

A Macro Sectorial Study of Semiconductor Production

Antônio Brejão, Marcos Morais, Oduvaldo Vendrametto

► **To cite this version:**

Antônio Brejão, Marcos Morais, Oduvaldo Vendrametto. A Macro Sectorial Study of Semiconductor Production. Bernard Grabot; Bruno Vallespir; Samuel Gomes; Abdelaziz Bouras; Dimitris Kirit-sis. IFIP International Conference on Advances in Production Management Systems (APMS), Sep 2014, Ajaccio, France. Springer, IFIP Advances in Information and Communication Technology, AICT-440 (Part III), pp.513-520, 2014, Advances in Production Management Systems. Innovative and Knowledge-Based Production Management in a Global-Local World. <10.1007/978-3-662-44733-8_64>. <hal-01387315>

HAL Id: hal-01387315

<https://hal.inria.fr/hal-01387315>

Submitted on 25 Oct 2016

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



A macro sectorial study of semiconductor production

Antonio Sérgio Brejão¹, Marcos de Oliveira Morais¹, Oduvaldo Vendrametto¹

¹ Paulista University-UNIP, Postgraduate Studies Program in Production Engineering,
Dr. Bacelar St. 1212, São Paulo, Brazil

{Antonio Sérgio Brejão - prof.sergiobrejao@uol.com.br}

Abstract. The increasing demand of electronic components has expanded business and investment in research. Noteworthy is the development of materials, specifically semiconductors. This study analyzes the macro sector of semiconductor production and the cyclical growth prospects of international trade and investment in this sector. Through a quantitative exploratory study it was possible to identify in the cyclical context the recent insertion of Brazil in the semiconductor production scenario with a growing view in the industry.

Keywords: Production of Semiconductors, Electronic Components, International Trade.

1 Introduction

The conjunctural issues in the semiconductor manufacturing industry can give the companies opportunities of being more competitive. To be competitive, the company requires planning, research, development of new manufacturing processes, primarily in technology, skilled labor, efficiency, profitability, and investment. In Brazil, new production models, macroeconomic policies and the growth of technologies are making the electronic industries more specialized, thus increasing the value added to the product and/or process. The increase in these processes and projects that are improved, well-defined and strategically productive can provide a higher competitive advantage to the country.

Global economies are leading the productive semiconductor industry with significant production, sales and employment generation. These economies have previously defined strategies for all production processes, making them more competitive.

2 Methodology

The approach will be the quantitative exploratory research with cyclical and macro sectorial analysis of import, export, production and national and international investments in the semiconductor industry.

3 Theoretical Framework

3.1 Processes of semiconductor production

The semiconductor fabrication begins with the production of wafers, namely a thin, round slice of a semiconductor material ranging in size from 152.4 mm to 304.8 mm in diameter. The finished wafer is approximately 15mm thick. After the production of wafers, integrated circuits that generate microprocessors and chips are assembled [1; 14].

3.2 Semiconductor production in Brazil

Brazilian Company of Semiconductors - CBS was supported by the government through the Program of Technological Development Support for the Semiconductor Industry - PADIS. The unit installed in Minas Gerais was formed with capital from German companies and Brazilian Bank for Economic and Social Development - BNDES. The company will manufacture electronic integrated circuits assembled, unassembled or in the form of discs (wafers) that have not been cut into chips yet. Incentives for semiconductor plants are a priority of the new industrial policy of the country. Upon qualification, CBS will produce circuits with tax exemptions, and incentives will expire in 2022 [2].

Brazilian government's strategic option for a sustainable development model focused on industry competitiveness was consolidated through the Greater Brazil Plan - PBM. Such plan encourages the productive sector in its efforts to technological development and innovation, including mechanisms to support business expenditure on research and development. The support includes financial, tax and regulatory instruments to encourage investments [3].

In 2005 the activity in the chip design center was started at the National Center for Advanced Electronic Technology - CEITEC, with the announcement of CI-Brazil program to support the design of commercial chips in the country. In 2008, federal authorization for the institutionalization of a public company in semiconductors, named CEITEC, was conferred by Federal Law N° 11759/2008, and such company was operated judicially in the year 2009 in order to encompass the previous operations of the Center Design of CEITEC [4].

CEITEC is a public company linked to the Ministry of Science, Technology and Innovation - MCTI that operates in the semiconductor industry by developing solutions for automatic identification (Radio Frequency Identification and smartcards) and specific applications [5]. As an extension of the PBM, law N° 11484 was approved in 2007, granting incentives to industries of digital TV equipment and semiconductor electronic components and rules on the intellectual property protection of topographies of integrated circuits, thus instituting PADIS, whose purpose is to support technology development for the semiconductor industry in Brazil [6].

Also in this context, the Federal Revenue of Brazil – RFB, by Normative Instruction N° 852, dated June 13, 2008, established procedures to authorize the Program of

Technological Development Support for the Semiconductor Industry in the country (PADIS) [7].

3.3 Brazilian foreign trade

According to Foundation for Research Support of the State of Sao Paulo - FAPESP magazine, the country exports metallurgical silicon at US\$ 2/kg. After purified abroad, the silicon is transformed into sheets used in the manufacture of semiconductors or photovoltaic cells, and the cost in that stage ranges between US\$ 50 and US\$ 1,000, depending on the purity and crystallinity [8].

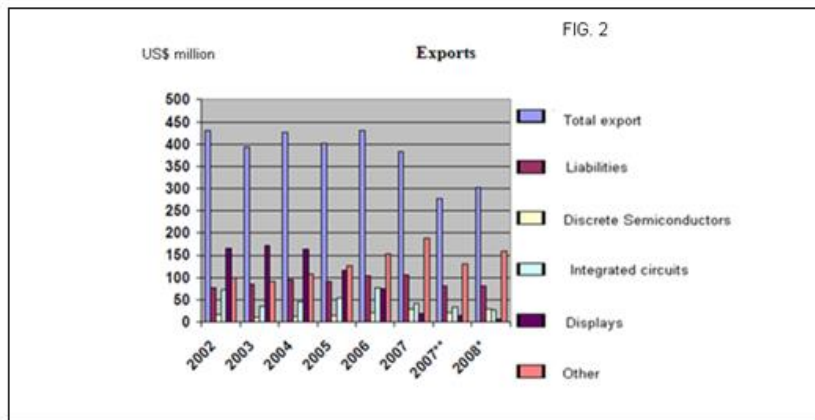
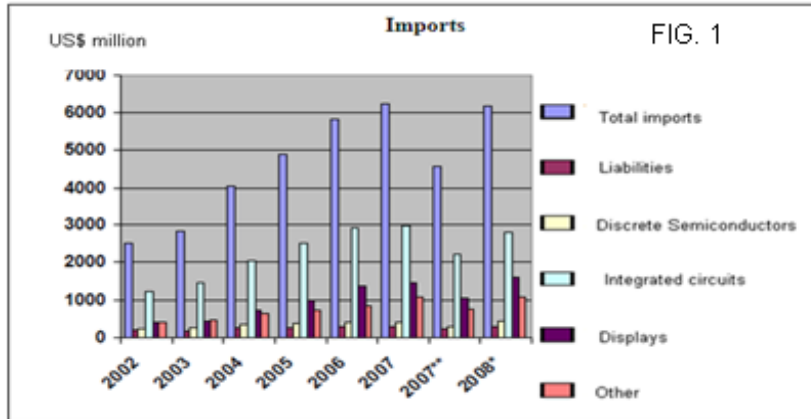
According to Brazilian Association of Electrical and Electronics Industry - ABINEE, the trade balance of the appliances and electronics sector in the period from January to November 2013 showed the following results: exports of US\$ 6.69 billion and imports of US\$ 40.48 billion, thus generating a deficit of US\$ 33.79 billion in the trade balance of electronics products. This result was 11% higher than the occurred in the same period in 2012 (US\$ 30.35 billion) [9].

3.3.1 Imports and Exports

For CBS the rate of import duty levied on imported goods was reduced to zero for products such as machinery, apparatus, tools, equipment, computer tools - software for incorporation into their fixed assets, intended for tunneling activities and testing of electronic semiconductor devices [2].

Imports of electrical and electronic components totaled US\$ 2.0 billion, being 14.7% higher than those occurring in November 2012, highlighting the components for telecommunications and semiconductors, which together totaled almost US\$ 1 billion [10]. The three most imported items in such industry were: components for telecommunications (US\$ 6.2 billion); semiconductors (US\$ 4.9 billion) and computer components (US\$ 3.0 billion) [10].

The Trade Balance of the components segment for the period 2002-2008 (Figures 1 and 2) had a small participation in the import and export of semiconductors and, in accordance with the BNDES, imports of discrete semiconductors (diodes, transistors, photodetectors and photoemitters) reached US\$ 423.1 million and exports totaled US\$ 29.6 million data is from September 2008 [4].



* until September 2008 ** until September 2007

Fig. 1 and Fig. 2 Adapted from Trade Balance of Components Segment Secex Aggregation BNDES [4]

3.3.2 International trade

The Semiconductor Industry Association - SIA, representing U.S. leadership in semiconductor manufacture and design, announced that worldwide semiconductor sales in 2013 reached \$ 305.6 billion, the highest annual total ever in the industry, and an increase of 4.8% in relation to the 2012 total of \$ 291.6 billion. Global sales in December 2013 totaled \$ 26.6 billion, marking the strongest amount recorded in December, while December sales in the Americas increased 17.3% compared to the same period of the previous year [11; 12].

A research conducted by KPMG U.S. indicated that, worldwide, the semiconductor market is extremely relevant, reaching a turnover of US\$ 295 billion in 2010, against US\$ 220 billion in 2009, and that the segment generates 200,000 jobs, according to the SIA [13]. Worldwide, some companies lead the semiconductor production as presented in (Table 1) in the biennium 2007/2008.

Table 1. Ranking of the top three semiconductor companies

Ranking 2007/08	Companies	Sales 2007 (US\$ Bi)	Sales 2008 (US\$ Bi)
1	INTEL	33.9	34.1
2	SAMSUNG	19.7	17.9
3	TEXAS INSTRUMENTS	12.3	11.5

Source: Adapted from BNDES - iSuppli, 2008 [4].

In Figure 3, BNDES presents a more updated scenario that shows a reduction of global semiconductor production between 2008 and 2011. With respect to investments in the semiconductor industry in the period of 2008-2011 (Figure 4), it is presented a sharp decline with signs of recovery in 2011.

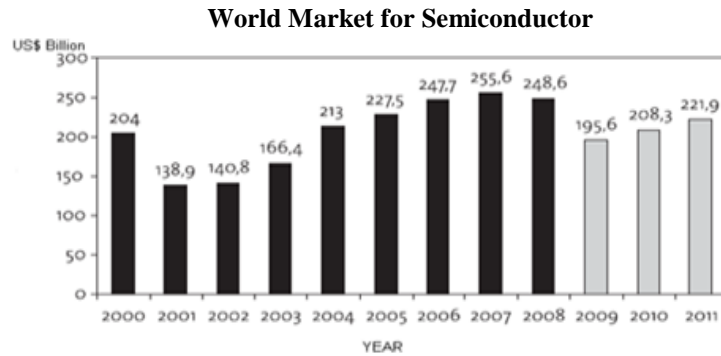


Fig. 3 World Market for Semiconductors (Adapted from BNDES *apud* SAI) [15]

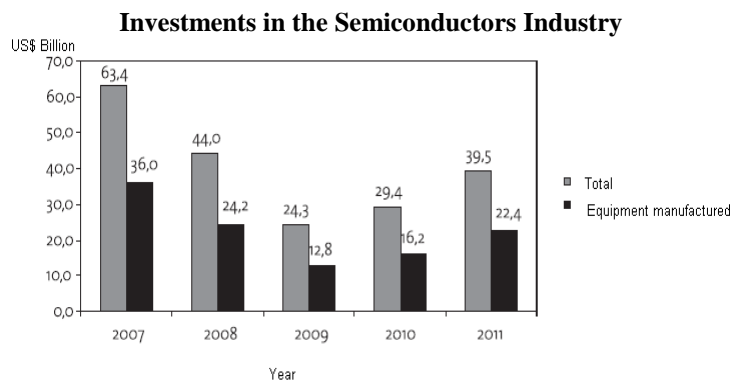


Fig. 4 Investments in the sector (Adapted from BNDES *apud* Gamerd; Fabtech) [15]

4 Results and Discussion

In Brazil, implementation processes for semiconductor production occurred in 2005, with the creation of CEITEC and, subsequently, various legal and tax incentives were adopted for the development of semiconductor and hence the creation of new businesses. On the national scenario of companies in the electronics industry subsystem, imports of semiconductors in 2013 grew 10% compared to 2012 with increasing trend.

There was a significant deficit in the trade balance of Brazil in the field of appliances and electronics, which includes semiconductors. Even so, discreetly, Brazil entered the international scenario of semiconductors export. The research shows the importance of the development of semiconductors with an increasing demand in many countries of the world and that, in 2013, the highest sales of semiconductors was recorded, in the order of 4.8%, according to ABINEE [10]. Semiconductors are among the most imported products in Brazil, with a variation of 10% in the period of 2012/2013. In 2007/2008, the sector had an important sales scenario, where in (Table 1) it is possible to see that the ranking of the three largest companies in US\$ billions is positive for the leader.

Despite of the growing sales trend, it is observed that the development of the sector in Brazil needs more technical/commercial diversification to add value to the primary product, which is a relevant question to make the national semiconductor industry more competitive.

In Brazil, the use of semiconductors is growing proportionally to the production of appliances and electronics, and the country is an exporter of primary raw material (silicon) for the production of semiconductors. According to the macro sectorial scenario, it is observed that with R&D investment the domestic industry will add value to the input manufacture process, making it more competitive and less dependent on imports. In the context of technological innovation, it is important to highlight the need of research and development of alternative materials for the production of semiconductor, such as niobium, since Brazil is the largest global producer, with a share of 96% of the market [16]. Brazil exports silicon, which is the main component for the production of semiconductors, which after purification and processing abroad return to the country as finished product, with a much higher aggregate cost, making obvious the need for investments in the sector. However, such export does not bring great benefits to the country because the added value is low, with the trading of product at US\$ 2.0/Kg, while after processing abroad it can cost around US\$ 1000, depending on the degree of purity, thus obtaining an expressive and attractive market value.

Although speculatively, it is necessary to mention that researches on the quantum computer are growing worldwide. If feasible, the conversion of physical principles into technological equipment with properties where the transistors are not used will have a strong impact on the semiconductor industry, reason why the participants of the semiconductor chain must pay attention to the evolution of the quantum computer research.

5 Conclusion

As noted in the article, it is a sector in full development. Additionally to investments in technology, the issue of qualification of the workforce should be considered in a broader and strategic project for the country.

Upon the growing demand, companies in the electronics sector have been seeking for new technologies and new processes in order to meet their productive and economic needs. Strategies should be defined for optimized production processes and public/private investments, thus generating greater competitiveness. National companies will be more competitive if they start using well-defined strategies developed by the R&D sector of the government and organizations that facilitate investment to meet the demand.

It is observed that there is a structured and measured design over the years for such process, allowing for a guaranteed repeatability, thus favoring the industry. In the macro sectorial environment, the semiconductor industry is booming with a strong tendency to adjust alternative materials.

References

1. Companhia Brasileira de Semicondutores: Caracterização do Empreendimento (Feb 2011), Available at: <http://www.semad.mg.gov.br/images/stories/Robson/Velhas2011/9.1-cia-semicondutores-pu.pdf> Accessed on: Feb 20, 2014.
2. Sociedade Brasileira de Microeletrônica: Companhia Brasileira de Semicondutores terá incentivos até 2022 (Feb 2014), Available at: <http://www.sbmicro.org.br/index.php?option=content&task=view&id=218&Itemid=2> Accessed on: Feb 28, 2014.
3. Brasil Maior: Agendas Estratégicas Setoriais (Apr 2013), Available at: <http://www.brasilmaior.mdic.gov.br/images/data/201304/d874d3cddb3a7e5d9cf32a28a3b083b0.pdf> Accessed on: Mar 12, 2014.
4. BAMPI, S. (Coord.) Perspectivas do investimento em eletrônica. Rio de Janeiro: UFRJ, Instituto de Economia, 2008/2009. 272 p. Relatório integrante da pesquisa. "Perspectivas do Investimento no Brasil", em parceria com o Instituto de Economia da UNICAMP, financiada pelo BNDES <http://www.projetopib.org/?p=documentos> (Oct 2009). / projeto PIB e Perspectivas do Investimento no Brasil, Available at: http://www.bndes.gov.br/SiteBNDES/export/sites/default/bndes_pt/Galerias/Arquivos/empresa/pesquisa/pib/pib_eletronica.pdf Accessed on: Mar 07, 2014.

5. Diário Oficial da União: (Nov 2008), Available at: http://www.ceitec-sa.com/assets/documentos/aceso_informacao/Decreto_6638_de_07112008_e_Estatuto_Social.pdf Accessed on: Feb 28, 2014.
6. Brasil: Lei nº 11.484, de 31 de maio de 2007, Do Apoio ao Desenvolvimento Tecnológico da Indústria de Semicondutores, Available at: http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2007/lei/11484.htm Accessed on: Feb 28, 2014.
7. Brasil: Instrução Normativa RFB nº 852, de 13 de junho de 2008, Programa de Apoio ao Desenvolvimento Tecnológico da Indústria de Semicondutores (Padis), Available at: <http://www.receita.fazenda.gov.br/Legislacao/Ins/2008/in8522008.htm> Accessed on: Feb 28, 2014.
8. FAPESP: Silício brasileiro para células solares Edição 197 (Jul 2012), Available at: <http://revistapesquisa.fapesp.br/2012/07/16/silicio-brasileiro-para-celulas-solares/> Accessed on: Feb 13, 2014.
9. ABINEE – Associação Brasileira da Indústria Elétrica e Eletrônica: Balança Comercial, (Jan/Feb 2014), Available at: <http://www.abinee.org.br/abinee/decon/decon14.htm> Accessed on: Mar 06, 2014.
10. ABINEE – Associação Brasileira da Indústria Elétrica e Eletrônica: Balança Comercial: do comércio exterior brasileiro (Jan/Feb 2014), Available at: <http://www.abinee.org.br/abinee/decon/decon10.htm> Accessed on: Feb 20, 2014.
11. Diário Comércio Indústria & Serviços: Setor de semicondutores apresenta vendas recordes em 2013 (Feb 2014), Available at: <http://www.dci.com.br/pr-newswire/setor-de-semicondutores-apresenta-vendas-recordes-em-2013-id382545.html> Accessed on: Feb 20, 2014.
12. PRNewswire: Semiconductor Industry Posts Record Sales in 2013 (Feb 2014), Available at: <http://www.prnewswire.com/news-releases/semiconductor-industry-posts-record-sales-in-2013-243300871.html> Accessed on: Feb 20, 2014.
13. KPMG: Enquanto Brasil tenta inserção, mercado de semicondutores (Oct 2011), Available at: http://www.kpmg.com/br/pt/estudos_analises/artigosepublicacoes/paginas/release-mercado-de-semicondutores.aspx Accessed on: Feb 20, 2014.
14. Pereira, A.L.: O que são wafers? (May 2012), Available at: <http://www.tecmundo.com.br/o-que-e/23660-o-que-sao-wafers-.htm#ixzz2tgGsIZ5g>. Accessed on: Feb 18, 2014.
15. Gutierrez, R.M.V., Mendes, L.R.: Complexo eletrônico: o projeto em microeletrônica no Brasil (Jul 2010), Available at: http://www.bndes.gov.br/SiteBNDES/export/sites/default/bndes_pt/Galerias/Arquivos/conhecimento/bnset/set3004.pdf Accessed on: Mar 31, 2014.
16. Instituto Brasileiro de Mineração: Nióbio (Apr 2014), Available at: <http://www.ibram.org.br/sites/1300/1382/00000042.pdf>. Accessed on: Apr 15, 2014.