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Environmental Challenge in the Canning Industry: The Portuguese Case in the Early Twentieth Century

Maria Eugénia Mata *

Abstract: *»Ökologische Herausforderung in der Konservenindustrie: Der Fall Portugal im frühen zwanzigsten Jahrhundert«*. Fish-canning industries are closely-linked to, and have an impact on environmental conditions, bringing great challenges to optimality. While entrepreneurship perspectives focus on the survival and profitability of firms, social utility perspectives focus on collective welfare and long-term sustainability. This paper illustrates the theoretical puzzle of the fish-canning industry in examining the historical experience of Portuguese public policies from the point of view of industrial economics and collective welfare.

Keywords: Portuguese canning, environmental challenges, fishing sustainability, regulation.

Fisheries and the Ecosystem Equilibrium

Fishing has been a well documented economic activity in Portugal since ancient times, as limited agricultural potential coupled with a long Atlantic sea coast offering ample fishing resources.[1] Commercially valuable species have supported a labour-intensive fishing industry along this coast from Roman times until today.[2] The historical record of fisheries in Portugal and their role in the exports of fish-preserves continue on through medieval and modern times.[3] Fish stocks offering valuable commercial opportunities remained comfortably abundant for many centuries, but the depletion of resources following industrialisation brought strong incentives to study efficient levels of harvesting in fisheries and critical thresholds among valuable species. According to the tools of environmental economics, there is a stable relationship between the growth

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I am grateful to John Huffstot for correcting my English, José António Pinheiro and Patrícia Xufre for analytical support, and Joseph Love for bibliography. Any error that remains is mine.

1 Parreira, 1938.

2 There are abundant historical vestiges at Tróia, an archeological site south of Lisbon. According to excavations, this was one of the most important fish-salting and preserving centers of the Western Mediterranean in the first century.

3 On the virtues of fish in the human diet, see Jorge, 1938.

of fish populations, the size of the fish populations and the scale of fishing and canning activities.[4]

As fisheries and canning were labour-intensive sectors, seaports were nests of marine and industrial jobs that supported local commerce, exports, consumption, standards of life, and intensive urban growth phenomena. Major threats to fisheries were also major economic threats to local urban activities. At the same time, business prosperity and growth were perverse to ecosystem destruction, and were severe threats to marine-life. In Portugal, strong fluctuations occurred in the availability of alternative species for canning, the most important of which were sardines, tuna and mackerel. These species occupy niches in the food chain in such a way that an abundance of tuna means a scarcity of sardines and mackerel.[5] If the stock of the prey species is more abundant, this implies a scarcity of the predator. Cycles for canning different species matched the needs of the canneries and provided a good answer to business and commerce opportunities, as well as to employment. Balancing the effects of booms were ecosystem difficulties arising from wastes, pollution, and sanitation problems. Depletion effects on the ecosystem also brought great difficulties for maintaining the scale of production. Conservation and protection of wildlife habitats became decisive features of production in vertical integration strategies of canning and fishing for long-term double-edge equilibrium.

Canning Industry: Scale and Depletion

Traditional preserving technologies were based on drying and salting, two methods to support exports and specialisation. The exceptional climatic conditions and the abundance of commercially valuable species for fishmeal activities explain why so many generations embraced this sector using traditional technologies. Sterilisation methods became widespread only in the second half of the nineteenth century, benefiting from the *Appert* method.[6] Evidence on the introduction of sterilisation technology in Portugal is available for sardine canning since 1855, achieved by boiling the cans at high temperatures after soldering them closed.[7] The world exhibition of Paris in 1855 presented showcased brands of sardines canned in olive-oil, from Portugal.[8] Plants belonging to Feliciano António da Rocha and Manuel José Neto introduced the method for canning sardines in oil in the city of *Setúbal*. A third brand, belonging to Gustavo Carlos Herlitz & Company was operating in 1861.[9]

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[4] Tientenberg, 2007.
[5] Brandão, 1938.
[6] On the presence of germs and bacilli, see May (1938).
[7] On the safety of sterilisation methods, see Lepierre, 1938.
[8] Moura, et al, 1957, p. 57. Parreira, 1938.
[9] Mata, 2009.

As preserving technologies improved and the average revenue per capita grew, the consumption of canned fish increased throughout Europe, the main international market for Portuguese produce. The continued abundance of fishing resources off the Portuguese shores must mean that the reduction in the stock due to out-migration, mortality and fishing was compensated by increases resulting from in-migration and growth of the fish populations.[10] Fishing is predation and is sustainable if and only if the catch harmonizes with the specie's growth rate, that is, the maximum sustainable yield for a specie's population is "the largest catch that can be perpetually sustained".[11]

Some problems occurred because of certain species' erratic migration routes in the Atlantic. In the 1880s sardines were scarce on the French and Italian coasts and some canning entrepreneurs moved to Portugal. An industrial inquiry in 1880 revealed that only twelve factories for food industries existed in Portugal at the time, and among them only five were devoted to canning fish. Four were on the Southern coast (Parodi & Roldan, S. Francisco, belonging to Francisco Rodrigues Tenório, Santa Maria, and Sebastião Migoni) and one on the western coast (Santos, Cirne & C[a]).[12] In the space of a decade the number of factories devoted to food industries increased to 52, and among the 45 which were devoted to canning fish, 11 belonged to foreigners who came to Portugal: Victor Tortrais, Emile Roullet, Wenceslau Chancerelle, F. Delany, Joseph Pierre Chancerelle & C[a], Sebastian Stephan, Jalma & Seguena, Frederico Delary, J. Labrouche, Domenico Migone, and Angelo Parodie.[13]

Delocalisation to Portugal brought new opportunities to foreign firms, more jobs in the Portuguese seaports, and dramatic competition to Portuguese producers.[14] Canning became the dominant industry along the coast, outstripping the importance of salt production, but shoals could disappear from the coast for unknown reasons. Fishermen's wages were not paid on a piecemeal basis, so demand and supply could adjust their revenues in the fish auction market, but poor catches always meant social problems.[15] If shoals changed their movement along the coast, fishing had to adjust, but the species' movements were difficult to predict, in spite of practical knowledge on the colour of the sea water to discover their location. To offset these difficulties, oceanographic studies were undertaken by the end of the nineteenth century.[16] Scientific observation discovered the species' main routes and habits. Frequently public

[10] Schaefer, 1957.
[11] Tietenberg, 2007, p. 219.
[12] Ministério das Obras Públicas, Comércio e Indústria, 1880.
[13] Ministério das Obras Públicas, Comércio e Indústria, 1890; Archive of the Portuguese Ministério das Obras Públicas, Comércio e Indústria, Sociedades Estrangeiras.
[14] Mata, 2009.
[15] Only in codfishing were wages paid on a piecemeal basis.
[16] Difficulties in locating shoals still exist today, in spite of the modern technologies employed.

authorities charged the cost of this research to public institutions. Portuguese Royal Navy vessels devoted efforts to marine biology and oceanographic research, particularly from 1896 to 1906, and provided valuable information for the potential future development of fishing and canning industries.[17]

As massive sums were invested in the fishmeal industry, the depletion of ocean resources continued: The massive extraction of sardines contributed to disappearance of tuna, as the 1st level of the food chain was destroyed.[18] The danger of species extinction was already visible in the 1920s, as tuna moved away from the coast.

International Competition, Cycles and Times of War

Factories required hygiene, and required much washing for beheading and cleaning the fish. Wastewater from canning was a challenge, beaches became dangerous places to swim or play, and canning seaports became toxic dumpsites. The floor of the plants needed to be cleaned and washed frequently because of the residues and smell. Plants needed abundant water supply, sinks and systems for draining waste water, even though they might be nothing more than light constructions along the beaches. Waste water was typically drained into the sea. Scaling the fish was avoided in order to preserve their fresh appearance and minimize the residues. The fishmeal industries' impact on the environment was a managerial challenge in increasing costs because of the *blood-water* and *stick-water* resulting from the production process, as these proved to be among the worst pollutants.[19]

The canning industry was soon driven by foreign firms located in Portuguese seaports. Of course, newcomers faced some entrance barriers resulting from the operation of the established producers. They had to struggle for market shares and learn about local conditions.[20] Local producers could also react by adopting better technologies and marketing their brands to retain consumers' loyalties and defend their market shares against the newcomers' competition.[21] However, the new entrants also had their own brands in their home markets or were established even in the global market of consumers.[22] Technological improvements were introduced among the established firms through new investment, providing innovation and scale, and increasing barriers to new entrants.[23] Moreover, business practices might also have reflected some deter-

[17] D. Carlos, 1899.
[18] Sousa, 1938.
[19] Clarke, 2008: 67.
[20] Schmalensee, 1981.
[21] Ferguson, 1974.
[22] Cubin, 1981.
[23] Stigler, 1968. Dixit, 1980.

rence effects, both in exhausting raw material and in lowering prices of the final product, in order to squeeze out competition.[24] Following a strategy for growth and internationalisation under high-quality standards, profits and reinvestment meant expansion into geographically diverse locations for factories.[25] Some firms managed to achieve vertical-integration to reinforce their positions.[26] Ramirez family and Júdice Fialho were successful entrepreneurs who followed this strategy from 1892 to 1934, and obtained positions among the eight largest producers in the 1950s.[27] Fishing by steamship was an important technological improvement that helped the Ramirez plants benefit from scale economies, a feature that increased deterrence effects.[28] Fialho's factories were vertically integrated with their own fleet of fishing vessels, which were built and serviced in the firm's own shipyard. Ramirez today boasts its status as 'the oldest cannery in the world', as it is now one of the few fifth-generation business families in Portugal).[29]

As it happened, deterrence effects against newcomers were blurred by foreign markets.[30] The increased scale of production after the 1880s thanks to new units belonging to foreign competitors worried the established canners, although one must consider the competitiveness consequences on the locally established producers, who could raise entry barriers to the newcomer.[31] The number of factories in Portugal increased during the war from 116 in 1912 to 188 in 1917.[32] Increased consumption resulting from the military demand during the First World War brought new opportunities for all producers. Food scarcity on the battlefields and in civilian markets increased the international demand, and most of the cannery entrants were European firms.[33] Increased production coupled with technological innovations linked to the use of steam-power to boil and sterilize the cans increased social welfare in the European and Latin American countries, due to higher overall demand. However, for such a large number of plants and scale of production, the urban equipment could not assure hygiene.

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[24] Caves & Porter, 1977.
[25] Soares (2005), p. 40. On the brand Cocagne see pp. 42 and 45.
[26] Spence, 1977.
[27] The other six large producers were Algarve Exportador &Cº, Ângelo Parodi Bartolomeo, Lopes da Cruz &Cº, Conservas Unitas, João Gargalo Herdeiros, and Francisco Alves & Filhos. Moura et al, 1957, p. 74. Fialho's traditional brands were Marie Elisabeth, Falstaff and Désirées. Faria, 2001, p. 44-45.
[28] Soares, 2005: 34, 35. Spence, 1980.
29 Soares (2005), p. 27.
[30] Stigler, 1968; Schmalensee, 1978.
[31] Demsetz,1982.
[32] And employed 14,679 people. Moura; Dubraz; Dores; Gonçalves; Chaves; Oliveira (1957), pp. 57-58. The estimation at Soares (2005), pp. 42, 45 is too optimistic.
[33] Dowell, 2006.

Hygiene and Health Problems. Environmental Effects

Running plants produced large quantities of harmful residual wastes that were tragic to ecosystems, both on land (near the urban core or residential shore zones in canning seaports) and in the sea, where fetid emissions were emptied directly into the bays. Although sanitation was a fashionable issue, there was a lack of piping for carrying sewage into septic tanks. In Portugal, fishmeal plants existed alongside the living quarters in the cities, and plants accumulated deposits of wastes on neighbouring lots.[34] As the cans were made of tin-plate, the terrain around the fish-canning factories littered with very dangerous sharp-edged metal waste. Such pollution coupled with the destruction of the ecosystem to threaten the sustainability of the fish-canning industry.[35] Overfishing was also a problem. Discarding fish on the beach to rot or throwing them back into the sea also aggravated environmental problems and provoked poor public relations.

Economic booms sometimes translate into ecological setbacks or even the extinction of some species.[36] Not only were some species being seriously overfished, but pollution from fish cleaning and canning increased the amount of pressure that was being put on the catch because industrial residues made it ever more difficult to harvest the decreasing stock of fish, as species moved away from the increasingly polluted coastal waters. Moreover, there was the need to avoid contaminating the potable water supply.[37]

For reasons that are perfectly clear, the fish-canning industries were very concentrated. As fresh fish were quickly perishable, proximity to beaches, seaports and auction markets for fisheries was critical for the provision of fresh raw-material, and avoiding transportation costs, (and refrigeration systems, later on). Concentration was (and still is) the rule for canning industries. The same occurs all over the world, and the higher is the concentration, the more impressive is the environmental challenge, with strong effects on health problems.[38] The estimation of concentration coefficients for the location of canneries in Portugal reveals that they are similar to those in the UK and US (0.68 in 1940 and 0.63 in 1950, in Portugal, against 0.66 in Great Britain and 0.70 in the USA).[39] However, for the districts of *Setúbal* on the western coast and *Faro* on the southern coast the coefficient attained very high levels (4.2 and 12.6, re-

[34] Brandão, 1923.
[35] Archive of the Portuguese Ministério das Obras Públicas, Comércio e Indústria, Sociedades Estrangeiras, Emile Louis Roullet. Stavins, 2007.
[36] Perman, R.; Ma, Yue; McGilvray, J., Natural Resources & Environmental Economics, New York, Longman, 1996.
[37] Lemos, 1991.
[38] Clarke, 2008.
[39] Moura et al, 1957, p. 61.

spectively, in 1954).[40] The higher the concentration, the greater was the proliferation of dirt and noxious odours.

Billowing factory smokestacks characterized the typical canning city of the nineteenth-century, and the unpleasant atmosphere represented a deterioration of living conditions, which also were unhealthy because of epidemics. Cholera and typhus killed 9,000 in Lisbon in the winter of 1855-56 and re-appeared in 1865. By the end of the century, smallpox was endemic in densely populated quarters, killing over 200 people annually in Oporto, and *bubonic* plague hit this city in 1899.[41] Jobs attracted labour from agricultural regions to canning seaports, exacerbating the demographic explosion. Contagious diseases were responsible for 44.2% of the deaths in the country, and tuberculosis was especially common among industrial workers.[42] The 1919 influenza epidemic alone killed 100,000 people in Portugal. In spite of citizens' complaints, the medical authority for factory inspections was not enough to control unhealthy industries. Local metropolitan authorities were overwhelmed, as resources were insufficient to meet public expenditures. Central state controls might have been effective, but petitions failed to bring intervention.

As a consequence, intense pollution arising from the canning industry dominated the cities' skylines. The number of factories increased from 188 to 400 from 1917 to 1925, but this depleted fishing resources. Government regulation sought to ensure that fisheries supporting the canning industry would become ecologically sustainable in perpetuity.

Public Regulation

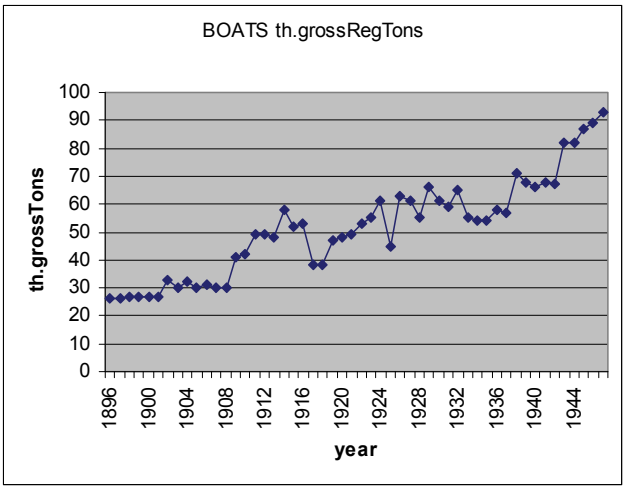
Maximizing the net benefits from the use of the biological resources is a good definition for economic efficiency allocation, considering the associated costs and benefits. From a static perspective, an efficient sustainable yield is a catch level that will produce the highest annual net profit, if maintained perpetually.[43] Such a static-efficient sustainable yield allocation to canning has constant net benefits for constant catches, species' populations, and effort levels.

If fishing effort increases, a maximum sustainable yield will be attained for identical levels of net benefits, catches, and species' populations.[44] In a long-run perspective, fishing is motivated to increase until profit becomes zero. To maximize profit, a fisherman increased his fishing effort until marginal cost equalled price. As ocean fisheries were common-property with open-access, entry barriers did not exist, deterrence effects could not take place, leading to

[40] Moura, 1957, p. 62.
[41] Ferreira, 1990.
[42] Cascão, 1993.
[43] Tisdell, 1994: 240-242.
[44] Tientenberg, 2007: 217-240.

increased effort levels (Figure 1 presents thousand gross-registered tons of fishing boats).

Figure 1



Source: Valério, 2001, pp. 241, 242; 246, 247, quoting *Estatística das Pescas Marítimas* from 1896 to 1945.

Thanks to the technological improvements before the First World War, the marginal cost of fishing declined. The new equilibrium corresponding to the higher effort level must have been associated with increased catches, lower species' populations and higher net benefits.

Too much fishing effort with too many boats and too many fisheries was leading to overexploitation of resources and decreasing fish stocks damaging the future level of activity and profits of coming generations.

Many things may be done to avoid unrestricted access to valuable species. The rationale for government intervention rests on the adverse economic consequences of depletion and overexploitation, as this implies lower income for fishermen, depression, and social crisis.[45]

The link between the economic and biological aspects is illustrated in the following equations:

$$(1)\ C_{a,t} = f_1(F_{a,t})$$

where $C_{a,t}$ is the amount of canned fish of age α at the year t, and $F_{a,t}$ the fish catches of age α at the year t. Note that

[45] Morais, 1938.

$\frac{dC}{dF} \geq 0$, because stocks are abundant in the beginning, and because fresh-fish consumption is subject to satiety.

$\frac{d^2C}{dF^2} \geq 0$, because the system is pressed by new-entrants, (as entrance barriers were not efficient to prevent newcomers to canning), and because of the large international demand for canned fish, which war periods increase still more.

$$(2)\ P_{t+1} = f_2(C_t)$$

where P_{t+1} means the effect of pollution effluents, and C*t* is the amount of canned fish of any age at the year *t* . Note that

$\frac{dP}{dC} \geq 0$, because canning produces effluents that are highly toxic for fish species.

$\frac{d^2P}{dC^2} \leq 0$, because investing in hygiene and recycling were managerial abilities to help in decreasing the pollutant effects on the sea.

$$(3)\ E_{t+1} = f_3(P_t)$$

where E_{t+1} means the effects on the effort level, and P_t means the effect of pollution effluents from year *t* . Note that

$\frac{dE}{dP} \geq 0$, because increasing pollution requires increasing effort levels to compensate the negative effects on the survival of fish species.

$\frac{d^2E}{dP^2} \geq 0$, because efforts must be very increased in introducing not only more (and larger) boats, but also more efficient technology (such as steamships and oceanographic studies).

$$(4)\ F_{at} = f_4(E_t) \text{ for a given fish stock } S_t.$$

Where $F_{a,t}$ the fish catches of age α at the year *t* and E_t means the effort level in year t. Note that

$\frac{dF}{dE} \geq 0$, because more and (or) larger boats combined with more efficient technology can increase the fish catch.

$\frac{d^2F}{dE^2} \leq 0$, because there are always technological constraints to consider (as no-freezing possibilities for harvesting too far away, at the time).

As a result, the four equations close a model. It represents a cobweb. Depending on the shape of the equations, the adjustments to face the challenges

expressed in each one of the four equations may lead the system to increasing or decreasing levels of fishing and canning.

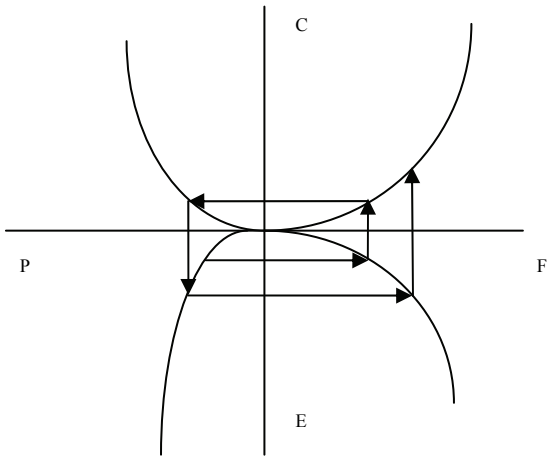
The case of increasing levels of fishing and canning, that Figure 2 represents, require that the birth rate of the species may benefit from highly efficient reactions to avoid pollution, and also accommodate the highly efficient effort levels, so that the stock may provide higher catches.

Note that

$$(5)\quad S_{t+1} = S_t + B_t - F_t - D_t,$$

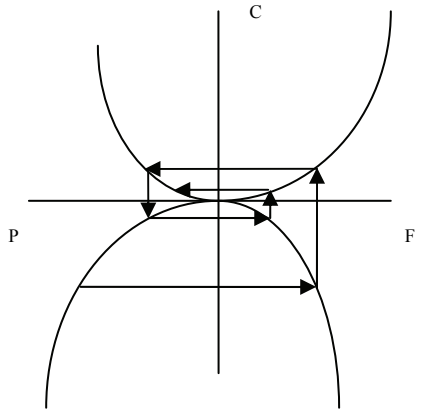
where S_{t+1} means the fish stock at the year $t+1$, S_t means the fish stock at the year t, B_t means fish births in year t, F_t fish catches in year t, and D_t fish deaths in year t.

Figure 2



The case of decreasing levels of fishing and canning, that Figure 3 represents, will occur whenever highly efficient reactions to avoid pollution are not enough for reaching the birth rates that can accommodate the predation that results from the higher effort levels. (Decreasing levels of fishing and canning, that Figure 3 represents, also will occur if less efficient reactions to avoid pollution and less efficient effort levels are adopted).

Figure 3



Unless regulation will be adopted, the consequences will translate into business failures, unemployment, setbacks of economic activities, and social problems in the urban life of seaport cities.

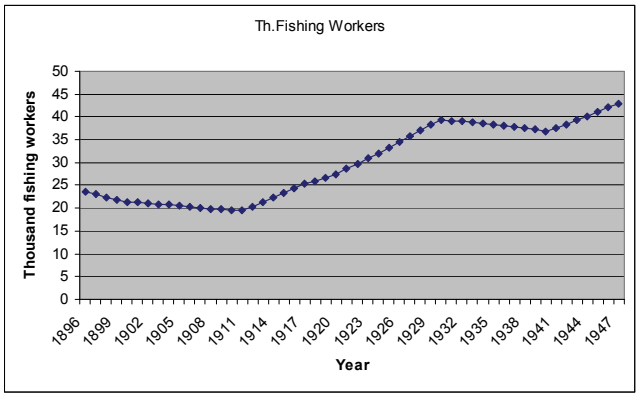
Sardine scarcity afflicted the Portuguese canneries during the 1920s (1927, 1929 and 1933 were the most severely affected), after the rapid expansion it experienced throughout the First World War and thereafter.[46] This difficulty brought high opportunity costs for jobs in a context of military demobilisation and political uncertainty, as well as for the exports and trade balance, as the Portuguese currency depreciated sharply from the end of the War until 1924.

The temptation to not interfere and not regulate sanitary conditions resulted from the favourable effects of the sector on exports and the trade balance. The government's prospect of earning high tax revenues from the industry may have had the same effect.[47] However, fish scarcity and falling production gave the policymakers their opportunity to choose. The crisis in the fish-canning industry led to heated debate in the Portuguese political circles. In 1927 a Congress on fisheries and canning was held, which led to the prohibition of founding new factories.[48]

Soon the Great Depression of 1929-33 provoked even graver difficulties, and the number of fishing workers declined, as Figure 4 illustrates.

[46] Valério, 2001:317-318.
[47] Coutinho, 1938.
[48] Decree 15581 of 15 June 1928.

Figure 4



Source: Valério, 2001, pp. 241, 242; 246, 247, quoting *Estatística das Pescas Marítimas* from 1896 to 1945.

Although prices declined, exports fell by 38% from 1930 to 1933.[49] Note that reactions for adjustments that would invert the trend could not work properly because disruption of international trade meant not only market lacunae, but also lack of raw-material for production, such as olive oil, which was another problem. The disruption of international trade had dramatic consequences for the fishmeal industry, raising the hope of increased consumption of canned fish, domestically and in the colonies, as Colonial territories only absorbed 1 to 2% of the Portuguese canning production, a luxurious consumption for the low local per capita average revenue.[50] To distinguish between private and social costs, a definition of property rights must be introduced to share the existing scarcer rent, because each new fishery and canning activity should enter until cancelling the rent.

The government aims were to maximize production and exports in a sustainable way, to create jobs, and implement economic growth. The solution settled on, was to reorganize the whole sector in 1933 under the government philosophy of Corporatism, after António de Oliveira Salazar, the Prime Minister, visited several factories and published a report on canning (when he was the Minister of Finance).[51] The state wished to enact and enforce a reorganisation for canneries under a bureaucratic structure. This is an inherently political issue that the Republican regime (1910-1926) could not manage, not

[49] R., J. M. V. 1996.
[50] Moura, et al, 1957, pp. 57-58, 83.
[51] Published in Diário de Notícias, 8 December 1931. Rodrigues, 1996:196. Salazar, 1935. For Corporatism and codfish, see Garrido, 2003.

only because of its short longevity, but also because of the overall political instability resulting from the short duration of governments.

Beginning in 1931, and according to decree nº 20521, the idea was

> to extend the beneficial effects of the government intervention to a larger field of industrial activity (…) being necessary to protect the national industry from the competition that the foreign industry is doing or might do, through skilful manoeuvres.

Such protection was beneficial for the largest producers, but many companies went bankrupt or were bought by larger firms. The general framework introduced institutional constraints that affected new-entrants. Industry was subject to government control, as all new units needed authorisation from the Minister of Commerce and Industry (with the exception of the Atlantic Islands, where fishing resources were abundant and the number of point-source pollutants was small). Existing firms also needed authorisation if they wished to increase their production.[52]

The decree nº 24947 of 10 January 1935 protected the existing operators and forbade the creation or transformation of existing firms into joint-stock companies, unless other companies exited. This obligation might be considered as a constraint on free enterprise, free market competition and free location. Moreover, the preservation of free access to commercial biological resources would mean initial higher catches at the expense of a lower steady-state profit level. Small units (having fewer than 5 workers) were not subject to government control and were free to innovate, grow and move, but canneries were labour-intensive factories employing dozens of workers.

Government intervention in policing ports, inspecting factories, or enforcing maximum permissible catch levels, always meant higher costs. The surveillance of these activities was attributed to the association of fishermen and canning producers (*Grémios*) in order to avoid ruinous competition, stimulate co-operation in grouping them to produce some brands together, and regulate maximum and minimum prices (for both fishmeal and canned fish) to avoid predatory practices.[53] The cooperation received from the police and the customs clerks was a decisive element.[54] As a result, the number of plants decreased from 203 in 1933 to 179 in 1954. By then, 6% of the firms (the largest) accounted for 28% of the production. The Gini coefficient showed a 20% concentration, as the survivors were the major producers – the only ones who could respond to the need of research for technological improvement and quality control, taking advantage of scale economies and government protection.

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[52] Decree 21623 of 27 August 1932.
[53] Decree nº 40787, Diário do Governo. Salazar, 1953.
[54] Decree nº 24947, (10 January 1935), Articles 78 and 86.

Alternative Regulations

Today it is common that a politicisation of the aquatic ecosystems addresses the regulation of coastal waters to avoid or limit the access of foreign fishing vessels to national waters, demanding public expenditure for naval surveillance and intervention. In Portugal, the adoption of Corporatism solutions sought to respond to several problems resulting from simple quota-systems for fishing or canning.

Alternative systems could include a control mechanism based on raising taxes, or one based on individual quotas.[55] Taxation might be seen as an approach to protect ecosystems, but it is inefficient, because of the perverse incentives to fish and work for more hours, to operate with more boats or enlarged plants or to adopt better equipment to increase fisheries and canning. If producers dislike taxation control-systems, they also eschew individual auctioned quotas. Producers who fail to reach their quota limits will sell them to others, who, having lower costs, soon discover that they may increase profits by enlarging their scale of production. It may be true that such a regulation system can improve technology, because those producers feel encouraged to adopt or introduce new cost-reducing equipment.[56] In any event, producers will always trade (transferable) quotas until market equilibrium is reached, and all obtainable rent is realized by that generation of producers, unless the government decides to auction the quotas and appropriate the whole rent for the central state. Systems for controlling these practices are expensive and may encourage evasion and/or bribery. Bribes, corruption of deputies (or congressmen), and lobbying may have the same effect of defending the interest of producers, with externalities for the smaller ones. Moreover, the aim of government should be to help industry to reach and sustain an efficient level of catch and allocation to canning to sustain a perpetual industrial activity.

The system adopted in Portugal in the 1930s did not solve all of the problems. Canning was a seasonal activity and this fact had consequences on the labour force, which was idle for much the year. Sardines, for example, have a better quality for canning during the five months around November. In 1935 the government forbade canning sardine from 1 January to 30 April in canneries located in the North of the country, 16 January to 15 May in canneries located in the centre, and 1 February to 30 May in canneries located in the south.[57] This policy defines seasonal bans on fishing and processing, *Vedas*, as well as off-loading fish on weekends. The largest producers could take advantage of the down-time for repairing ships and nets, or improving production techniques, to make fishmeal an extremely profitable venture.

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[55] Tientenberg, 2007: 230.
[56] Stigler, 1968.
[57] Decree nº 24947 (10 January 1935) , article 78.

To protect the species' reproduction, regulation was enacted defining the minimum length of fish for canning (sardines no smaller than 12cm, for example, a two-year old fish). This control was already in place in the 1880s and continued throughout the twentieth century.[58] Government management of wharves and docks provided an opportunity for more surveillance over sanitary conditions of fish for canning, without onerous bureaucracy.

Port captaincy licences to fish was also an alternative way to regulate the sector. However, there are many negative effects in such a system. As fishermen were paid according to the quantity of fish off-loaded, no wages were paid if they remained on land and no money was available for shops and markets in the communities.[59] The policy of seasonal bans on canning mainly affected women, who were the dominant gender in this work, as they were more devoted to cooking activities, docile, and less well-paid.[60] Women made up more than 80% of the labour force in canneries in the 1950s and 99% of the seasonally recruited labour force. Women were competing with men even to solder the cans, thanks to the introduction of new technology for this purpose. In Portugal, as in the USA, the loss of men's jobs to machines and women brought success to unions and gender conflicts in the industrial labour-market, from the early twentieth century to the Second World War.[61]

Some factories also canned other foods, namely vegetables and meat in olive oil, or fruits in sugar, as profitability criteria were dominating survival and business rationale. These policies stimulated managerial solutions to overcome the inconvenience of closed seasons. Following a diversified-product strategy, Fialho's factories coupled fish canning with agricultural production and animal husbandry, and the subsequent canning of the vegetables and fruits, all "produced on his 16 farms, using cans that were made in his own locksmith workshop, and decorated in his own lithography shop to be packed in wooden crates from his own carpentry workshop".[62]

Public Policies versus Managerial Initiatives

The Consórcio Português de Conservas de Peixe, (re-named *União dos Industriais e Exportadores de Conservas de Peixe,* by the Decree 24947) was the institution comprising all producers and exporters, watching over and improv-

[58] Ministério das Obras Públicas, Comércio e Indústria, Direcção Geral do Commercio e Industria, Repartição do Trabalho Industrial (nº2), (Lisbon, Imprensa Nacional, 1905), p. 94.

[59] Morais, 1938.

[60] Moura et al, 1957 p. 66 mentions that the average female wage was about one half of the male average wages in the 1950s: 14$25 and 26$00, respectively.

[61] R. 1996: 196. For the USA, May, 1938.

[62] Mata, 2009: 52. (Faria, 2001, cap. III). This firm survived until 1988, when it was bought by the American Heinz.

ing production to ensure quality, establish minimum prices for domestic sales and exports, avoid predatory managerial policies, and decide on producers' shares in the market. It also introduced strict rules on hygiene, preserving the environment, decreasing operation costs, and contributing to rationality and collective welfare. Other very important missions for *The Union* were the efforts in marketing, branding, protection against unfair competition, defining rules for labour-force protection, and the regular apportioning of raw-material to the sector.[63] The enforcement was assured through a regime of severe penalties that included fines, temporary suspension of activity, or even forced closure.[64]

The Portuguese seaports with canneries developed an exporter bourgeoisie from middle-class origins that became a genuine local oligarchy. Literature addressing historical cases in other countries observes that local oligarchies were living in elegant quarters of nearby regional capital cities, doing little effort to improve local conditions in the cannery seaports.[65] Contrary to these situations, in Portugal most of the nineteenth-century canning families lived in the coastal cities where their factories were located.[66] Canners made some efforts to improve the ecological impact of the fishmeal plants or improve social infrastructures. If not, the Portuguese cannery communities would have been slums, unacceptable to the wealthy families owing the firms.[67] Fish-washing water was recycled to produce oils, although they had limited use (because of odours acquired), but were used as lubricants for ships' masts, animal harnesses, in the soap industry.[68] The fish waste was also recycled in the production of fertilizers.[69] However, collection and storage were in the open air, not always far from residential areas. $Ca(OH)_2$ was added to accelerate the decomposition into humus, so that it could be used to fertilize soils. The Portuguese seaport of *Setúbal*, for example, had large stores of this kind of fertilizer, and even Lisbon, the Portuguese capital, had one.[70] Government regulation also stipulated that fish wastes should be removed daily from the factories in the Portuguese seaports, in order to improve the urban centres' sanitation.[71]

The tin-waste, mentioned above, was also re-cycled. Using a pitchfork, the small pieces were collected in a cubic wooden box and beaten down with a

[63] On the advantages of firms' coordination in clusters, see Chandler et al, 1998: 325.
[64] Chapter X (articles 95-99) of the Decree 24947.
[65] Clarke, 2008.
[66] The Spanish-origin Ramirez & Cº Ltd always lived near the family plant, The Cumbrera & Cº,from 1853 on, Soares (2005), pp. 28, 30, 32.
[67] Reis, 1988.
[68] Ferreira (1906), p. 181.
[69] Ferreira (1906), pp. 179, 180 for evidence on the period before 1914. Moura et al, 1957, p. 64 for twentieth-century evidence.
[70] Fertilizer was sold at a price of about £3.1/ton ($15/ton or 14 milreis/ton) at the Pereira Lima fertilizers.
[71] Article nº 82 of Decree 24947 (10 January 1935).

mace. Two men were enough in the port city of *Setúbal,* the largest canning centre in Portugal until 1936, to do this.[72] Removing the sides of the box revealed a cubic foot of compressed tin-plate pieces to be melted down and exported to produce toys.[73] The polluter-pays-principle was at work.[74]

To appraise the effects of government regulation of the 1930s, many features related to explicit and control costs must be weighed.[75] Portuguese historians long discussed the public regulation policies. As the 1920s were a very unstable period, the1930s' abundant legislation, which imposed severe government regulation, must be studied and interpreted according to the tools of industrial and environmental economics.[76] Most of the industrial sectors were included in the entrance-deterrence law that sought to limit excessive competition to Portuguese industries.[77] This kind of regulation is frequently identified as a negative measure, because protection is inefficient. Historians also point out that the 1930s government policy resulted from the political power of industrial families in Portuguese society, and lobbying is recognized as a restriction to the market structure, reducing collective welfare, in comparison with free-entrance.[78] Fish canning received special attention from the regulatory authorities.[79] The 1930s regulation was imposed from the perspective of employment and social justice for disadvantaged groups, preventing competition to defend the firms' survival in the Great Depression years and its aftermath.[80] Moreover, economics literature shows that an oligopolistic market with firms generating high-quality products to compete among themselves for market share, and lobbying to try to overcome their rivals in looking after higher profits, can improve growth and welfare under general-equilibrium conditions, depending on the adjustments in the labour market.[81]

From an international perspective, in the 1930s, the greater the difficulties facing the Spanish, French and Moroccan producers vis-à-vis the Portuguese canners, the better it was for the largest Portuguese firms. It is well-known that one country's production constricted the other countries' market shares, and vice-versa. The Spanish Civil War was a new opportunity for exporting Portuguese canned goods, as was the Second World War. Not only was the main competitors' production ravaged, but the increased international demand

[72] Matosinhos would take the first position from then to now. Moura et al, 1957, p. 62.
[73] Tin plate waste was sold at the price of £2.7/ton (about$13/ ton or 12 milreis/ton). Ferreira (1906), p. 183.
[74] Tisdell, 1993:240, 242.
[75] Callan & Thomas, 2000: 237-250.
[76] Field, 1997:179-190.
[77] Decree 19354 of 01-03-1931.
[78] Brito, 1989. Confraria, 1992.
[79] Decree 24947 of 01-10-1935.
[80] On moral aspects and justice see Chapman: 79.
[81] Pereto, (1996, 1998). Júlio, 2008.

brought in a new boom for Portuguese canners. [82] In the next decades, regulatory inspections became ineffective, bureaucracy grew out of control, and historians recognize that public policies failed, as the factories implemented their initiatives without authorisation.[83] This means that external and agglomeration economies could work, as operators were enacting independent decisions to expand along the Atlantic coast and to relocate in the Portuguese seaports, according to Krugman's analysis.[84] The petitions for government authorisation reflected this desire to benefit from clustering, and the authorisations granted simply confirm the trend.[85]

Conclusion

As the size of fish stocks is jointly determined by oceanographic biology and management decisions for production levels in the fishing and canning industries, technological improvements impacted the rate of depletion of ocean resources. The species of fish particularly desirable for canning were overfished in some periods, threatening the ecosystems in a variety of ways, including depletion and pollution (land, air and sea), and giving origin to business crises in the sector. Technological improvements stimulated economic links, particularly to the shipbuilding industry, and entrepreneurs' pursuit of profits put ecosystems under great stress, as booms and contractions were extended from the fishmeal industry to shipyards. The First World War stimulated canning so strongly that mature open-access fisheries were severely exploited, putting Portugal into the rankings of fishing and canning nations. Fishing and canning represented an assault upon the ecosystem resources and polluted the coastal bays through the run-off of blood from the factories.

The need to reduce the pressure on biological resources and sustain the economic activity in the long run is obvious. Fishermen, canners, local authorities and central government were the main actors, using their own strategies. Entrepreneurs bought larger boats, built more plants, reinvested in raw-materials, promoted the marketing and branding of their high-quality produce, and took measures to control refuse.[86] The government performed a role in regulating and organizing the sector for business survival, shortening fishing seasons, minimizing damage to the ecosystem, and preserving jobs. The methods to reach these goals were difficult to implement and control by government, but business rationality always created managerial abilities that overcame the challenges.

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[82] According to Barbosa, 1941, WWII brought a local 41 thousand tons maximum of exports.
[83] Brito, 1989. Confraria, 1992. Brito, 2004.
[84] Krugman, 1995.
[85] Moura et al, 1957, pp. 73-74.
[86] Vernon, 1973.

Producers performed an important role in disposing of human and industrial wastes and building local infra-structures to control pollution, such as sewer systems and potable water provision. Canning was thus an inventive sector.

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