柴油车燃料消耗量低于汽油车的幅度

在式（3）中带入自变量，可绘制出如图 58 所示的曲线，从图中可以看出，柴油车燃料消耗量比汽油车平均低大约 22%。随着车辆质量的增长，柴油车在燃料消耗量方面相对汽油车的优势更加明显。在制定乘用车燃料消耗量标准时，之所以对二者采用同样限值，是为了

Diesel fuel has a higher energy density than gasoline, and diesel engine has a larger compression ratio, with the thermal efficiency roughly being 1.2 times of that of gasoline engines [3]. Hence, the fuel consumption of diesel vehicles is clearly lower than that of gasoline ones (Figure 55and Figure 56).

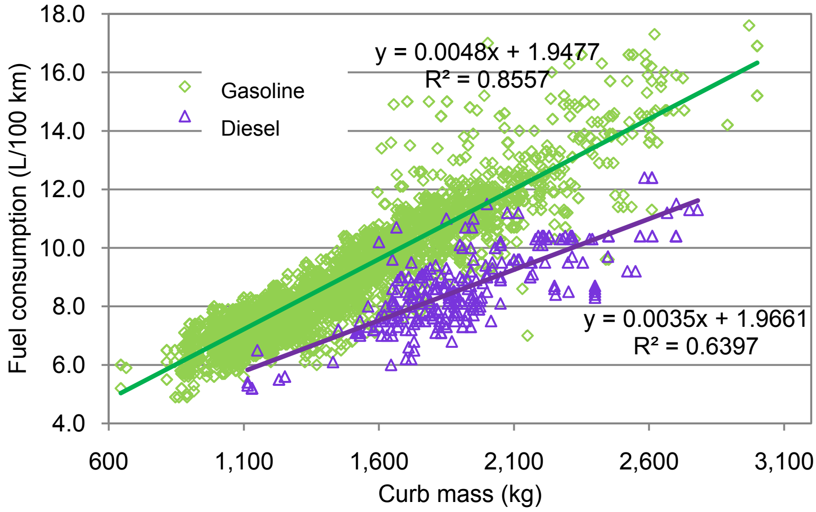


Figure 57 Fuel consumption distribution of passenger cars of different fuel types

In order to probe into the difference between gasoline and diesel vehicles in terms of fuel consumption level, the fuel consumption data of all vehicles (irrespective of the construction) are plotted onto a same graph, in addition to removing the abnormal points encircled in Figure 50. Assuming that the fuel consumption of gasoline and diesel vehicles is FC_G and FC_D, respectively, and the curb mass is 'M', the following may be obtained according to the formulae fitted in Figure 57:

$$FC_G = 0.0048 \times M + 1.9477 \quad \text{.....................(1)}$$

$$FC_D = 0.0035 \times M + 1.9661 \quad \text{.....................(2)}$$

Assuming that the fuel consumption of diesel vehicles is lower than that of gasoline vehicles by 'a', then:

$$a = 1 - \frac{FC_D}{FC_G} = 1 - \frac{0.0035 \times M + 1.9661}{0.0048 \times M + 1.9477} \quad \text{.....(3)}$$

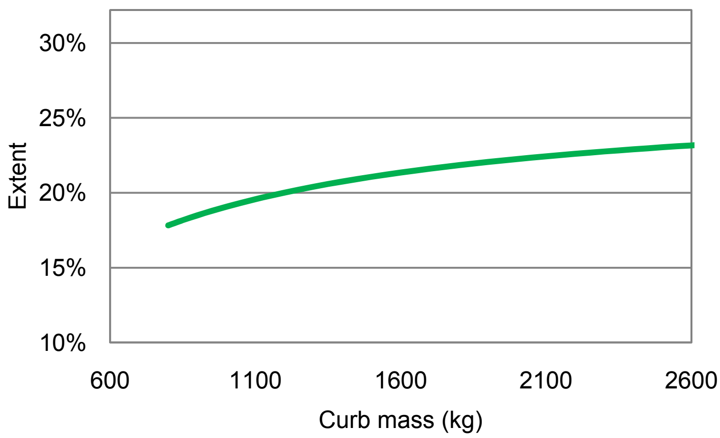


Figure 58 Extent by which the fuel consumption of diesel vehicles is lower than that of gasoline ones

By substituting independent variables in Formula (3), a curve like that shown in Figure 58 may be plotted. As shown in the graph, on average the fuel consumption of diesel vehicles is lower than that of gasoline ones by 22% or so. With the rise in vehicle mass, the superiority of diesel vehicles in fuel consumption is further salient. Upon formulation of the standard for fuel consumption limits of passenger cars, same limit values are established for gasoline and diesel vehicles, with the aim to

鼓励柴油车发展，通过调整汽车市场结构达到降低总体燃料消耗量水平的目的。

表 9 不同燃料类型车辆三阶段限值符合情况

		总车型数	满足三阶段限值	
			车型数	所占比例
汽油车	特殊结构	3146	329	10.5%
	非特殊结构	2090	292	14.0%
	合计	5236	621	11.9%
柴油车	特殊结构	217	194	89.4%
	非特殊结构	136	111	81.6%
	合计	353	305	86.4%
其它	特殊结构	27	12	44.4%
	非特殊结构	92	16	17.4%
	合计	119	28	23.5%
合计		5708	926	16.2%

表 10 各排量段与质量段燃料消耗量分布情况（均值）

	<=1.0	1.0-1.3	1.3-1.6	1.6-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	>4.0
CM≤750	5.7	5.9							
750＜CM≤865	5.9								
865＜CM≤980	6.4	6.8	6.5						
980＜CM≤1090	7.1	7.2	7.0	7.5					
1090＜CM≤1205	7.2	7.2	7.2	7.8					
1205＜CM≤1320	5.6	7.9	7.6	7.9					
1320＜CM≤1430		7.4	7.8	8.3	8.5	9.6			
1430＜CM≤1540			7.5	8.8	9.4	9.5	9.8		15.0
1540＜CM≤1660			8.0	9.3	9.8	9.2	9.9	10.7	14.5
1660＜CM≤1770				9.8	10.4	9.2	10.7	11.5	15.8
1770＜CM≤1880				9.9	10.6	9.4	10.5	11.3	16.9
1880＜CM≤2000				10.6	10.8	10.5	11.1	11.4	13.4
2000＜CM≤2110				10.1	11.0	10.8	12.0	12.5	13.3
2110＜CM≤2280					10.8	12.1	10.5	13.0	13.1
2280＜CM≤2510				10.7	10.4	10.2	12.3	13.3	14.4
2510＜CM					10.4	10.9		12.9	15.1

质量段（纵）单位：kg 排量段（横）单位： L 燃料消耗量单位： L/100km

注：表示横向极值，即与该质量段对应的燃料消耗量最低的排量段；

表示纵向极值，即与该排量段对应的燃料消耗量最高的质量段；

表示横向极值与纵向极值相同。

表 10 列出了在不同排量段和质量段的车型燃料消耗量均值。可以看出，几乎所有固定质量段或排量段燃料消耗量的均值均随排量或质量增大而增加。同时可以看到在每个质量段，都有最为经济的“黄金排量”（如图中所示），即与整车整备质量对应的最佳匹配排量。在相关配置和技术水平相同的情况下，如果整车整备质量与发动机排量匹配合理，那么车辆可以达到更低的燃料消耗量。

encourage the development of diesel vehicles and reduce the overall fuel consumption level by adjusting the structure of the auto market.

Table 9 Conformity of vehicles of different fuel types with the Phase III targets

		Total number of vehicle types	Conformity with Phase III targets	
			Number of vehicle types	Share
Gasoline vehicles	Special construction	3,146	329	10.5%
	Other than special construction	2,090	292	14.0%
	Total	5,236	621	11.9%
Diesel vehicles	Special construction	217	194	89.4%
	Other than special construction	136	111	81.6%
	Total	353	305	86.4%
Others	Special construction	27	12	44.4%
	Other than special construction	92	16	17.4%
	Total	119	28	23.5%
Total		5,708	926	16.2%

Table 10 Distribution of fuel consumption in each engine displacement segment and mass segment (mean value)

	<=1.0	1.0-1.3	1.3-1.6	1.6-2.0	2.0-2.5	2.5-3.0	3.0-3.5	3.5-4.0	>4.0
CM ≤ 750	5.7	5.9							
750 < CM ≤ 865	5.9								
865 < CM ≤ 980	6.4	6.8	6.5						
980 < CM ≤ 1,090	7.1	7.2	7.0	7.5					
1,090 < CM ≤ 1,205	7.2	7.2	7.2	7.8					
1,205 < CM ≤ 1,320	5.6	7.9	7.6	7.9					
1,320 < CM ≤ 1,430		7.4	7.8	8.3	8.5	9.6			
1,430 < CM ≤ 1,540			7.5	8.8	9.4	9.5	9.8		15.0
1,540 < CM ≤ 1,660			8.0	9.3	9.8	9.2	9.9	10.7	14.5
1,660 < CM ≤ 1,770				9.8	10.4	9.2	10.7	11.5	15.8
1,770 < CM ≤ 1,880				9.9	10.6	9.4	10.5	11.3	16.9
1,880 < CM ≤ 2,000				10.6	10.8	10.5	11.1	11.4	13.4
2,000 < CM ≤ 2,110				10.1	11.0	10.8	12.0	12.5	13.3
2,110 < CM ≤ 2,280					10.8	12.1	10.5	13.0	13.1
2,280 < CM ≤ 2,510				10.7	10.4	10.2	12.3	13.3	14.4
2,510 < CM					10.4	10.9		12.9	15.1

Mass segment (longitudinal) in kg; engine displacement segment (transverse) in L; fuel consumption in L/100 km

Notes:

Represent the transverse extreme, i.e., the engine displacement segment with the lowest fuel consumption corresponding to the mass segment concerned;

Represent the longitudinal extreme, i.e., the mass segment with the highest fuel consumption corresponding to the engine displacement segment concerned;

Represent the equality of transverse and longitudinal extremes.

Table 10 lists the average fuel consumption of vehicle type for different engine displacement segments and mass segments. Obviously, it is almost a general rule that, in each fixed mass segment or engine displacement segment, the mean fuel consumption increases with engine displacement or mass. At the same time, it may find that, for each mass segment, there is a most economical "golden displacement" (as indicated by in the graph), i.e., the optimal matching engine displacement corresponding to the curb mass. Given the sameness in related configurations and technical level, if the matching between curb mass and engine displacement is reasonable, then the vehicle may attain much lower fuel consumption.

3.2.4 CO_2排放量与燃料消耗量

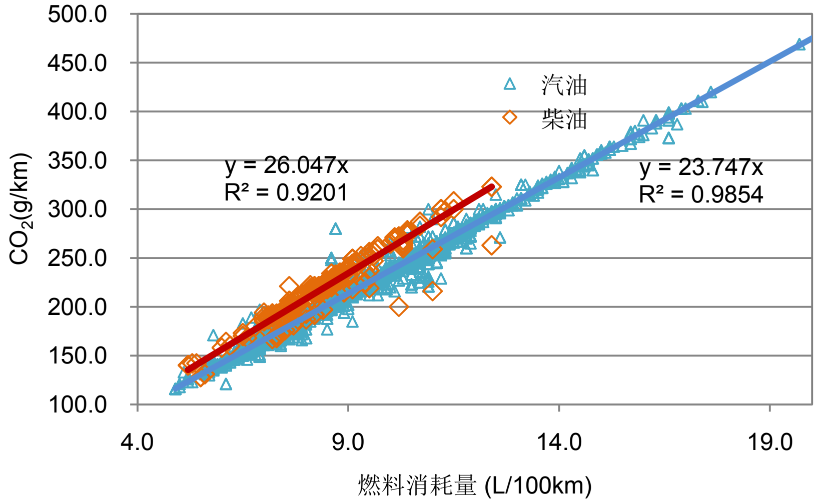


图 59 CO_2 排放量与燃料消耗量

国内外的试验数据表明，车辆行驶所消耗的燃料与该过程产生 CO_2 的量之间存在一定的相关性；受不同燃料化学构成差异的影响，使用不同燃料产生的 CO_2 也有所差别。

2006 年的《<乘用车燃料消耗量限值>国家标准实施效果评估报告》中对当年中国汽、柴油与 CO_2 排放量的关系进行了分析，得出汽油与 CO_2 排放量的换算关系为 1 L/100km =23.8 g/km，柴油为 1 L/100km =26.7 g/km[4]。本报告则根据现有数据对汽车燃料消耗量和 CO_2 排放之间的关系进行了更改分析。如图 59 所示，按照 2010 年的数据，每消耗 1 L 汽油，产生 2374.7 g 的 CO_2，即 1 L/100km=23.747 g/km；每消耗 1 L 柴油，产生 2604.7 g 的 CO_2，即 1 L/100km=26.047 g/km。可以看出，在燃料消耗量相同的情况下，燃用柴油所排出的 CO_2 略高于汽油。与 2006 年的数据相比，汽油与 CO_2 排放量的换算系数几乎没有发生变化，柴油车变化幅度较大，造成柴油与 CO_2 排放量换算系数有所差别的原因有两点：1）2006 年报告中缺少国内柴油车资料，得出的换算系数来自于英国和德国的燃料消耗量数据；2）从图中可以看出，2010 年的数据中有部分柴油车数据有所偏离，从而导致了换算系数偏小。

4 车辆节能技术应用状态

本章对 2010 年我国乘用车上应用节能技术的状态进行了汇总统计，并定性分析了节能技术对燃料消耗量的影响。

4.1 节能技术应用情况统计

3.2.4. CO_2 emissions vs. fuel consumption

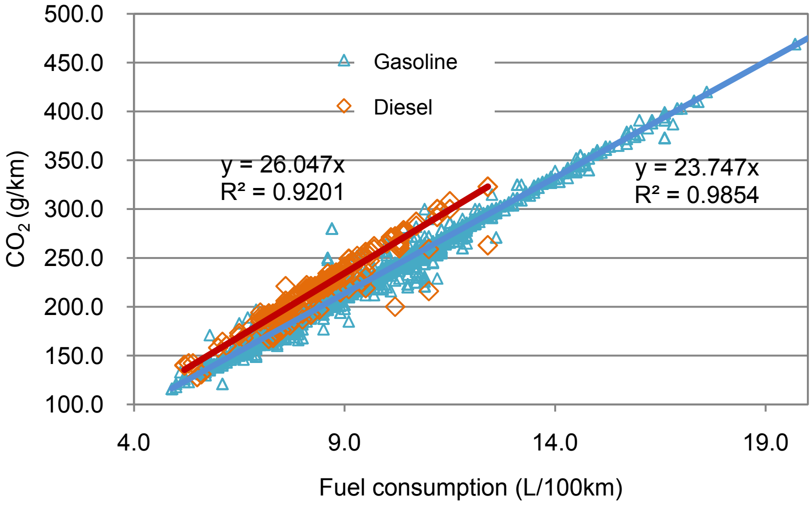


Figure 59 CO_2 **emissions vs. fuel consumption**

As indicated by local and foreign test data, a certain correlation exists between the fuel quantity consumed by vehicle travel and the CO_2 emissions emitted thereof; whereas different fuels present non identical chemical composition, the use of different fuel would emit different volume of CO_2.

In the "Appraisal Report on Implementation Effectiveness of the National Standard 'Limits of fuel consumption limits for passenger cars'" (2006), analysis was conducted to the correlation of gasoline and diesel fuel with CO_2 emissions in China for the year 2006, leading to the conversion formula between gasoline and CO_2 emissions, i.e., 1 L/100 km = 23.8 g/km, and, in the case of diesel fuel, 1 L/100 km = 26.7 g/km[4]. This report, based on the currently available data, conducts updated analysis to the relation between automotive fuel consumption and CO_2 emissions. As shown in Figure 59, according to the data of 2010, for each liter of gasoline consumed, 2374.7 g CO_2 would be emitted, that is, 1 L/100 km = 23.747 g/km; and for each liter of diesel fuel consumed, 2604.7 g CO_2, that is, 1 L/100 km = 26.047 g/km. Obviously, given identical fuel consumption, the use of diesel fuel emits slightly more CO_2. As compared to the data of 2006, the conversion factor between gasoline and CO_2 emissions almost remains unchanged, while, in the case of diesel vehicles, the change is apparent. The reasons for the apparent change may be attributed to the following two points: 1) In the 2006 report, the data of local diesel vehicles were not available, the resulted conversion factor came from the fuel consumption data of the United Kingdom and Germany; and 2) As shown in the graph, the data of some diesel vehicles are somewhat divergent, consequently leading to the relatively small conversion factor.

4. Application Status of Automotive Energy-saving Technologies

This Chapter unfolds sum-up statistics to the application status of energy-saving technologies for passenger cars in China in 2010, in addition to the qualitative analysis over the effects of energy-saving technologies on fuel consumption.

4.1. Statistics of application status of energy-saving technologies

表 11 先进节能技术状态和应用情况

技术编号	技术名称	应用车型	比例	国产	进口	汽油	柴油	其他
TECH1 01	可变气门正时 VVT	701	54.1%	591	110	689	0	12
TECH1 02	缸内直喷 GDI	77	5.9%	54	23	65	12	0
TECH1 03	连续可变气门正时 CVVT	77	5.9%	77	0	77	0	0
TECH1 04	高压共轨 CR	69	5.3%	65	4	1	68	0
TECH1 05	涡轮增压 TC	66	5.1%	49	17	62	4	0
TECH1 06	燃油分层喷射 FSI	55	4.2%	26	29	55	0	0
TECH1 07	无回油系统 NROS	42	3.2%	42	0	41	0	1
TECH1 08	增压中冷 TCI	40	3.1%	40	0	25	15	0
TECH1 09	可变进气系统 VIS	39	3.0%	39	0	39	0	0
TECH1 10	电子节气门控制 ETC	24	1.9%	17	7	24	0	0
TECH1 11	可控燃烧速率 CBR	21	1.6%	21	0	21	0	0
TECH1 12	可变涡轮截面增压 VGT	9	0.7%	9	0	4	5	0
TECH1 13	燃油增压分层喷射 TFSI	5	0.4%	0	5	5	0	0
TECH1 14	电控分配泵 EDP	4	0.3%	4	0	0	4	0
TECH1 15	电控单体泵 EUP	1	0.1%	1	0	0	1	0
TECH2 01	可变气门升程 VVL	50	3.9%	46	4	50	0	0
TECH2 02	可调机油泵 AOP	7	0.5%	7	0	7	0	0
TECH2 03	可变气缸管理系统 VCMS	3	0.2%	3	0	3	0	0
TECH2 04	智能双模变速器 DT	2	0.2%	0	2	2	0	0
TECH3 01	废气循环处理 EGR	4	0.3%	4	0	0	4	0
合计		1296	100.0%	1095	201	1170	113	13

考虑到我国汽车节能技术水平和应用比例存在较大差异，轻型汽车燃料消耗量标识备案时并没有对节能技术及其技术原理作统一的规定，而是由各企业自行申报。为对不同节能技术及其节能效果进行对比分析与评估，本报告首先对企业申报的节能技术进行汇总整理，将技术原理及功能相同或类似的技术进行归类，并对不同企业申报的相同或类似技术的名称进行统一。例如将“可变进气道长度”与“可变进气歧管”统一归类为“可变进气系统”。

根据专家问卷调查结果，多点电控燃油喷射，空燃比闭环控制，（双）顶置凸轮轴，电控燃油喷射、独立点火、高压点火等几种节能技术已经在我国乘用车上普遍采用，因此本报告在分析节能技术对燃料消耗量的影响时，并未将以上所列节能技术考虑在内。

表 11 中列出的 TECH1 表示只采用了一项节能技术或采用多项节能技术的车型中使用频率较高的技术，TECH2 表示除采用 TECH1 外的第二项技术 TECH3 表示除采用 TECH1、TECH2 外的第三项技术，对各节能技术的描述请参阅附录 A。从表格 11 中可以看出，“可变气门正时”由于技术成熟、成本较低等原因而成为国产车与进口车采用频率最高的节能技术；“高压共轨”为柴油车目前采用最为普遍的节能技术。

Table 11 Status and application of advanced energy-saving technologies

Item No.	Description of technology	Number of vehicle types employing such technology	Share	Domestic	Imported	Gasoline	Diesel	Others
TECH1 01	Variable Valve Timing(VVT)	701	54.1%	591	110	689	0	12
TECH1 02	Gasoline Direct Injection (GDI)	77	5.9%	54	23	65	12	0
TECH1 03	Continuous Variable Valve Timing (CVVT)	77	5.9%	77	0	77	0	0
TECH1 04	Common Rail (CR)	69	5.3%	65	4	1	68	0
TECH1 05	Turbo Charge (TC)	66	5.1%	49	17	62	4	0
TECH1 06	Fuel Stratified Injection (FSI)	55	4.2%	26	29	55	0	0
TECH1 07	No Return Oil System (NROS)	42	3.2%	42	0	41	0	1
TECH1 08	Turbo Charging Innercooling (TCI)	40	3.1%	40	0	25	15	0
TECH1 09	Variable Intake System (VIS)	39	3.0%	39	0	39	0	0
TECH1 10	Electronic Throttle Control (ETC)	24	1.9%	17	7	24	0	0
TECH1 11	Controlled Burn Rate (CBR)	21	1.6%	21	0	21	0	0
TECH1 12	Variable Geometry Turbocharge (VGT)	9	0.7%	9	0	4	5	0
TECH1 13	Turbocharged Fuel Stratified Injection (TFSI)	5	0.4%	0	5	5	0	0
TECH1 14	Electronic Distribution Pump (EDP)	4	0.3%	4	0	0	4	0
TECH1 15	Electronic Unit Pump (EUP)	1	0.1%	1	0	0	1	0
TECH2 01	Variable Valve Lift (VVL)	50	3.9%	46	4	50	0	0
TECH2 02	Adjustable Oil Pump (AOP)	7	0.5%	7	0	7	0	0
TECH2 03	Variable Cylinder Management System (VCMS)	3	0.2%	3	0	3	0	0
TECH2 04	Dualogic Transmission(DT)	2	0.2%	0	2	2	0	0
TECH3 01	Exhaust Gas Recirculation (EGR)	4	0.3%	4	0	0	4	0
Total		1,296	100.0%	1095	201	1,170	113	13

In consideration that a large difference exists as to the local level of automotive energy-saving technologies and the proportion of applications, the filing of automotive fuel consumption label puts forward no unitary prescriptions with respect to energy-saving technologies and their principles; rather, each manufacturer may declare by themselves. For the sake of comparative analysis and assessment on different energy-saving technologies and their energy-saving effectiveness, this report firstly sums up and collates the energy-saving technologies as declared by manufacturers, classifies the technologies based on same/similar working principles and functions, and unifies the description of same/similar technologies declared by manufacturers. For instance, the "variable intake length" and "variable intake manifold" are combined under the title of "variable intake system".

According to the questionnaire survey results conducted to the experts, whereas some energy-saving technologies are already extensively applied on the local passenger cars (e.g., Multi Points Injection, AF Ratio Closed Loop Control, (Double) Overhead Camshaft, Electronic Fuel Injection, Independent Ignition System, and High Voltage Ignition), they are ignored by this report upon analyzing the effects of energy-saving technologies on fuel consumption.

TECH1 shown in Table 11 represents the high-use-frequency technologies employed by the vehicle types which utilize only one or more energy-saving technologies; TECH2 represents a second technology besides TECH1; and TECH3 represents a third one apart from TECH1 and TECH2. For the description of each energy-saving technology, please consult Annex A. According to Table 11, being an off-the-shelf technology and featuring low costs, "VVT" turns into the energy-saving technology utilized, at the highest frequency, by both domestic vehicles and imported ones; while "CR" is the most popular energy-saving technology applied on the diesel vehicles.

4.2 节能技术对燃料消耗量的影响

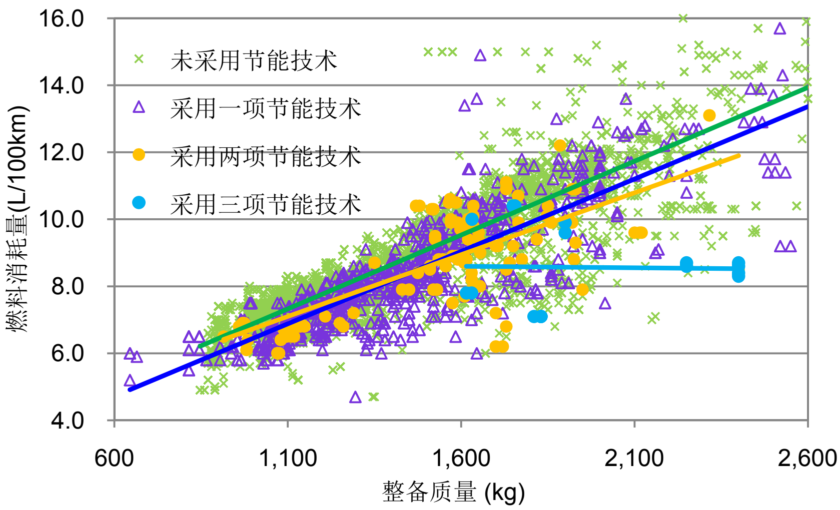


图 60 采用节能技术对燃料消耗量的影响

如图 60 所示，按照之前所述的节能技术应用分类方法，是否采用节能技术对燃料消耗量影响的规律性非常明显。未采用节能技术车辆的燃料消耗量最高，采用节能技术越多，则燃料消耗量越低。图中采用三项节能技术的趋势线由于数据量的影响，走势比较特殊，但未影响其规律性。

表 12 采用节能技术情况统计

	国产	比例，%	进口	比例，%	合计	比例，%
未采用节能技术	4117	81.2%	470	72.0%	4587	80.1%
采用一项节能技术	842	16.6%	157	24.0%	999	17.4%
采用两项节能技术	97	1.9%	26	4.0%	123	2.1%
采用三项节能技术	17	0.3%	/	/	17	0.3%
合计	5073	100.0%	653	100.0%	5726	100.0%

另外，从表 12 中可以看出进口车节能技术的应用比例高于国产车，而未应用节能技术的比例则低于国产车。

5 节能车燃料消耗量及技术状态分析

自 2010 年 6 月起，国家工业和信息化部、发展改革委、财政部三部委联合组织开展了节能汽车推广工作，制定了《“节能产品惠民工程”节能汽车（1.6 升及以下乘用车）推广实施细则》（下简称细则），定期向社会公布满足节能车要求的车型目录，对消费者购买节能汽车给予一次性 3000 元的定额补助，以此推动节能车的生产与销售。截止 2010 年底，已发布了四批节能车名单，共计 272 个车型。

《细则》中判定节能车的标准是，（1）发动机排量为 1.6 升及以下的燃用汽油、柴油的乘用车（含混合动力汽车和双燃料汽车）；（2）已列入《车辆生产企业及产品公告》和通过

4.2. Effects of energy-saving technologies on fuel consumption

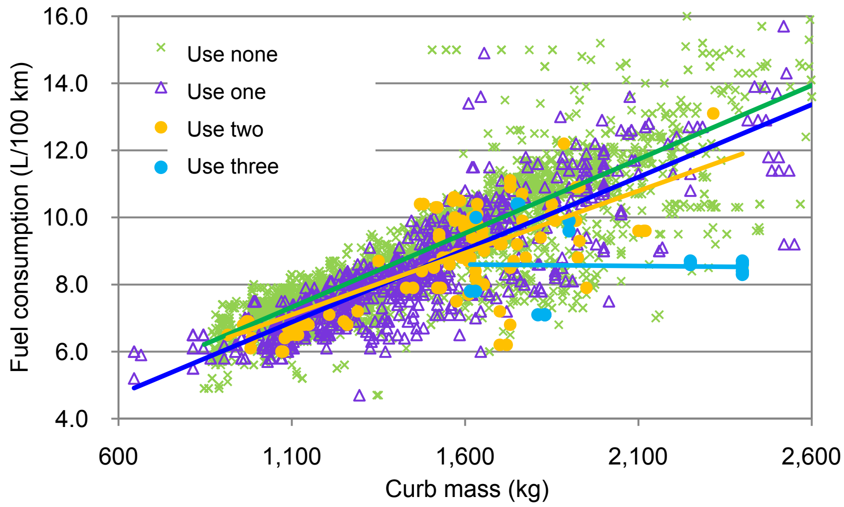


Figure 60 Effects of the use of energy-saving technologies on fuel consumption

As indicated in Figure 60, according to the classification method of application of energy-saving technologies, the use (or not) of energy-saving technologies has a clear indication on fuel consumption. The vehicles employing no energy-saving technologies present the highest fuel consumption, and the more the energy-saving technologies are adopted, the lower the fuel consumption. In the graph, the trend line of employing three energy-saving technologies is quite special due to the data size; nevertheless, the regularity mentioned above is still clear.

Table 12Statistics of application status of energy-saving technologies

	Domestic vehicle types	Share, %	Imported vehicle types	Share, %	Total	Share, %
Employing no energy-saving technology	4,117	81.2%	470	72.0%	4,587	80.1%
Employing one energy-saving technology	842	16.6%	157	24.0%	999	17.4%
Employing two energy-saving technologies	97	1.9%	26	4.0%	123	2.1%
Employing three energy-saving technologies	17	0.3%	/	/	17	0.3%
Total	5,073	100.0%	653	100.0%	5,726	100.0%

In addition, it is clear from Table 12 that a higher share of imported vehicle types adopt the energy-saving technologies, while the share of employing no energy-saving technology is lower than that of the domestic vehicles.

5. Analysis of Fuel Consumption and Technical Status of Energy-saving Vehicles

After June 2010, MIIT, in conjunction with NDRC (National Development and Reform Commission) and Ministry of Finance, has organized and unfolded the popularization of energy-saving vehicles, by working out the “Detailed Implementation Rules for Popularizing Energy-saving Vehicles (Passenger cars ≤ 1.6 L) under the Framework of ‘Huimin Project of Energy-saving products’ (hereinafter the “Detailed Implementation Rules”), periodically making public the catalogue of vehicle types satisfying the requirements for energy-saving vehicles, and granting a lump-sum subsidy (RMB3,000 yuan) to each individual who purchases an energy-saving vehicle, so as to propel the production and sales of energy-saving vehicles. By the end of 2010, 4 batches of catalogues of energy-saving vehicles had been released, involving 272 vehicle types in total.

The “Detailed Implementation Rules” adopt the following judgment criteria for energy-saving vehicles: (1) gasoline or diesel fuelled passenger cars having engine displacement not exceeding 1.6 L (incl. HEVs and dual-fuel vehicles); (2) already present on the “Announcement on Vehicle Makers and Their Products” and already filed with respect to automotive

汽车燃料消耗量标识备案；（3）提前满足《乘用车燃料消耗量评价方法和指标》（以下简称“三阶段标准”）车型燃料消耗量目标值。

本章研究了前四批节能车与非节能车间燃料消耗量水平和主要技术参数及性能间的差异，为分析细则的实施和推广成效提供参考依据。

5.1 节能车/非节能车燃料消耗量对比

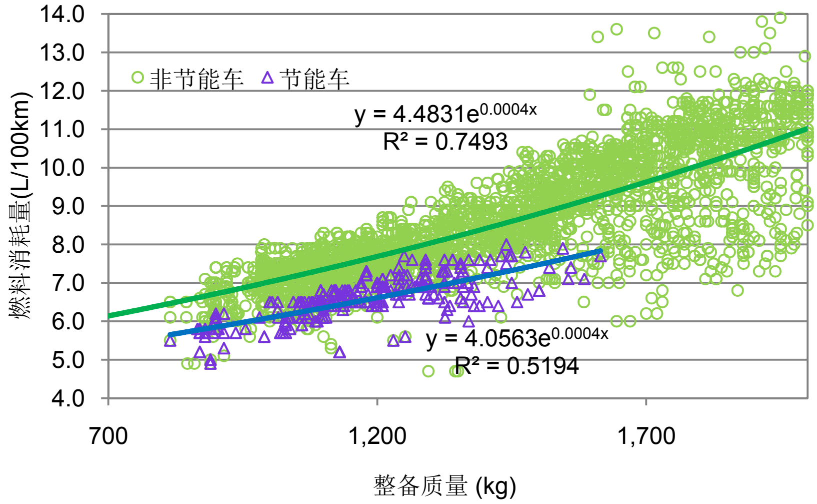


图 61 节能车/非节能车燃料消耗量分布情况

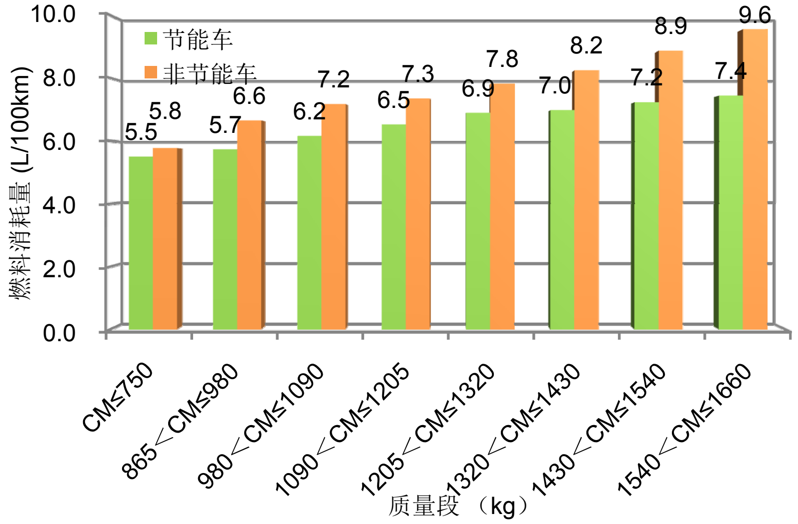


图 62 节能车/非节能车燃料消耗量对比

如图 61 所示，前四批节能车的整备质量均在 1660 kg 以下，并且没有整备质量在 750 kg-865 kg 之间的车型。在对同质量段的节能车与非节能车的燃料消耗量进行对比分析后发现，每个质量段非节能车的燃料消耗量比节能车高约 14%。

5.2 节能车/非节能车节能技术应用情况对比

fuel consumption label; and (3) satisfying the target fuel consumption of vehicle type as laid down in the standard "Fuel consumption evaluation method and targets for passenger cars" (hereinafter the "Phase III Standard") in advance.

This Chapter probes into the differences between the first four batches of energy-saving vehicles and the non energy-saving ones with respect to fuel consumption level, main technical parameters and performance, so as to provide a reference basis for the analysis of the execution and popularization effectiveness of the "Detailed Implementation Rules".

5.1. Comparison of fuel consumption between energy-saving vehicles and non energy-saving ones

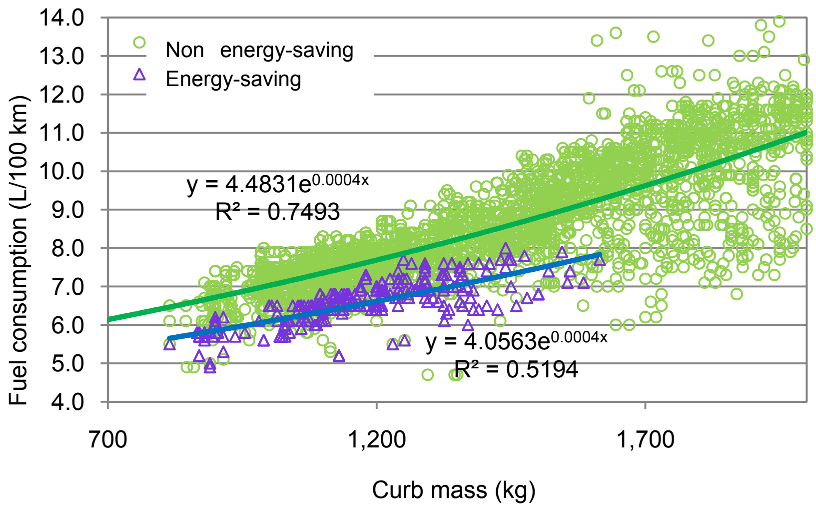


Figure 61 Distribution of fuel consumption of energy-saving vehicles/non energy-saving vehicles

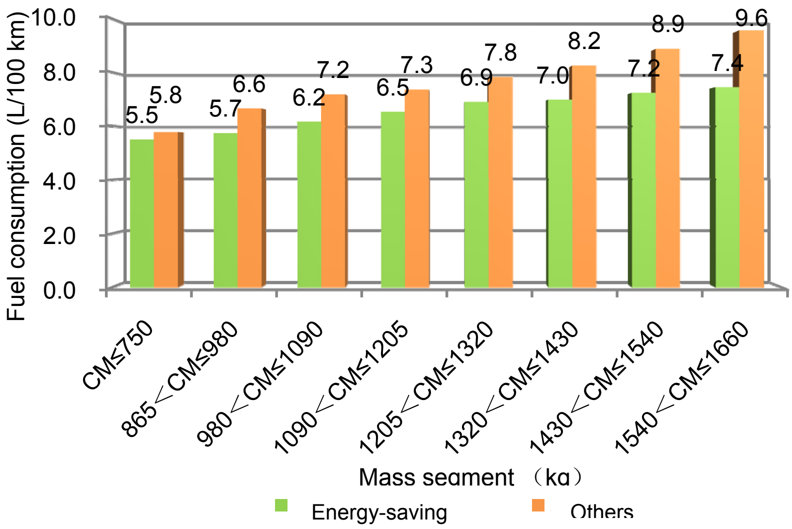


Figure 62 Fuel consumption comparison between energy-saving vehicles and non energy-saving ones

As shown in Figure 61, the first four batches of energy-saving vehicles present a curb mass below 1,660 kg, without any exception; plus, no vehicle type has the curb mass falling within750 kg ~ 865 kg. Through the comparative analysis between energy-saving vehicles and non energy-saving ones in each mass segment, it is found that the energy-saving vehicles have lower fuel consumption (roughly by 14%) than the non energy-saving ones.

5.2. Comparison between energy-saving vehicles and non energy-saving ones with respect to the application status of energy-saving technologies

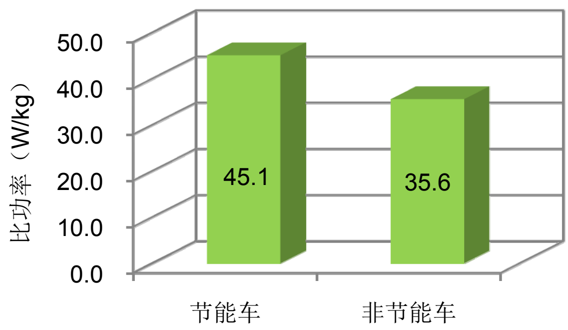
表 13 节能车/非节能车采用节能技术比例

	节能车	比例	非节能车	比例
未采用节能技术	198	60.2%	2855	81.2%
采用一项节能技术	123	37.4%	677	16.3%
采用两项节能技术	8	2.4%	81	2.2%
采用三项节能技术	0	0.0%	3	0.3%
合计	329	100%	3616	100%

为研究节能技术对节能车的影响，将节能车与非节能车节能技术的应用比例做了统计分析。

表 13 中统计了整备质量在 1660 kg 以下节能车与非节能车对节能技术的应用情况，可以看出，在现有的数据量下，节能车未采用节能技术的比例为 60.2%，而非节能车的这一比例为 81.2%；而采用一项节能技术的节能车所占比例为 37.4%，非节能车为 16.3%，前者是后者的两倍以上；采用两项节能技术的节能车所占比例为 2.4%，也略高于非节能车。但由于数据量限制，目前尚无采用三项节能技术的节能车。总体来看，节能技术在节能车上的应用情况和普及程度要优于非节能车。

5.3 节能车性能特点分析



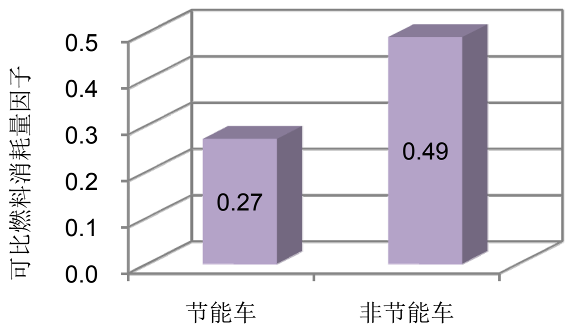


图 63 节能车/非节能车比功率对比图 64 节能车/非节能车可比燃料消耗因子对比

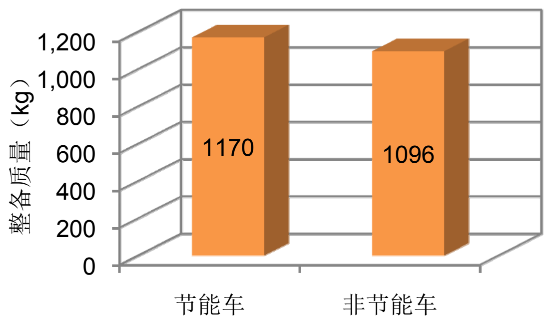


图 65 节能车与非节能车整备质量对比

Table 13 Shares of energy-saving vehicles/non energy-saving vehicles employing energy-saving technologies

	Energy-saving vehicles	Share	Non energy-saving vehicles	Share
Employing no energy-saving technology	198	60.2%	2855	81.2%
Employing one energy-saving technology	123	37.4%	677	16.3%
Employing two energy-saving technologies	8	2.4%	81	2.2%
Employing three energy-saving technologies	0	0.0%	3	0.3%
Total	329	100%	3616	100%

In order to probe into the effects of energy-saving technologies on energy-saving vehicles, statistical analysis is conducted to the shares of energy-saving vehicles and non energy-saving ones employing the energy-saving technologies.

Table 13 sums up the application of energy-saving technologies by the energy-saving and non energy-saving vehicles having the curb mass below 1,660 kg; obviously, given the existing data size, 60.2% energy-saving vehicles employ no energy-saving technologies, while for non energy-saving vehicles, such a share is 81.2%; 37.4% energy-saving vehicles employ one energy-saving technology, and 16.3% non energy-saving vehicles do, with the former over twice of the latter; 2.4% energy-saving vehicles employ two energy-saving technologies, slightly higher than the non energy-saving vehicles. Due to restriction in data size, however, there is no energy-saving vehicle type employing three energy-saving technologies. As a whole, the application and popularization of energy-saving technologies on the energy-saving vehicles are superior to the case of non energy-saving vehicles.

5.3. Analysis of performance characteristics of energy-saving vehicles

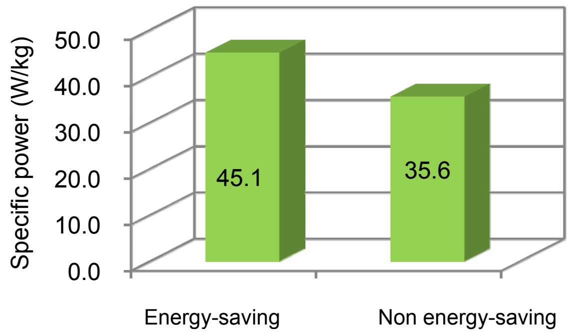


Figure 63 Comparison of specific power between energy-saving vehicles and non energy-saving ones

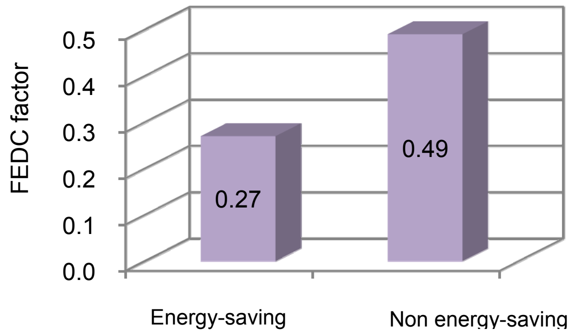


Figure 64 Comparison of FEDC factor between energy-saving vehicles and non energy-saving ones

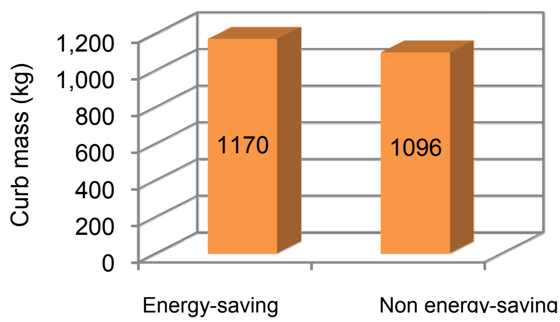


Figure 65 Comparison of curb mass between energy-saving vehicles and non energy-saving ones

在对 1.6 L 及以下排量的车型数据进行分析后发现,节能车的比功率和可比燃料消耗因子两项指标均优于同类型的非节能车,而整备质量略大于非节能车。这说明节能车在降低燃料消耗量时并未牺牲其动力性和舒适性。

6 按销量加权的平均燃料消耗量

最新制定的三阶段标准对现行标准体系进行了重大改革与完善，不再采取“一刀切”的方法，要求企业所有产品都必须达到标准规定的车型燃料消耗量目标值，而是引入企业平均燃料消耗量和和企业平均燃料消耗量目标值的概念，将制造商作为评价对象，根据制造商所有乘用车产品的车型燃料消耗量和对应的产量设定该制造商的企业平均燃料消耗量目标值。本章按照三阶段标准中规定的方法，对 2010 年我国主要乘用车生产企业的企业平均燃料消耗量进行了测算，并进一步计算了全国平均燃料消耗量和按技术来源的平均燃料消耗量。

6.1 企业平均燃料消耗量

企业平均燃料消耗量（CAFC）是指某汽车生产企业在某年度生产、进口或销售的乘用车车型燃料消耗量按当年度对应生产、进口或销售量加权计算得出的平均燃料消耗量（具体采用何种数据量由主管部门确定，本报告中是采用生产量进行的测算），用每行驶 100 公里所消耗的燃料表示。计算方法可描述为：汽车生产企业在一个车型年内制造并销售的所有乘用车车型的燃料消耗量与对应的车型产量乘积的和除以该汽车生产企业在本年度的乘用车生产总量。

$$CAFC = \frac{\sum_{i}^{N} FC_i \times Vp_i}{\sum_{i}^{N} Vp_i}$$

其中：

N 表示乘用车车型序号；

FC_i 表示第 i 个车型的燃料消耗量；

Vp_i 表示第 i 个车型的年度生产量

将上式中的 FC_i 替换为第 i 个车型的整备质量，则可以算出企业平均整备质量，将 FC_i 替换为第 i 个车型对应的三阶段限值则可以得到企业平均燃料消耗量目标值。

如图 66 所示，本报告中按 2010 年企业乘用车销量统计了前 50 位企业的企业平均燃料消耗量，企业名称不一一列出，以序号代替。这 50 家企业的乘用车产量之和占 2010 年我国全部乘用车产量的 98.7%（图 67 中气泡大小表示企业 2010 乘用车产量），因此完全可以反

According to the analysis conducted to the data of the vehicle types having engine displacement not exceeding 1.6 L, energy-saving vehicles are superior to the non energy-saving ones of the same type with respect to both specific power and FEDC factor, while the curb mass is slightly higher than the latter. This means that the lower fuel consumption of energy-saving vehicles is not at the cost of power performance and comfort.

6. Sales Weighted Average Fuel Consumption

Being recently developed, the Phase III Standard initiates key reform and perfection to the existing standard system; that is, by getting rid of the practice of "mechanically and unitarily" requiring all the products of manufacture to satisfy the target fuel consumption of vehicle type as specified by the standard, it introduces the concepts of CAFC and target CAFC, in which manufacturer is regarded as the object for assessment, and the target CAFC is established for the manufacturer based on the fuel consumption of vehicle type of all the passenger car products of the manufacturer and the corresponding production. This chapter estimate, as per the procedures laid down in the Phase III standard, the CAFC of the local main passenger car manufacturers in the year of 2010, in addition to further calculating the national average fuel consumption and the average fuel consumption of each technical source.

6.1. CAFC

Company average fuel consumption (CAFC) means the average fuel consumption of an auto maker calculated by weighing the fuel consumption of vehicle type of the passenger cars produced/imported/sold by the manufacturer in a certain year against the volume of production/importation/sales in that year (the use of concrete data type is dependent upon the competent authority in this report, the volume of production is utilized for the estimation), as expressed in the volume of fuel consumed per 100 km of travelled distance. The calculation method may be depicted as follows: sum up the products between fuel consumption of each vehicle type of passenger cars fabricated by a manufacturer and the volume of production of the vehicle type in a model year, and then divide the total volume of passenger cars fabricated by the manufacturer within that year.

$$CAFC = \frac{\sum_{i}^{N} FC_i \times Vp_i}{\sum_{i}^{N} Vp_i}$$

Where:

N means the serial number of vehicle type of passenger cars;

FC_i means the fuel consumption of the i^{th} vehicle type;

Vp_i means the yearly production of the i^{th} vehicle type

Substituting the curb mass of the ith vehicle type for 'FC_i' in the above formula, the average curb mass of the manufacturer may be computed; by replacing 'FC_i' with the corresponding Phase III limit of the ith vehicle type, then the target CAFC may be obtained.

As shown in Figure 66, this report sums up, based on the sales of passenger cars of manufacturers for the year 2010, the CAFC of the top 50, with manufacturers represented by serial number only. The sum of the production of passenger cars of these 50 manufacturers represent 98.7% of the total in China (In Figure 67, bubble size indicates each manufacturer's

映我国乘用车企业的燃料消耗量水平[5]。

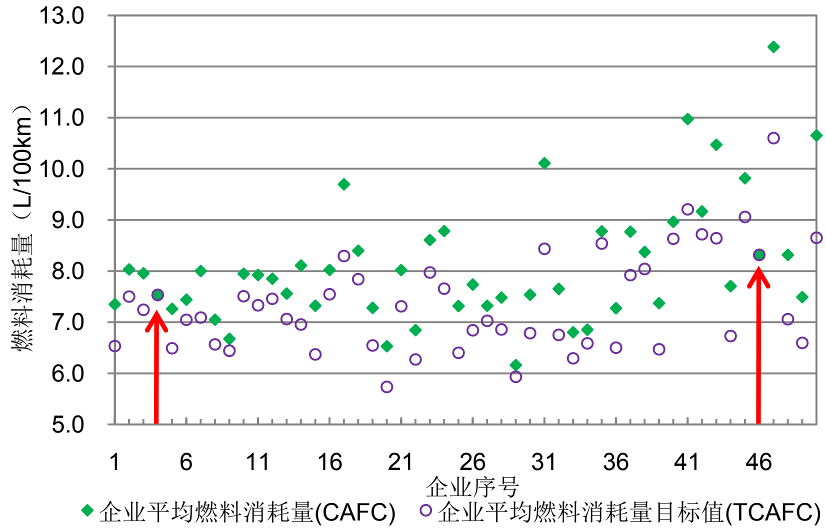


图 66 企业平均燃料消耗量与目标值

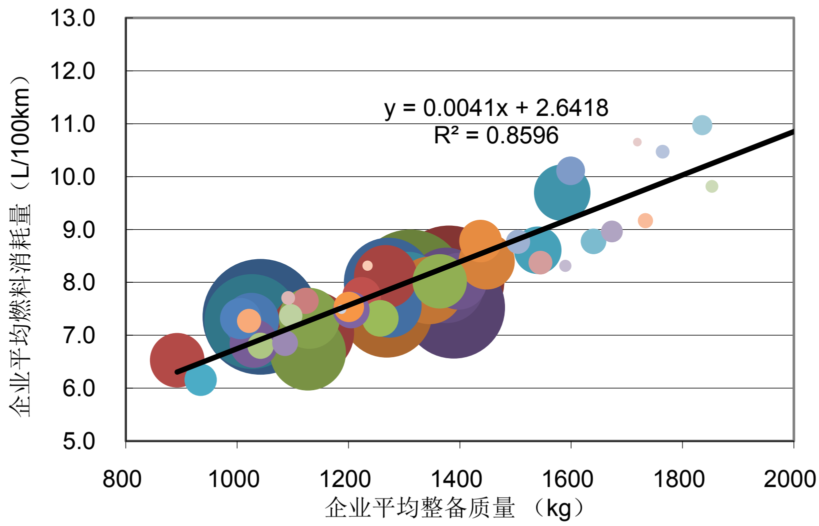


图 67 前 50 家主要乘用车企业产量、按产量加权的整备质量和燃料消耗量

从统计结果中可以看到，2010 年乘用车产量前五十位的乘用车生产企业中，能达到本企业平均燃料消耗量目标值的仅有两家（如图 66 中箭头所示），占被统计企业数的 4%。企业平均燃料消耗量数据差别很大，最高者为 12.38 L/100km，最低者为 6.16 L/100km。在未达到企业平均燃料消耗量目标值的企业中，超过目标值幅度最低的为 3%，最高为 23%。

6.2 全国平均燃料消耗量

所谓全国平均燃料消耗量(NAFC)是某一车型年内生产并在中国市场销售的所有车型，按生产量或销售量加权平均的燃料消耗量（本报告中采用生产量进行测算）。全国平均燃料消耗量(NAFC)可用本年度所生产的所有车型的燃料消耗量用生产量加权计算，也可根据所有汽车生产企业的公司平均燃料消耗量计算得出。

production of passenger cars in 2010), which can subsequently reflect the fuel consumption level of the local passenger car manufacturers[5].

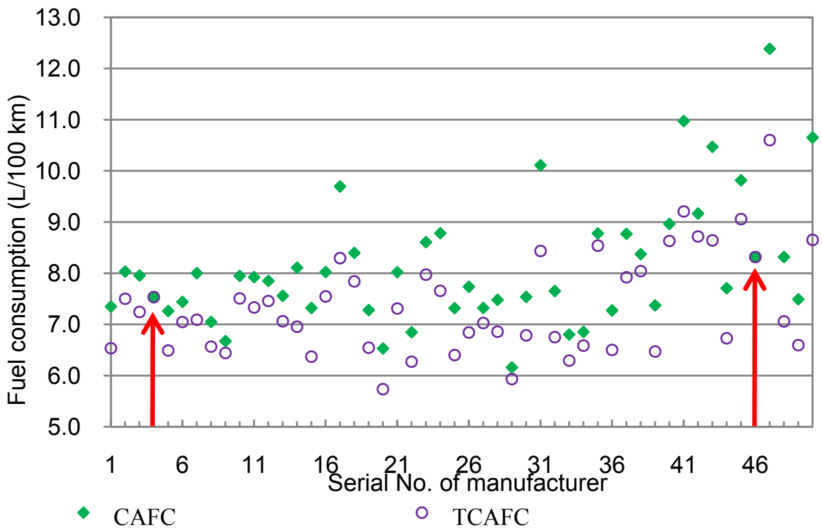


Figure 66 CAFC vs. target CAFC

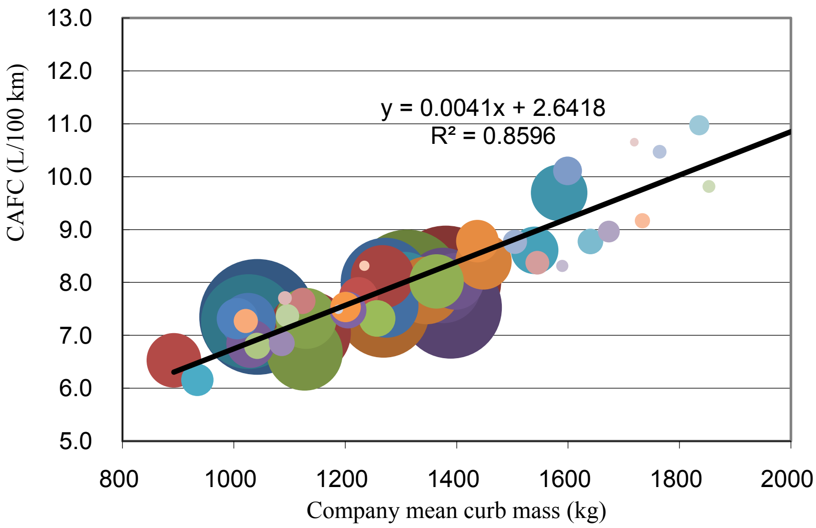


Figure 67 Production of passenger cars, production-weighted curb mass and fuel consumption of Top 50 manufacturers

According to the statistical results, amongst the top 50 manufacturers of passenger cars in the year 2010, only two ones can satisfy the respective target CAFC (see the arrows in Figure 66), occupying 4% thereof. The CAFC data vary largely, with the highest being 12.38 L/100 km, and the lowest, 6.16 L/100 km. In terms of the manufacturers failing to satisfy respective target CAFC, the lowest outstripping is 3%, while the biggest one, 23%.

6.2. National average fuel consumption

As defined, national average fuel consumption (NAFC) means the average fuel consumption of all vehicle types sold on the Chinese market within a certain model year, as weighted by production or sales volume (in this report, estimate is conducted as per the volume of production). NAFC may be calculated by the production weighted fuel consumption fabricated within that year, or computed by the CAFC of all the auto manufacturers.

$$NAFC=\frac{\sum_{i}^{N}FC_{i}\times Vp_{i}}{\sum_{i}^{N}Vp_{i}}=\frac{\sum_{j}^{M}CAFC_{j}\times V_{j}}{\sum_{j}^{M}V_{j}}$$

其中：

N 表示车型序号；

FC_i 表示第 i 个车型的燃料消耗量；

Vp_i 表示第 i 个车型的年度生产量

M 表示生产企业序号；

$CAFC_j$ 表示第 j 个生产企业的企业平均燃料消耗量；

Vj 表示第 j 个乘用车生产企业的年度生产量

本报告采用第二种方法计算全国乘用车平均燃料消耗量(NAFC),按照现有的 50 个乘用车生产企业的平均燃料消耗量和各企业乘用车总产量数据，如图 68 所示，计算得出 2010 年我国乘用车的全国平均燃料消耗量(NAFC)为 7.70 L/100km，比 2006 年的 8.06 L/100km 下降了约 4.5%。同样，将 $CAFC_j$ 换成第 j 个生产企业的企业平均整备质量可计算出 2010 年我国乘用车的全国平均整备质量为 1253 kg

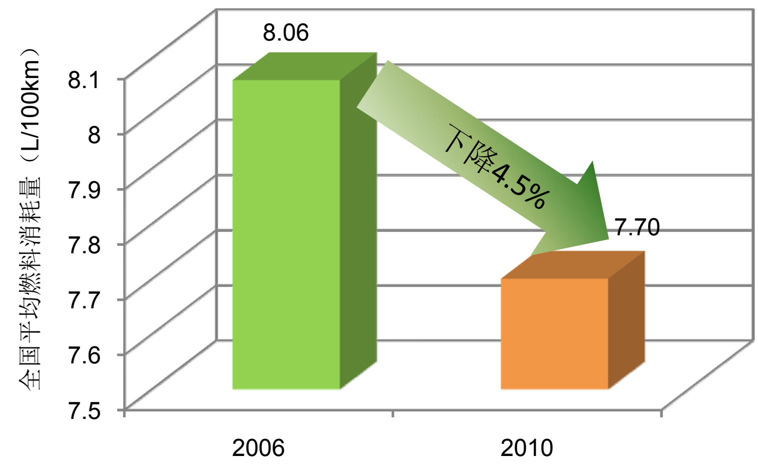


图 68 2006-2010 全国平均燃料消耗量

为更加直观地反映出我国企业乘用车平均燃料消耗量的分布情况，将 50 家企业的平均燃料消耗量绘制成图 69，图中蓝色水平点划线为我国三阶段标准中拟达到的全国乘用车平均燃料消耗量水平，截止 2010 年底，达到该目标的企业有 6 家，占被统计企业的 12%。绿色水平点划线为我国 2010 年按产量加权计算的全国乘用车平均燃料消耗量水平，达到该目标的企业有 23 家，占被统计企业的 46%。

$$NAFC = \frac{\sum_{i}^{N} FC_i \times Vp_i}{\sum_{i}^{N} Vp_i} = \frac{\sum_{j}^{M} CAFC_j \times V_j}{\sum_{j}^{M} V_j}$$

Where:

N means the serial number of vehicle type;

FC_i means the fuel consumption of the i^{th} vehicle type;

Vp_i means the yearly production of the i^{th} vehicle type;

M means the serial number of manufacturer;

$CAFC_j$ means the CAFC of the of the j^{th} manufacturer;

V_j means the yearly production of the j^{th} passenger car manufacturer

This report utilizes the second method to calculate the NAFC of passenger cars; based on the average fuel consumption of the 50 passenger car manufacturers and the total production of passenger cars of each manufacturer (see Figure 68), the NAFC of passenger cars of China in 2010 is 7.70 L/100 km, about 4.5% lower than that of 2006 (i.e., 8.06 L/100 km). Likewise, through substituting $CAFC_j$ by the average curb mass of the jth manufacturer, the national average curb mass of passenger cars in China in 2010 is computed, i.e., 1,253 kg.

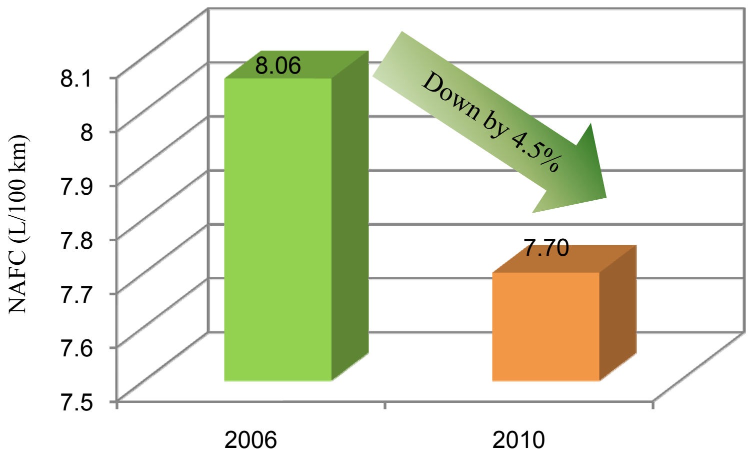


Figure 68 National average fuel consumption during 2006 ~ 2010

In order to more visually depict the distribution of average fuel consumption of passenger cars of the local manufacturers, the average fuel consumption of 50 manufacturers are plotted onto Figure 69, where blue horizontal dotted line indicates the national average fuel consumption of passenger cars planned to be reached in the Phase III Standard; by end of 2010, 6 manufacturers had attained such target, occupying 12%. The green horizontal dotted line represents the production-weighted national average fuel consumption level of passenger cars for China in 2010; 23 manufacturers may attain the target, occupying 46%.

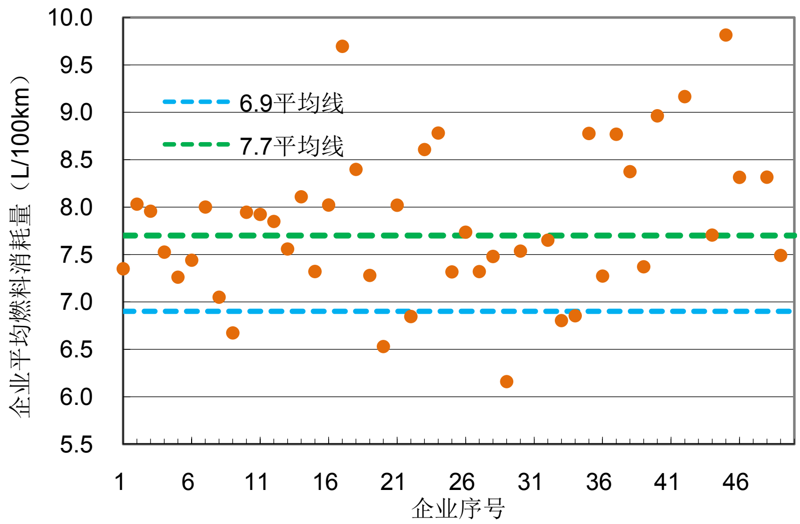


图 69 2010 年乘用车 CAFC 分布图

6.3 按技术来源的平均燃料消耗量

我国乘用车制造商以合资居多，多数主流车型系从国外引进生产。为便于分析，按照技术来源不同，将乘用车产品分为欧洲、美国、日本、韩国和中国等不同的分组，并分别计算不同技术来源平均燃料消耗量（TSAFC）。

所谓技术来源平均燃料消耗量是某技术来源的所有乘用车生产企业在某一车型年内制造并在中国市场销售的所有乘用车车型，按生产量或销售量加权平均的燃料消耗量（本报告中采用产量进行测算）。

$$TSAFC = \frac{\sum_{i}^{N} FC_i \times Vp_i}{\sum_{i}^{N} Vp_i} = \frac{\sum_{j}^{M} CAFC_j \times V_j}{\sum_{j}^{M} V_j}$$

其中：

N 表示某技术来源内乘用车车型序号；

FC_i 表示某技术来源内第 i 个车型的燃料消耗量；

Vp_i 表示某技术来源内第 i 个车型的年度生产量

M 表示某技术来源内乘用车生产企业序号；

$CAFC_j$ 表示某技术来源内第 j 个乘用车生产企业的公司平均燃料消耗量；

Vj 表示某技术来源内第 j 个乘用车生产企业的年度生产量

将式中的 FC_i 换为 CM_i，即技术来源内第 i 个车型的整备质量，就可以算得技术来源平均整备质量。

根据计算，各技术来源车型的平均整备质量从大到小的顺序排列依次为：日本、美国、

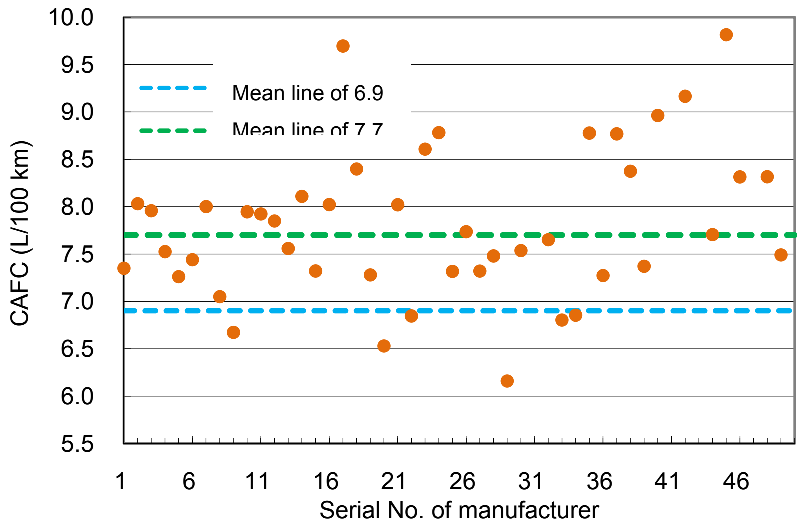


Figure 69 CAFC distribution of passenger cars in 2010

6.3. Average fuel consumption per technical source

In China, the manufacturers of passenger cars are mainly of joint ventures, and a majority of mainstream vehicle types are introduced from overseas. For the sake of analysis, passenger car products are divided into different groups in view of the technical source (EU, USA, Japan, S. Korea, and China), for which respective Technical Source Average Fuel Consumption (TSAFC) is calculated.

By definition, TSAFC means the production or sales weighted average fuel consumption of all the vehicle types of passenger cars fabricated by all the passenger car manufacturers of a certain technical source during a certain model year, which are intended for the local market (this report adopts production for the estimate).

$$TSAFC = \frac{\sum_{i}^{N} FC_i \times Vp_i}{\sum_{i}^{N} Vp_i} = \frac{\sum_{j}^{M} CAFC_j \times V_j}{\sum_{j}^{M} V_j}$$

Where:

N means the serial number of a vehicle type of passenger cars within a certain technical source;

FC_i means the fuel consumption of the i^{th} vehicle type within a certain technical source;

Vp_i means the yearly production of the i^{th} vehicle type within a certain technical source;

M means the serial number of a passenger car manufacturer within a certain technical source;

$CAFC_j$ means the CAFC of the j^{th} passenger car manufacturer within a certain technical source;

V_j means the yearly production of the j^{th} passenger car manufacturer within a certain technical source.

Through substituting FC_i by CM_i, i.e., the curb mass of the ith vehicle type within the technical source, the technical source average curb mass may be computed.

As calculated, based on the average curb mass of vehicle types, various technical sources are ranked (in the descending

韩国、欧洲和中国；平均燃料消耗量按从高到低的顺序依次为：日本、美国、欧洲、中国、韩国。这个结果与 2006 年相比有很大的变化，2006 年平均燃料消耗量从高到低的顺序排列依次是：美国、欧洲、日本、韩国、中国。日系车的平均燃料消耗量水平从次于欧洲、美国变成五个技术来源中的最高者，这主要因为日系车的产品结构越来越偏向高档、豪华、大型化的车辆，从而导致其平均整备质量和平均燃料消耗量在这四年间显著上升。而韩系车在降低燃料消耗量方面成效显著,成为平均燃料消耗量最低的技术来源。

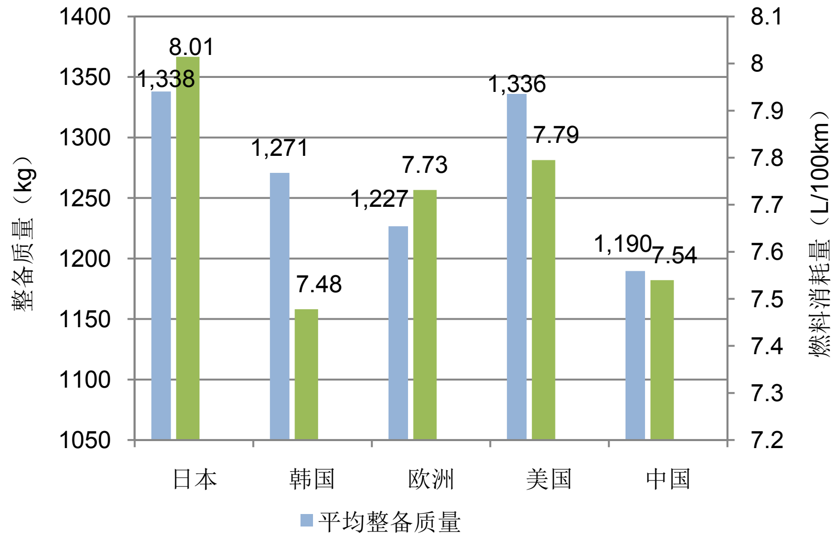


图 70 不同技术来源平均燃料消耗量

7 结论

7.1 2010 年我国乘用车主要技术参数特点

2010 年我国乘用车主要技术参数的特点可以从以下几个方面进行描述：

1）发动机排量呈明显的橄榄形分布，大部分车型集中在中间排量段，排量为 2.0L 的车型所占比例最高。国产车和进口车排量分布差异明显，有 94%的国产车型发动机排量在 2.5 L 以下，而进口车大部分集中在大排量段，1.6 L 以下的车型只占 6%。

2）我国乘用车仍以手动变速器为主，以自动变速器为辅，采用其它变速器型式的车型很少。手动变速器多数为 5 档，自动变速器则以 4 档为主。而进口车主要采用自动变速器，之中一半为 6 档。

3）国产车以前轮驱动与后轮驱动为主，全时全轮驱动车型所占比例仅为 3.3%，进口车采用全时全轮驱动的比例则达到了 48.7%。

4）我国乘用车产品仍以汽油为主，柴油车所占比例仅为 6.2%，其余燃料类型车辆约占 2.1%。

sequence) as follows: Japan, USA, S. Korea, EU and China; based on average fuel consumption, the sequence (also in descending order) is as follows: Japan, USA, EU, China, and S. Korea. Such result is largely different from the situation of 2006, for which year the sequence (in the descending order of average fuel consumption) was USA, EU, Japan, S. Korea, and China. Before, the average fuel consumption of Japanese-source vehicles followed both EU and USA, and now, it takes up the top position, for which the main reasons lie in that the product mix of the Japanese source has kept escalating towards high grade, deluxe, and large size (for sure, its average curb mass and average fuel consumption has maintained salient rise during the recent four years). In contrast, the vehicles of the S. Korean source have attained eye-catching fruits in terms of fuel consumption, making it the technical source enjoying the lowest average fuel consumption.

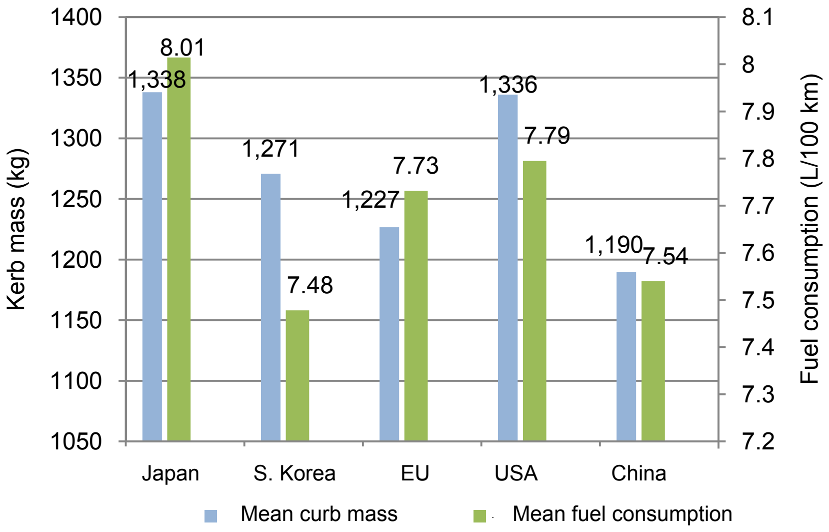


Figure 70 Average fuel consumption of different technical sources

7. Conclusions

7.1. Characteristics of main technical parameters of local passenger cars in the year 2010

For 2010, the characteristics of the main technical parameters of local passenger cars may be depicted from several aspects below:

1) The distribution of engine displacement is quite like an olive, with a majority of vehicle types concentrated in the middle segments of engine displacement and the share of vehicle types with engine displacement of 2.0 L is the highest. The difference is big between domestic vehicles and imported ones as to the distribution of engine displacement; 94% domestic vehicle types have the engine displacement below 2.5 L, while most of the imported ones are concentrated at the large segments of engine displacement, with the share of vehicle types below 1.6 L being just 6%.

2) For the domestic passenger cars, MT is still the mainstream, while AT plays the complementary role. Only a minor portion of vehicle types employ other types of transmission. MT vehicle types are mainly of 5-gear, while AT ones, mainly of 4-gear. In contrast, the imported vehicle types mainly adopt AT, where half employs 6-gear.

3) The domestic vehicle types are mainly of Front- and rear-wheel drive, with the share of all-wheel drive being just 3.3%; while 48.7% imported vehicle types employ the all-wheel drive.

4) The passenger car products are still based on gasoline, with the share of diesel vehicles being just 6.2% and that of other fuel types about 2.1%.

5）国产车发动机的额定功率、净功率和比功率三项指标均低于进口车，动力性差距明显。

6）本报告首次对乘用车排量段与质量段的对应分布以及不同排量段、质量段内的燃料消耗量分布情况进行了分析，分别确定提出了不同质量段所对应的“黄金排量”，即最佳匹配排量。

7.2 2010 年我国乘用车燃料消耗量水平

7.2.1 单车燃料消耗量

《乘用车燃料消耗量限值》标准规定自 2009 年 1 月 1 日起适用于本标准的所有车辆都需要满足第二阶段限值的要求。从数据分析的结果来看，《乘用车燃料消耗量限值》标准作为国家汽车产品准入管理的重要技术文件对降低和控制乘用车燃料消耗量发挥着不可替代的作用，除部分进口车型还未满足标准规定的二阶段限值的要求外，其余车型都被严格控制在限值以内。同时还看到，截止至 2010 年底，乘用车单车燃料消耗量能达到三阶段目标值的车型所占的比例还很低。

7.2.2 企业平均燃料消耗量

通过对 2010 年国内 50 家主要汽车生产企业的企业平均燃料消耗量进行测算得出，这 50 家企业的平均燃料消耗量比其目标值平均高约 10%，能达到或低于目标值的企业只有两家，占全部企业的 4%。全国平均燃料消耗量为 7.7 L/100km，比 2006 年下降了约 4.5%，这些数据表明在目前的技术状态下，要达到全国平均 6.9 L/100km 的目标还需要在 2010 年的水平上再下降 9%以上，后续节能压力仍然很大。需要说明的是，本报告中采用的是截止 2010 年 12 月的乘用车销量和燃料消耗量数据，因此三阶段标准实施并进行核算前，这一数据应该还会变化。

7.3 节能新技术应用状态

汽车生产企业为达到标准及相关政策法规的要求，而采用了多种节能新技术以降低其产品的燃料消耗量水平，很大程度地上促进了节能技术的进步。通过对采用不同节能技术车辆的燃料消耗量数据进行分析后发现，节能技术的应用对降低乘用车燃料消耗量效果非常显著，并且从统计角度来看，在其余技术参数接近的同类型车辆中，采用节能技术种类越多的车辆，其燃料消耗量水平就越低。进口车对节能技术的应用比例略高于国产车，但进口车与国产车应用节能技术的车型比例都比较低，因此乘用车燃料消耗量随着节能技术应用比例的提高仍然有进一步下降的空间。

5) With respect to the three criteria of engine (namely, rated power, net power, and specific power), the domestic vehicles are inferior to their imported counterparts, indicating a big indent as to power performance.

6) This report takes the lead in analyzing the corresponding distribution between engine displacement segment and mass segment of passenger cars, as well as the fuel consumption distribution in each engine displacement segment and mass segment, in addition to proposing the "golden displacement" corresponding to each mass segment, i.e., the optimal matching engine displacement.

7.2. Fuel consumption level of domestic passenger cars in 2010

7.2.1. Individual-vehicle fuel consumption

As specified by the standard "Limits of fuel consumption limits for passenger cars", from Jan. 1st, 2009, all the vehicles subjected to this standard shall satisfy the Phase II limits. As indicated by the data analysis, the standard "Limits of fuel consumption limits for passenger cars", as the key technical document intended for state administration over access of automotive products, has played an incomparable role in cutting down and controlling fuel consumption of passenger cars; except some imported vehicle types, all the vehicle types have been strictly controlled within the Phase II limits. It shall member, however, that by end of 2010 only a tiny share of vehicle types of passenger cars could attain the Phase III targets for individual-vehicle fuel consumption.

7.2.2. CAFC

According to the CAFC estimated for the 50 local main auto manufacturers in 2010, on average the CAFC is higher than respective target CAFC by 10% or so; only 2 manufacturers could satisfy the target CAFC, occupying 4% thereof. The national average fuel consumption is 7.7 L/100 km, roughly 4.5% down from 2006. These data indicate that, given the current technical state, a further reduction of 9% or more (on the level of 2010) is necessary to realize the national average goal, namely, 6.9 L/100 km, and the subsequent task for energy saving would still be quite heavy. It shall take note that this report has utilized the passenger car sales and fuel consumption data up to Dec. 2010; changes would surely occur before the implementation of the Phase III standard and the start of the corresponding accounting.

7.3. Application status of new energy-saving technologies

For the purposes of satisfying the standard provisions and the requirements of related policies and regulations, vehicle manufacturers have adopted multi types of new energy-saving technologies to reduce the fuel consumption level of their products, which, to a certain extent, promote the advances of energy-saving technologies. Through analyzing the fuel consumption data of vehicles employing different energy-saving technologies, the application of energy-saving technologies has a quite salient role in cutting off passenger cars fuel consumption; moreover, in statistical perspective, for a same kind of vehicles which are similar in other parameters, the more types of energy-saving technologies are used, the lower the fuel consumption level. The application share of energy-saving technologies on the side of imported vehicle types is slightly higher than that of domestic vehicles; nevertheless, irrespective of the imported vehicle types or the domestic ones, the proportion of the vehicle types employing energy-saving technologies is low. Therefore, along with the more extensive application of energy-saving technologies, the fuel consumption of passenger cars would further go down.

7.4 2010 年我国乘用车 CO_2 排放水平

2010 年我国汽、柴油车燃料消耗量与 CO_2 排放量的对应关系分别为：1 L/100km=23.747 g/km 和 1 L/100km=26.047 g/km。如前所述，目前我国乘用车的保有结构中绝大部分为汽油车，因此利用汽油消耗量与 CO_2 排放量的换算关系 1 L/100km=23.8 g/km 可近似计算我国目前乘用车的 CO_2 排放水平。对应 2010 年我国乘用车的平均燃料消耗量为 7.7 L/100km，由此得到我国乘用车 2010 年 CO_2 排放水平大约为 183.3 g/km。

7.5 前四批节能车技术状态

在对前四批已列入推广目录的 272 个节能车型的技术参数以及燃料消耗量数据进行分析后得出，节能汽车的整备质量平均值大于相同排量段的非节能车，而其燃料消耗量水平比后者低约 14%，并且其额定功率、FEDC 因子（2.7）、对节能技术的应用比例等数据均优于后者，这充分说明列入推广目录的节能车在同类车辆中具有技术优势。

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7.4. CO_2 emissions level of passenger cars in China in 2010

In 2010, the correspondence between fuel consumption and CO_2 emissions for gasoline and diesel vehicles is respectively as follows: 1 L/100 km = 23.747 g/km and 1 L/100 km = 26.047 g/km. As mentioned above, in the local present mix of passenger cars, a great majority is represented by gasoline vehicles. Consequently, the conversion between gasoline consumption and CO_2 emissions, i.e., 1 L/100 km = 23.8 g/km, may approximate the local current CO_2 emissions of passenger cars. Now that, in 2010, the local average fuel consumption of passenger cars is 7.7 L/100 km, the CO_2 emissions level of the local passenger cars in 2010 is roughly 183.3 g/km.

7.5. Technical state of the first four batches of energy-saving vehicles

Based on the analysis to the technical parameters and fuel consumption data of the 272 energy-saving vehicle types of the first four batches already present on the catalogue of popularization, the energy-saving vehicles have a higher average curb mass than the non energy-saving vehicles of the same segment of engine displacement, the fuel consumption level of the former is lower by the latter by about 14%, and the former is superior to the latter with respect to rated power, FEDC factor (2.7), application share of energy-saving technologies, etc.; all these indicate that the energy-saving vehicles present in the catalogue of popularization are of technical superiority among the vehicles of the same kind.

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附录 A 节能技术描述

技术编号	中文名称	英文名称	描述
TECH1 01	可变气门正时	**V**ariable **V**alve **T**iming	为使发动机满足在不同转速下对配气相位的不同要求，通过配备的控制及执行系统调节发动机进气排气系统的升程、重叠时间与正时（其中一部分或者全部），从而使得气门开启、关闭的时间随发动机转速的变化而变化，以提高充气效率，增加发动机的效率与动力。
TECH1 02	缸内直喷	**G**asoline **D**irect **I**njection	通过安装在燃烧室的喷油嘴将汽油直接喷注在汽缸燃烧室内，空气则通过进气门进入燃烧室与汽油混合成混合气被点燃做功。
TECH1 03	连续可变气门正时	**C**ontinue **V**ariable **V**alve **T**iming	通过电子液压控制系统改变凸轮轴打开进气门的时间早晚，可根据发动机工作状况的连续变化实时控制气门重叠角的大小，从而改变汽缸进气量。
TECH1 04	高压共轨	**C**ommon **R**ail	共轨技术是指高压油泵、压力传感器和ECU 组成的闭环系统中，将喷射压力的产生和喷射过程彼此完全分开的一种供油方式，即由高压油泵将高压燃油输送至公共供油管，通过电磁阀对公共供油管内的油压实现精确控制，使高压油管压力大小与发动机的转速无关，从而大幅减少发动机转速变化对柴油机供油压力造成的影响。
TECH1 05	涡轮增压	**T**urbo **C**harge	利用内燃机工作时排出废气的热量及流量驱动安装在进气口前的涡轮增压器，使进气压力和密度增大，从而提升发动机的功率和效率。
TECH1 06	燃油分层喷射	**F**uel **S**tratified **I**njection	由控制单元经过计算分析，精确控制燃料的喷射时间与喷射量，并通过对发动机燃烧室的设计，让混合气能产生较强的涡流使空气和汽油充分混合。然后使火花塞周围区域能有较浓的混合气，其他周边区域有较稀的混合气，保证了在顺利点火的情况下尽可能的实现分层均质稀薄燃烧，进而提高发动机效率。

Exhibit A   Description of Energy-saving Technologies

No. of technology	Title in Chinese	Title in English	Description
TECH1 01	可变气门正时	**V**ariable **V**alve **T**iming	To enable engine to satisfy the actual demands for distribution phase under different rotational speeds, adjust, via the fitted control and execution systems, the lift, overlapping time and timing (partial or all thereof) of the intake/exhaust gas system of engine, so that the open/close time of air valve alters along with engine speed, thus improving charge efficiency and enhancing engine's efficiency and power performance.
TECH1 02	缸内直喷	**G**asoline **D**irect **I**njection	Via fuel injection nozzle mounted in combustion chamber, directly inject gasoline into the combustion chamber of cylinder; air enters the combustion chamber via air inlet, and forms gas mixture with gasoline, which is subsequently ignited and applied to work.
TECH1 03	连续可变气门正时	**C**ontinue **V**ariable **V**alve **T**iming	Via electronic hydraulic control system, alter the time point at which air inlet valve is opened by camshaft; based on successive change in working state of engine, it may control, in the real-time manner, the extent of overlapping angle of air valve, thus altering the gas input volume of cylinder.
TECH1 04	高压共轨	**C**ommon **R**ail	Means a fuel supply technology by which the generating of injection pressure is totally separated from the injection loop in the closed loop system consisting of high-pressure fuel pump, pressure transducer and ECU; that is, high-pressure fuel pump delivers the high-pressure fuel to the common fuel delivery pipe, and, via solenoid valve, actualizes precision control over the fuel pressure in the common fuel supply pipe, thus making the pressure of high-pressure fuel pipe have nothing regard to engine speed, and consequently largely reducing the effects of change of engine sped on the fuel supply pressure of diesel engine.
TECH1 05	涡轮增压	**T**urbo **C**harge	By making use of the heat and flow of exhaust gas emitted during operation of internal combustion engine, actuate the turbocharger mounted upstream air inlet, soas to increase intake air pressure and density and subsequently improve the output and efficiency of engine.
TECH1 06	燃油分层喷射	**F**uel **S**tratified **I**njection	Via calculation and analysis, the control unit exercises precision control over fuel injection time and injection quantity; and, through design of engine's combustion chamber, let the gas mixture to engender a strong eddy current, thus realizing the sufficient blending between air and gasoline. Then, enable dense gas mixture to exist in the surrounding area of spark plug, and lean gas mixture in other adjacent areas, thus ensuring the stratified, homogeneous, and lean combustion as far as possible under the pre-condition of smooth ignition, and subsequently improving engine efficiency.

技术编号	中文名称	英文名称	描述
TECH1 07	无回油系统	**N**o **R**eturn **O**il **S**ystem	将燃油泵、燃油滤清器及燃油调节器等均内置于燃油箱中，燃油压力调节器工作时的回油在油箱内完成回流，从燃油箱到燃油分配管只有供油管，燃油箱只有泵出的燃油而没有回流的燃油。这种燃油供给系统燃油箱内部采用绝对压力调节器，因此，燃油分配管内的压力是恒定的。
TECH1 08	增压中冷	**T**urbo **C**harging **I**nnercooling	增压中冷技术就是当涡轮增压器将新鲜空气压缩经中段冷却器冷却，然后经进气歧管、进气门进入燃烧室。采用有效的中冷技术可以大幅降低增压温度，有助于减少废气的排放，降低大负荷工况排气烟度、PM 排放量以及燃料消耗量。
TECH1 09	可变进气系统	**V**ariable **I**ntake **S**ystem	分为可变进气道和可变进气歧管两种方式。根据发动机不同转速，使用不同长度或容积的进气管向汽缸内充气，以便能形成惯性充气效应及谐振脉冲波效应，从而满足不同工况下发动机对进气量的需求。使发动机在小负荷低转速到大负荷高转速都能保持较高的扭矩输出。
TECH1 10	电子节气门控制	**E**lectronic **T**hrottle **C**ontrol	由发动机电控单元接收油门踏板位置、脚踩踏板的速度以及发动机转速、冷却液温度和底盘电子控制信号等信息，计算出节气门实际开度，由执行器自动调整节气门位置，使节气门开度得到精确控制。
TECH1 11	可控燃烧速率	**C**ontrolled **B**urn **R**ate	将发动机每缸的进气道分为切向气道和中性气道，在低速、低负荷工况下，通过滑片式进气涡流控制系统关闭中性气道，由切向气道进气产生强涡流比，提高混合气燃烧速率从而降低燃料消耗量和排放；在高速、高负荷时，通过打开中性气道来保证足够的扭矩输出。
TECH1 12	可变涡轮截面增压	**V**ariable **G**eometry **T**urbocharge	在低转速、低排气量的工况下关闭部分导流叶片，调节调涡流截面从而增大发动机的进气压力,能够显著改善低转速时的响应时间和加速能力。
TECH1 13	燃油增压分层喷射	**T**urbocharged **F**uel **S**tratified **I**njection	带有涡轮增压的燃油分层喷射技术（FSI）。
TECH1 14	电控分配泵	**E**lectronic **D**istribution **P**ump	只用一套泵油机构为所有汽缸供油，泵内设有燃油分配装置，能够将燃油适时、适量地分配给各个汽缸。目前有单柱塞式和转子式两种压缩型式的分配泵。

No. of technology	Title in Chinese	Title in English	Description
TECH1 07	无回油系统	No Return Oil System	All the fuel pump, fuel filter and fuel pressure regulator are fitted inside fuel tank; during operation of fuel pressure regulator, the backflow of return oil winds up in the fuel tank; only fuel feed pipe exists between fuel tank and fuel distribution pipe, and the fuel tank involves the pumped-out fuel only, having nothing regard to any returned oil. For such kind of fuel supply system, absolute pressure regulator is fitted inside fuel tank, and consequently the pressure in fuel distribution pipe remains constant.
TECH1 08	增压中冷	Turbo Charging Innercooling	Fresh air is compressed by turbocharger and cooled by the intercooler; then, it enters the combustion chamber via intake manifold and air inlet valve. Effective intercooling technology may largely reduce the supercharging temperature, beneficial for the cut-down of exhaust emissions, exhaust smoke at big load, PM emissions and fuel consumption.
TECH1 09	可变进气系统	Variable Intake System	Two types are involved: variable intake duct, and variable intake manifold. Based on different engine speed, intake pipe of different length/volume is used to charge the cylinder, so as to form the inertia charge effect and resonant pulse wave effect, and consequently satisfy engine’s demands for air input under different modes. In this way, engine could maintain high torque output, irrespective of small load and low speed or big load and high speed.
TECH1 10	电子节气门控制	Electronic Throttle Control	Engine ECU receives such information as accelerator pedal position, pedal pressing rate, engine speed, coolant temperature and chassis electronic control signals, and calculates the actual opening of throttle valve; then executor automatically adjusts the position of throttle valve, thus having its opening precisely controlled.
TECH1 11	可控燃烧速率	Controlled Burn Rate	The air intake duct of each cylinder of engine is divided into tangential duct and neutral duct; at the mode of low speed and low load, cut off the neutral duct via the sliding inletting vertex control system, and the air inlet from the tangential duct engendersthe strong eddy current ratio, thus improving the combustion rate of gas mixture while reducing fuel consumption and emissions; at high speed and high load, the opening of the neutral duct could guarantee the sufficient torque output.
TECH1 12	可变涡轮截面增压	Variable Geometry Turbocharge	At the mode of low speed and low displacement, shut off some guide vanes to adjust the cross-section, thus enlarging the intake pressure of engine, and largely improving the response time and accelerating capability at low speed.
TECH1 13	燃油增压分层喷射	Turbocharged Fuel Stratified Injection	Fuel stratified injection (FSI) technology with turbocharging.
TECH1 14	电控分配泵	Electronic Distribution Pump	Only one set of fuel pumping unit is employed to supply fuel for all the cylinders; fuel distributing device is set up inside pump, which could distribute fuel to each cylinder at a proper time point and proper rate. Presently, distributing pump involves two compression types, i.e., single plunger type and rotor type.

技术编号	中文名称	英文名称	描述
TECH1 15	电控单体泵	**E**lectronic **U**nit **P**ump	发动机每个汽缸燃油喷射由各自的独立喷射单元来完成。单体泵与喷油器之间用高压油管连接。柴油通过置于单体泵体内、由电磁控制的溢油阀供给喷油器。ECU 接收和处理各传感器传来的发动机运行参数信息，并与存储的最优值进行比较，控制喷油正时和喷油量。
TECH2 01	可变气门升程	**V**ariable **V**alve **L**ift	由控制机构切换使用凸轮轴上两组具有不同角度的凸轮，从而改变气门开启升程。在低速状态下利用进气惯性较小，较小的气门升程，可以提高气流流速，达到多进气的目的，而高速下采用较大的气门升程以降低气流阻力，增大进气量。
TECH2 02	可调机油泵	**A**djustable **O**il **P**ump	分为压力调节和体积流量调节。压力可调式机油泵仅由调压阀来限制其最大压力，它是通过将多余的体积流量通过旁通道直接流人油底壳来实现的；而体积流量可调式机油泵则是按照需求来产生压力和体积流量，从而将必需的传动功率降低到最低程度。
TECH2 03	可变气缸管理系统	**V**ariable **C**ylinder **M**anagement **S**ystem	在不同工况下使用不同的汽缸工作模式，即在起步、加速或爬坡等任何需要大功率输出的情况下保证所有汽缸投入工作。而在中速巡航和低发动机负荷工况下，仅运转一个汽缸组。在中等加速、高速巡航和缓坡行驶时，发动机将会运转介于二者之间的汽缸数目。
TECH2 04	智能双模变速器	**D**ualogic **T**ransmission	是一种配备智能电动液压系统，自动控制和管理离合与变速的自动机械变速器。在手动变速器的基础上改用电脑控制液压进行离合、换挡，使车辆能够在合适的时间进行离合和档位切换，从而提高传动效率，降低燃料消耗量。
TECH3 01	废气循环处理	**E**xhaust **G**as **R**ecirculation	将发动机排出的部分废气通过 EGR 阀回送到进气歧管，并与新鲜混合气一起再次进入气缸。由于废气在燃烧室内不参与燃烧，因此它可以通过吸收燃烧产生的部分热量来降低燃烧温度和压力，从而减少氮氧化物的生成量。

No. of technology	Title in Chinese	Title in English	Description
TECH1 15	电控单体泵	**E**lectronic **U**nit **P**ump	For each engine cylinder, fuel injection is completed by respective, independent injection unit. A high-pressure fuel pipe is used to connect unit pump with injector. Diesel fuel is fed to injector via the electromagnetically controlled overflow valve fitted inside unit pump body. ECU receives and processes the information of engine operating parameters transmitted by each sensor, and compared with the stored optimal values, thus controlling injection timing and injection quantity.
TECH2 01	可变气门升程	**V**ariable **V**alve **L**ift	The control unit switches over two sets of cams with different angle which are fitted on camshaft, thus altering valve opening and lift. At low speed, the use of smaller valve lift with smaller intake inertia may uplift the air flow rate and attain the goal of inletting more air; at high speed, the use of higher valve lift may reduce air flow resistance and uplift the air input.
TECH2 02	可调机油泵	**A**djustable **O**il **P**ump	Divided into pressure regulating type and volumetric flow regulating type. For pressure adjustable oil pump, only pressure control valve is sued to restrict its max. pressure, which is realized by directly bypassing the superfluous volumetric flow into the oil sump tank; while volumetric flow adjustable oil pump engenders pressure and volumetric flow based on demands, thus minimizing the requisite transmission power.
TECH2 03	可变气缸管理系统	**V**ariable **C**ylinder **M**anagement **S**ystem	Different cylinder working patterns are used under different modes; i.e., it ensures all cylinders operate in any case where big power output is needed (e.g., startup, accelerating, hill climbing, etc.). By contrast, for mid-speed cruising and low engine load, only one cylinder group operates. For mid acceleration, high-speed cruising, and travel on a gentle slope, engine will let some cylinders (with the number falling between the cases above) operate.
TECH2 04	智能双模变速器	**D**ualogic **T**ransmission	A type of automated mechanical transmission complete with intelligent electrohydraulic system, capable of automatically controlling and managing clutching and sped shifting. Based on MT, microprocessor is used to control the hydraulic pressure for the clutching and gear-shifting purposes, such that the vehicle could proceed with clutching and gear shifting at a proper time point, consequently improving the transmission power and reducing fuel consumption.
TECH3 01	废气循环处理	**E**xhaust **G**as **R**ecirculation	Partial exhaust gas emitted from engine is sent back, via EGR valve, to the air intake manifold, which is then fed into cylinder together with fresh gas mixture. Whereas exhaust gas doesn't join in the combustion within the combustion chamber, it may absorb some heat arising from the combustion process to reduce combustion temperature and pressure, subsequently cutting off the resultant NOx.

未列入统计的节能技术

技术编号	中文名称	英文名称	描述
TECH0 01	独立点火系统	**I**ndependent **I**gnition **S**ystem	每个气缸的火花塞配一个点火线圈，独立向火花塞提供高压电，使各缸直接点火。
TECH0 02	（双）顶置凸轮轴	（**D**ouble）**O**verhead **C**amshaft	单顶置凸轮轴是指在气缸盖上用一根凸根轴，直接驱动进、排气门，双顶置凸轮轴是在缸盖上装有两根凸轮轴，一根用于驱动进气门，另一根用于驱动排气门。
TECH0 03	空燃比闭环控制	**AF R**atio **C**losed **L**oop **C**ontrol	是为了将空燃比控制在理论值附近的闭环反馈控制系统。由氧传感器、计算机和混合气浓度调整装置组成。氧传感器安装在排气系统催化净化器的前面，监测排气中的氧含量，对不同的混合气浓度，输出不同的电压信号。计算机根据氧传感器传来的信号，判断混合气是否过浓或过稀，然后对电子控制化油器或电子控制燃油喷射系统进行控制，调整混合气的浓度，使其保持在理论的空燃比。
TECH0 04	多点电控燃油喷射	**M**ulti **P**oints **I**njection	在每缸进气口处都安装有喷油器，由电控单元进行分缸单独喷射或分组喷射，汽油直接喷射到各缸的进气前方，再与空气一起进入汽缸形成混合气。是目前普遍采用的燃油喷射方式。
TECH0 05	电控燃油喷射	**E**lectronic **F**uel **I**njection	利用各种传感器采集表征发动机运行工况的参数信号，由电控单元经过计算、分析、对比，精确控制发动机在各种工况下所需的喷油量，保证发动机具有良好的动力性、经济性和排放性。目前已在国内外汽车上广泛应用。

Energy-saving technologies not considered for the statistics

No. of technology	Title in Chinese	Title in English	Description
TECH0 01	独立点火系统	**I**ndependent **I**gnition **S**ystem	Spark plug of each cylinder is provided with an ignition coil, and high-tension current is provided to spark plug independently, such that each cylinder could be separately ignited.
TECH0 02	(双) 顶置凸轮轴	(**D**ouble) **O**ver**h**ead **C**amshaft	Single overhead camshaft means one camshaft is used on the cylinder head for directly actuating both air inlet and exhaust valves. Double overhead camshaft means two camshafts are fitted on cylinder head, one for actuating the air inlet valve, and the other for actuating exhaust valve.
TECH0 03	空燃比闭环控制	**AF R**atio **C**losed **L**oop **C**ontrol	A closed loop control system intended for controlling A/F ratio around its theoretic value, consisting of OS, microprocessor and mixture concentration regulator. OS is mounted upstream the catalytic converter, used for monitoring oxygen content in exhaust gas and outputting different voltage signals for different mixture concentration. Based on the signals transmitted from OS, microprocessor judges whether the mixture is too rich/lean and then controls the electronically controlled carburetor or electronically controlled fuel injection system, and adjust the mixture concentration, thus maintaining it at the theoretic A/F ratio.
TECH0 04	多点电控燃油喷射	**M**ulti **P**oints **I**njection	Fuel injector is fitted at the air inlet of each cylinder; ECU proceeds with by-cylinder separate injection or by-group injection; gasoline is directly injected duly in front of air inlet of respective cylinder, which is then fed into the cylinder together with air, consequently forming the gas mixture. It is generally accepted fuel injection pattern at present.
TECH0 05	电控燃油喷射	**E**lectronic **F**uel **I**njection	Various sensors are used to gather the parametric signals characterizing engine operating modes; through computation, analysis, and comparison, ECU exercises precision control over the injection quantity needed under each engine mode, thus assuring satisfactory power performance, economics and emission performance of engine. By now, it is already extensively employed on both local and foreign vehicles.

附录 B 变速器与驱动型式说明

变速器

中文名称	英文名称	特点
手动档变速器	ManualTransmission	用手拨动变速杆改变变速器内的齿轮啮合位置，改变传动比，从而达到变速的目的。
自动档变速器	Automatic Transmission	此处 AT 特指液力自动变速器，是由液力变扭器、行星齿轮和液压操纵系统组成，通过液力传递和齿轮组合的方式来达到变速变矩。
机械式自动变速器	Automated Mechanical Transmission	在普通手动变速器的基础上，加装电子控制装置和液压系统管理离合器和换档过程，使驾驶员在不操作离合器的情况下实现手动或自动换档。
无级变速器	ContinuouslyVariableTransmission	与其他形式变速器（MT、AT 等）相比，CVT 的最大特点是其传动比不是间断的点（如、6、7、8），而是连续变化的值（如从 6 一直到 7）。
双离合变速器	Dual Clutch Transmission	DCT 除了拥有手动变速器的灵活性及自动变速器的舒适性外，还能提供无间断的动力输出。

驱动型式

中文名称	英文名称	特点
前轮驱动	Front Wheel Drive	四轮汽车按照驱动轮的数量分为两轮驱动（有且只有两个驱动轮）与四轮驱动（四轮均可驱动），其中发动机只驱动一对前轮的动力分配方式称为前轮驱动，只驱动后轮称为后轮驱动。
后轮驱动	Rear Wheel Drive	
全时全轮驱动	All Wheel Drive	即指汽车在行驶的任何时间，四个车轮都分配有驱动力的驱动方式。

Exhibit B Description of Transmission and Type of Drive model

Transmission

Title in Chinese	Title in English	Characteristics
手动档变速器	**M**anual **T**ransmission	By manually shifting the gear level, alter the gear engagement position of the transmission, thus changing the drive ratio and reaching the goal of gear shifting.
自动档变速器	**A**utomatic **T**ransmission	Here, AT specially refers to hydraulic AT, consisting of hydraulic torque converter, planetary gear and hydraulic control system. Speed and torque are changed via hydraulic transfer and gear combination.
机械式自动变速器	**A**utomated **M**echanical **T**ransmission	Based on common MT, electronic control unit and hydraulic system are added to managing clutch and gear-shifting process, such that automated or manual gear-shifting could be realized without driver's manipulation of clutch.
无级变速器	**C**ontinuously **V**ariable **T**ransmission	As compared to other transmission types (MT, AT), CVT's biggest feature lies in that its drive ratio is not represented by intermittent point (e.g., 6, 7, 8), both continuously varying value (e.g., from 6 to 7).
双离合变速器	**D**ual **C**lutch **T**ransmission	In addition to the flexibility of MT and comfort of AT, DCT may provide uninterrupted power output.

Type of drive model

<table>
<tr><th>Title in Chinese</th><th>Title in English</th><th>Characteristics</th></tr>
<tr><td>前轮驱动</td><td>Front Wheel Drive</td><td rowspan="2">Based on quantity of driving wheels, four-wheel motor vehicles are classified into two-wheel drive (having two and only two driven wheels) and four-wheel drive (having four driving wheels)' concretely, Front-wheel drive means the engine drives the pair of Front wheels only, while rear-wheel drive means only the rear two wheels are driven.</td></tr>
<tr><td>后轮驱动</td><td>Rear Wheel Drive</td></tr>
<tr><td>全时全轮驱动</td><td>All Wheel Drive</td><td>A type of drive model by which, at any time point during vehicle travel, all the four wheels are distributed with tractive force.</td></tr>
</table>