Development of Engineering Competencies in Brazil and Innovation Policies, an Overview of the Automotive Sector

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Abstract. As consequence of the economic growth, it is observed the increase of the demand for engineering professionals. The problem of scarcity of engineering manpower is being faced as one of the main obstacles to the continuity of the Brazilian economic growth. The natural demands of infrastructure and industry allied to the fact that engineers are also recruited to occupy non-engineering positions constitute, themselves, already a difficult equation to solve. Besides, along the years, the Brazilian's scientific production in the engineering field has demonstrated to be very shy. Such combination, either in macro or in micro-economy, reflects in the innovation and competitiveness. The objective of this research is to discuss actions to create engineering competencies in micro-economy that could attenuate those structural problems. Additionally, this work aims having an overview of those actions combined with the new regulatory policy for the automotive sector announced in April/12, which integrates the program "Inovar-Auto".

Keywords: lack of engineers, engineering competence creation, Brazilian innovation programs, competitiveness in the automotive sector

1 Introduction

Recently, concerns about the scarcity of engineering manpower in Brazil became object of researches as per Gusso and Nascimento [1] and Nascimento et al [2].

World indicators of education appoint that in Brazil less than 5% of the graduates come from engineering areas, which seems to be a very low figure, while, OCDE members, in average, 12% of its graduates come from this field. Moreover, countries like South Korea have 23% of its graduates in engineering; Japan has 19% and Russian Federation 18% [3].

Nowadays, the country contributes with around 2% of the world's scientific production [4] and, more specifically, in the engineering subject area, the Brazilian scientific production shows to be very shy, with a number of publications around 2300 documents (Table 1), far behind countries like the USA with around 45000 documents, Japan with 14000, South Korea with 9000 and other BRIC countries:

India with 6000, Russian Federation with 3500 and the impressive number of 63000 from China [5].

Table 1. Top 20 World Scientific Production – Year 2010 – Subject Area: Engineering. Adapted from [5]

Ranking	Country	Documents	Citable documents	Citations	Self-Citations	Citations per Document	H index
1	China	63361	62857	26110	18570	0,4	157,0
2	United States	44983	42787	40246	22501	0,9	448,0
3	Japan	13716	13382	7073	3516	0,5	181,0
4	Germany	10270	9821	9126	3920	0,9	197,0
5	United Kingdom	9956	9348	9342	3621	0,9	221,0
6	South Korea	8733	8550	6657	2635	0,8	129,0
7	France	8233	7944	7221	3019	0,9	180,0
8	Canada	7452	7174	6527	2186	0,9	180,0
9	Taiwan	6666	6501	4882	2143	0,7	123,0
10	Italy	6457	6188	5803	2393	0,9	160,0
11	India	6065	5887	4316	1826	0,7	115,0
12	Spain	5003	4833	4992	2133	1,0	127,0
13	Australia	4220	4015	4235	1449	1,0	137,0
14	Iran	3916	3819	3737	2018	1,0	63,0
15	Russian Federation	3540	3498	1102	506	0,3	85,0
16	Netherlands	3021	2888	4121	1294	1,4	153,0
17	Poland	2588	2517	1153	540	0,5	75,0
18	Turkey	2480	2397	1986	772	0,8	83,0
19	Singapore	2430	2354	3291	1036	1,4	122,0
20	Brazil	2355	2298	1444	577	0,61	90

A wealth of a nation is determined by its internal productiveness, but, principally through its own capacity to create value, besides of the resources available to be applied. So forth, the growth of a country is no longer sustainable while prevail poor or inexistent policies oriented to the productivity. In other terms, a country should prosper if its people have the right and updated capabilities and skills that enable determined specializations, therefore wealth and growth will be limited concomitantly if skills are merely for some [6].

The surplus of US$ 29.8 billion of the Brazilian Trade Balance in 2011, indicates a figure 47.9% higher than 2010 [7], but, a deep analysis shows that 63% of the country exports structure has been based in Food (31%), Agricultural raw material (4%), Fuels (10%), Ores and Metals (18%); whilst Manufactures represents the rest 37% [8], indication that the nation is losing its competitiveness, once in the year 2000, Manufactures represented 58% of the country's exports structure [8].

Regarding the Automotive sector, in global perspective, Brazil has already secured its position as one of the main players, through an internal market over 3.6 million units and internal production over 3.4 million units, in 2011 [9]. For the internal economy, the sector has expressive importance with nearly 20% share in Industrial GDP [10].

However, in deeper investigation, it is possible to find out that the Brazilian automotive industry competitiveness has been based in premises of weak economic pillars. First, the national production is substantially dependent of the internal market, circa 2.7 million units, which represents 81% of the production share [9]. Second, the imports increased in one year from 18.8% to 23.6% of the market share [9]. Third, the Brazilian trade balance, positive between the years 2002 and 2007, dropped from US$5251 in 2005 to US$(5404) million in 2010 [10]. Finally, the market share of vehicles with engines over 1000cm3, which means, vehicles with higher added value than the ones that the market has been based, have increased contemporarily with the market share of the imports [9].

The consequences of the loss of competitiveness can be observed in the Figure 1, which presents a modest increase in production during the period of 2007 to 2011, compared to other BRIC countries, for instance, China and India. That reflected in the position that Brazil historically has occupied as the 6th major world vehicles producer.

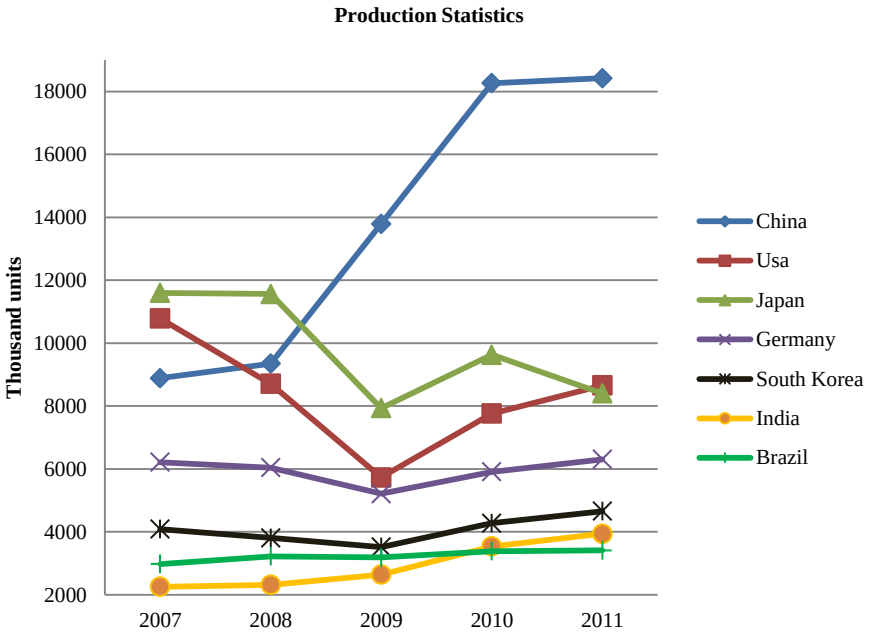

Fig. 1. Countries Vehicles Production Statistics. Adapted from [11]

2 Objectives

The objective of this research is to present actions oriented to create engineering competencies in micro-economic perspective, face to the present structural scenario. Furthermore, this work aims the combination of such actions with the new regulatory policy announced for the automotive industry, through the program "Inovar-Auto", valid to the period between 2013 – 2017 and that integrates the program "Brasil Maior", which seeks social and economic growth across the mobilization of the productive forces and industrials, focusing the innovation and the competitiveness of the country, both to the internal and to the external markets, through the establishment of a set of industrial, technological, trade and services policies.

3 Methodology

The methodology applied for this research is based in bibliographic review, based upon data of the Brazilian automotive sector, that have been obtained through the ANFAVEA annual report (National Association of Auto-motor Vehicles Producer), across the world development indicators - World Bank 2012 , global education figures of 2010 - OCDE (Organization for Economic Co-operation and Development), IPEA (Institute of Applied Economic Research) publications regarding engineering

resources in Brazil - 2010 and 2011, ranking of global scientific production and scientific production in the area of knowledge engineering - SJR (SCImago Journal & Country Rank, by drawing a parallel with other bibliographic references.
In addition, it focuses the analysis and comprehension of program "Inovar-Auto", identifying and determining opportunities for engineering competence creation.
All of this in order to create subsidies that demonstrate the importance to develop engineering competencies, mandatory to foment innovation through researches & developments, innovation one that, enables to create value and differentiation of the country goods.
Notwithstanding, the definition of a model, proper to enlarge the development of the human capital and competencies, based, for example, in Asian nations, which have supported the rapid growth that have allowed the technological development for innovation [12].

4 Results and Discussion

The numbers of the Brazilian automotive industry in the first months of 2012 demonstrate that the model of concentration of its production to supply the internal market is achieving its limit. The number of vehicles produced in Brazil in the period January to May - 2012 is 9.5% lower compared to the same period of 2011, 5.9% lower compared to 2010 and 7.9% lower, when compared with 2008 (Table 2). In fact, the numbers of automobiles produced at this period, surpass only the production achieved in the year 2009, time when the automotive sector experienced the collapse and major automakers like GM and Ford had to go through restructure and very few countries like China and India (Figure 1) had growth in this industry.

Table 2. Vehicles Production in Brazil from January to May – years 2008 to 2012. Adapted from [12], [13] [14], [15].

Period	Vehicles Production				
	JAN	**FEB**	**MAR**	**APR**	**MAY**
2008	255,2	254,0	283,7	302,5	293,9
2009	184,9	204,4	275,1	253,9	269,5
2010	233,4	236,6	318	274,8	297,3
2011	238,9	294,6	295,1	282	304,2
2012	211,8	217,8	308,5	260,8	280,8

The strength that allowed the country attenuating the effects of the world economic crisis initiated in 2008 is no longer a fruitful strategy. The internal market sales of the period January to May (Table 3) dropped down to volumes even lower than the ones observed in the first months of 2009 when the country has faced the effects of the world crisis.

Table 3. Brazilian Internal Market – Vehicle Sales from Jan to May -years 2008 to 2012. Adapted from [13], [14], [15], [16].

Period	Sales Volume / Internal Market				
	JAN	**FEB**	**MAR**	**APR**	**MAY**
2008	215,0	200,8	232,1	261,2	242,0
2009	197,5	199,4	271,4	234,4	247,0
2010	170,3	180,5	295,6	228,1	206,1
2011	187,3	212,2	243,8	225,1	243,8
2012	200,4	188,3	229,7	199,5	223,8

Moreover, along the years the country did not take the necessary actions to improve its infrastructure, especially the ones with positive impacts over logistics of transportation of goods. Similar inertness can be observed in the internal bureaucracy, so forth, in the amount and in the burden of the taxes that still prevail.

Labor costs, as well as, other direct and indirect costs have increased tremendously. On the other hand, the level of skills, competencies, such as the efficiency have not grown in same levels.

Face to the presented scenario of loss of competitiveness and lack of skilled and competent resources, authorities decided to create the program "Brasil Maior", a set of policies that focus the competitiveness, productivity of the country industry, by supporting and encouraging the increment of the technology of the processes and value chain, all of this, in order to create a proper scenario for investments and for the innovation [17].

In respect to the automotive sector, dedicated attention has been observed, the program "Inovar-Auto", a part of the program "Brasil Maior", provides incentives to the technological innovation and the densification of vehicles productive chain to the period between 2013 and 2017. The aim is to support the technological development, the innovation, the safety, the environmental protection, the efficiency and the quality of automobiles, trucks, busses and auto-parts locally produced. Companies already installed and producing in the country, such as companies that have plans approved to install production plants in the Brazil may take advantage, from January/13, of IPI deduction (VAT over industrial production) based on quarterly outlays made in the country in: researches; technological developments; innovation; strategic inputs; tooling and qualification of suppliers [18].

The technological capacity of a nation is a cluster of abilities, experiences and efforts, allowing companies take benefit and, from this capacity, improving and creating new technologies [12].

By electing strategic areas, Brazilian authorities seek to boost the innovation and R&D initiatives to increment the country competitiveness. Tax reliefs may contribute and force competence creation in micro-economy.

To develop a learning process, the studies appoint to a model based on competence development, as per Kim [12] [19] and Ulrich [21].

According to the model, Knowledge initiates from the Cognitive Perception (Know-what), which is the base knowledge obtained through education and schooling. Despite the fact that this is a pivotal knowledge, other, more advanced ones are required for competitive advantage [21]. That is the kind of knowledge that a nation, at least, should care about.

Advanced Skills (Know-how) are necessary for any productive activity; it is the ability to turn knowledge into practice, the capacity of applying learned disciplines in real and complex problems [12], [19], [21].

Finally, the Systemic Comprehension (Know-why) is the inclination of understanding the principles of a technology. It is the most advanced knowledge that allows professionals thinking beyond the execution, pro-acting in cause-effect analysis [12], [19], [21].

The tax benefits shall contribute to develop competencies, even in face of a scarcity of engineering human resources, they could have important role, and their own history can determine technological efforts across its objectives [19].

The nation can adapt the model adopted in South Korea, that thru its industries, individuals have developed the necessary technological skills [19].

Although individual enterprises are one of the keys for the technological activity, the capacity of a nation is more than a sum its companies' skills and competencies, in individual perspective. It comprehends extra-market systems of networks and the relation between companies, the way of do business and the presence of development institutions [12].

Companies shall handle competencies through methods of competence analysis and management, defining own criteria and steps to achieve know-how / know-why levels.

In any case, technology shall not be obtained uniquely through a radical R&D, the learning process can be developed adjacently to reverse engineering, imitation, licenses, cooperation agreements [19], [20].

The example of innovation of Japan should also be a reference, since, there, the competence is obtained through innovation, incrementally, so that an innovation becomes subsidy to the next [19], [22], [23].

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