OPHTHALMIC-OPTICAL FOREIGN SECTOR AND POLICY IMPLICATIONS

BARRERA, Margarita[1]
MAINAR, Alfredo[2]
VALLÉS, José[3]

Abstract

The aim of this paper is to analyse how the ease of manufacturing a product may influence the evolution of exports of specific products in the Spanish economy. This research focuses on the analysis of the international trade of ophthalmic-optical products to ascertain how the so-called complexity index may determine the strength of international competition. More specifically, the foreign sector, in terms of products and countries, is studied for the period 1978 to 2014. Results demonstrate that specialization in products of low complexity is a determining factor for the lack of success of this type of product in international competition.

JEL Codes: F14: Empirical Studies of Trade; L52: Industrial Policy, Sectorial Planning Methods;

Keywords: International trade, Optics, Economic complexity

1. Introduction

The aim of this work is to determine the structure of Spanish ophthalmic-optical exports and to ascertain whether its capacity to widen the scope of the foreign market is optimal. To this end, international trade flows in terms of products are analysed for the period from 1978 to 2014. Analysis by product enables the complexity level of exports to be compared based on the product complexity index (PCI).

Product complexity is understood as the power of a product to maintain its comparative advantage in the global frame. The PCI[4] is calculated through the range of countries manufacturing that particular product (Hausman et al., 2011). The first work to directly address the concept of economic complexity (EC), in the sense to which we refer, is that of Hidalgo et al. (2007), which is based on the idea of the ability of a country to produce a specific product that is dependent on the production of other products and on the production in neighbour countries. This concept relies on

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[1] Margarita BARRERA LOZANO, Department of Applied Economics III. University of Seville. E-mail: mbarrera3@us.es

[2] Alfredo MAINAR CAUSAPÉ. European Commission. Joint Research Centre - Institute of Prospective Technological Studies.

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[3] José VALLÉS FERRER, Department of Applied Economics III. University of Seville.

[4] The Product Complexity Index (PCI) classifies products according to the knowledge necessary for their manufacture which can be translated into the diversity of countries producing specific products and the

$$\tilde{M}_{p,p'}^{P} \equiv \sum_{c} \frac{M_{cp} M_{cp}'}{k_{c,0} k_{c,0}}$$

scope of products manufactured in each country. (The atlas of economic complexity, 2015)

indicators developed from the original comparative advantage concept presented by Balassa (1986).

Economic Complexity is constructed within the framework of a multitude of indicators from among which the economic complexity index (ECI) and the product complexity index (PCI) stand out. The former has been used as an indicator of economic development, in the form of the diversity of products included in the basket of exports of a specific country, which is related to the possibility of achieving sustained economic growth (Hidalgo & Hausmann, 2009). The same concept has been complemented by Cheng et al. (2013), whereby they subtract what they call a "hidden network" from the ECI, in order to build a capacity model to classify countries in terms of their level of development. The ECI has also been used by Hollander et al. (2012), who conclude that economies with a high level of economic complexity demonstrate superior behaviour in terms of production. The latter, PCI, has been implemented to study the diversification of food products in Africa, and it has been found that non-complex product exports decrease the total value of exports (Yaméogo, Nabassaga, & Ncube, 2014). The last conclusion follows those of Bournakis (2014), who recommend international competence strategies be supported by the economic complexity concept.

Issues concerning optical products have been studied by Aikens (2012) in relation to existing standards in this specific field, and by Friersch and Grupp (2006), who analyse optical technology adoption and diffusion processes, both within the international economic framework. Here, the use of PCI is proposed as a suitable indicator for the analysis of the exportation structure of certain optical products, in particular ophthalmic-optical products, with the aim of boosting international competitiveness in this field.

This work proposes ophthalmic-optical PCI values as a benchmark for the analysis of the evolution and structure of ophthalmic-optical exports in the Spanish economy, to allow in-depth distinctions of their weaknesses to be realised and therefore to enable these weaknesses to be tackled. This analysis is innovative not only by way of its field of application and the shortage of studies on the economic implications of visual corrective products, but also in its use of PCI, whose demonstrated utility can be deduced from previous references.

This work is divided into the following sections: Section 1, introduction of the complexity concept and justification of the development of the analysis; Section 2, determination of the main sources in the sphere of optics and EC values; Section 3, analysis of export flows of ophthalmic-optical products; and Section 4, discussion of the results and presentation of the main conclusions.

2. Ophthalmic optics by product: Sources and indicators.

The high specificity of products referred to in this work presents a disadvantage in accessing data due to the disaggregation needed. The first mention of export data in ophthalmic optics corresponds to the late seventies, available in Pita-Salorio (1981). The most recent data can be found though databases, such as Estacom (ICEX, 2015) and Comtrade (UN, 2015), both of which are accessed, for the analysis by country in the most recent years and for the analysis by product for the period from 1989 to 2014.

In regards to PCI, two levels of complexity are found. These can be classified into lenses, frames, and sunglasses, according to "The atlas of economic complexity" (2015).

Table 1. Product complexity for Spanish optical products in 2013

Code	Commodity description	Rank 1995	Rank 2013	PCI 1995	PCI 2013	C.G. 1995	C.G. 2013
9001	Optical fibres	422	267	2.11	2.48	47	17
9003	Frames and mountings for spectacles, goggles, or the like	291	261	2.73	2.50	7	-39
9004	Spectacles, goggles, corrective, protective	593	714	1.34	0.69	3	-314

Source: The atlas of economic complexity (2015). Code based on Harmonised System (HS): 9001 includes ophthalmic and contact lenses, among others; 9003: frames; 9004 spectacles and similar, includes sunglasses. PCI: Product complexity index. C.G: complexity gain.

Complexity indices for 1995 and 2013 are shown in Table 1. The only product that improves the indicator is that of lenses; even though the frames index has deteriorated, it has still improved its position in the product ranking. However, sunglasses have been weakened in both the PCI and the ranking position. In short, information in Table 1 shows ophthalmic-optical products to present a high heterogeneity in their international competitiveness perspectives. Therefore, product specialization, within the same sector, is proposed in order to advance towards the optimization of results from foreign trade.

The group for ophthalmic lenses (9001) is that which presents major strength in complexity gain, and is justified by a PCI 30% higher than the average of ophthalmic-optical products and by the improvement of the index from 1995 to 2013, quantified by an increase of 17%. The second group with higher strengths is that of frames (9003) which, despite a higher PCI, has decreased by 8% in the period of reference. However, not only does the group for sunglasses (9004) present a PCI below 70% of the average, but it has also diminished by 49% within the same period, as proof of the high heterogeneity among these products.

3. Ophthalmic-optical international trade in Spain.

In the late seventies, ophthalmic-optical exports accounted for 0.07% of total Spanish exports, with frames as the leading products which covered half of the total value, as extracted from Table 2.

Table 2. Spanish Exports in 1978

	Exports
Total economy	6,018,433
Oph.-Optical products	4,201
Ophthalmic lenses	627
Refraction frames	2,690
Sunglasses and protection spectacles	884

Own elaboration. Source: INE (1979) and Pita Salorio (1981). Units in thousands of euros.

The distribution of export destinies of these products is allocated in Asia, The Americas (except USA) and countries of the European Economic Community (EEC). France and Asia stand out as recipients of ophthalmic lenses; The Americas and the Netherlands as the destiny of spectacle frames; and Germany as the consumer of Spanish sunglasses, together with Asia and The Americas (except USA).

Furthermore, from 1973 to 1978 there are several changes attracting attention: First, the decrease of lenses and sunglasses to Italy, by 96% and 61% respectively, and of spectacle frames towards the United Kingdom, by 43%; Second, the increase in lenses to France, reaching three times the initial value, and the increase of sunglasses to Germany and France, and frames to Germany, Italy and the Netherlands.

During this period, a restructuring of export flows took place, to focus on more specific destinies, probably as a result of the new means of trade channelling, through intermediaries, with the correspondent effect on the value added. This comes from the fact that countries with diminishing demand for certain products, start to increase their demand for other products. For instance, there is a decrease in exports of lenses and sunglasses to Italy, while an increase in frames take place; frames exported to the UK decrease, while exports of sunglasses increase. These changes result in an overall increase in Spanish ophthalmic-optical exports to the EEC, in the following order: sunglasses, frames, and ophthalmic lenses.

The increase in the magnitude of Spanish exports between 1989 and 2014 (Figure 1), shows an exponential growth tendency up to the crisis, a period of stagnation, followed by a recovering period. However, this trend is not accompanied by an increase in the size with respect to the total economy, therefore this growth has been guided by the economic situation.

Figure 1 Evolution of ophthalmic-optical exports from Spain to the rest of the World
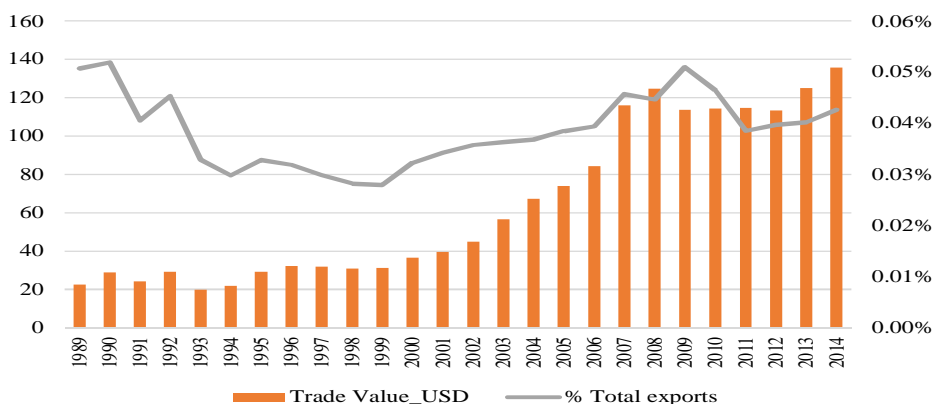
Own elaboration. Source: (UN, 2015). Data of exports in millions of USD.

The weight in the total exports follows a decreasing tendency until 1999, with a relapse of 45%, together with an increase in the average prices of 25%. The period from 1999 to 2014 is that of a recovery, in global terms, with an improvement of 52%, although there is a drop in prices of 85%.

As can be concluded from Table 3, the structure of exports by product has varied significantly from 1989 to 2014. There are four differentiated stages: the first

stage, from 1989 to 1993, with sales focused on metallic frames and mineral ophthalmic lenses; the second stage, from 1994 to 1999, with contact lenses gaining importance and metallic frame exports decreasing (and therefore the whole frame segment); the third stage, from 2000 to 2006, with a major growth in the sales of sunglasses; whereas, in the last stage, 2007 to 2014, growth in the sales of sunglasses is maintained and that of plastic frames increases, at the same time as exports of mineral lenses and metallic frames diminish.

Export prices decrease from 1990 to 2014 by 54%, as extracted from Table 4, in contrast to the import price evolution that remained stable throughout the period. Variations differ among products: only the price of exports of plastic lenses rise, while in the case of imports, both those of plastic frames and ophthalmic lenses increase.

The analysis of the evolution of ophthalmic-optical exports by product, together with the evolution of prices disclose that sunglasses represent the only type of product where both variables, exports and prices, are inversely correlated (R^2=0.17), since no other ophthalmic-optical product shows an inverse relation. That is to say that the increase in sunglass exports is due to the decrease in the unitary price.

Table 3. Exports of ophthalmic optics by product

	89	90	91	92	93	94	95	96	97	98	99	00	01
CL	401	492	383	492	690	2,146	4,156	4,123	3,990	5,164	5,940	11,812	6,660
MF	11,510	14,469	12,261	13,582	9,888	9,908	14,120	14,451	14,250	13,023	10,549	9,139	7,817
PF	2,261	2,704	2,344	2,344	1,707	2,106	644	960	1,109	477	862	698	736
GL	5,152	6,039	5,212	4,672	3,481	3,488	3,675	4,369	3,787	3,433	4,146	4,870	10,499
PL	726	1,096	853	1,923	1,333	1,565	2,669	2,795	2,634	2,311	3,665	3,828	3,388
SG	2,492	4,074	3,345	6,109	2,931	2,586	4,121	5,686	5,953	6,429	5,955	6,250	10,660

	02	03	04	05	06	07	08	09	10	11	12	13	14
CL	8,702	8,479	10,105	11,466	8,044	11,746	13,319	13,424	19,171	17,989	17,900	21,473	21,457
MF	6,960	7,506	8,149	10,240	13,287	17,368	16,801	14,409	10,612	7,299	9,243	8,093	9,972
PF	840	1,279	1,780	1,945	2,568	6,285	10,566	13,845	16,208	21,986	29,295	33,276	42,796
GL	13,159	19,353	18,536	19,963	23,344	27,890	30,550	27,680	16,850	13,019	6,068	3,725	2,482
PL	4,316	6,172	10,099	8,511	9,509	13,282	12,772	11,424	9,823	9,664	9,033	10,468	9,521
SG	10,980	13,903	18,580	22,041	27,505	39,464	40,622	32,933	41,630	44,845	41,868	47,901	49,593

Own elaboration. Source (UN, 2015). CL: contact lenses; MF: non-plastic frames; PF: Plastic frames; GL: Lenses of glass; PL: non-glass lenses; SG: sunglasses. Values in thousands of USD, nominal prices.

**Table 4. Average price of exports by product, 1989-2014**

	89	90	91	92	93	94	95	96	97	98	99	00	01
CL	149	397	420	242	11	225	250	203	53	1,095	918	588	352
MF	416	412	559	441	447	427	452	334	279	437	289	217	177
PF	403	137	329	274	418	448	249	377	139	344	n.a.	233	64
GL	102	123	129	131	102	116	117	137	116	n.a.	n.a.	389	96
PL	133	159	184	215	207	143	148	172	152	n.a.	n.a.	223	96
SG	137	231	56	246	148	125	57	98	58	87	76	73	85

	02	03	04	05	06	07	08	09	10	11	12	13	14
CL	212	243	3,241	2,576	884	15	1,095	252	137	147	152	482	281
MF	292	184	307	229	262	15	1	88	123	156	170	148	8
PF	210	229	483	301	46	31	1	128	404	266	208	220	31
GL	70	86	1,545	149	99	2,739	72	122	225	320	45	27	7
PL	93	105	560	105	110	174	304	257	222	168	149	197	278
SG	61	75	80	54	233	59	3	38	4	69	59	48	73

Own elaboration. Source (UN, 2015). CL: contact lenses; MF: non-plastic frames; PF: Plastic frames; GL: Lenses of glass; PL: non-glass lenses; SG: sunglasses. Values in USD per kg (from 1989 to 1999) or USD per unit (1999 to 2014), nominal prices. n.a.: Not available.

With regard to export distribution by country, the European Union is the main destiny, with around 75% of the total, followed by USA and Morocco, with 2.5% and 1%, respectively. This structure has been stable from 2004 to 2013, as can be observed in Figure 2. The main destinies are Portugal (25%), France (19%), and Italy (13%), followed by Germany (10%), Map 1, while the main countries of origin are represented in Figure 3: Italy (34%), China (17%) and the United Kingdom (13%).

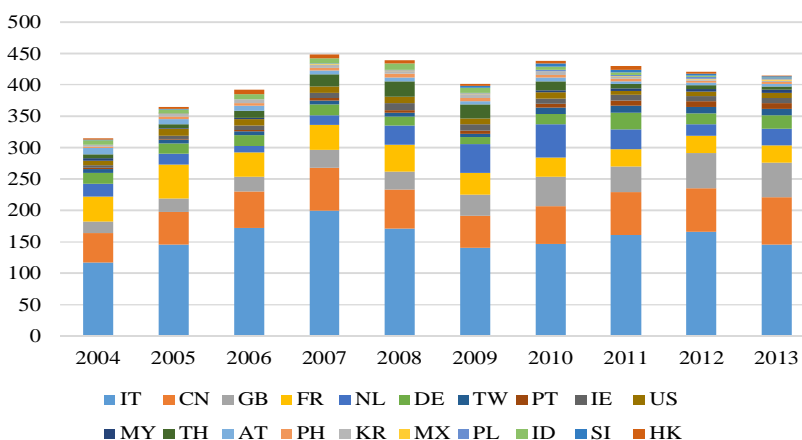**Figure 2. Evolution of the composition of exports by territory**
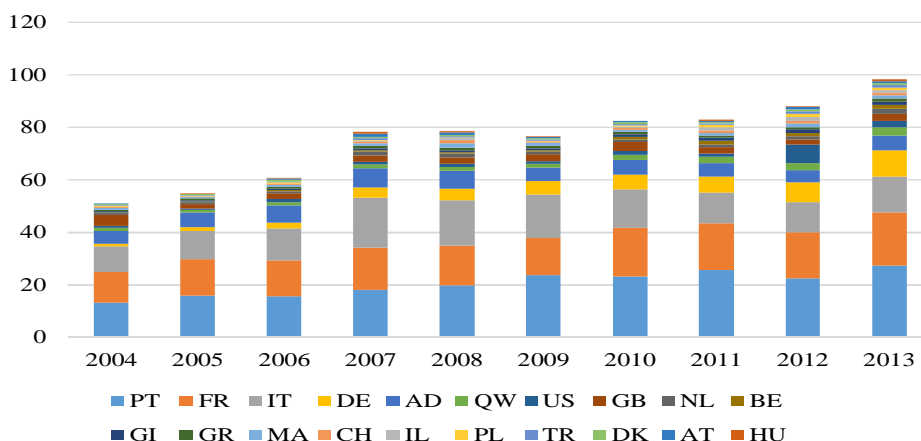
Own elaboration. Source: Estacom (ICEX, 2015). Data in millions of euros. Territory descriptions follow ISO 2 geographical codes.

Map 1. Ophthalmic-Optics exports by country in 2013
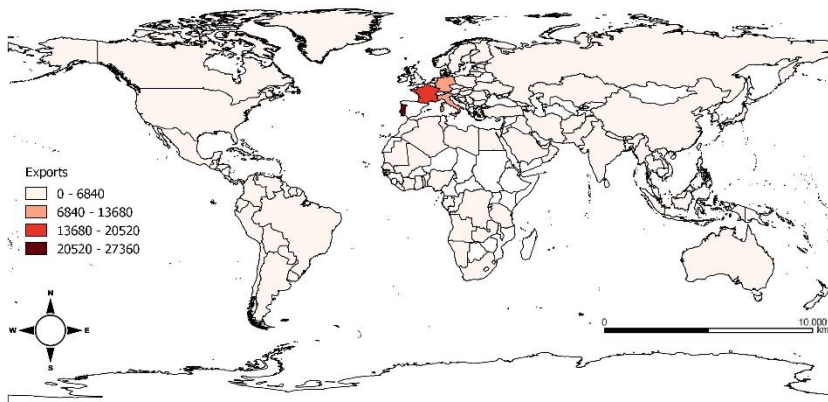
Own elaboration. Source: Estacom (ICEX, 2015). Data in thousands of euros.

Figure 3. Evolution of the composition of imports by territory

Own elaboration. Source: Estacom (ICEX, 2015). Data in millions of euros. Territory descriptions follow ISO 2 geographical codes.

According to Estacom 2013 data, destinies vary by product: Portugal is the main receptor of contact and ophthalmic lenses, the second receptor of frames, and the third of sunglasses; France is the main consumer of frames, the second of sunglasses, and the third of ophthalmic lenses; Italy is the main destiny of sunglasses and the fourth of ophthalmic lenses; and Germany is the fourth of sunglasses and the third of frames. That is to say that Spain allocates most of its ophthalmic-optical exports, as well as the rest of its commodities, in the European Union, with a subsequently high dependency. Portugal is the main destiny of high complexity index products in the form of ophthalmic lenses and contact lenses, while France is the second, focused on frames.

Meanwhile, coverage rate (CR) of ophthalmic-optical products has been traditionally below that of the total economy. However, the deterioration within the 37 years of reference is remarkable: CR went from 55% in 1978 to 25% in 2014, and most of the change took place during the first years of trade liberalization, with a drop in CR to 26% already in 1989, as Table 5 explains by product. In-depth analysis of this rate

shows a markedly different behaviour by product, and a different evolution in time: Until 1994, metallic frames and mineral lenses were the best positioned; from 1995 to 2000, every product presents a CR below 25%; from the beginning of the century to the beginning of 2008 crisis, ophthalmic mineral lenses reached a CR close to 85%; and in recent years, ophthalmic lenses have been placed at 13%, while plastic frames became the best positioned, with 72% in 2014.

In other words, only those lenses and frames that present higher PCI have reached a CR close to the general CR of the Spanish economy. However, sunglasses present a lower CR than the average, over the whole period, despite the high representation in the total ophthalmic-optical exports, and the export increase observed.

Table 5. Coverage rate of ophthalmic optics by product, 1989-2014

	89	90	91	92	93	94	95	96	97	98	99	00	01
CL	0.06	0.06	0.04	0.04	0.06	0.16	0.27	0.20	0.16	0.19	0.22	0.40	0.22
MF	0.51	0.56	0.40	0.41	0.36	0.32	0.34	0.30	0.30	0.24	0.19	0.20	0.17
PF	0.13	0.10	0.10	0.10	0.12	0.17	0.05	0.09	0.14	0.05	0.06	0.07	0.07
GL	0.56	0.42	0.35	0.27	0.24	0.20	0.20	0.20	0.18	0.15	0.20	0.21	0.53
PL	0.11	0.13	0.08	0.18	0.15	0.15	0.17	0.16	0.15	0.11	0.14	0.16	0.13
SG	0.10	0.11	0.09	0.13	0.08	0.06	0.08	0.09	0.10	0.09	0.09	0.09	0.14

	02	03	04	05	06	07	08	09	10	11	12	13	14
CL	0.28	0.21	0.20	0.22	0.20	0.19	0.15	0.15	0.18	0.17	0.20	0.23	0.20
MF	0.13	0.10	0.11	0.11	0.17	0.18	0.15	0.19	0.14	0.10	0.17	0.14	0.17
PF	0.06	0.07	0.07	0.07	0.07	0.16	0.26	0.50	0.48	0.47	0.61	0.63	0.72
GL	0.66	0.96	0.83	0.93	0.82	0.82	0.84	0.63	0.44	0.40	0.27	0.13	0.13
PL	0.12	0.13	0.17	0.13	0.13	0.15	0.13	0.12	0.14	0.16	0.16	0.17	0.13
SG	0.12	0.11	0.13	0.12	0.13	0.15	0.17	0.16	0.21	0.19	0.21	0.21	0.21

Own elaboration. Source (UN, 2015). CL: contact lenses; MF: non-plastic frames; PF: Plastic frames; GL: Lenses of glass; PL: non-glass lenses; SG: sunglasses.

4. Discussion and Conclusions.

A change in the export structure of Spanish ophthalmic-optical products is found, from a high PCI, corresponding to frames, to a low PCI, that of sunglasses. However, the evolution over time indicates that the years previous to 2008 are characterized by a higher weight of the most complex products: ophthalmic lenses. Therefore, the evolution of exports had followed a positive trend, influenced by economic instability, thereby causing an increase in exports in less complex products with a lower price.

Nevertheless, it remains necessary to go into greater depth in the previous analysis in order to better understand the reasons for the disappearance of exports of the most complex products. This disappearance has to do with the lack of innovative measures and the tendency to produce out-of-style designs. The delay in product adaptation leads to a loss in international opportunities.

The considerable deterioration of CR, within the 37 years analysed, corresponds to the first years of trade liberalisation and has continued until 1999. It can be concluded that the Spanish sector was not prepared for international competence,

and therefore faced obstacles in international trade. A substantial improvement took place from 2000 to 2014, and the high CR of 1989 was again achieved. During that period, exports presented a better position of high PCI products. However, export prices have diminished in every other product, especially from 2000, except regarding contact lenses and plastic ophthalmic lenses, which maintain a similar price to that of 1990.

An initiative in favour of ophthalmic lens specialization is proposed by Bahar et al. (2014), who point out distance as a determinant factor in the probable inclusion of a product in exports, therefore ophthalmic lens specialization in France can serve as a support to boost Spanish ophthalmic-optical exports with high PCI. This phenomenon is similar to what is happening in other sectors, as is the case of the canning industry (Abreu Sernandez, 2013).

It is highly recommended that this strategy be considered at the same time as high levels of innovative processes, in order to enable diversification in the export basket and to promote the stabilization of prices. Not only would this initiative prevent the loss of less-complex-product exports, but it would also enable the strengthening of more-complex-product exports.

In relation to innovation, in Spain it took a full six years from the moment when metal frames started to be out-dated until some specialization in plastic frames could be observed, with the consequent decrease in spectacle frame exports. This reflects a lack of adaptation to market trends, related with a shortage in innovation strategies. At the same time, an increase in sunglass sales is observed, which presents higher international competition. A similar example is found in mineral ophthalmic lenses, boosted in the time that the implementation of new materials for ophthalmic lenses, based on polymers, took place, leading to the disappearance of ophthalmic lens sales in 2014, with a representation of just 8% of total ophthalmic-optical exports. Additionally, contact lenses seem to have maintained their share in the market since the beginning of their foreign trade in Spain.

Overall, the CR of less complex products has not reached that of the average of the total ophthalmic-optical products, even though, with a high representation in the total exports, that is the case for sunglasses. To summarize, Spain had managed to boost the majority of its complex products, those of mineral ophthalmic lenses, previous to the crisis, with a change in that structure towards the near disappearance of ophthalmic lenses and an improvement in plastic frames and, especially, in sunglasses.

Due to the loss in PCI, it is necessary to establish a number of lines of intervention in this field, such as: an increase in innovation to compensate for the shortage of complexity and to maintain competitiveness; promotion of the development of products of a greater complexity; development of a higher diversification in the allocation of products in neighbouring countries to the south, which are experiencing increasing health demands, in order to take an advantage of the good opportunity offered by their spatial proximity; attention paid to less complex exports in order to maintain a more diversified basket of exports and thus, following Hidalgo & Hausman (2009), to approach sustained growth through offering not only product complexity but also economic complexity. Furthermore, the aforementioned needs for the stimulation of innovation processes to reach a higher market share and for an appropriate

institutional frame to boost proper conditions in the Spanish territory can also represent requisites for the rest of Spanish products for export.

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