Export sunk costs: can spillovers open the bottleneck?
- determinants of Chilean wine exports

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May 26, 2011
Abstract

This thesis follows previous research on sunk cost associated with exports of heterogeneous goods. The impact of sunk cost is evaluated at the industry level, using the Chilean wine industry as a case study. Data for export flows to 92 destination countries over the period 1990 – 2006 shows strong evidence on the importance of sunk costs for future export decisions, and the results are statistically significant for linear as well as non-linear estimation.

Using three different export diversification indices, the issue of potential sunk cost spillover effects is investigated. The purpose is to see whether the exports from other industries can create spillover effects that reduce the sunk costs associated with engaging in wine exports. This topic is examined through a dynamic random-effects probit model, but the data shows however, no evidence of such spillover effects.

The conclusion is that the sunk costs associated with the initiation of exports of heterogeneous goods is bounded by the intrinsic characteristics of the goods themselves, and therefore not transferrable between industries. Therefore, further studies on intra-industry spillover effects would be relevant that evaluate the effects of cooperation within heterogeneous good industries.

Keywords: Heterogeneous goods, Sunk costs, Spillovers, Chile, Wine.
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1. Introduction

1.1 Background

During the second half of the 20th century the dynamics of trade needed to be reassessed; trade in heterogeneous goods fitted poorly in models based on the assumptions of perfect competition, zero entry & exit costs and full information availability in a world of identical firms. As trade data grew more and more detailed, it became evident that the Heckscher-Ohlin (H-O) model that had been the workhorse in international economics could not explain the evidence associated with differentiated goods.

Because of the deficiency of traditional models in explaining the trade in heterogeneous goods, a new trade theory (NTT) emerged. It captures consumer behaviour with respect to the demand for heterogeneous products through the Spence-Dixit-Stiglitz’s (S-D-S) love for variety preferences (Helpman and Krugman, 1985). Returning to the firm, a “newer” new trade theory was proposed by Melitz (2003) that allows firms to be heterogeneous with respect to their productivity level, which works as a determinant of their respective trade decision. The Melitz model is supported by empirical results that show how a small number of firms constitute the major part of international trade within an industry, suggesting that there is some threshold productivity level that allows certain firms to derive positive trade profits and others not to (Mayer and Ottaviano, 2008). When firms engage in trade, there is empirical evidence of export sunk costs, a non-refundable fixed cost associated with the initiation of trade to a specific destination (see for example Gullstrand, 2011). The presence of such a sunk cost would explain why only the more productive firms in an industry start trading, and why they will keep doing so for several time periods. The characteristics of sunk costs have been the target for many recent studies, and even though most studies have found evidence of the existence of such costs, the dynamics affecting their size have been shown to need further investigation.

One topic that has been under investigation is whether the exports of one firm could create an information spillover effect, which would positively affect the probability of another firm establishing exports. Positive spillovers could occur, for example, by observing foreign firms’ strategies, through reversed engineering or international
cooperation such as joint venture and FDI. Negative spillovers might also be present. These could also stem from reversed engineering by competing firms, or bad reputation in the case that firms from the same country misbehave. Sunk costs associated with investigating markets should be lower between countries that share legal and cultural origins, for example countries within the European Union and ex-colonies in South America.

The marketization process that has been present in many South American countries has allowed for smaller enterprises to engage in foreign trade and diversify the countries’ export sectors. Naturally, as trade possibilities emerge, the need for investigation of potential destination markets increases as well as the setting up of proper networks. Chile was, until trade liberalisation started in the 1970’s, highly dependent on its copper exports but exports have become more diversified as other industries have started targeting international markets. An example of this is the wine industry, which has grown into an important part of Chile’s total exports. Food and beverage sectors can be expected to face high sunk costs due to stricter regulations than other industries, which makes the Chilean wine industry an interesting case for examining the characteristics of sunk costs and potential spillovers.

1.2 Previous research

Most previous research on sunk costs on the firm level has shown a strong relationship between current and previous export statuses, even after one has controlled for firm and market characteristics. Bernard and Jensen (2004) showed that firms in the United States that exported in one period are on average 36 percent more likely to export in the next period. Roberts and Tybout (1997) found that the same probability increased by 60 percent for Colombian firms, Requena-Silvente (2005) found it to increase by 75 percent in the United Kingdom, and for Italian firms, Bugamelli and Infante (2002) found the increased probability to be as high as 90 percent. These numbers can, however, vary depending on what econometric methodology is used. For example, the results by Gullstrand (2011) on the export status of Swedish exporters in the food and beverage industry varied between 77 percent and 37 percent depending on the choice between a linear model and a dynamic random-effects probit model. The control variables used in the different papers also differ, which naturally affect the results. These numbers do, however, show that sunk costs play an important role in firms export decision.
The research that has been done on export spillover effects in sunk costs is limited and has mainly been done within a given industry or in order to measure the effects of agglomeration of firms into geographical regions (e.g. technology parks). The results from these tests have been inconclusive; a few have shown strong presence of positive spillovers (Aitken et al., 1997), some have been unable to show any significant relationship at all (Barrios et al., 2003), and in some cases even negative spillovers have been found (Bernard and Jensen, 2004). Koenig et al. (2009) found agglomeration effects for firms within the same industry in France, but these effects decline as the distance between the firms increase or if the firms export different type of products. Bernard and Jensen (2004) measure the spillovers between firms, both within the same region as well as within the same industry. They find all the coefficients to be negative or insignificant. Also, most studies that have found positive spillover effects from other exporters have measured the effects of multinational exporters within the same geographic area and the positive effect on the export decision of the domestic firm comes out of productivity increases (Greenaway and Kneller, 2007).

None of these studies have measured to what extent one industry’s exports towards a particular market are affected by the overall level of exports between the home country and the destination market.

### 1.3 Problem Discussion

The establishment of trade chambers (e.g. the Swedish Trade Council, Exportrådet) would indicate that the accumulation of “trade knowledge” should serve some purpose in facilitating the establishment process of new exporters. What we will examine in this thesis is whether this type of trade knowledge could also be transferred between firms from different industries outside of formal institutions. If that is indeed the case, this should manifest itself by the existence of a positive relationship between other industries exporting to a market and the reduction of sunk costs of entering that market.

Given the different theories regarding the determinants for trade, the markets for heterogeneous goods would be more appropriate than homogeneous goods for such an investigation. First, the trade of a homogeneous good, as explained in the H-O model, would be the result of different factor endowments, and the total volume of trade would only result from relative production/relative consumption. In the case of a
heterogeneous good, the intrinsic properties of each variety will give rise for a demand of it, and the total volume of trade as well as the number of bilateral trade flows would typically be larger. Second, firms in a heterogeneous industry can be assumed to have access to the same technology, but acting in a monopolistically competitive market will give each firm a position where, under the assumption of S-D-S preferences, the threat from its competitors is smaller than it would be in a homogeneous industry.¹

The set up for investigating this would thus be through a heterogeneous good that is not the exclusively exported product. Wine is a highly differentiated good with respect to different grapes and countries of origin. Furthermore, since alcoholic beverages often are subject to regulations, the trade flows are expected to be well documented, and there are many production countries to choose from. To investigate potential sunk cost spillovers, however, using data from the biggest producers could be a disadvantage due to the fact that export is likely to be present in all periods. Thus, a moderately big producer such as Chile would appear to be more appropriate.

Choosing what other industries to search for potential spillover effects is somewhat problematic, since these not necessarily need to stem from an adjacent industry. This would leave an immense set of industries to compare, and also taking into account the impact from other factors such as distance, size and exchange rate relative to the export destination. Instead of choosing and testing the spillovers from many different industries separately, more reliable results would be obtained by testing the sunk costs against export diversity indices. By doing so we capture the compound effect from a large number of different industries at the same time, instead of testing each of them separately.

### 1.4 Purpose

The purpose of this thesis is to investigate the presence of sunk costs in the Chilean wine export industry and in what manner, if any, these costs are subject to spillover effects from other exporting industries in Chile.

### 1.5 Limitations

This thesis investigates the relationship between sunk costs and export spillovers in the Chilean export for the period 1990 and 2006. Using 1990 as starting year is motivated

¹ Spence-Dixit-Stiglitz preferences will be explained closer in Chapter 3.
by data accessibility. First, industry specific export data becomes less reliable as one move further back in time. Second, because of the large demographical and geographic difference between the 1980s and the 1990s following the collapse of the Soviet Union, many of the country panels would be inapplicable.\(^2\)

We use industry level data on aggregate country level for each year and industry and not for specific firms. By doing this, we measure the spillovers between industries at large rather than between individual firms. The explicit sunk cost of an individual firm is therefore not our focus, but rather the probability of a positive export status of Chilean wine exports given previous wine export status as well as previous export diversity.

With respect to control variables, different studies use different ones. Most commonly, GDP, distance, common language, cultural/political similarities and the sharing of colonial heritage are included. For this study, the last three ones will be omitted since their effects are expected to be captured by the distance variable.\(^3\)

### 1.6 Disposition

Chapter 2 contains a presentation of the theories underlying the thesis, such as heterogeneous goods, sunk costs and spillover effects. Even though this thesis will be based on industry level data, chapter 2 will also contain a short introduction to heterogeneous firms due to their importance for understanding the intuition behind how sunk costs affect the export status of firms. Readers that are already familiar with the heterogeneous firm model can skip this section. Chapter 3 begins with a short introduction to the Chilean wine industry and then describes the data set used for the tests. Chapter 4 presents the methodology: the variables included and their expected impact on sunk costs, the econometric estimation techniques together with issues related to these. Chapter 5 describes the results followed by an analysis of these in chapter 6, and our conclusions are presented in chapter 7.

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\(^2\) Many of the destination countries measured in this paper did not exist until the early 90's, as they were part of the Soviet Union.

\(^3\) Although this assumption is a generalization, with respect to colonial heritage, common language and historic political development, one can say they are fairly similar when considering the Latin-American countries.
2. Theoretical Background

2.1 Heterogeneous goods

Recent attempts to model different markets have started off by characterizing the type of good as homogeneous or heterogeneous, respectively. The main difference is that for a heterogeneous good, the producer differentiates the chosen product, thus creating a market situation that builds on imperfect competition. That is, as some consumers clearly prefer a red car for a blue, all else equal, in this case the producers of red cars will possess monopolistic power. (Helpman and Krugman, 1985). The distinction between what is to be considered homogeneous or heterogeneous is, however, not always straightforward. Rauch (1999) defined homogeneous goods as those that have a reference price or are traded on organized exchanges, whereas heterogeneous goods by their intrinsic nature cannot be generally traded at a reference price. More importantly, differentiated goods carry with them a search cost, which can be considered a barrier of entry for a market.\(^4\)

Following the work of Dixit and Stiglitz, a model of consumer behaviour has been evolved to explain how the demand for heterogeneous good is not only a function of the price and – implicitly – the elasticity of demand, but also for the number of available varieties of a specific good. The demand function can be expressed for a continuum of goods as well as a discrete number. For a discrete set of varieties, \(\omega \in \Omega\), the upper tier utility function can be expressed as:

\[
U = \left[ \sum_{\omega \in \Omega} q(\omega)^\rho \right]^{1/\rho}
\]

where \(\rho\) is the share of variety \(\omega\) of total consumption such that \(0 < \rho < 1\). With S-D-S preferences, the aggregate price for a bundle of varieties \(\omega \in \Omega\) can be expressed as:

\[
P = \left[ \sum_{\omega \in \Omega} p(\omega)^{1-\sigma} \right]^{1/(1-\sigma)}
\]

\(^4\) As Rauch (1999, p.9) puts it, although a certain plastic component in shoes might not be traded on an exchange, they can still be valued at a reference price regardless of who is producing it, whereas this “anonymity” does not apply to the shoe produced since it is branded. Therefore, producers and consumers need to incur a search cost when taking into account multidimensional characteristics of a certain type/brand of shoes.
where $\sigma$ is the elasticity of substitution between two goods such that $\sigma = 1/(1 - \rho) > 1$. This implies that an increase in the price of variety $\omega$ will lead to a substitution effect, but as consumers value variation per se, they will typically substitute their consumption with less than 1. Consequently, as soon as a new variety is introduced, there will be a demand for it since it implies a greater possibility of variation in the consumption bundle. (Melitz, 2003).

### 2.2 Heterogeneous firms

Recent work has tried to identify the determinants of trade in firms producing heterogeneous goods, where the Heckscher-Ohlin (H-O) model clearly lacks in explanatory power (Helpman and Krugman, 1985). Since the H-O model shows predictions of trade in factors of production, it will not be able to explain intra-industry trade where huge trade flows with a net factor content of zero typically are not identified (e.g. a bilateral trade of wine of the same quantity). Since goods in the H-O model are assumed to be homogeneous, there would be no reason for intra-industry trade given that countries specialize in the production of goods for which they have comparative advantage in, and simply trade the production surplus for other products. Apart from country specialization, exchange rate is one of the bigger influences of exports in classic economic theory.

Exports in these models are measured exclusively in the quantity exported and these exports are divided between an unknown numbers of homogeneous firms. Since all firms in an exporting industry are identical, it also follows that all firms in the industry export an equal amount. This, as shown by among others Mayer and Ottaviano (2007), is most often not the case. They show that most exports are generated by a small number of firms that are both bigger and more productive than other firms on the market. This firm behavior was formalized by Melitz (2003) in his heterogeneous firm model.

In the Melitz model, the respective productivity of each firm is the main determinant of its performance. Prior to entry, all firms are considered identical, and in entering each firm has to make an initial investment. Then they make a random draw from a distribution of productivity, which determines how well they perform in comparison with other similar firms. When relating the productivity level to trade costs – fixed

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5 Intra-industry trade is when countries both export and import the same good.
6 See Krugman and Obstfeld (2006) for the dynamics of exchange rates.
and/or variable – it becomes apparent that only the more productive firms will be able to make positive profits from exports. Thus, in these models, exchange rates no longer determine a firm’s export decision, which is instead predetermined by the firm’s productivity and the sunk cost of entering foreign markets. (Melitz, 2003)

2.2.1 Sunk Costs

The productivity of a firm is in many cases quantifiable and, although some differences exist in the exact definition, it is often expressed as the firm’s output in relation to the inputs needed for its production. Sunk costs of exporting are, on the other hand, not as easily measured. They are normally defined as the costs of entering a foreign market, containing, for example, tariffs or search and information costs (researching the export-market demand structure and legal structure, modifying your product to fit the foreign market, setting up distribution and service networks and advertising). Defined as non-refundable costs, the sunk costs are usually the same regardless of the exporting volume, from which it follows that these costs are less restrictive to larger firms with a larger exporting capacity than smaller ones, something also showed empirically by Das et al. (2001). Also, as noted by Gullstrand (2011), sunk costs could be more important for firms in the food and beverage industries since more than other firms, these will have to modify their goods in order to comply with the different rules and regulations of the destination markets.

The discrete-choice decision to export in a given time period can be described by the following equation:

\[ Y_{fpt} = \begin{cases} 1 & \text{(exporter)} \text{ if } \pi_{fpt} > c_{fpt} + s_{fpt}(1 - Y_{fpt-1}) \\ 0 & \text{(non-exporter)} \text{ otherwise} \end{cases} \]  

(1)

In Eq. (1), \( Y_{fpt} \) will equal 1 if firm \( f \) chooses to export to market \( p \) in period \( t \) and 0 if it does not. \( \pi_{fpt} \) is the current and expected value of revenues from exporting, \( c_{fpt} \) is current costs and \( Y_{fpt-1} \) takes the value 1 if the firm exported in period \( t-1 \) and 0 if it did not. This means that the variable \( s_{fpt} \) represent the sunk cost of entering market \( p \), which will only take on a value different from zero if the firm did not export in previous periods.
Sunk costs are, however, not easy to quantify since they consist of a lot of smaller costs that compiled create a barrier of entry. Therefore, due to lack of exact data, studies made on the subject have made the assumption that sunk costs can be measured by the importance of previous export status on the present status and persistence in exporting would through this logic be explained by sunk costs. This persistence in exporting is the reason behind export hysteresis, meaning that the export entry and exit are inert. This is because it costs more to enter a market than to stay there, so once the entry sunk cost is paid the firm will stay in the market even though they might make a loss for a period (due to e.g. exchange rate fluctuations), only to avoid having to repay the entry cost on re-entering the market.

There are some commonly named variables that are assumed to affect the size of the sunk costs. As mentioned previously, exchange rates are classically assumed to be one of biggest influences on exports, but research has shown that they do not play a very large role in affecting sunk costs. They do however seem to have an effect in the intensive margin of current exporters, meaning that the exchange rate does not influence the choice of a non-exporter to start exporting but it does affect the quantity exported by established exporters. Baldwin (1988) proposed the argument that since the sunk cost in most cases must be paid in foreign exchange, exchange rates should affect the extensive margin. This has, however not been empirically shown.

Trade policies of both the exporting country and its target market could also have large influence on sunk costs. Previous research has not been conclusive in its results, but in general it has been shown that increased trade liberalization has the effect of increasing exports, while export promotion policies have had a more mixed effect (Greenaway and Kneller, 2007). In our framework, increased trade liberalization reduces both variable exporting costs as well as export sunk costs. Sunk costs could be reduced by liberalization by, for example, reducing the costs of getting trade approvals as well as reducing the bureaucratic administration. A sort of export promotion that both Bernard and Jensen (2004) and Alvarez (2004) found to increase exports is non-monetary promotion such as market studies and network creation with experts and potential associates in the foreign market.

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7 The intensive margin of exports refers to the quantity exported by an established firm to a specific market, while the extensive margin refers to the number of exporting firms, see for example Chaney (2008).
2.2.2 Sunk Cost Spillovers

In theory, the externalities associated with the exports of one firm could lead to a reduction of sunk cost for another firm exporting to the same region. This externality, or spillover, is assumed to take on many forms; it could concern regional spillovers from a firm located nearby or a firm within the same industry (Greenaway and Kneller, 2007). These spillovers could also affect all firms exporting to a certain market. Information regarding demand structure or how to set up transportation channels is not restricted to firms within the same region or industry, but could be observed by all exporters within a country. Previous exporters could also function as an informal guide through bureaucratic hinders, saving time and legal fees for new entrants to a market and provide information on foreign prices, demand structures and standard requirements. (Krautheim, 2008). Given that this is the case it would show itself in a reduction of the sunk cost coefficient $s_{fp_t}$ in Eq. (1) when introducing the other firms’ exports into the model.
3. Data

This section covers the data collection process, thereby containing both a description of data sources as well as graphs describing the collected sample. Since the main focus of the thesis concerns the Chilean wine industry, a short introduction of its development on the international markets will open the chapter.

3.1 Wine in Chile

The production of wine was influenced by European colonizers, who brought wine to the country thus incorporating it in the diet of the colonized areas. As the Chilean soil proved adequate for cultivating grapes, imports were gradually replaced by domestic production. Initially, however, the domestic wine was of poor quality and mainly destined for local consumption. During the 1980’s, producers started focusing on improving the quality of their wine, which then allowed Chilean wines to compete on the international markets.

As seen in Graph 3.1, the left hand side shows the production and export quantities of wine between 1989 and 2002. The right hand side shows the export percentage of total production. Production increased from 390,000 to 562,000 thousand litres per year, corresponding to 44 percent. The more dramatic increase is in quantities and percentage exported, where the former has grown with 1,142 percent and the latter has increased by 56 percentage points.

Graph 3.1. Wine Production and Exports in Chile, 1989 - 2002

Graph based on Chandra (2006) Table 7.1, p.228.

13
Chile’s share of the world wine market grew steadily from less than 0.5 percent in 1988 to approximately 4 percent by the year 2000 (Chandra, 2006, p.226). The 1990’s trade liberalisations, combined with a domestic fall in the per capita consumption of wine and an increase in wine consumption in the United States, Canada and United Kingdom, increased the export share of Chilean wine production from 7 to 63 percent between 1989 and 2001. Much of technology improvements in the production did not come from R&D, but rather from “learning by looking” as Chilean wine producers – as well as producers from other countries – travel around during harvest time to study other producers. In Chile, these “technology-capturing tours” are partly financed by the government. Consulting is also common as well as international wine fairs, leading to technology exchange between countries. Furthermore, 45 of the biggest wineries formed “Viñas de Chile”, an association with the purpose of facilitating joint venture projects and overall cooperation between wineries in order to avoid duplicated research and protecting smaller producers from price consequences of overproduction (Chandra, 2006).

3.2 Data Sample

Our export data is collected from the United Nations Commodity Trade Statistics Database (COMTRADE) and covers the period 1990 to 1996. It contains information regarding the trade between Chile and 100 export destinations, for which we chose the countries with the highest GDP per capita in 2008 according to the World Bank. One reason for making this restriction was due to the lack of data for the poorer countries. Of these 100, Chile had not exported at all to 8 countries during the selected period and these were therefore dropped from the sample. Country specific data is taken from Centre d’Etudes Prospectives et d’Informations Internationales (CEPII). The data contains information of distance, colonial heritage and common language among other things, but we only include distance in our models due to reasons previously mentioned. The GDP data is taken from the World Bank.

Although the data downloaded from COMTRADE contains information on both value and quantity of exports, we have chosen to work with the value of exports since information on quantity is often lacking or estimated with the help of exported value. A problem with the data obtained is that COMTRADE does not distinguish between when export is zero and when it only appears to be zero due to the fact that trade has not been reported. We
therefore define all missing values as zeroes since these are needed in order to measure the transition from not exporting to exporting. This can, which we are aware of, produce biased results as we may report zeroes when there in fact were some exports.

The downloaded data concerns exports from 31 different industries that were picked from the Harmonized Commodity Description and Coding System (HS) at a two-digit level, except for wine, which is defined at a four-digit level. The HS system was developed by the World Customs Organization and at its six-digit level it consist of about 5,000 commodity groups that are organized according to product characteristics, such as “animal” or “metal” products. At the two-digit level the HS system is made up of 99 categories, which in turn can be divided into 15 groups of product characteristics. We include two industries from each one of these 15 industry-groups with the exception this being group 1, “Animal and Animal Products”, where three industries are included. The reason for this is that “Meat” and “Fish” are defined as two different categories, and we wanted to include both of these as well as “Dairy and Eggs”. We obtained a total of 50,000 industry-destination-time observations out of which approximately 16,500 observations showed a positive export status.

Most export during the period went to the United States that imported to a total value of approximately 1.5 billion followed by the United Kingdom that imported to a value of 1.3 billion. The third place was Canada that imported to a value of 560 million dollars. Of the 92 countries in the sample, 8 countries did not import any wine at all during the period and 30 imported during all of the 17. On average, Chile exported to each country in the sample approximately 10 of the 17 years, to a total value of 78,806,710 USD or 4 815 314 USD/Year.

The growth of export destinations of wine is shown in Graph 3.2.

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8 A list of the included industries is found in Appendix A1.
The number of countries in our sample that imported Chilean wine more than doubled as it grew from 35 to 76 during the period.

Graph 3.3 shows the corresponding development for total export destination, which also grew, albeit more moderately.

Graph 3.4 compares these two when put together and expressed as percentage growth. Starting with 1990 as base year, the wine export sector has since mid 1990's grown more rapidly than total exports. As mentioned in chapter 2, exports of domestically produced wine were until recently fairly small, which probably explains why the
number of export destinations has grown more rapidly during the 1990's and 2000's in comparison with the 31 industries aggregated.

Graph 3.4. Export destinations growth, 1991 - 2006

Growth since 1990

Year

Percentage change, wine
Percentage change, all goods
4. Method

The method follows Roberts and Tybout (1997), Bernard and Jensen (2004) and Gullstrand (2011). The goal is to estimate a probability model that captures the effect of previous exports by including a set of control variables and lagged dependent variables. We start by introducing the variables used and then present how the models are specified and how these can be estimated.

4.1 Variables

The variables presented in this chapter are calculated for each destination country each year. Since the exporter remains the same, it is not expressed explicitly in the subscripts. Thus, the index $E_{ipt}$, for example, considers exports from Chile to each of the included destination-country-years in the sample. The purpose of using indices instead of simply inserting values for each of the categories is that an index should manage to capture the overall effect of having a diversified import sector, whereas the use of dummies or quantities for each of the 31 product classes might produce low and/or insignificant values. Since the definition of export differentiation is not obvious, we use three different ones and test them separately for sunk cost spillover effects. The first three variables in this section are our diversification indices, and the last three are control variables for destination specific effects.

4.1.1 Spillover variables

The Herfindahl-index is a measure of how diversified the imports are in a given country. Following Gollop and Monahan (1991), it is calculated by:

$$E_{ipt} = 1 - \sum_i h_{ipt}^2,$$

where $h_{ipt}$ is the share of good $i$ of total exports from Chile to country $p$ in period $t$. A value of $E_{ipt}$ close to zero implies that exports are highly concentrated within a few industries, whereas a value close to one represents a well-diversified export. To calculate the index, we use 31 relatively broad product groups from the HS-classification for each destination-year.

The Herfindahl-index is expected to have a positive effect on the export-decision of wine. This is because a well-diversified export market should increase the probability of
export in a given period due to the larger number of firms that can create the potential positive spillover effects on the inter-industry level. On the other hand, a low value does in no way exclude the presence of trade in each sector, it only illustrates how densely distributed the quantities are. One disadvantage of using the Herfindahl-index is that it does not take into account the size of the country, so a relatively small country that is well diversified would in this sense be “better” than a relatively large country with less diversification, although the latter might constitute an immensely larger trading partner.

The Export participation-index is a discrete variable based on dummies for each of the 31 industries; it is the sum of all industries where trade occur in each period, thus ranging in the interval (0,31):

\[
E_{2pt} = \sum_{i=1}^{31} D_{ipt},
\]

where \( D_{ipt} \) is a dummy such that:

\[
D_{ipt} = \begin{cases} 
1 & \text{if } q_{ipt} > 0 \\
0 & \text{otherwise} 
\end{cases},
\]

where \( q_{ipt} \) represents exports of good \( i \) to country \( p \) in period \( t \). The export participation-index is expected to be positively correlated with the probability of wine exports in the subsequent period. Since it is based on dummies, a one-dollar trade flow will be of the same importance as one of a million. This need, however, not be seen as a disadvantage, since the nature of sunk costs is assumed to be independent of trade volumes.

The Share of exports-index indicates the importance of the destination country in total exports from Chile a given year. It is calculated as:

\[
E_{3pt} = \frac{Q_{pt}}{\sum_p Q_{pt}},
\]

where \( Q_{pt} \) is total exports from Chile to country \( p \) in period \( t \). A greater value of this index shows that a specific destination country is relatively important in overall exports from Chile. The probability of spillover effects would thus increase since more trade flows (or at least bigger in quantities) are present that could positively affect the export decision of wine. This index, as opposed to the previous one, will not be able to capture the actual number of exported products, but rather how the size of total quantities could
increase the probability of wine exports. This allows us to capture potential size effects from each trading partner.

4.1.2 Additional variables

The Revealed Comparative Advantage (RCA) measure serves as a proxy for showing whether or not a country has a comparative advantage in a specific industry. This index will naturally only be calculated for the wine trade. Vollrath (1991) presents an assorted list of different RCA measures, out of which we use the fifth:

\[
RCA_{ipt} = \frac{(X_{ipt} - I_{ipt})}{(X_{ipt} + I_{ipt})},
\]

where \(X_{ipt}\) and \(I_{ipt}\) represent exports and imports of good \(i\), respectively, in period \(t\) for country \(p\). Thus, a positive (negative) RCA-value signifies a revealed comparative (dis)advantage. The effect of the RCA is somewhat ambiguous. Under S-D-S preferences, consumers in any given country would demand each variety produced, regardless of the domestic production. If this is the case, the RCA as we define it would not have an apparent effect of the demand for a given country’s wine exports/imports. On the other hand, if the RCA is positive, that is, the country has a net export of wine, the comparative advantage suggest that the domestically produced wine could be relatively cheap, and since the demand function is to some extend price elastic, the consumers might buy a greater quantity of the domestically produced wine. In this case, the RCA would be negatively correlated with the probability of wine exports from Chile.

The GDP per capita is used as a proxy for market size and is calculated as annual GDP divided by average population per year. In the estimation, the logarithms of the GDP per capita are used. We expect an increase in the GDP of the destination country to have a positive effect on the probability of exporting wine, since a higher income suggests a higher demand for consumer goods. On the other hand, as presented by Melitz and Ottaviano (2008), a bigger destination-market size suggests higher competition, which would negatively affect the wine export decision.

The last control variable included is distance. Although different measures of distance exist, we use a simple that is the straight-line distance between the capitals of Chile and the destination country (CEPII, 2011).


4.2 Econometric Specification

Previous studies on sunk costs start off with the assumption that a firm will choose to export if the expected revenue of doing so is greater than current costs and any sunk costs of entering the foreign market, which was described by Eq. (1) in chapter 2.2.1. In our framework, the subscript \(f\) is dropped since the data is on industry level rather than firm level.

By extending Eq. (1), we can now measure the importance of sunk costs on an industry level by the following model:

\[
Y_{pt} = \begin{cases} 
1 \text{ (exporter)} & \text{if } \beta X_{pt} - s^{1}(1 - Y_{pt-1}) - s^{2}(1 - Y_{pt-1})Y_{pt-2} + \varepsilon_{pt} > 0, \\
0 \text{ (non–exporter)} & \text{otherwise}
\end{cases}, \quad (2)
\]

where \(Y_{pt}\) is the export of wine to market \(p\) in period \(t\) and \(X_{pt}\) is a vector with market-time specific variables for the destination market. Market-time specific shocks are captured by \(\varepsilon_{pt}\). The parameters to be estimated are thus \(\beta\), which measure the market-time specific variables, and \(s^{1}\) and \(s^{2}\) that measure the sunk cost of exporting. Here, \(s^{1}\) will capture the lower probability of exporting in this period if there were no exports in the previous period, while \(s^{2}\) will represent effects from last exporting two periods back. The latter is included since there is a possibility that sunk costs incurred two periods back might have persistent effects despite a year’s absence of exports. However, since we expect that the effect will decrease over time, the absolute value of \(s^{2}\) should be lower than that of \(s^{1}\).

Assumed that the estimation of Eq. (2) shows the presence of sunk costs, the next step is to include the export diversification indices to test for sunk cost spillovers:

\[
Y_{pt} = \begin{cases} 
1 \text{ (exporter)} & \text{if } \beta X_{pt} + \delta E_{np_{pt-1}} - s^{1}(1 - Y_{pt-1}) - s^{2}(1 - Y_{pt-1})Y_{pt-2} \\
- s^{E}(1 - Y_{pt-1})E_{np_{pt-1}} + \varepsilon_{pt} > 0 & \text{otherwise}
\end{cases}, \quad (3)
\]

where \(E_{np_{pt}}\) represents each of the three diversification indices \(n\), respectively. In this model, \(s^{1}\) and \(s^{2}\) will represent the average importance of sunk costs and \(s^{E}\) the effect the diversification will have on this. Thus, a significant value on \(s^{E}\) would imply that sunk cost spillovers exist.
4.2.1 Econometrical issues

In a panel data setting, the dependent variable is likely to be affected by unobserved individual-specific heterogeneity. In our context, we can assume that the export status of wine will, apart from sunk costs, be affected by destination-specific characteristics such as bureaucratic and legal structure and cultural similarities. Since this unobserved heterogeneity is time-invariant, it will cause serial correlation. Hence, the error term from Eq. (2) and Eq. (3) will consist of a destination-specific component, $\alpha_p$, and a transitory component, $u_{pt}$, such that:

$$\varepsilon_{pt} = \alpha_p + u_{pt}.$$

One way to handle this problem of serial correlation is to estimate a fixed-effects model, which would remove the destination-specific effects. However, since the lagged dependent variable is correlated with the destination-specific effects, the removal of these will give us downward biased estimates. The other option is to use a random-effects model, which on the other hand requires that $\alpha_p$ be uncorrelated with the explanatory variables. This can be handled, though, by using a dynamic random-effects probit model. (Bernard and Jensen, 2004). Since the value of $Y_{p0}$ in the starting year, 1990, is conditional upon destination characteristics, including it in the regression will capture the destination specific component, $\alpha_p$ (Wooldridge, 2005). The variable $Y_{p0}$ is therefore included in the vector $X_{pt}$ of control variables in the estimations of Eq. (2) and Eq. (3).

Although we expect the dynamic random-effects probit model to give us the most reliable results, we will also perform alternative tests on the importance of sunk costs, using a random-effects probit as well as a fixed-effects linear probability model. This will provide us with a lower and upper bound on the sunk costs coefficients and test if the data produce the results predicted in this section for the different specifications.
5. Results

In table 1 we can see the results from Eq. (2) where we test the original model for sunk costs in both the last and second last period. The elasticity coefficients illustrate the economic interpretation and the number within the parentheses show the statistical significance of the coefficients.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Sunk costs and destinations specific var. explaining export status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fixed-Effects Linear Probability</td>
</tr>
<tr>
<td><strong>Lagged export status</strong></td>
<td></td>
</tr>
<tr>
<td>Exported last year</td>
<td>0.304 (0.000)</td>
</tr>
<tr>
<td>Last exported two years ago</td>
<td>0.010 (0.001)</td>
</tr>
<tr>
<td>Initial dummy value</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Market characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>Distance</td>
<td>n/a</td>
</tr>
<tr>
<td>Revealed comparative advantage</td>
<td>0.011 (0.289)</td>
</tr>
<tr>
<td>Ln GDP/Capita</td>
<td>0.676 (0.000)</td>
</tr>
</tbody>
</table>

| Rho | 0.541 | 0.491 | 0.341 |
| ChiSq p-value (H0: all coefficients zero) | n/a | 0.000 | 0.000 |
| R-squared | 0.33 | n/a | n/a |
| Log Likelihood | n/a | -320.868 | -309.597 |
| # Obs | 1112 | 1112 | 1112 |

Numbers in parentheses are p-values

*All coefficients are elasticities

These results follow both our own predictions as well as the previous research done on sunk costs. All the coefficients used in the model are statistically significant except for the revealed comparative advantage-index, which shows low significance regardless of the estimation technique used.

The two other destination-specific variables are both statistically significant and have the anticipated signs. The distance coefficient implies that the probability of exporting decreases with distance, as expected. Distance is removed when running the fixed effects model since it is a constant.

The GDP per capita growth of the export destination is also strongly significant, with a positive impact on the probability of exporting.
The three estimations provide us with a window for the importance of previous exports. The fixed-effects linear estimation gives a lower bound where exporting the previous year increases the probability of a continued export with 30 percent. The upper bound comes from the probit random-effects model, where the probability of exporting increases by 94 percent in the presence of previous exports. Finally, the dynamic random-effects probit estimator lowers that probability to 88.3 percent. All three estimates are strongly significant and the exporting status for the initial year 1990 introduced in the dynamic model also shows a strong significance, where a positive initial export status increases the probability of exporting in any of the years in the sample with 48.5 percent. The importance of last having exported two years ago varies between one and approximately three percent.

Since the dynamic random-effects probit model uses more of the available information, it is likely to produce the most reliable results. Therefore it is the one we use when testing for sunk cost spillovers. Table 2 shows the results of introducing the export diversification indices into the dynamic random-effects probit model. As can be seen in all three columns none of the indices enter the model with any significance.

Beginning with column 1, where the Herfindahl-index is introduced as an explanatory variable, we can see that the cross product of the Herfindahl-index and Exported last year is not statistically significant which indicates that export diversification does not affect the sunk costs in this sample. The lagged Herfindahl-index by itself, on the other hand, is significant at a 10 percent level, which indicates that a diversified export do affect the probability of exporting by itself. Column 2, which explains the effect of number of products previously exported, shows similar results as the Herfindahl-index, even though the p-value for the cross-product is lower than for the Herfindahl-index. It is however still at a level where we cannot reject that the number of products exported previously has no effect on sunk costs. The third index in column 3, Share of total exports, shows essentially the same results as the previous two, with the exception that in this case the lagged diversity index in isolation is also statistically insignificant in affecting the probability of exporting by itself.

Thus, none of the three indices in our data set show any significant effect on the sunk costs observed in Table 1.
<table>
<thead>
<tr>
<th></th>
<th>Herfindahl</th>
<th>Nr. Products</th>
<th>Share of exports</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lagged export status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exported last year</td>
<td>0.370 (0.016)</td>
<td>0.630 (0.000)</td>
<td>0.378 (0.003)</td>
</tr>
<tr>
<td>Last exported two years ago</td>
<td>0.007 (0.203)</td>
<td>0.019 (0.017)</td>
<td>0.012 (0.014)</td>
</tr>
<tr>
<td>Initial dummy value</td>
<td>0.403 (0.000)</td>
<td>0.183 (0.037)</td>
<td>0.122 (0.037)</td>
</tr>
<tr>
<td><strong>Market characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance</td>
<td>-0.268 (0.282)</td>
<td>-0.429 (0.033)</td>
<td>-0.300 (0.023)</td>
</tr>
<tr>
<td>Revealed comparative advantage</td>
<td>0.003 (0.887)</td>
<td>0.002 (0.925)</td>
<td>-0.009 (0.441)</td>
</tr>
<tr>
<td>Ln GDP/Capita</td>
<td>0.600 (0.001)</td>
<td>0.450 (0.014)</td>
<td>0.270 (0.023)</td>
</tr>
<tr>
<td><strong>Interactions with export diversity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herfindahl index t-1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herfindahl t-1*Exported Last Year</td>
<td>0.002 (0.982)</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Nr. Products t-1</td>
<td></td>
<td>1.014 (0.000)</td>
<td>...</td>
</tr>
<tr>
<td>Nr. Products t-1* Exported Last Year</td>
<td>...</td>
<td>-0.250 (0.389)</td>
<td>...</td>
</tr>
<tr>
<td>Share of Exports t-1</td>
<td></td>
<td>...</td>
<td>0.365 (0.156)</td>
</tr>
<tr>
<td>Share of exports t-1*Exported Last Year</td>
<td>...</td>
<td>...</td>
<td>0.340 (0.240)</td>
</tr>
<tr>
<td><strong>Rho</strong></td>
<td>0.56</td>
<td>0.219</td>
<td>0.232</td>
</tr>
<tr>
<td>ChiSq p-value (H0: all coefficients zero)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>-193.229</td>
<td>-290.965</td>
<td>-301.144</td>
</tr>
<tr>
<td># Obs</td>
<td>901</td>
<td>1112</td>
<td>1112</td>
</tr>
</tbody>
</table>

Numbers in parantheses are p-values

The reported coefficients are elasticities
6. Analysis

6.1. Analysis of the sunk cost model

The results showed that there are sunk costs present in the wine export industry, which to a large extent goes in line with previous studies on sunk costs. As opposed to previous studies that use firm level data, our data is on an industry level, which slightly affects the interpretation of the results. We can, however, start by concluding that besides the presence of sunk costs, the control variables affect the probability of wine exports as anticipated.

The different estimators provide us with a bounded interval regarding the impact of each variable, respectively. Some differences need to be pointed out, however, when analyzing the results. Since the random-effects probit estimator does not account for the initial conditions, it systematically overestimates the importance of each variable while the fixed-effects will underestimate the coefficients. Even with these differences, the estimations provide coherent positive/negative relationships in the coefficients, despite the variations in the coefficient values. This serves as a sensitivity analysis of the model specification with respect to the included variables.

The probability of exporting wine decreases with distance due to transportation costs that increase with distance. This variable could however, as discussed in chapter 4, capture cultural differences that also increase with distance and thus further reduce the probability of exporting. This is especially relevant in the case of Chile, since many South American countries are culturally and linguistically similar to one another. Distance could in that sense partly catch the fact that the variable transportation costs increase with distance, reducing the expected profits from exporting, but also the difficulty of matching ones products with markets that are more distant in a cultural sense.

The variable for GDP per capita has a strongly significant impact on the probability of exporting. This is explained by the fact that an increased income for the destination market means a stronger purchase power and an increased aggregate demand. One could argue, however, that more “exotic” varieties would only be demanded as the level of income passes a certain level, because a larger fraction of the disposable income could then be spent on this type of luxury items. This could therefore also explain the
increased probability of Chilean wine exports, especially when considering the more exclusive varieties that could be sold on a market where the variety spectrum was previously too narrow. The S-D-S preferences, however, point rather to the first explanation, given that all available varieties should be demanded simply due to their existence and an increased demand should stem from a pure income effect.

Our third control variable, the revealed comparative advantage (RCA), that was intended to capture destination market comparative advantages in wine production, did not show to be statistically significant, regardless of the estimation technique used. This could be due to how this RCA measure is constructed and whether or not it is a good proxy for comparative advantage; in fact, this RCA measure shows little variation over time for each country. We find it probable that, in general, there is little variation in the production and consumption of wine, although export destinations may vary. This could be tested by using another of the definitions of RCA mentioned in the literature. Another more parsimonious explanation would be that the comparative advantage for the destination market simply does not play an important role when it comes to explaining the probability of exports in heterogeneous goods, which could be implied by the small coefficient value. Following the theory in 4.1.2, the insignificant RCA goes in line with S-D-S preferences.

The effect of previous export statuses on the Chilean wine export decision is substantial, even when looking at the lower bound fixed-effects estimation. Since regulations on food and beverages are extensive – especially on alcohol beverages – the fixed costs associated with export should be of great importance. Another explanation for the strong findings regarding these sunk costs probably comes from the fact that they are measured for the entire Chilean wine industry. As mentioned in chapter 3.1, this industry is characterized by cooperation through the creation of the association “Viñas de Chile”. From this it can be assumed that the sunk costs that concern product adaptation, transport channels or legal matters are, to some extent, shared among the different exporters. If this is the case it would mean that even producers of lower quality wines, who are likely to have smaller expected future profits from exporting, can afford to enter new markets. This solves the issue of sunk costs being a larger problem for smaller, less profitable firms. Hence, Chilean wine exports will cover both the high-quality as well as the low-quality market, and once the industry has paid its sunk costs
for a new market at least one of these quality groups are likely to keep exporting. This would explain why the sunk cost coefficient found in our data is greater than the ones found by, for example, Roberts and Tybout (1997) or Gullstrand (2011). However, sunk costs of our magnitude on firm-level was found by Buramelli and Infante, which shows that the magnitude of sunk costs is hard to generalize as it appears to depend on the industry subject to the study.

The effect of last exported two years ago is interesting, being a modest 2 percent. The explanation for this could be that regulations are quite transitory and that having a one-year break in the export would necessitate some new search costs despite having exported previously. Another explanation is that the varieties of wine available in the world are substantial, and that the existing trade relationships must be guarded in order to not be substituted for another exporter. This would rather be a practical limitation of the S-D-S preferences since stores in different countries have limited space, thus not being able to offer every variety available. As a wine exporter, this would emphasize the importance of guarding ones shelf-space and that a one-year break could make it hard to regain a place in the shelves.

The issues concerning serial correlation in our models described in chapter 5 is worth mentioning. The presence of unobserved destination-specific heterogeneity in the data would create biased results, but can to some extent be solved by the inclusion of our initial value as a dummy variable. The strong statistical significance of this variable suggests that it captures a lot of the heterogeneity effects that could not be captured by our other control variables. More importantly, the inclusion of initial values decreases the average importance of previous exports, which is what we would expect. If Chilean wine exports were present in a given country in the first period, this will most likely affect future export decision and can be seen as some path dependence. Neglecting the initial condition would thus overestimate the importance of sunk costs, which is why the dynamic random-effects probit model is better suited than the others.

6.2. Analysis of the sunk cost spillover models

The results in Table 2 did not show any significant relationship between sunk costs and export diversification. When considering how the control variables change after introducing the indices, for the Herfindahl-index, both the Last exported two years ago
and Distance become insignificant, which could indicate that this index creates some problem in the specification. For the other two indices, all control variables except the RCA measure remain significant at the 5 percent level, which makes the interpretation more straightforward, that there are simply no spillover effects present.

When considering the one-year lag of three indices by themselves, these are statistically significant for the first two; the Herfindahl-index at a 10 percent significance level and the Number of products even at a 1 percent level. The interpretation of this is that the lagged indices, when not interacted with sunk costs, illustrate an average effect that a diversified export has on the probability of exporting wine. That is, if many industries export to a certain market, the likelihood that Chile will also export wine to that market increases. Therefore, this variable serves merely as a proxy for the extent of openness to trade; that there are generally low trade barriers between Chile and the destination country and thus more exports. Therefore, no immediate causal relationship between sunk costs and a diversified export can be derived from any of the indices.

The lack of spillover effects in the sunk costs could be explained by the nature of the goods themselves. As we have chosen a heterogeneous good, we have also implicitly imposed a restriction on the nature of the sunk costs. More specifically, the search cost that is typical for a branded good – as opposed to a homogeneous good that is traded at a reference price – would make each good somewhat unique and thus limit the transferability of the sunk costs. Since the majority of the Chilean wineries are using Viñas de Chile to coordinate distribution and facilitate network creation in the destination market, what is mostly left for the individual wine producer is to differentiate its own variety to fit the destination market. This is however, unlikely to be facilitated by the sunk costs incurred by a different industry in previous periods. This means that, for example, the export of cars could only to a certain extent diminish the search costs for a potential wine exporter, since the goods have intrinsic characteristics that are not transferrable with respect to trade.

From this, we draw the conclusion that the absence of industry level sunk cost spillovers towards the Chilean wine exports is explained by product heterogeneity, which reduces or eliminates the usefulness of previous export experiences from other industries.
7. Conclusions

The export status of the Chilean wine industry between 1990 and 2006 shows history dependence, where the export status of the previous period increases the probability of exports in the present period. This result emphasizes the importance of export sunk costs for future export decisions, and the results are in line with previous research that has been done on firm level data. Depending on whether one uses a linear or non-linear estimation, last year’s exports increase the probability of exporting this year by somewhere between 30 and 94 percent. The most reliable result is provided by a dynamic random-effects probit model, which estimates this effect to be 88 percent.

Our assumption that sunk costs incurred by other exporting industries could create positive spillover effects on the wine industry cannot be proved by the data and estimation techniques used. We explain the lack of sunk cost spillover effects between industries by the heterogeneity of the goods, which impedes the transferability of sunk costs. However, spillovers are most likely to be present – albeit on an intra-industry level – between Chilean wine producers who cooperate in production and distribution processes through the association “Viñas de Chile”. A relevant topic for future research would therefore be to investigate to what extend associations such as “Viñas de Chile” can create positive export spillover effects within industries and thus be important tools for encouraging exports.
References


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Appendix

A1.
Country List

<table>
<thead>
<tr>
<th>Algeria</th>
<th>Cuba</th>
<th>Kazakhstan</th>
<th>Russian Federation</th>
</tr>
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<tbody>
<tr>
<td>Andorra</td>
<td>Cyprus</td>
<td>Kuwait</td>
<td>Saint Kitts and Nevis</td>
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<td>Croatia</td>
<td>Japan</td>
<td>Romania</td>
<td>Venezuela</td>
</tr>
</tbody>
</table>
A2. Product groups with corresponding HS-classification code

2204 Wine of Fresh Grapes, Grape Must, NESOI
  2 Meat & Edible Meat Offal
  3 Fish & Crustaceans
  4 Dairy, Eggs, Honey, & Ed. Products
  7 Edible Vegetables
  9 Coffee, Tea, Mate & Spices
 16 Ed. Prep. Of Meat, Fish, Crustaceans, etc.
 22 Beverages, Spirits & Vinegar
 25 Salt, Sulphur, Earth & Stone, Lime & Cement
 27 Mineral Fuels, Oils, Waxes & Bituminous Sub
 28 Inorganic Chem, Org/Inorg Compounds of Precious Metals, Isotopes
 29 Organic Chemicals
 39 Plastics & Articles thereof
 40 Rubbers & Articles thereof
 41 Raw Hides & Skins & Leather
 42 Articles of Leather, Saddlery & Harness, Travel Goods, Handbags, Articles of Gut
 44 Wood & Articles of Wood, Wood Charcoal
 48 Paper & Paperboard, Articles of Paper Pulp
 61 Articles of Apparel & Clothing - Knitted
 62 Articles of Apparel & Clothing - Non-knitted
 64 Footwear, Gaiters, & the like
 65 Headgear & other parts
 69 Ceramic Products
 70 Glass & Glassware
 72 Iron & Steel
 74 Copper & Articles thereof
 84 Nuclear Reactors, boilers, machinery, etc
 85 Electrical Machinery & Equip.
 87 Vehicles other than Railway or Tramway rolling
 89 Ships, Boats & Floating Structures
 94 Furniture, Bedding, Cushions, Lamps & Lighting fittings NESOI,
     Illuminated signs, Nameplates & the like, Prefabricated Buildings
 96 Miscellaneous Manufactured Articles