Blood Alcohol Regulations and EU Beer Exports

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Abstract

We examine how blood alcohol content (BAC) regulations have affected EU beer exports over the 1995–2019 period. We use BAC levels to group destination markets into five groups and examine how beer exports vary across BAC stringency. We distinguish between changes in the breadth of countries serviced (the extensive margin) and the trade deepening (the intensive margin). We find BAC rules affect the two margins differently. The breadth of EU exports is lower for destination markets with the least stringent BAC rules than markets with more stringent rules (i.e., lower BAC cutoff). By contrast, we find that the depth of EU exports increases as the BAC rules become less stringent. We offer possible explanations for the divergent effects of BAC rules on trade patterns but the results highlight the need for ongoing research on the topic. (136 words)

Keywords: beer exports, blood alcohol content, trade depth, trade breadth, regulation
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INTRODUCTION

Over the last 30 years consumption and trade of beer has increased worldwide. For example, between 1999 and 2019, worldwide exports of beer from EU members have increased by 35%. Despite the impressive average growth there is significant variation across EU members. For example, British and Greek exports decreased by 27% and 41%, respectively, while Romanian and Bulgarian exports increased by more than 2,000%. One source of the variation in the growth of beer exports across EU members has to do with newfound opportunities of new members following successive rounds of expansion of the EU since 2000 and another is due to trade deepening.

A complicating factor for understanding the evolution of beer trade is that alcohol exports, in general, and beer exports, specifically, are subject to numerous regulations in destination markets. Some countries, such as Egypt, Indonesia, Iran, and Pakistan, prohibit the consumption of any alcohol or beer, a rule that one would imagine has a depressing effect on trade![1] More commonly, countries allow but regulate beer and alcohol consumption. A common regulation involves blood alcohol content (BAC), also referred to as blood alcohol level. Governments often establish a maximum BAC for driving a motor vehicle and motorcycle. BAC regulations vary across countries, with some countries having lower legal limits and others having higher limits. Assuming BAC rules are enforced, a lower BAC level should affect the amount of alcohol consumed. Further, one could expect BAC rules to affect a supplier's exports across markets with more exports to those countries with less restrictive regulations. We focus on the role of blood-alcohol content level as it is a regulation that is imposed in virtually all countries and hence allows us to conduct a large

[1] A total of 26 countries in our data prohibit consumption of beer.

cross-country investigation, covering multiple exporters and virtually the entirety of their destination markets, rather than focusing on a specific case study focused on a less universal regulation.

In this chapter we offer an initial examination of the interplay between BAC regulations and beer exports. The focus of our investigation is how BAC regulations in destination markets affect the extensive and intensive margins of EU members' exports. The extensive margin captures the *breadth* of exports and is most often measured as a simple count of the number of markets a country exports. The intensive margin captures the *depth* of exports and reflects how large exports are to an average destination. It is typically measured as average sales across all markets.

We discover a number of interesting patterns. To begin with, we find that beer exports are observed even for destination countries where alcohol consumption is prohibited. The prohibition appears to be more binding for beer in kegs and less binding for beer in cans and bottles – packaging formats which presumably are easier to avoid detection.[2] Second, while we find that it is generally true that lower BAC levels imply lower levels of consumption and trade, the observed trade dynamics are not uniformly related to differences in BAC levels. Broadly stated, beer exports are higher to countries with less restrictive BAC rules. This is not an unexpected result. However, we find that exports to countries with the least restrictive BAC rules are lower than to those with somewhat more restrictive BAC rules.

Both the breadth and the depth of beer exports are higher for countries that were already in the EU before its expansion in 1995, many of whom are considered to be the traditional beer-brewing countries, such as

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[2] Our data is reported by exporters, not importers. As our exporters are member of the EU it is possible they report exports to countries where consumption is prohibited. Presumably were we able to use import data reported by countries where alcohol is prohibited we would not observe any imports in trade. If that were indeed the case, we could conclude that beer in cans and bottles is imported in ways that avoid detection.

Belgium, Germany, Great Britain, the Netherlands, and Ireland. The new members that joined in 1995 have a higher extensive margin, exporting to more destinations, than those that joined after 2003, while the differences between the two sets are more muted on the intensive margin, the average sales to a destination. Once we take into account the different packaging containers in which beer is sold, exports of beer in cans, bottles, and kegs tend to reach fewer destination markets with higher BAC levels, i.e., have a lower extensive margin. However, exports to markets with higher BAC levels generally involve much larger values resulting in significantly larger intensive margins, especially for bottles and kegs exported to markets with highest BAC levels. Our findings make it clear that the observed beer trade patterns are more complicated than one might expect from a simple rank ordering of BAC cutoffs. Additional study of the reasons for these empirical findings is an interesting path for future research.

RELATED LITERATURE

A number of previous studies have documented the effect of regulations on beer consumption and production. While none of these studies have focused on beer trade they provide helpful background and context for our results. There are four key insights from the prior literature that are particularly relevant.

The first key issue stressed in the literature is that BAC is just one type of (beer) regulation. Staples et al., (2021) document that within the United States alone there are literally thousands of regulations governing the production, distribution, and consumption of beer. Moreover, they point out that regulations vary significantly across production and consumption localities. These varying regulations can mean that some beer products might be sold and consumed in certain localities (and/or consumption outlets) but not in others. More generally, the complicated web of regulations raises the cost of distribution and sales. These higher costs will limit which brewers and beer brands will be available to each market. As Melitz (2003) demonstrated, higher trade costs (which in this case are due to regulatory regimes) will reduce the number

of beer varieties available. In addition, economic theory predicts that smaller brewers and the most geographically distant brewers will not service high regulatory cost locations.

The second key issue is the challenge of compiling consistent regulatory measures across a large set of countries. For example, Staples et al. (2021) are limited to variations across U.S. localities. Limited data on regulations across a broader set of countries handicaps most of the literature. The cross-country empirical studies that have been conducted are mostly limited to high income, developed countries. For example, Brand et al. (2007) create an index based on five regulations governing beer consumption (where more restrictive measures are given higher index scores) and use this index to study the impact of beer regulations across countries. They find a negative correlation between their index and per capita alcohol consumption – in other words, more restrictive regulations reduce beer consumption. This finding confirms that regulations work; however, their study is limited to just 30 OECD countries. We note, however, that like this study Brand et al. (2007) include BAC levels for operation of motor vehicles as one of their five regulations.

In addition to the far wider set of countries in our analysis another key difference between this paper and Brand et al. (2007) is that they do not separately identify the impact of BAC nor do they attempt to identify any nonlinearities in the regulatory impact. Nonlinear effects have been identified in the literature, most notably by Colen and Swinnen (2011) who identify a nonlinear effect between income and beer consumption. In particular, they find an inverse U-shape where beer consumption initially increases with rising incomes, but at higher levels of income beer consumption falls. They argue that in addition to possible regulatory reasons, the wider availability of substitutes (e.g., spirits, wine) in the highest income countries likely plays an important role in the decline in beer consumption at the highest income levels. It should be noted that their finding is mostly based on temporal income variation rather than cross-section variation as they only have data for seven countries.

Cook et al. (2014) look at a somewhat larger set of countries (38) and find policies regulating the physical availability of alcohol, particularly those concerning business hours or involving a licensing system for off-premises alcohol retail sales, as well as minimum legal drinking age, were the most consistent predictors of alcohol consumption. This work implies that alcohol policies that regulate the physical availability of alcohol are associated with lower alcohol consumption in low- and middle-income countries. By contrast, they find policies that BAC limits for drivers and random breath testing to enforce BAC limits were not associated significantly with alcohol consumption. The lack of significance of BAC on consumption could be due to their linear specification as our results suggest the impact of BAC on consumption is non-linear. However, their finding could also be due to the relatively small set of countries in their study, a data limitation which severely hinders their ability to identify a non-linear impact of BAC on consumption.

A third theme that emerges in the literature is that socio-economic and cultural conditions have a complex interrelationship with alcohol regulations. For instance, alcohol consumption tends to be associated positively with a country's living standards. Cultural and social practices also influence alcohol consumption. To the extent that these additional factors are at odds with the regulatory policies can result in complex cross-country differences in how regulations affect consumption. At one extreme, for example, in societies where abstinence as a cultural norm is widespread, lax regulations may have little effect.

Relatedly, a U.S. government study on foreign trade barriers frequently cites alcohol beverages as being subject to significant trade restrictions and quotas (USTR, 2021). The USTR (2021) report does mention that such trade restrictions are often associated with cultural and social norms against alcohol consumption. This makes it likely our BAC metric is not the only, or at least not the most direct, regulation that could restrict beer importation. It is unfortunate that the USTR report highlights trade barriers governing alcohol imports only for those countries with restrictions and therefore does not provide information to allow us to directly quantify the independent role played by such trade barriers.

Finally, the fourth theme that emerges from the literature is the incredible growth in global beer markets, both in terms of the variety of beer varieties and also in terms of the number of independent brewers (suppliers). Howard (2014) discusses how the globalization of beer has affected local beer markets noting that it has become increasingly difficult to compete, particularly in larger markets. Garavalia and Swinnen (2017) discuss the growth of micro- and craft breweries over the last two decades highlighting the increase in competition and an end of the worldwide consolidation in the beer industry. As we argue in our conclusion, increased competition may be one explanation of our results.

DATA

There are two key pieces of data used in this study – beer exports and BAC levels.

TRADE DATA

Our data on European Union (EU) member countries' beer exports are sourced from Eurostat's Comext database.[3] Comext provides detailed product-level data on exports of all EU member countries to all destination markets across the globe. Products are classified according to the EU's 8-digit Combined Nomenclature (CN) classification which codifies about 9,500 products. The reporting thresholds are codified by EU legislation and require any extra-EU transaction involving more than €1,000 in value or 1,000 kilograms in net weight be reported. Reporting thresholds for intra-EU transactions are higher and member-specific.

[3] http://epp.eurostat.ec.europa.eu/newxtweb/

Our analysis uses trade data at the annual frequency starting in 1995 and ending in 2019. During this period Comext uses three product codes to capture trade in beer with codes differentiated by how beer is packaged rather than by the type of beer. The first code, 22030010, is defined as beer in containers bigger than 10 liters, which we will refer to as kegs. The other two codes capture trade of beer in containers smaller than 10 liters and are differentiated as bottles, 22030001, and "other containers excluding bottles," 22030009. We will refer to the former packaging as bottles and the latter as cans. As a result, our data reflect trade in beer exported in the three most common packaging formats: cans, bottles, and kegs.

During the time period we analyze, the EU went through several rounds of expansion. Austria, Finland, and Sweden joined the EU in 1995 and thus are in our dataset every year. There were three subsequent rounds of expansion. Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia joined in 2004, while Bulgaria and Romania joined in 2007. For these countries, data in Comext are available starting in 1999. Croatia was the last country to join the EU in 2013 with Comext reporting its data starting in 2001. Given the compositional changes the EU has undergone we adopt the following notational convention when referring to different groupings of EU exporters. EU28 refers to all 28 EU members as of the last year of our sample, 2019, which includes Great Britain which departed at the end of January 2020. In other words, EU28 refers to an all-EU aggregate. EU12 refers to the 12 EU members as of 1994, prior to the 1995 expansion. We refer to countries that joined in 1995 as EU12–15. Finally, we use EU15–28 to refer jointly to countries that joined the EU after 2003. Comext provides trade data measured in current euros for every country. In order to compare the value of imports and exports across time, we deflate the values using the annual GDP deflator for the Eurozone obtained from OECD with 2015 as the base year.[4]

[4] https://stats.oecd.org/Index.aspx?QueryId=61354

BLOOD ALCOHOL CONTENT

Blood alcohol content (BAC) regulations for drivers are available from the World Health Organization (WHO).[5] WHO reports blood alcohol regulations in three years, 2013, 2015, and 2018. In our analysis we use the maximum legal level of blood alcohol for the general population (some countries have different regulations for young drivers). We use the earliest available year for every country. For the majority of countries to whom the EU members export beer, BAC levels are available in 2013. For the rest of the countries we use BAC levels from 2015 or 2018, allowing us to identify BAC levels for 188 countries.

Only a handful of countries report changes to their BAC level over the 2013–2018 period. Out of 188 countries in the WHO database, 22 report changes in their BAC levels in the three years for which data are available. Two countries first relax their regulation, increasing the BAC limit, followed by a reduction to the original level.[6] Another 8 countries relax their BAC regulation by increasing the legal limit.[7] Finally, twelve countries increase the stringency of their policy by reducing the BAC level.[8] Most changes in the WHO database involve a country transitioning from a missing BAC value to a positive BAC level. The fact

[5] https://www.who.int/data/gho/data/themes/topics/indicator-groups/indicator-group-details/GHO/drink-driving

[6] Armenia and Nigeria.

[7] Czechia, Democratic Republic of Congo, Georgia, Liberia, Myanmar, Romania, Samoa, and Turkmenistan.

[8] Botswana, Brazil, Colombia, Cuba, Equatorial Guinea, Ireland, Laos, Malta, Mongolia, Montenegro, New Zealand, and Uruguay.

we rarely observe changes in BAC levels in the WHO database gives us confidence in our assumption that the reported BAC data reasonably applies to the years prior to 2013.[9]

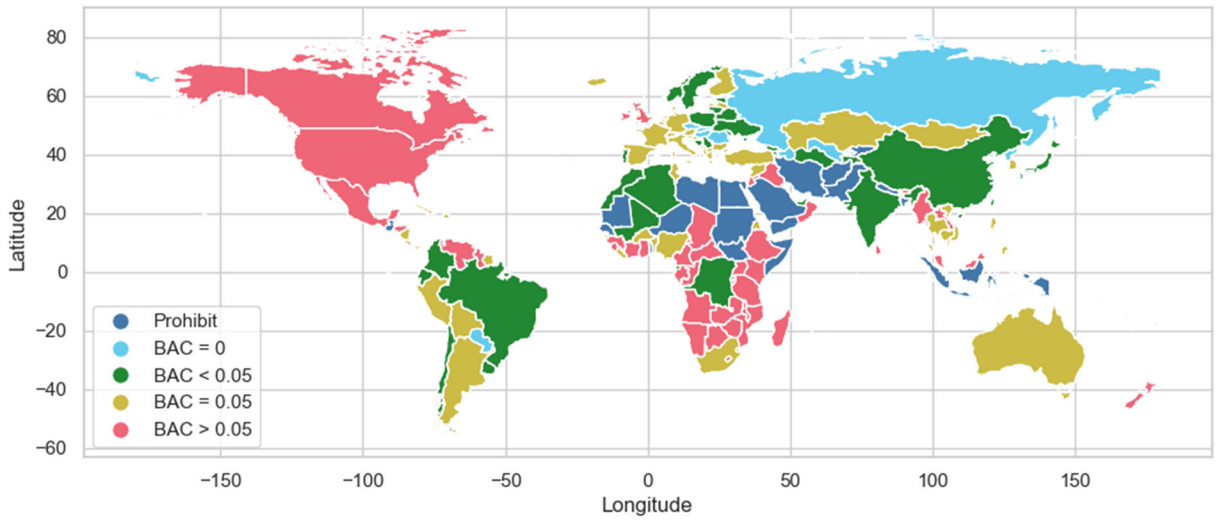

***Figure 1**: Worldwide blood alcohol content limits for drivers*

The WHO identifies countries that prohibit consumption of alcohol as well as those that allow consumption of alcohol but set a maximum BAC value. The highest BAC level we observe in our data is 0.12 and the lowest level is 0. There are three clusters of countries across the BAC levels. There are 36 countries that prohibit consumption or have a BAC limit of zero. Another 59 countries have set their BAC limit at 0.05, while 56 have set it at 0.08. As a result we categorize countries into 5 groups: (1) countries that prohibit alcohol consumption (26 countries), (2) countries that set their BAC at 0 (10 countries), (3) countries where

[9] Countries with a non-missing BAC value change almost always involved very small changes in the BAC level (e.g., from 0.03 to 0.02) and such changes did not imply a difference in the BAC group assigned to the country.

the BAC limit is less than 0.05 but greater than 0 (31 countries), (4) countries with the BAC equal to 0.05 (59 countries), and (5) countries with a BAC limit above 0.05 (62 countries).

Figure 1 depicts the BAC levels across countries using the above grouping system to classify them into five groups. As seen, countries that prohibit alcohol are largely Middle Eastern countries including Afghanistan, Iran, Kuwait, and Pakistan. Countries that have BAC set to zero are mostly located in Eastern Europe. Africa, Asia, and Europe are the most diverse continents with countries in each of the five BAC-level groups.

METHODOLOGICAL APPROACH

Our investigation examines two measures of the patterns of EU exports of beer: (1) the extensive margin (or the breadth) of exports and (2) the intensive margin (or the depth) of exports.

We use simple definitions often used in the literature to measure the two margins.[10] The example in Table 1 allows us to clarify how we calculate the intensive and extensive margins. The table depicts a hypothetical EU country exporting beer to five partner countries, labeled A, B, C, D, and E, starting in 1995 and ending in 1999. The annual value of exports are indicated for each destination market. For example, €3M was exported to country A in 1996; the exporter did not sell any beer to country A in either 1995 or 1999. In addition, we assume that destination markets A, B, and C share a similar BAC regulation level (group 4) and destination markets D and E share another BAC regulation level (group 5).

[10] See Besedeš, Goldbach, and Nitsch (2017) for example.

Country	BAC Group	Year				
		1995	1996	1997	1998	1999
A	4		3	2	2	
B	4		2		2	2
C	4		1	1	1	1
D	5	4	4	4	4	4
E	5	1		1		
BAC Group 4 (BAC=0.05)						
Extensive Margin (Breadth)		0	3	2	3	2
Utilized Ext. Margin (Relative Breadth)		0	1.0	0.67	1.0	0.67
Average Intensive Margin (Depth) (millions €)		0	2.00	1.50	1.67	1.5
BAC Group 5 (BAC>0.05)						
Extensive Margin (Breadth)		2	1	2	1	1
Utilized Ext. Margin (Relative Breadth)		1.0	0.5	1.0	0.5	0.5
Average Intensive Margin (Depth) (millions €)		2.50	4.00	2.50	4.00	4.00

***Table 1**: Hypothetical Exports to Five Destination Markets (millions €) and the Extensive, Utilized Extensive and Intensive Margins of Trade*

Studies often examine how the extensive and intensive margins evolve over time (Besedeš and Prusa 2011). The extensive margin is simply the count of the number of partner countries to which exports are sent. Hence, the extensive margin measures the *breadth* or the reach of a country's exports. Note that in our example, the extensive margin for BAC Group 4 equals 2 in both 1997 and 1999. However, only one of the countries is active in both years, country C, while country A was active in 1997 and country B was active in 1999.

As we are interested in how beer exports differ across destination markets and BAC regulations, we use a relative measure of the extensive margin which we call utilized extensive margin (Besedeš and Prusa 2011), or *relative breadth*. Comparing the sheer number of destinations a country exports to within each of our

five BAC-level regulation groups of countries only makes sense if the groups have an equal number of countries. However, they do not. It is entirely different to export to eight markets when there are a total of ten possible destinations than it is to export to eight markets when there are 62 possible destinations. The sizes of our five groups of countries based on BAC regulations are 26, 10, 31, 59, and 62. In order to compare how broad exports of beer are across destination markets within each of these groups, we compute the utilized extensive margin which is simply the ratio of the number of active destinations to the possible number of destinations in a market. This means the utilized extensive margin ranges from 0 to 1. For the example depicted in Table 1, if we assume that the entire set of BAC Group 4 potential destination markets is just the three countries A, B, and C, we can compute the relative breadth for each year. The extensive margin is 3 in 1996 which means the relative breadth (i.e., utilized extensive margin) is 1; by contrast, the extensive margin is 2 in 1997 which means the relative breadth is 0.67. Similar calculations can be done for BAC Group 5 (countries C and D) for each year.

The intensive margin is the average value of trade across active destination markets in each year. Hence, one can think of it as a measure of how deep a country's exports penetrate a market on average. In our example, the *depth of trade* (i.e., the intensive margin) varies from year to year depending on which countries are actively trading and how large each destination market's purchases are. In our example, overall between 1995 and 1999 the depth grew from €0M to €1.5M for BAC Group 4 and from €2.5M to €4M for BAC Group 5. There is no equivalent to the utilized extensive margin on the intensive margin side. There is no upper bound on the size of the intensive margin as there is for the extensive margin, where if there are 56 possible destinations, the highest the extensive margin can become is 56. We compute both margins for every year in our sample and for every EU member; we note that the destination markets are grouped by BAC level which means for each EU exporting country we calculate each margin for each BAC level.

RESULTS

DESCRIPTIVE SUMMARY

We begin our analysis by first providing a descriptive summary of the breadth and depth of EU beer exports. Figure 2 offers a sense of how the breadth of EU exports varies across destination markets grouped according to BAC regulations and for various groupings of EU countries averaged across the entire 1995–2019 sample period. We group EU members into four groups, with the utilized extensive margin measure averaged across EU members in each group.

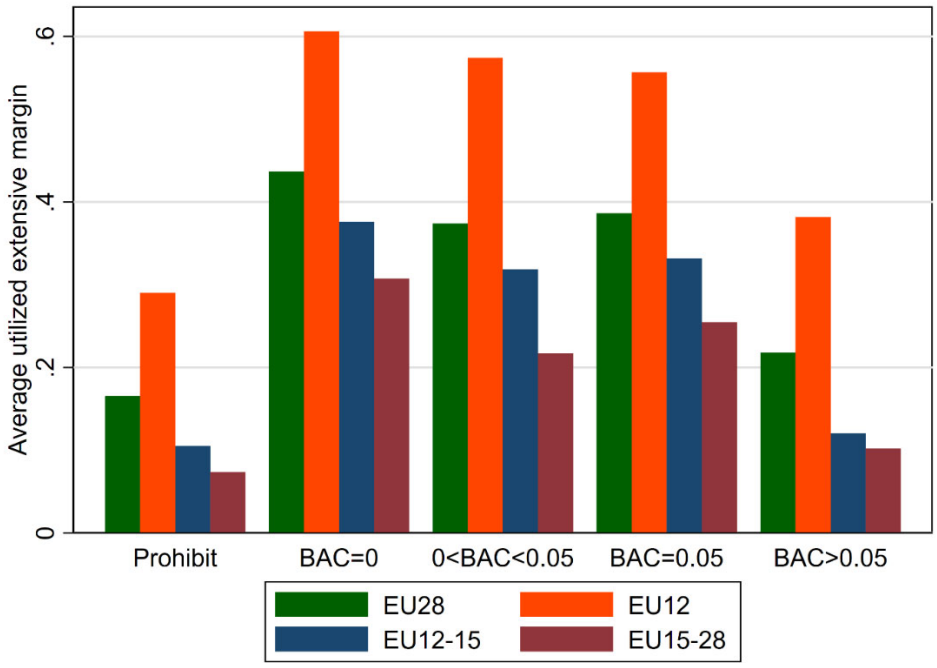

***Figure 2**: Average utilized extensive margin (relative breadth)*

Note: BAC refers to the blood-alcohol content limits for drivers. EU28 refers to all 28 EU members in 2019. EU12 captures the 12 members prior to 1994, EU12-15 refers to Austria, Finland, and Sweden who joined in 1995, and EU 15-28 refers to the post-2000 new member countries.

Not surprisingly, the average relative breadth (i.e., utilized extensive margin) is the smallest for the group of destination markets that have prohibited consumption of alcohol. What is surprising, on the other hand, is that the relative breadth is not zero for these countries. Across all 28 EU members, the average relative breadth in these markets is 16%. That is, the EU28 countries, on average, export beer to 16% of the countries who prohibit alcohol consumption. Across the three groups of EU exporters, grouped by their accession to the EU, the EU12 countries have the largest utilization rate at 29% while EU15–28 additions average 7%.

Interestingly, the largest relative breadth is for destination markets that have set their BAC level at 0. This is true across all four groupings of EU exporters. EU12 countries, some of which are traditional producers and consumers of beer, have the highest average relative breadth, at just above 60%, in destination markets with BAC regulation set at 0, followed by the EU12–15 additions and then EU15–28.

Somewhat surprisingly, across all four groupings of EU exporters the relative breadth in destination markets with highest BAC levels is the lowest across all countries that allow consumption of alcohol. One might expect that as the maximum level of BAC increases, that EU exporters may be able to reach more markets. This does not seem to be the case.[11] As we will shortly argue, the average intensive margin sheds a different, yet complementary, perspective on this result.

Figure 3 presents a different view of how the relative breadth (i.e., utilized extensive margin) varies across the five levels of BAC regulations and across EU members. The figure shows five maps of EU exporters, one for each of the five destination BAC level groups, where exporters are identified by their respective relative breadth, which is grouped by quintiles. Thus, the dark blue color denotes the first quintile of

[11] We will offer possible explanations for this surprising pattern in the final section of this chapter.

utilization identifying countries who utilize less than 20% of their extensive margin. The second quintile, identified by light blue color, identifies countries whose utilization is in the second quintile, between 20% and 40%, and so on. The figure offers a somewhat more granular summary of the relative breadth than Figure 2 and allows us to observe some of the same patterns as well as identify some new ones. The relative breadth is smallest in the set of countries that prohibit consumption of alcohol. No EU member utilizes more than 80% of the possible breadth in this group of destination markets. Interestingly, the same is true of the set of countries with maximum BAC level above 0.05. Relative breadth is highest in the set of destination markets with BAC levels set between 0 and 0.05, with only Germany and the Netherlands utilizing more than 80% of the possible extensive margin (identified by pink color in the figure). Note that none of the countries that join the EU utilize more than 80% of the relative extensive margin to any BAC grouping during this period. We should note that Figure 3 depicts the average relative breadth. Thus, it may be possible for some countries to utilize more than 80% in some years, but not when averaged over our 25-year long sample. With 25 years and 5 BAC defined groups of destination markets, we measure relative breadth 125 times for each exporter. In theory, an exporter can utilize more than 80% of the extensive margin a total of 125 times. The Netherlands does it most often, 75 times or 58% of the time, with Germany next highest at 65 times or 52%. Other countries that utilize more than 80% of their extensive margin do so much less frequently: Austria (2 times), Belgium (15), Czechia (4), Denmark (12), Spain (6), France (4), Great Britain (10), Italy (2), and Poland (2). EU28 as a whole utilizes more than 80% of the extensive margin in almost every possible instance, 122 times of the possible 125. EU12 does it 121 times, while the EU12–15 and EU15–28 additions do it much less frequently, 2 and 23 times respectively.

One pattern we can see in Figure 3 common across all five panels is that irrespective of the destination markets' BAC regulation level, the EU countries with the highest relative breadth tend to be countries with a tradition of beer brewing: Germany, the Netherlands, Denmark, and Belgium, with Czechia the only newer EU member joining them. Across the five panels, the lowest relative breadth belongs to most other

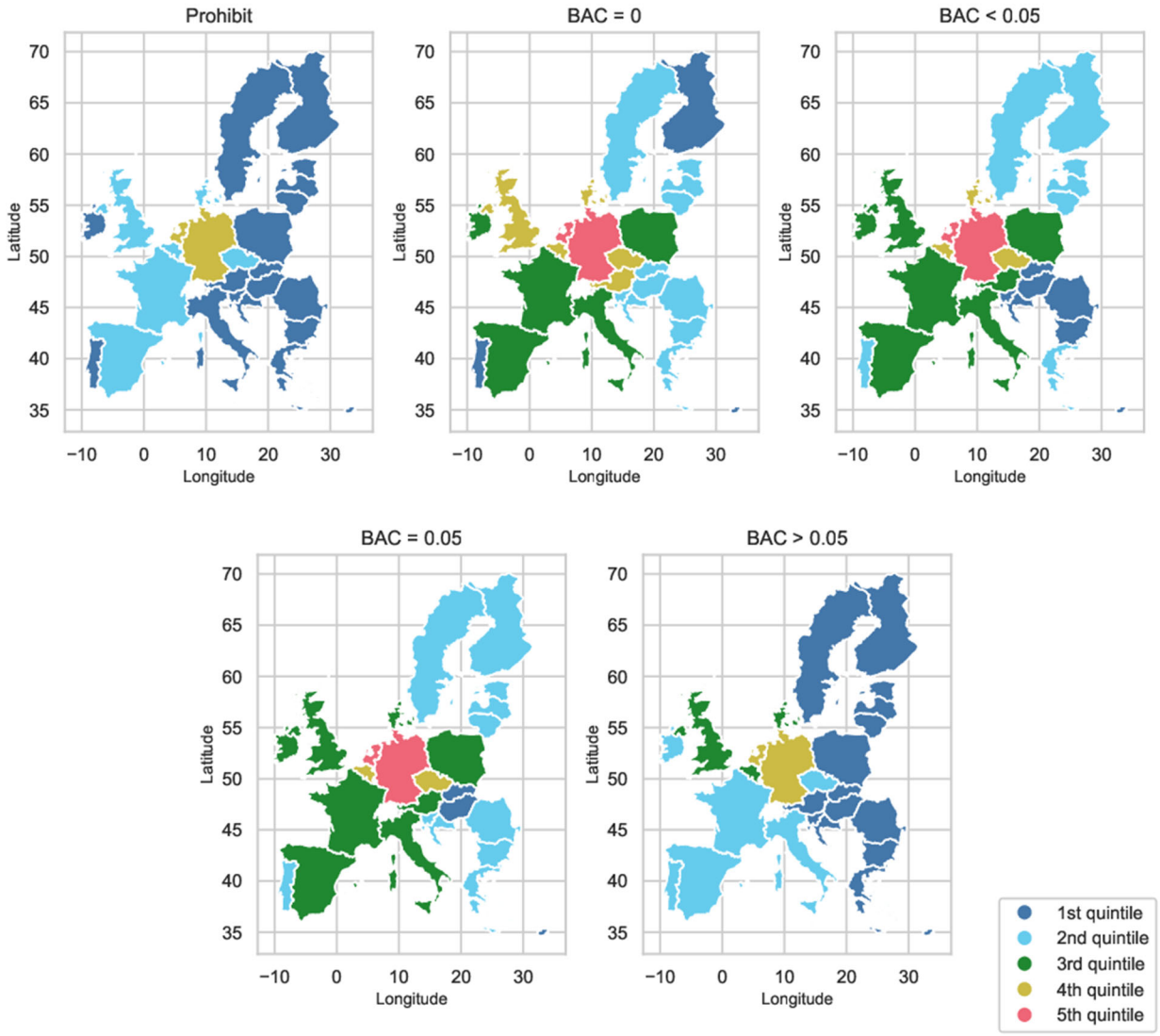

***Figure 3**: Utilized Extensive Margin (relative breadth) by BAC Level*

Note: The figure reports the size of each EU member's utilized extensive margin across destination markets. Each panel shows the geographic differences in utilization of the extensive margin for a specific group of destination markets, which are grouped according to their BAC level. The size of the utilized extensive margin is identified by the quintile in which it belongs, so that the utilization of 0.35 (35% of the possible extensive margin) would be in the 2nd quintile.

eastern and central European countries as well as countries with a stronger wine producing and drinking culture, such as Italy, France, Spain, and Portugal.

Turning our attention to the depth of exports (or intensive margin), Figure 4 shows the average depth, in millions of (real) euros, across the same groupings of EU exporters and the same five groupings of destination markets according to their BAC levels. As depicted in the example in Table 1, to compute the depth for each destination market we aggregated exports for each group of EU exporters (e.g., EU12) and then averaged by the number of markets where those exports were going.

The analysis of the depth of exports helps explain two surprising results we found above when we looked at the utilized extensive margins. One unexpected finding was that EU countries were able to export beer even to countries that have prohibited consumption of alcohol. The depth (i.e., intensive margin) results clearly indicate that while there are some positive exports to this group of markets, the exports are very small in size, almost negligible.

The other puzzling result was the observation that the utilization of the extensive margin decreased as the maximum BAC level regulation increased, suggesting an inverse U-shape. In other words, as the maximum level of BAC in destination markets increases, EU countries export to fewer markets. Figure 4 shows that for the entire EU28, and the original EU12 countries, the average size of exports to a destination market increases with BAC regulation levels, with the difference starkest for exports to countries with BAC below 0.05 and those with BAC at or above 0.05. For example, EU12 exports to countries with maximum BAC level of at least 0.05 are at least five times as large as average exports to countries with BAC level set to 0 and at least three times as large as their average exports to countries with BAC level set to between 0 and 0.05. In other words, the relationship between BAC and depth of trade is positive, not inverse U-shaped, for the largest beer exporting countries.

For the EU15 additional countries, the average trade depth is small, not surprising for countries without as much of a beer brewing tradition (Austria, Finland, and Sweden), and decreasing as the BAC level in the destination markets increases. For EU28 additions, the intensive margin is smallest in alcohol-prohibited

markets, largest in those that have set their BAC level to 0 and then decreases for the other three groups of destination markets.

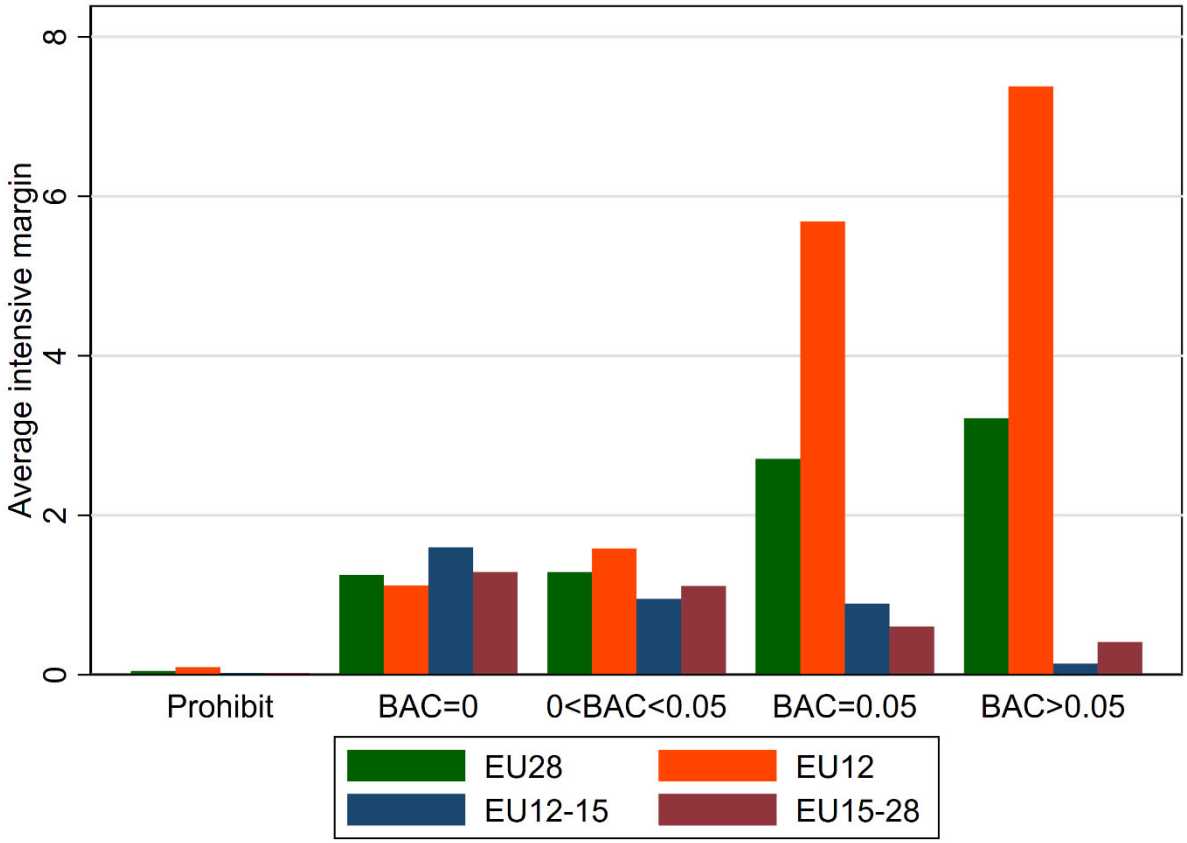

***Figure 4**: Average intensive margin (depth of trade)*

Note: BAC refers to the blood-alcohol content limits for drivers. EU28 refers to all 28 EU members in 2019. EU12 captures the 12 members prior to 1994, EU12–15 refers to Austria, Finland, and Sweden who joined in 1995, and EU 15–28 refers to the post-2000 new member countries.

REGRESSION RESULTS

While Figures 2–4 allow us to visually assess differences across EU exporters in the breadth and depth of their beer exports, they mask a lot of the variation across both exporters and time. To better account for

these sources of variation we estimate two different regression specifications. The first specification examines how the depth (i.e., the intensive margin) and the relative breadth (i.e., the utilization of the extensive margin) differ by BAC regulation in the destination markets, taking into account differences across EU exporters and time. We estimate the following specification:

$$y_{ibt} = \beta_0 + \sum_b \beta_b BACLevel_{ib} + \gamma_i + \delta_t + \varepsilon_{ibt}, \quad (1)$$

where y_{ibt} denotes the outcome variable of interest (i.e., either the relative breadth or the depth). Subscript i denotes a particular EU member (the exporter), subscript b indicates the BAC-regulation-level group (1, 2, 3, 4, 5), and subscript t indicates the year of the observation.[12] We use two sets of fixed effects. To control for all factors that are common to each exporter across time we use country fixed effects γ_i. To capture factors common to each calendar year we use year fixed effects δ_t.

The coefficients of interest are β_b which indicate differences in the margins across BAC regulation levels, with each regulation level represented as a dummy variable. Since there are five possible levels, we have to exclude one level that will serve as a reference to which other levels are compared. We will use the markets that prohibit alcohol as the reference category. Thus, this specification allows us to examine how the margins vary with BAC level while preserving the granularity in our data as the dependent variable

[12] In effect the specification summarizes country i's exports across the destination markets within each of the five BAC groups.

reflects the exporter's intensive or extensive margin in a given year and given BAC regulation level in the destination market. Our results are summarized in Table 2.[13]

Before discussing our estimates, we briefly note how we estimate our regressions. We use OLS when examining the depth of trade, which is measured in euros (i.e., levels). However, since the relative breadth is a double bounded measure[14] we use the FLEX estimator of Santos Silva, Tenreyro, and Wei (2014) developed in part to correctly estimate extensive margin regressions; as is commonly done in FLEX estimations, we report the marginal effects rather than estimated coefficients.

Results in Table 2 are based on exports of all three packaging types added together.[15] We can see that the relative breadth of exports is higher for every level of BAC regulation compared to markets that have prohibited alcohol. Interestingly, the relative breadth is largest for countries which have set maximum BAC level to 0, followed by the two intermediate levels, which, while individually precisely estimated, are not statistically different from each other. The utilization of the extensive margin for markets with the highest maximum BAC level is the lowest from all non-prohibited groups of markets, with a coefficient less than half the size of the other regulation-level groups of countries. This confirms our observation from the descriptive summary that the relative breadth of exports largely decreases with BAC regulation level if alcohol can be legally consumed.

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[13] Full estimation results including time and country fixed effects are available upon request.

[14] It is bound below by zero and above by one, the highest extent of utilization of the extensive margin.

[15] Suppose Germany exports all three packaging types to, say, Chile. For example, €100 in cans, €200 in bottles, and €300 in kegs. The specification in Table 2 would reflect that Germany exports €600 of beer to Chile.

	Relative Breadth (Utilized Extensive Margin)	Depth (Intensive Margin)
Prohibited	—	—
	(—)	(—)
BAC= 0	1.865***	1.492***
	(0.166)	(0.396)
0 <BAC< 0.05	1.571***	1.538***
	(0.116)	(0.377)
BAC= 0.05	1.622***	3.075***
	(0.135)	(0.891)
BAC> 0.05	0.705***	3.791***
	(0.090)	(0.317)
Constant	-1.695***	-0.248***
	(0.088)	(0.389)
omega	0.621***	
	(0.194)	
Observations	2,977	2,977
Country Fixed Effects	Y	Y
Year Fixed Effects	Y	Y

Robust standard errors in parentheses
Marginal Effects reported for utilized extensive margin
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

***Table 2**: Estimation Results (all beer packaging types)*

Note: Estimates are based on equation 1.

The conclusion is opposite when it comes to the depth of exports; this is similar to what we saw in our descriptive analysis. In markets where alcohol is not prohibited, the average export depth increases with the maximum BAC level, with a stark increase for markets that have set their BAC level to at least 0.05. The average value of exports of beer to markets with BAC level set at 0.05 are twice as large, on average by about 1.5 million euros, and even larger to markets with BAC above 0.05 by some 700,000 euros.

We also offer a second specification which allows us to examine how the depth and the relative breadth differ by BAC regulation in the destination markets, taking into account differences across EU exporters and time. However, in this specification, rather than examining the breadth and depth of all beer exports (aggregated across packaging types), we now examine both margins for each type of packaging. As a result, when the outcome of interest is the relative breadth, y_{ibkt} denotes the relative breadth of EU member i's exports to BAC group b of beer packaged in container type k (cans, bottles, kegs) in year t. Similarly, with respect to trade depth y_{ibkt} captures the average exports of EU member i to BAC group b of beer packaged in container type k in year t. We then estimate the following specification with the variable *PackageType* identifying the container in which beer is sold:[16]

$$y_{ibkt} = \beta_0 + \sum_b \sum_k \beta_{bk} \left(BACLevel_{ib} \times PackageType_k\right) + \gamma_i + \delta_t + \varepsilon_{ibkt}, \qquad (2)$$

As with the previous specification, parameters of primary interest are β_{bk}. Rather than discussing a table of parameter estimates we think the results are more cleanly described by plotting the estimated β parameters.[17] Figure 5 depicts the results for the relative breadth. The excluded group is cans sold to countries that prohibit alcohol consumption. As a result, the breadth for other packaging types (relative to

[16] The FLEX estimator is again used for the utilized extensive margin and OLS is used for the intensive margin.

[17] The full estimates are available upon request. All key parameters are statistically significant at the 1% level.

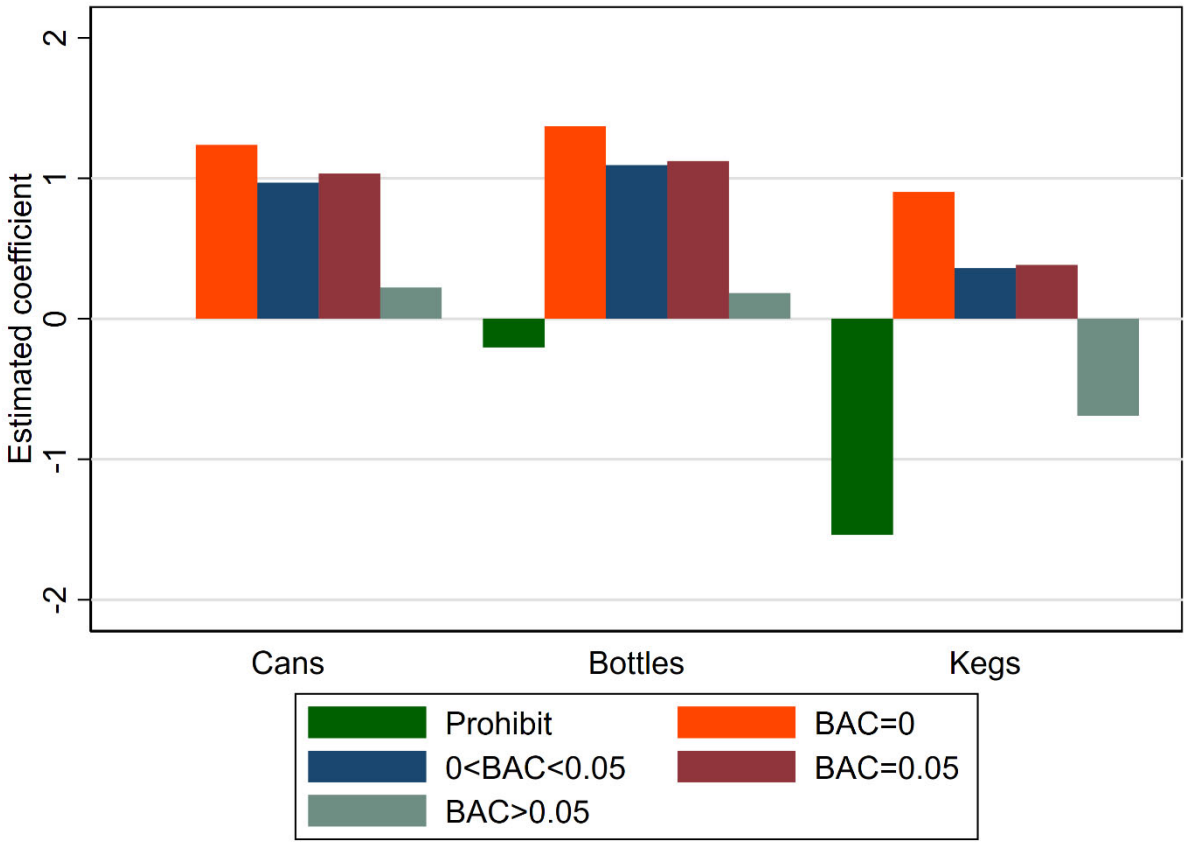

***Figure 5**: Estimated Utilized Extensive Margin (relative breadth) by BAC Level and Packaging*

Note: BAC refers to the blood-alcohol content limits for drivers. EU28 refers to all 28 EU members in 2019. EU12 captures the 12 members prior to 1994, EU12–15 refers to Austria, Finland, and Sweden who joined in 1995, and EU 15–28 refers to the post-2000 new member countries. Estimates are based on equation 2.

cans to prohibited markets) can exceed 1 (or be negative).[18] To streamline the discussion we only report the packaging type specification for the entire EU28 group. The results largely reinforce what we learned

[18] Negative values for bottles and kegs to prohibited markets indicates it is even rarer to service those markets in those types of containers compared to cans of beer.

previously. First, ignoring markets that prohibit alcohol, for all three packaging types the relative breadth of exports decreases as the BAC regulations become less stringent. For cans and bottles the decrease is modest until the highest BAC level (BAC>0.05) but in general the decrease is seen for all three package types. Second, kegs have the lowest utilized extensive margin for each BAC level. We presume this reflects that (i) transportation costs are larger for kegs and (ii) kegs are almost exclusively consumed outside the home. Thus, many countries that export beer in kegs to some markets do not find it worthwhile (or are unable) to export to as many markets as the other packaging types.

Figure 6 depicts the results for the depth of exports. The results are quite interesting. First, when it comes to markets that prohibit alcohol consumption, not only do bottles and kegs have a lower breadth they also have a much lower depth (as compared to cans). This confirms the difficulty of these packaging types entering the prohibited markets. Second, the depth (i.e., intensive margin) increases across BAC levels for bottles and kegs; however, for cans the depth for the highest BAC level (BAC>0.05) falls compared to the less stringent BAC levels. This may reflect bottles and kegs longer presence in the beer market as cans are a relatively newer packaging type and may still be lacking some consumer acceptance. Moreover, certain types of beer might be more difficult to export in cans to certain markets.

In Figure 7 we graph the year fixed effects from our estimates of equation 2. The black solid line depicts the point estimates for the breadth and the black short-dashed lines reflect the 95% confidence intervals. The orange long-dashed line depicts the point estimates for the depth of trade and the orange short-dashed lines reflect the 95% confidence intervals. Looking first at the breadth, it is clear that not only has it increased over time but that the year effects post-2006 are statistically different from zero. In other words, over time EU countries are increasing the number of available markets they are exporting to. On the other hand, the depth of trade does not change much over time, once we take into account exporter and destination market differences. Taken together, controlling for packaging types and BAC levels, the results indicate

that (i) EU beer exporters have increased the scope of their export sales over time, exploiting new markets, etc. and (ii) how much they sell on average in a market has remained constant.

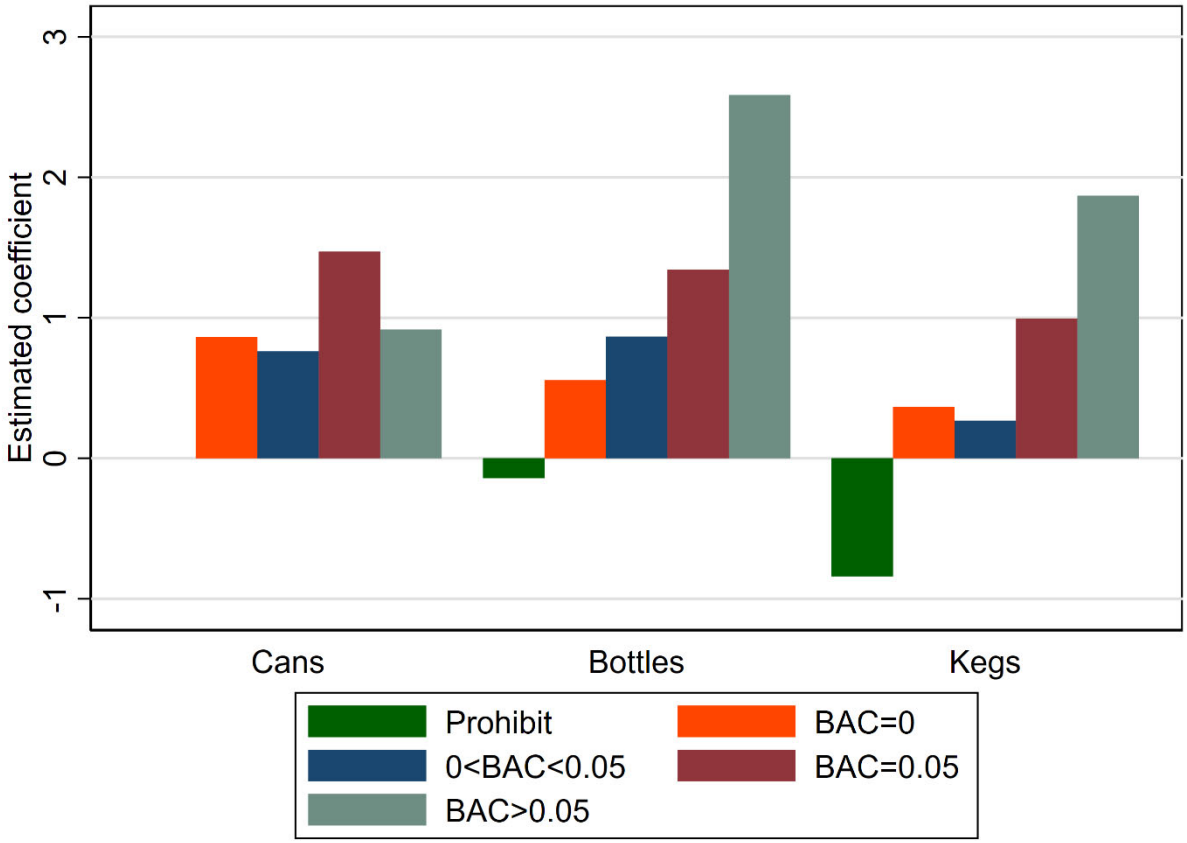

***Figure 6**: Estimated Intensive Margin (depth of trade) by BAC Level and Packaging*

Note: BAC refers to the blood-alcohol content limits for drivers. EU28 refers to all 28 EU members in 2019. EU12 captures the 12 members prior to 1994, EU12–15 refers to Austria, Finland, and Sweden who joined in 1995, and EU 15–28 refers to the post-2000 new member countries. Estimates are based on equation 2.

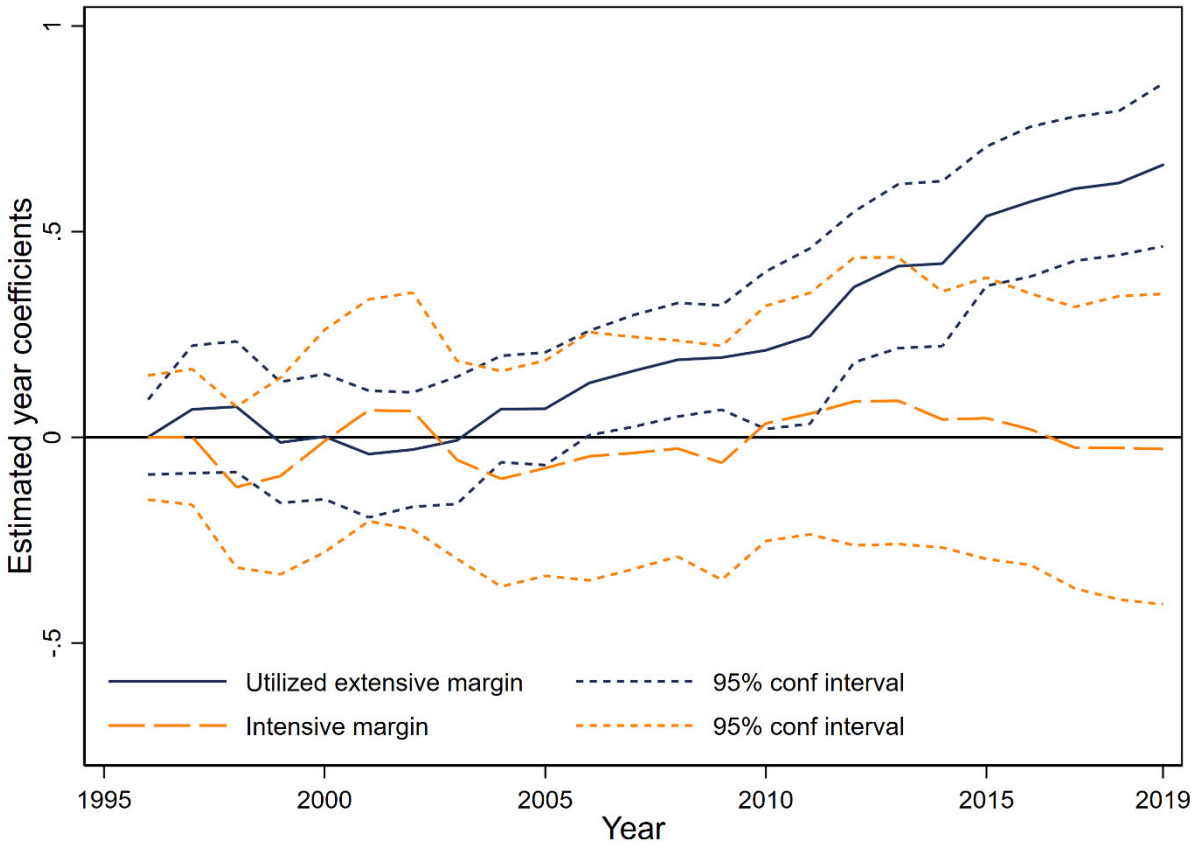

***Figure 7**: Estimated Year Effects*

Note: The black solid line shows the estimated year fixed effects for utilized extensive margin (breadth of trade). The long-dashed orange line shows the estimated year fixed effects for the intensive margin, depth of exports. The short-dashed lines show the 95% confidence interval for respective estimates, black for utilized extensive margin and orange for intensive margin (depth of trade). Estimates are based on equation 2.

CONCLUSION

This chapter is an initial effort to study the impact of how BAC regulations affect the export patterns of beer. Our analysis indicates that EU beer exports have grown both by expanding the number of markets serviced, the breadth of exports, and also the depth of sales to each market. Nevertheless, it appears the increased scope has had the greater impact (at least statistically). It is reasonable to assume that the trade

effect would follow the stringency of BAC rules. Namely, one would expect that countries with very stringent BAC rules would have less trade than those with more relaxed BAC rules. This would especially be the case if the stringency of other alcohol regulations is correlated with the stringency of BAC rules. We find that the expected relationship holds for the intensive margin (i.e., the depth) but not for the extensive margin (i.e., the breadth). In particular, somewhat surprisingly we find EU exporters have a larger extensive margin for destination markets with low BAC cutoff level (i.e., more stringent regulations).

A better understanding of this empirical finding should be the subject of additional research. Our findings indicate that while BAC levels matter, their impact is not a simple linear (or even positive) relationship for at least the breadth of trade. We offer three possible explanations for our findings. First, they are consistent with Cook et al. (2014) who argue that the stringency of other alcohol regulations do not reflect a country's relative BAC rules. For instance, a country might have a high BAC cutoff but not allow beer to be purchased by anyone younger than 21 years of age. Or, conversely, a country might have a low BAC cutoff but not allow beer to be purchased by anyone regardless of their age.

A second possibility is that countries with higher BAC cutoffs may also have larger domestic beer industries. If true, a larger domestic beer industry might lobby for a higher BAC cutoff (which would suggest more trade) but the domestic beer producer(s) may also pose stronger competition to foreign beer producers. Consequently, we might observe fewer foreign suppliers even with higher BAC cutoffs. Larger domestic beer markets, whether driven by macro-brewers or craft brewers, may make for more competitive markets that not all exporters can enter due to the extent of competition and the cost of entry, but when they do enter, they sell a lot of beer. Such behavior could reconcile our finding that markets with highest BAC levels have fewer EU members exporting to them, but are exporting more on average. There may be an additional source of competition.

Third, countries with higher BAC levels may also have more robust markets for alcoholic drinks that are substitutes for beer, such as wine and liquor (Colen and Swinnen, 2011). In that case, it may be more difficult to enter as exporters are not only competing with domestic brewers but also domestic and foreign producers of close substitutes. Said differently, an understanding of the political economy of BAC rules might be an important explanation of the trade patterns documented in this chapter.

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