JÖNKÖPING INTERNATIONAL
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# The Effect of Per-Unit Ethanol Tax on Wine Prices

## A Comparative Perspective: Sweden and Germany

Bachelor's thesis within Economics


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# Abstract


After Swedish alcohol retail monopoly, Systembolaget, changed the taxation for alcohol sold in retail stores according to its absolute alcohol content in 1992, Ponicki et al. (1997) used this opportunity to examine the effect of per-unit alcohol tax on the prices of spirits, comparing before and after, and found that beverages from higher price range experienced a relatively smaller rise in price in percentage terms than the beverages from lower price range, which can be described as compression of prices. This paper builds on the statement and findings by Ponicki et al. in 1997 and looks at whether or not unit taxes on ethanol content, as opposed to ad valorem taxes, compress the price range and make low quality wines relatively more expensive after-tax in Sweden as compared to no alcohol-content taxation. For the purposes of comparison German wine market is selected due to its market specifics (no per-unit taxes on wine), geographical proximity and availability of wide range data. The perception that the Swedish Pigouvian alcohol content tax should make wines in low price ranges relatively more expensive than its pre-tax price and in high ranges relatively cheaper (Kronstam, B.-G., 2010) did not receive thorough support in this paper.

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# 1 Introduction

The sale of alcoholic beverages at prices higher than their production and distribution costs is a generally accepted custom. Quite often the purpose and rationale for special taxes on alcoholic beverages are not, however, explicitly stated. In practice, taxing alcoholic beverages has been a well-established means of raising government revenue. In some countries, alcoholic beverages have been susceptible to such taxation because of their status as luxury commodities, offering a credible justification to tax them. In other, alcoholic beverages have been suitable objects for excise taxes because of their nature as an everyday commodity offering a wide tax basis, and in some countries they have been taxed because of their detrimental social and public health consequences, and the external costs they impose on the state and society (Österberg, 2004).

Nordic countries and in particular Sweden has a long history of alcohol restriction policies which can be dated back to the nineteenth century. They have been founded upon the principle of limiting private profit motive by establishing alcohol monopolies and enforcing other strict regulations, which would consequently reduce the amount sold and consumed. In 1992 the taxes were changed for alcohol sold in state-run stores based only according to absolute alcohol content. Absolute alcohol content is defined by the amount of ethanol content in the beverage. Hence, Swedish policy makers tax alcohol on per-unit basis, according to the amount of ethanol content in the beverage.

The rationale behind taxing ethanol content is to reduce the external cost per unit of ethanol consumed, as ethanol is the active agent which is responsible for health problems among users.. The consumer should be encouraged to drink lower amounts of absolute alcohol as a prevention strategy to reduce both chronic and acute alcoholic problems. Presumably, by setting retail alcohol prices according to some system related to ethanol content the harmful effects of drinking can be reduced (Ponicki et al., 1997). However, from the consumers' point of view, excise duties on alcoholic beverages as everyday consumer products are factors which are increasing their prices and exerting additional pressure on household budget. If an increase in alcohol taxes and alcohol prices leads to a large decrease in alcohol consumption, then the share of alcohol expenditure in family budgets may also decrease (Österberg, 2004).

Bengt-GöranKronstams, referred to as "Systembolaget's best friend and worst critic" (DagensNyheter, 2010),published an article in a Swedish daily newspaper in 2010, *DagensNyheter*. The article concerned the development of wine industry in Sweden and among other things discussed the Swedish public policy and ethanol-based taxation of wine. Kronstams (2010) wrote that the Swedish alcohol tax was designed in a way that an additional SEK 10 on a wine bottle would deliver a product of twice as much quality. With this he emphasized the inefficiency and the price-distortive nature of per-unit ethanol taxes, in relationship to the quality. The proposition could suggest that unit taxes as opposed to ad valorem taxes would compress the price range and make low quality wines relatively more expensive after-tax.

The effects of taxation on price and related variables depends on how the prices are set and what type of taxes are applied. To investigate the effects of the taxation under different policies this paper analyzes the situation in Swedish and German wine markets. These countries were particularly interesting to compare due to differences in the market organization. Sweden, a heavily regulated market with the tax burden and restricted distribution, as compared to Germany, a liberal market with tax rates on wine set to the

minimum amount allowed by EU (i.e. EUR 0 – no tax). German price levels change following supply and demand rather than being increased according to the tax rate (Kraus, et al., 2002; Karlsson&Österberg, 2002) whereas in Sweden the final price of the commodity is highly influenced by the amount of tax levied. Additional qualifications that lead the authors of the paper to choose Germany for a comparative analysis was georgraphical proximity and availability of large database of alcoholic beverages and respective prices and the plausibility of comparison with the Swedish market prices on alcoholic beverages.

No earlier research on the topic has dealt explicitly with the price distortion on a relative scale. Ponicki et al. (1997) have analyzed the effects on price by the change from ad valorem to per-unit taxes and found substantial price range compression in spirits and wine.

The analysis in this paper focuses on finding differences in wine prices between Sweden and Germany. It is done by a comparison regression of observed prices in both markets, and prices excluding VAT. The study also considers these in the context of several price ranges in order to identify relative, or percentage, differences. The expectation from theory is that the price level should be higher in absolute terms in the country with per-unit taxes – in this case, Sweden. Expressed in percentage terms, this would indicate price distortion since a price increase for cheaper commodities is more significant than an increase of the same absolute size for expensive ones.

## 1.1 Purpose and Problem Statement

The purpose of this study is to investigate whether or not any disproportionate dissimiliarity exists between the prices throughout the different price ranges when price is adjusted for VAT and the effect of per-unit ethanol tax remains.

The per-unit tax on wine in Sweden is theorised to distort prices in a way that the after-tax price when per-unit tax is applied (adjusted for VAT) in lower-priced wine rises significantly more in percentage terms than after-tax price of high-price wines, since wine has very similar alcohol content across all price ranges. In absolute terms, the entire price range would rise by the same amount, but the lower-price wines would become more expensive relative to their initial, pre-tax price.The analysis will investigate the effects that this difference of per-unit ethanol content-based tax has on the price levels of wine in Sweden as compared to their German counterparts.

## 1.2 Paper Disposition

The rest of this paper is structured as follows: section 2 explores the history of alcohol taxation in both Sweden and Germany, providing a background; the theoretical framework discusses various taxes, their effects and implications in section 3. With section 4 begins the empirical part, portraying the data sample used and the methodology of analysis, and section 5 is the analysis with detailed description and results, while section 6 gives a conclusion and summary.

# 2 History of Alcohol Taxation in Sweden and Germany

Governmental alcohol taxation policy is primarily aimed at containment of alcohol consumption and protection of public health (Eriksson &Fotina, 2010). This is due to the fact that the cost of alcohol beyond its material value is revealed by research conducted at both the societal and individual level and it has been found to increase the risk of death from a number of specific causes (World Health Organization, 2009).. This section provides a further investigation of differences in taxation and choice of the restrictive policy.

## 2.1 Sweden

Excise and customs duties have a long history in Sweden. About a hundred years ago, customs duties, along with excise duties on spirits and sugar, were the most important sources of government revenues. Now excise duties make up a mere 8% of total tax revenue, among which the excise duty on alcohol is still a significant source of revenue. Although the need for revenue has always been the driving motive, these duties have also been justified on moral and health grounds (Skatteverket, 2009).

National alcohol policies in the Nordic countries, including Sweden, have historically had the goal of reducing alcohol-caused problems by a combination of high alcohol prices and restrictive access to alcohol. This has been accomplished mainly by a combination of high alcohol taxes, a comprehensive state-owned alcohol retail monopoly and municipal control over licensing alcohol sales on premises (Andreasson et al., 2006).

The origin of the Swedish alcohol policy system can be dated back to the mid-19$^{th}$ century, when the Swedish Government banned private distillation of spirits. This ban was a response to what some considered to be the period of high alcohol consumption in Swedish history (Frånaberg, 1987 cited in Karlsson&Österberg, 2002). The state monopoly on import, export, manufacture and sale of any alcoholic beverages except for certain kinds of light beer operated from 1919. The peak of the anti-alcoholic policy was the referendum in 1922 on the enactment of Prohibition in Sweden. A total ban was rejected, but severe restrictions received evident support from the population. Until 1955 alcohol was sold through a system of specialized ration books (Johansson, 2006 cited in Eriksson &Fotina, 2010).This system was unique to Sweden. It was based on the idea that people who are able to drink without social damage should be allowed to purchase alcoholic beverages off the premises and those who cannot, should be denied to buy them. This system became known as the Bratt system, named after its inventor Ivan Bratt. The ration book was provided to those authorized to purchase distilled spiritis(Systembolaget, 2006). Thus, the three cornerstones of Swedish alcohol policy tradition can be summarized as restriction of the private profit motives, restriction of availability, and high alcohol prices (Tigerstedt 2001 cited in Karlsson, 2008).

The restrictions were gradually reduced on the physical availability of alcoholic beverages since the Second World War (Holder et al., 2005) but some aspects of the rigid alcohol control system were retained. Local off-premise retail monopolies were merged into a national off-premise alcohol retail monopoly, ‘Systembolaget’, which was given the monopoly on off-premise sales of distilled spirits, wine and strong beer, as well as wholesale of the same beverages to restaurants. The restructured alcohol control system still followed the historical principle of limiting the private profit motive on the sale of

alcoholic beverages. In 1960s the approach to alcohol control was somewhat liberalized, however in late 1970s and early 1980s it was again replaced with more restrictive policies and legislation (Holder et al., 1998 cited in Karlsson&Österberg, 2002).

In 1992, the Swedish alcohol retail monopoly changed the taxationon alcohol sold in state stores from ad valorem to per-unit tax, according to absolute ethanol content. Since ethanol is the active ingredient in alcoholic beverages that is responsible for causing the alcohol-related health and social problems, the duty rates applied to alcohol are related to the alcohol content of the beverage.

According to current statistics, every year around 4000 people die in Sweden because of alcohol-related health issues and around 1000 road accidents occur due to driving under the influence of alcohol (Swedish National Institute of Public Health, 2006). The main argument by the Swedish government in favour of high-level alcohol tax is the health promotion and the alcohol-related health costs that the pre-tax price of the beverage cannot take into account. High tax is intended to decrease the affordability of alcohol and therefore keep alcohol consumption at a rather low level (Eriksson &Fotina, 2010). Furthermore, alcohol consumption canincreaseexternal costs and demand for public goods, such as healthcare and medical treatment, police, social services, insurance, education, law enforcement.

## 2.2 Germany

Sweden was not the only country with concerns about increased alcohol consumption. Nineteenth century Germany was also facing increasing alcohol abuse statistics. High availability of distilled spirits, especially in North Germany, lead to an increase in alcohol abuse. In 1850 the first so-called “temperance associations” were founded, and even then they could already count more than one million members (Kraus et al., 2002). The temperance associations especially criticized consuming alcohol in public. Although the associations could notirectly change the drinking behavior, they succeeded in changing the public attitude towards drinking. Alcoholism was recognised an illness and not condemned as a moral problem or a vice (Kraus et al., 2002). German society started viewing alcohol not only as an individual danger but also as a serious threat to people’s health. Alcohol abuse prevention was considered on three levels: legal, social and educational. Legislation could influence the availability of alcohol and impose taxes in order to increase prices and reduce consumption. On the social level, counselling and help could be offered, and on the educational level, anti-alcoholic propaganda was to prevent drinking in youth.

Despite similiarity in the final outcome of the German policy makers (prevention and decrease in consumption) the alcohol licensing and retailing policies, if contrasted to Sweden, are currently very liberal. The excise duty levels are on relatively low level for distilled spirits and beer and are set to zero for still wine (Kraus, et al., 2002). Germany resorts to secondary prevention which includes means that directly initiate or extend offers of counselling or help. Communicative means are carried out by the mass media, posters, advertisements and press on the one hand, and by education and life-competence programmes on the other. The health authorities funded by government operate in order to carry out aforementioned actions. No license is required for production, wholesale or retail sale of alcoholic beverages (Kraus, et al. 2002). There are basic age-restrictions on underage population (below 16 & 18) but youth over the age of 14 are provided the privilege to drink alcoholic beverages under supervision of a responsible

adult (a person over 18 entrusted with the care of a child) (Kraus, et al. 2002). The only restriction on availability is by limiting opening hours and hours during which alcoholic beverages can be sold.

Prevention policy in Germany aims at making people aware of the general problems of psychotropic substances, and includes creating a critical and objective attitude towards alcohol (Kraus, et al. 2002). The eventual outcome is that the commodity price levels change according to supply and demand rather than being increased according to the tax rate (Kraus, et al. 2002; Karlsson&Österberg, 2002) whereas in Sweden the final price of commodity is highly influenced by the amount of tax levied.

## 2.3 EU and its Influence on Public Policy

With the introduction to EU in 1995, the Swedish restrictive alcohol policy came into conflict with the EU's emphasis on market freedom, and was forced to adapt to EU rules (Eriksson &Fotina, 2010). According to the directive harmonizing alcohol excise duty structure in EU member states (92/83/EEC), alcohol excise duties have to be levied either on the basis of liters or on the basis of liters of ethyl alcohol in the finished product. EU member states are free to decide their own alcohol excise-duty levels as long as they stay over the EU minimum level (Österberg, 2011). Germany is one of the countries that has kept the excise level duty rates quite near the minimum rates, whereas Sweden still has very high excise-duty levels compared with minimum rates. Sweden also had to restructure from the monopoly on imports, exports, production and distribution of alcohol. Before 1st January, 1995, 'Vin&Sprit' and 'Systembolaget' were the sole traders in wholesale of all distilled spirits and wine (Holder et. al., 1998 cited inKarlsson&Österberg, 2002).This practice changed after EU membership.

In agreement between the European Commission and the Swedish government, it was decided that Systembolaget would retain its retailing monopoly if wholesale monopolies would be abolished. Today, both domestic producers and private licensed importers have the right to distribute wine and distilled spirits. Systembolaget still continues as a wholesale distributor but cannot import any alcoholic beverages (Karlsson&Österberg, 2002).

Whether taxation of alcoholic beverages is appropriate means of reducing social costs of alcohol consumption is still a continuing public issue. Sweden views it as a threat to public health and state budget in terms of damage reimbursement. The treatment of alcohol taxation in Sweden is as elimination of negative externality and reimbursement of social cost. The price-elasticities for alcoholic beverages estimated in different studies have shown that when other factors remain unchanged, an increase in price has generally led to a decrease in alcohol consumption, and that decrease in price has usually led to increase in alcohol consumption (Health EU, 2006).

# 3 Theoretical Framework

Alcohol taxation has two main roles in the economy:on the one hand, it is a means for collecting state revenue and on the other, a mechanism to reduce total alcohol consumption and alcohol-related damage. In a market that would otherwise be Pareto-optimal, taxes will cause distortions one way or another. The effects of taxation on price and related variables depend on how the prices are set and what type of taxes are applied.

## 3.1 Ad Valorem versus Per-Unit Taxes

Comparisons of ad valorem and per-unit taxes appeared a century ago with works of Cournot (1828) and Wicksell (1896). Suits and Musgrave (1955) showed that ad valorem taxation gives a larger aggregate surplus than unit taxation, providing the same yield. Moreover, results by Cheung (1998) demonstrate that ad valorem taxation is superior to unit taxation under all criteria. The yield from any given unit tax is always smaller than the yield from ad valorem tax which would result in the same final output and price. The maximum yield which may be obtained from a unit tax is smaller than the maxium yield possible from an ad valorem tax. If the same yield is obtained from a unit and an ad valorem tax, the final price will be higher (the output smaller) under the unit tax (Suits & Musgrave, 1953).

The theoretical foundation supports findings by the EU Health Report (2006) that the taxes on alcohol in Sweden are not aimed to maximize tax revenue, but rather to tax the health impairing ingredient, ethanol, in accordance to the Pigouvian tradition.

Beside the effects listed above, the insight about price distortion under two competing taxation techniques is one of the most solid assumptions. Price distortion is exaggerated less by an ad valorem tax than a unit tax. Results of superiority of ad valorem taxation to unit taxation with respect to effects on price distortion are robust in studies bySuits & Musgrave (1955); Cheung (1998); Skeath&Trandel (1994).

## 3.2 Pigouvian Taxes

Alcohol taxes in Sweden can be considered to be Pigouvian taxes. The Pigouvian tradition is emphasis on internalizing externalities through the imposition of corrective taxes or subsidies. The orthodox Pigouvian analysis suggests that the levy of corrective taxes on a per-unit basis, once the aspect of the production that generates the negative externality is identified, will induce the behavioral changes that will move the economy to the efficiency locus (Buchanan, 1969). In other words, the optimal price for the externality-generating product is equal to the (Pareto-optimal) level of its entire social marginal cost, while the optimal price of any item *I*, which generates no externalities is simply its marginal private cost (Baumol, 1972).

Since the external diseconomy is involved, the assumption follows that there exists an over-production and over-consumption of the good under consideration. As the supply and demand of the good is closely linked to its price, it becomes an automatic stabilizer of the optimal output level. A high tax rate will thus encourage a lower level of output and consumption.

Applied to alcohol taxation, the price level of alcoholic beverages influences the per capita consumption levels of ethanol, as well as the incidence of alcohol abuse and its health related consequences. Consumers tend to drink less ethanol, and have fewer al-

cohol-related problems when alcoholic beverage prices are increased or alcohol availability is restricted. An increase in price results in reduced consumption, not only by the volume of beverage but also of ethanol. The rationale behind taxing the ethanol content is to reduce the external cost per unit of the ethanol consumed (Cook & Moore, 2002).

## 3.3 Effects of Alcohol Taxation

The idea behind the Pigouvian tradition is to eliminate the negative externality by imposing the tax. Standard welfare theory assumes that all consumers of alcohol enjoy positive net benefits (consumer surplus) (Pogue &Gnotz, 1989). However, taxes and subsidies to control externalities will not produce an optimal allocation of resources in the complex world of reality (Baumol, 1972). A tax on alcohol would reduce consumption indiscriminately and therefore reduce the satisfaction experienced by millions of sensible drinkers without necessarily reducing the harm caused by few excessive drinkers (Littlefield, 1986).

Even though increases in alcohol taxes mean lower alcohol consumption, in practice the identification of correct amount of social cost is associated with difficulties of measurement. Errors in estimation may lead to over- or under-taxation and stir the market in a different direction, other than the Pareto-efficient optimum. Incorrect approximation of the tax amount is one of the shortcomings of per-unit taxation. Other estimated effects include indifference between the taxed population by ignoring the difference in the elasticity of consumption among abusers and non-abusers; higher burden on lower-income population; resource misallocation; compression of the price range due to difference in relative change in prices of same beverage category (see e.g. Cook & Moore, 2002; Buchannan, 1969; Österberg, 2004; Ponicki et al., 1997). The EU health report also (2006) estimates the price effects on beverage preferences, young people and heavy drinkers, use of other drugs, frequency of drinking, and harm done by alcohol; these are, however, deviating from the research topic at hand and will not be discussed further here.

The most notable effects of taxation change in 1992 [to per-unit level] in Sweden were substantial compression of the range of prices for spirits and wine and corresponding expansion of the price spectrum of beer. Beverages with high alcohol content but low prices had a substantial increase in taxes per container (Ponicki et al., 1997).

Before the ethanol-based tax was applied, the price ranges were according to the pre-tax cost of the beverages. After the new taxation laws, a change in price that consumers had to pay on an after-tax product was directly related to the ethanol content only.

The expected outcome excluding application of Value Added Tax (VAT) would be for the after-tax price in lower-priced wines to rise significantly more in percentage terms than the after-tax price of high-priced wines in comparison to their pre-tax price. Thus, the after-tax price of one liter of wine with original value of SEK 50 and 13% of ethanol content would be 71.58 SEK, whileafter-tax price of wine with original per liter value of SEK 1000 and the same ethanol content it would be 1 021.58 SEK.theresective percentage increases in the above pricesare 43.16% and 2.16%. The difference in price due to the per-unit tax shall be characterized with a significant relative upward pressure on the lower-priced range of goods. The distortion is expected to arise from the disproportionate percentage increase in the after-tax price of the good due to the tax specifics.

## 3.4 Wine Pricing in Sweden and Germany

The retail prices of alcoholic beverages in Sweden is based on the cost of the product to Systembolaget including variable and fixed overhead, ethanol-based tax SEK 21.58/liter with eventual VAT of 25% applied to the after-ethanol-tax price of beverage. The pricing process consists of 4 steps, as explained in Table 1. The price from the supplier excluding the tax is summed with the variable overhead of 19% of the wholesale price and fixed overhead SEK 3.5; finalizing with the alcohol tax applicable to the beverage category calculated based on the pure ethanol content and VAT of 25% of the sum.

Table 1. Alcohol Price Determinants

| **Sweden** | **Germany** |
|---|---|
| +Purchase price for the retailer | +Purchase price for the retailer |
| +Variable overhead | +Variable overhead |
| +Fixed Overhead | + Fixed Overhead |
| +Alcohol taxes per unit of Ethanol content (SEK 21.58/liter of 8.5-15% wine) | |
| +VAT (25% ad valorem) | +VAT (16% ad valorem) |
| Final Price to the Consumer | Final Price to the Consumer |

Source: Systembolaget, 2006; Kurdadze&Simaityte, 2008

The table shows that the difference between the final price of the wine in Sweden and Germany arises from the difference in excise duty on alcohol and ad valorem VAT tax rate.

## 3.5 Formulation of Hypothesis

The introduced theory suggests that distortion in pricing ought to occur due to taxation. The differences in pricing structure in Sweden and Germanyare expected to result in a particular type of distortion, price range compression and a high relative increase in after-tax price in the lower-price wine categories.

The analysis of wine prices in different countries shall investigate the effectper-unit ethanol-content-based tax has on the prices of wine in Sweden as compared to their German counterparts. The authors will analyze the VAT-adjusted prices for red and white wines and conclude whether or not per-unit ethanol taxes cause wine on the Swedish retail market to appreciate relatively more in price due to the per-unit tax.

# 4 Methodology and Data

## 4.1 Data

The data used in this analysis was limited to red and white wines according to whether they were listed on both Systembolaget network and online German stores in the exact same brand, vintage and packaging volume. Wines produced inside Germany and Sweden were excluded in order to avoid potentially extreme price differences caused by transportation costs, however other transportation costs are not taken into consideration due to their complexity. Since that is not the main focus of the paper, the purchase price, which includes transportation costs, is taken as given.The Swedish prices are all quoted from the official Systembolaget webpage, and the German prices were collected from several online stores selling alcohol and wines internationally, namely moevenpick-wein.de (2011), hawesko.de (2011), and ebrosia.de (2011), which by several searches were found to be the three largest online wine stores (weinonlinekaufen.com, 2008).

A total of 166 identical wines in both original databases were identified, which formed the sample that was used throughout the analysis. In the sample were 38 white and 129 red wines; however this differentiation is not used further on as ethanol content is similar in all wine types. Every wine in the sample had two prices: one from each market, e.g. a 750ml bottle of white wine "Bourgogne Les Sétilles" produced in Bourgogne, France in 2009, sold for 139SEK in Systembolaget, and 15.8EUR in moevenpick-wein.de.

All German prices were originally quoted in Euros, but converted to SEK for comparison, at the average exchange rate during the period of data collection (1 EUR = 8.981541 SEK). All data was collected in the course of 11 days in order to avoid unnecessary involution with exchange rate fluctuations. It could be argued that since prices are sticky, this should not cause large discrepancies, but in fact Systembolaget does adjust prices when necessary; e.g. in 2009, prices were reported to shift upward twice – in April and again in October (Rörbecker, 2009), and online prices are not very costly to change.

All wine prices are for 750ml bottles, recognizing that the process of bottling has a cost itself, transportation of different types of containers is very different, and therefore converting different packaging and different volumes into e.g. price per liter, while possible, may cause loss or inaccuracy of data.

## 4.2 Methodology

To test the sample for price distortion, all data is divided into 5 groups according to Swedish price ranges approximately a quintile each. That is to say, the cheapest 33 (out of 166) listed wines according to their Swedish price formed group 1, the next 34 formed group 2, etc. In every group there are at least 30 different wines.

The comparison regression of Swedish price versus German price, where Swedish price is used as an independent variable and German as the dependent can be expressed as follows:

$$P_{DE} = \alpha + \beta * P_{SV}$$

Where P are prices in, respectively, Germany (DE) and Sweden (SV), α is the intercept, or the constant, and β is the slope coefficient.

A linear relationship is forced on the regression because of the nature of comparison. In the hypothetical case of perfectly matching prices in both countries, the estimation would be linear with β of exactly 1 and α of 0. In the case of taxation per alcohol content, however, the expectation is that the entire range would be pushed by the same absolute value, consisting of the fixed fee overhead and the alcohol content tax, meaning the slope should remain the same at 1, while the intercept (α) should be negative at the value of the total sum of unit taxes. The α constant in the regression, therefore, expresses the absolute price increase caused by the taxes in Sweden. Both the entire sample and then each group separately are tested whether these statistics are significantly different from the previously described.

Should any of the slopes prove significant, as expected with the alcohol content tax, each group will be tested whether the percentage difference from the proxy prices (German) is different between groups. This would indicate distortion in the sense that although the absolute value price increase was even in the entire range, the end buyer is more affected by the perception of an increase as a portion of price rather than by absolute value. Furthermore, the differences between the German and the Swedish price of each particular wine are calculated and depicted graphically for inspection. The differences between German and Swedish prices expressed as percentage of Swedish price are used in order to avoid overvaluation of differences in the high price ranges and tested for heteroscedasticity.

### 4.2.1 VAT Exclusion

The value added tax makes up one of the larger portions of beverage price, and can also cause distortion. VAT in Sweden is 25% and only 16% in Germany, which reflects general national price levels more than an actual difference in alcohol pricing. Therefore to better isolate the effect of the ethanol tax, prices without VAT are compared. That is, since VAT is the last addition in the Swedish pricing system, same analysis is valid to be repeated with prices excluding it.

# 5 Analysis and Results

*All German prices are reported converted to SEK.*

As can be seen from Figure 1, which shows the distribution of the sample according to Swedish prices on the horizontal axis, most of the sample is concentrated near the lower end of the price range. Although not clearly indicated here, but as seen later in Figure 2, the two most expensive wines in the sample, falling in Group 5, may appear to be outliers; however they are actual observed market prices, and therefore should not be treated as "mistakes" or discrepancies, but rather seen as lack of data in the range between the top 2 points and the cluster with the rest of data. In light of that, it may be more appropriate to consider them as a separate group with too few data points, as they may have enough gravity to affect the regression results and it should be kept in mind when interpreting results.

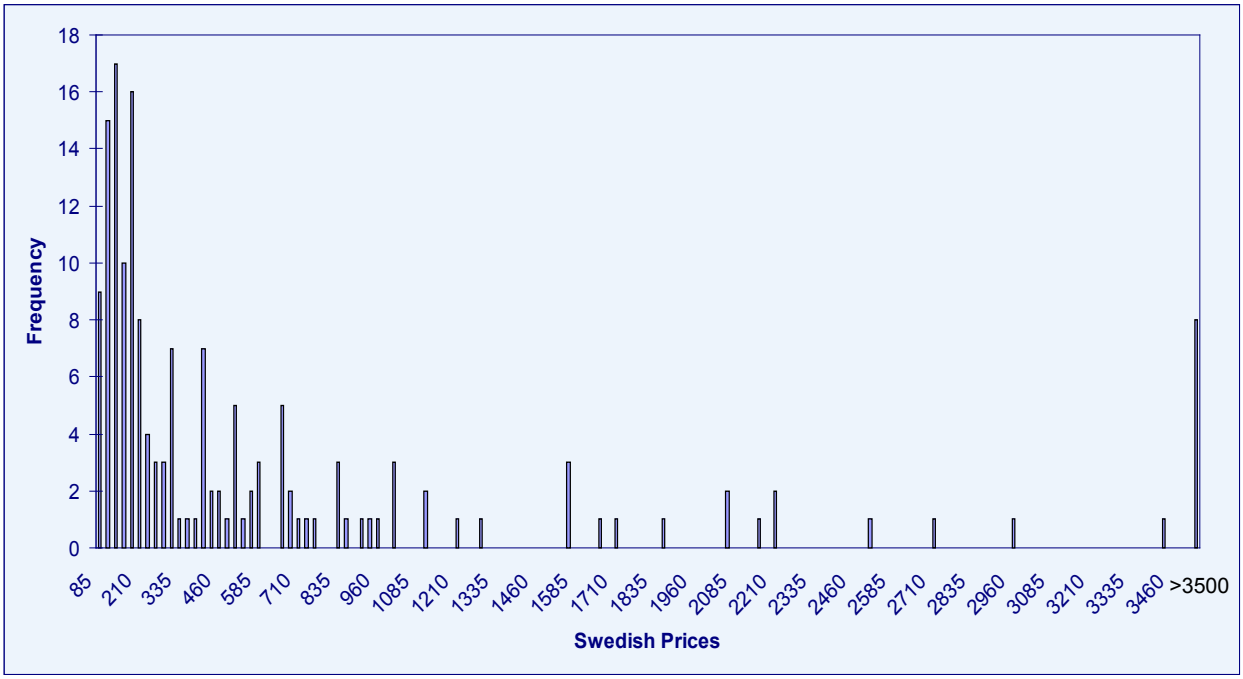


Figure 1. Histogram. Sample distribution according to price

No direct conclusions should be made from the range of the sample about the total price range of all the wines available in either of the markets, since the German sample is taken entirely from online stores specializing in alcoholic beverages. The price range of the particular sample, however, does contain valuable information and is not biased, since these are prices from both markets for exactly identical wines. There is no direct indication of price compression from the highest and lowest price boundaries, since both are lower in Germany (see Table 2), thus simply indicating that the general price level in Germany can be expected to be lower, as is no surprise considering VAT differences.

Because the price ranges were decided through arbitrary division of the number of wines in the sample, the price ranges within the groups may change as the exchange rate fluctuates.

The initial analysis is made with VAT-inclusive prices in order to determine whether it can be justified to investigate VAT-adjusted price levels

Basic statistics for each group, as well as for the overall price range, are presented in Table 2:

Table 2. Group statistics

| | Entire range | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
|---|---|---|---|---|---|---|
| No. of wines | 166 | 33 | 34 | 31 | 34 | 34 |
| Swedish price range | 63-11897 | 63-128 | 129-184 | 185-398 | 399-848 | 849-11897 |
| German price range | 52.99-11008.67 | 52.99-142.81 | 85.32-205.68 | 130.23-377.22 | 259.57-853.25 | 853.25-11008.67 |
| α | 16.7104 | -7.9481 | 12.6849 | -15.0755 | 65.6936 | 172.1861 |
| α t-statistic | 0.7774 | -0.4928 | 0.4631 | -0.3670 | 0.8796 | 1.2731 |
| p-value of α=0 | 44% | 63% | 65% | 77% | 39% | 21% |
| β | 0.9202 | 1.0148 | 0.8264 | 0.9716 | 0.7863 | 0.8931 |
| β t-statistic | 77.6821 | 6.2853 | 4.6805 | 6.3732 | 6.1199 | 26.1116 |
| p-value of β=1 | 0% | 93% | 33% | 85% | 11% | 0% |
| $R^2$ | 0.97 | 0.56 | 0.41 | 0.58 | 0.54 | 0.96 |

None of the intercepts proved to be significantly different from 0 at any reasonable confidence level, as indicated by p-values of intercept all being above 10%. It should be pointed out that in Groups 2 and 4, while the intercept is shown positive (but insignificant), the slope value still renders the entire regression estimate to be under the perfect match in the entire active range; that is, the range reported for each group in Table 2. As for Group 5, the intercept is positive and remains positive in the active range both with the top 2 data points and without. For comparison's sake, removing the said top 2 wines from the sample, though, makes the intercept for the entire range negative (-2.10), which would be in accordance with the expectations, although still insignificantly different from 0 (p-value = 92%).

The slope, however, is found to be significantly different from 1 for the entire range, as indicated by p-value of 0%; while slightly off, but not significantly different from 1 in most groups (p-value>10%), except for the highest price range in Group 5. Again, removing the top 2 data points gives different results for Group 5, and shows the slope at 0.9247 with a p-value of 19%, making it, as the rest of the groups, insignificantly different from 1. This is the most important finding as it does imply price distortion in the sense that while within the groups the prices are changing proportionately the difference in price level among the groups in fact varies. This suggests that as price increases, differences in prices become larger. However, whether this is caused by VAT or by actual price distortion is still unclear.

Figure 2 depicts the distribution of prices, where the dotted line is a 45° mark with the intercept at 0, representing a would-be perfect match of prices:

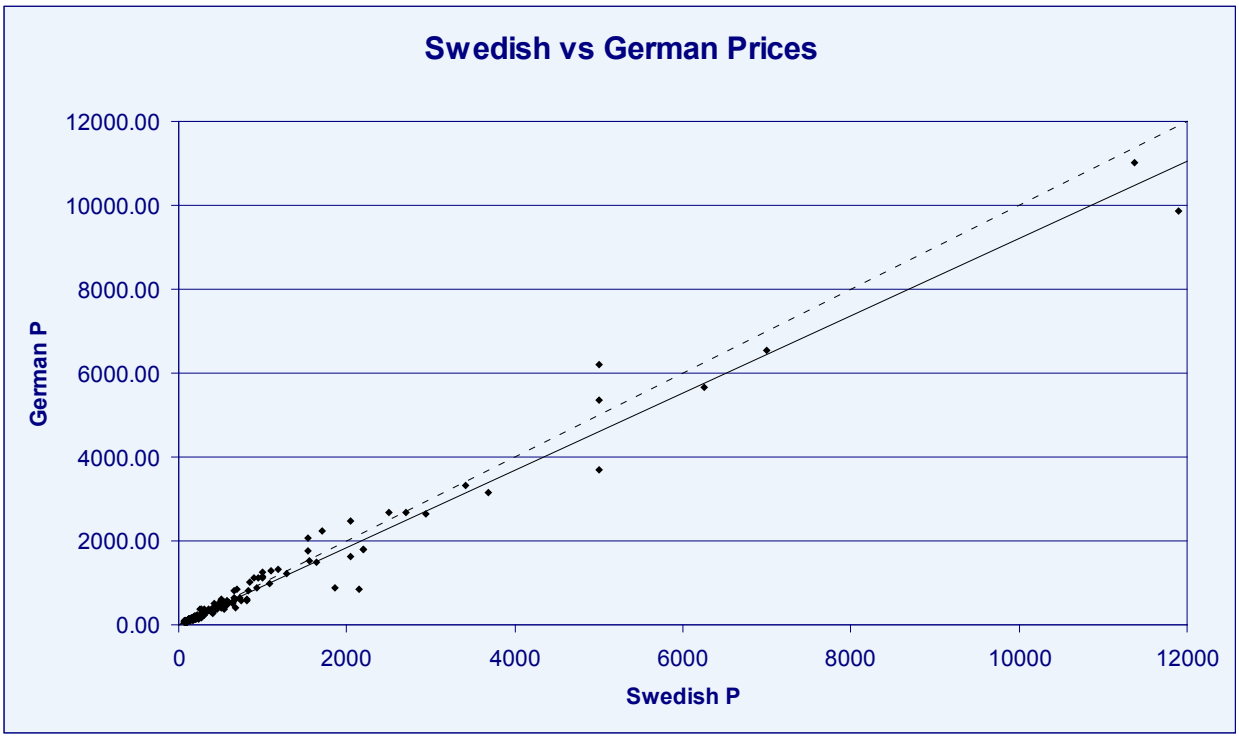


Figure 2. Distribution of prices

All data points below the dotted line represent wines that are cheaper in Germany, and above it – cheaper in Sweden. The solid line represents the estimated relationship of the prices, and is clearly seen to be below the 45° line, implying that the German price level is in fact lower than Swedish, as would be consistent with the different policies of taxation.

While the initial impression of the absolute differences in prices (German price - Swedish price) is that the differences become larger as the price increases, this is expected if the differences are caused by factors which are expressed as percentage of price, such as VAT or other ad valorem taxation. This can be directly observed in Figure 3, which expresses price difference in terms of percentage of price – the level of differences appear to be similar over the entire range, with most differences lying within 20%, and only 3 extreme observations above 40%. I.e. there is no indication of the differences being larger in the lower-price end of the figure, as could have been expected from the theory. Moreover, Figures 2 and 3 confirm the previously made observation that the overall price level in Germany is lower, showing that negative differences are much more numerous than positive. This has important implications, because it could be an initial indication that the price distortion caused by differences in price levels among the groups may simply be the result of differences in VAT taxation between Germany and Sweden and not due to alcohol content taxation in Sweden.

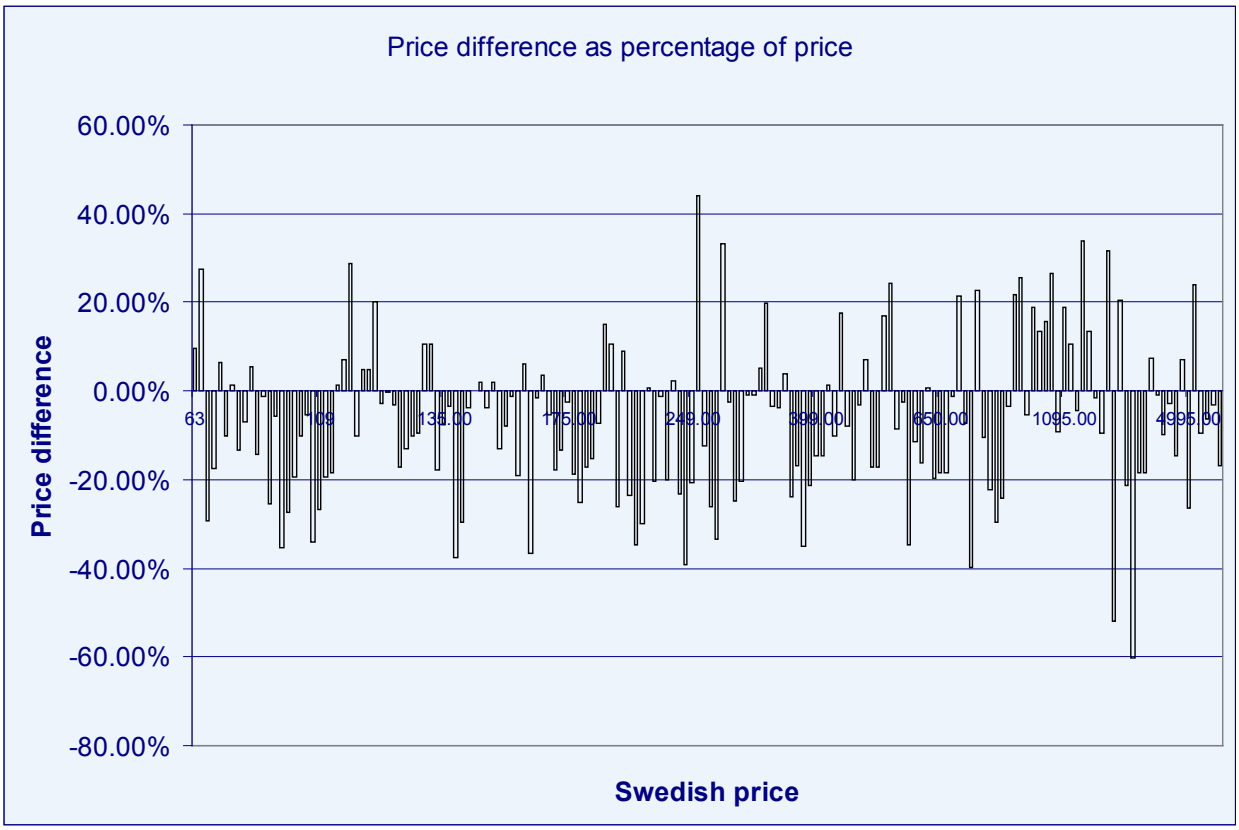


Figure 3. Price differences (German price – Swedish price) expressed as percentage of Swedish prices

Due to this reason, all further sections of this paper will concentrate on analysis of prices without VAT.

## 5.1 VAT Exclusion

This section of the paper covers the analysis performed with prices adjusted for VAT i.e. 80% (1/1.25) of Swedish prices and 86.2% (1/1.16) of German prices, corresponding with the VAT levels in the countries. It is done in order to better isolate and identify the effect of other taxes applied in Sweden.

Table 3 presents summary statistics equivalent to those of Table 2, for the prices excluding VAT:

Table 3. Group statistics

| | Entire range | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
|---|---|---|---|---|---|---|
| No. of wines | 166 | 33 | 34 | 31 | 34 | 34 |
| Swedish price range | 50.4-9517.6 | 50.4-102.4 | 103.2-143.2 | 148-316 | 319.2-663.2 | 679.2-9517.6 |
| German price range | 45.68-9490.24 | 45.68-123.11 | 73.56-177.31 | 112.27-325.19 | 223.76-735.56 | 735.56-9490.24 |
| α | 14.4055 | -6.8518 | 10.9353 | -12.9961 | 56.6324 | 148.4363 |
| α t-statistic | 0.7774 | -0.4928 | 0.4631 | -0.3670 | 0.8796 | 1.2731 |
| p-value of α=0 | 44% | 63% | 65% | 72% | 39% | 21% |
| β | 0.9916 | 1.0936 | 0.8905 | 1.0470 | 0.8473 | 0.9623 |

| | | | | | | |
|---|---|---|---|---|---|---|
| β t-statistic | 77.6821 | 6.2853 | 4.6805 | 6.3732 | 6.1199 | 26.1116 |
| p-value of =1 | 51% | 59% | 57% | 78% | 28% | 31% |
| $R^2$ | 0.97 | 0.56 | 0.41 | 0.58 | 0.54 | 0.96 |

The ranges, compared to Table 2, are naturally lower because now only the specified fraction of the observed price is used.

As for the intercepts, none of them can be said to be significantly different from 0, as seen in p-values all well above 10%. The indication is that the constant in the regression is not significantly different from 0, meaning the taxes (other than VAT) added to wine in Sweden are not directly perceived in the end-consumer price, i.e. the overall difference between wine prices in the two countries is not significant.

$R^2$, the portion of explained variance, is above 0.95 for the entire range and Group 5 regressions, where the slope coefficients β are significant. The $R^2$ in Group 5 is still 0.90 after removing the top 2 points. In Groups 1-4, the low $R^2$ indicates that the Swedish prices only explain about half ($R^2$ values are between 0.41 and 0.58) of the variance in the German prices, and could be caused by several reasonse.g. there is little relationship or model specification is inaccurate, such as if there are not enough variables or, the most likely, the relationship is not linear.On a side note,as these are not different databases, only using manipulated prices within the same sample, all t-statistics and $R^2$are identical to the ones in previous analysis with full observed prices.

The slopes are now not significantly different from 1 in any of the groups or the entire range either, in contrast to the post-VAT analysis. Jointly, the two above conclusions regardingintercept and slope mean that no significant difference can be found between Swedish and German prices or their patterns when calculated excluding VAT.

Figure 4 is equivalent to Figure 2, now for prices without VAT, and show that indeed the estimated regression is much closer to the “perfect” match of prices, depicted by the dotted line.

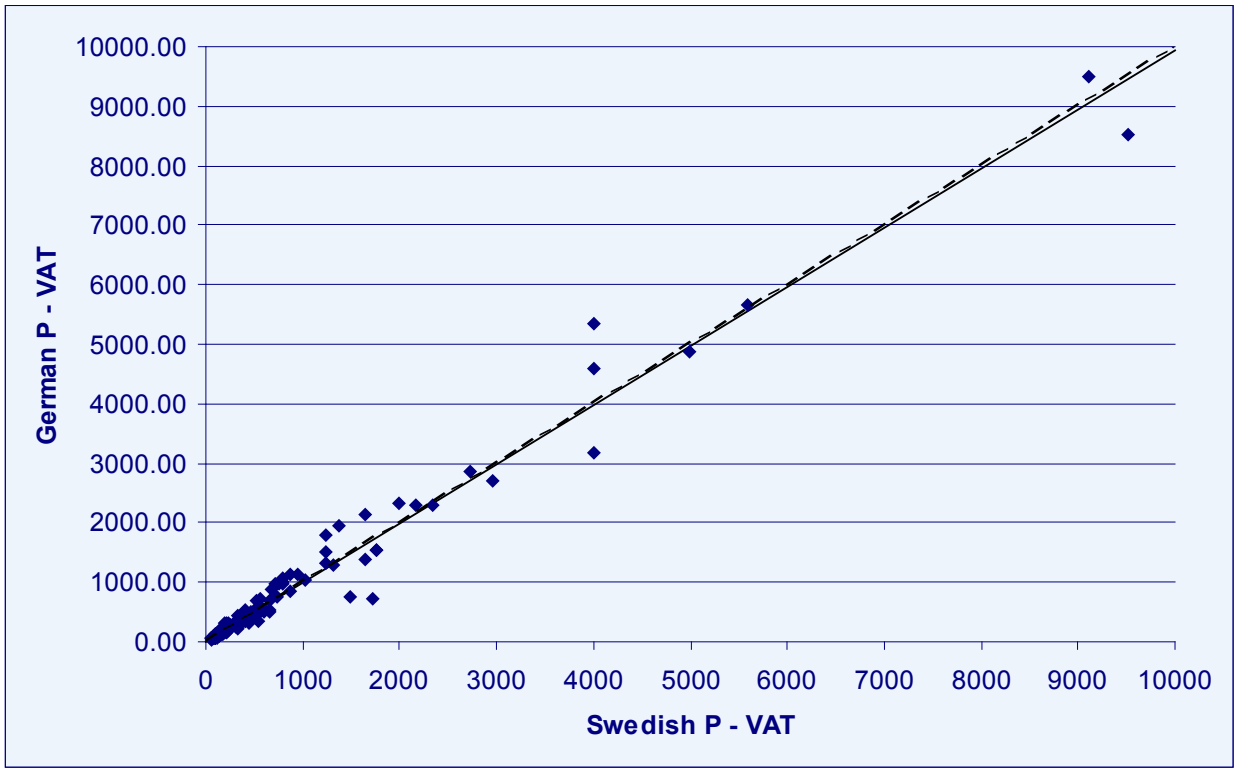


Figure 4. Distribution of prices without VAT

The implication is that when calculations are made with prices excluding VAT no form of price distortion can be observed when comparing German and Swedish markets, and the additional taxes levied in the Swedish market do not make an impact that can be detected in prices excluding VAT. This could also be caused by mark-ups demanded by German retailers which are not an official tax, but rather a seller's choice.

Figure 5 once again shows the differences between Swedish and German prices, both without VAT, expressed as percentage of Swedish prices without VAT, similar to Figure 3 in the previous section.

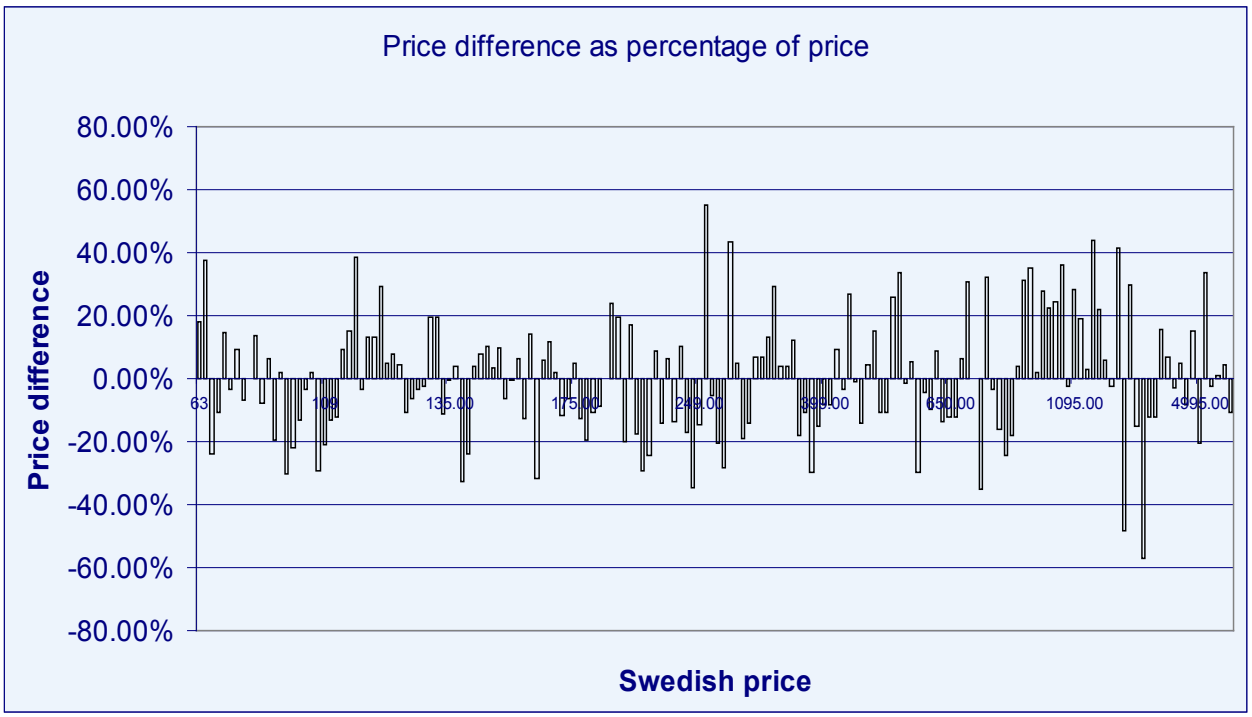


Figure 5. Price differences (German price without VAT– Swedish price without VAT) expressed as percentage of Swedish prices without VAT

Since VAT is higher in Sweden, excluding it from the analysis changes the pattern. Now there are 83 positive and 83 negative values in Figure 5, changing the previous conclusion when, including VAT, prices were clearly lower in Germany. However, there is still no noticeable effect of prices being relatively larger in the lower-price range on the left, and therefore no indication of the expected per-unit tax effect.

# 6 Conclusion

The strongest and most obvious observation of the analysis is that the observed price with VAT levels for both red and white wines are lower in Germany than in Sweden for any of the price ranges tested in the sample.

The analysis also found that while the overall price level is lower in Germany, the difference is much larger in higher price ranges, indicating that this may be caused by differences in the VAT tax between the two countries. However this also means that the price-quality information conveyed to the end consumer may not be entirely identical even for a sample of identical wines.

The analysis of prices excluding VAT, however, showed no significant indication of any price distortion, since there were no statistically significant differences between the German and Swedish prices without VAT. This, however, does not directly confirm that the additional taxes in the Swedish pricing system do not affect the prices, because the German prices might also be pushed up by other factors than the original costs, such as mark-ups, making the pre-VAT price levels equal. The conclusion is still that there is no price differences without VAT, even if it cannot be directly implied that the alcohol tax does not increase the prices.This is not directly in accordance with previous results, e.g. Ponicki et al. (1997) found substantial price range compression in spirits and wine, but the study in question was comparing prices in Sweden before and after the change of taxation in 1992, and is not contradicting current findings.

The perception that the Swedish Pigouvian alcohol content tax should make wines in low price ranges relatively more expensive and in high ranges relatively cheaper (Kronstam, B.-G., 2010) did not receive support in this paper.A particular limitation of this study however is no available data of retailer costs of each beverage, considering that the proportion of purchase costs versus the profit mark-up is likely a significant part of the end-consumer price. This is also an opportunity for further research.

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# Appendix

Table 4. Entire range statistics

| | | | |
|---|---|---|---|
| β | 0.92018212 | α | 16.71041067 |
| SE β | 0.011845487 | SE α | 21.49483932 |
| $R^2$ | 0.973542012 | SE ($P_{DE}$) | 247.8686089 |
| f | 6034.506152 | df | 164 |
| SS(reg) | 370753101.8 | SS(resid) | 10075970.95 |
| t-stat β | 77.68208386 | t-stat α | 0.777415007 |
| p-value β=0 | 2.8136E-131 | p-value α=0 | 0.438033942 |
| t-stat β-1 | -6.738252281 | | |
| p-value β=1 | 2.5896E-10 | | |

Table 5. Entire range statistics excluding top 2 points

| | | | |
|---|---|---|---|
| β | 0.953019861 | α | -2.102158 |
| SE β | 0.016095638 | SE α | 20.8655 |
| $R^2$ | 0.95583187 | SE ($P_{DE}$) | 227.8372 |
| f | 3505.803005 | df | 162 |
| SS(reg) | 181985532.3 | SS(resid) | 8409388 |
| t-stat β | 59.20982186 | t-stat α | -0.100748 |
| p-value β=0 | 1.1482E-111 | p-value α=0 | 0.919875 |
| t-stat β-1 | -2.918811816 | | |
| p-value β=1 | 0.004013879 | | |

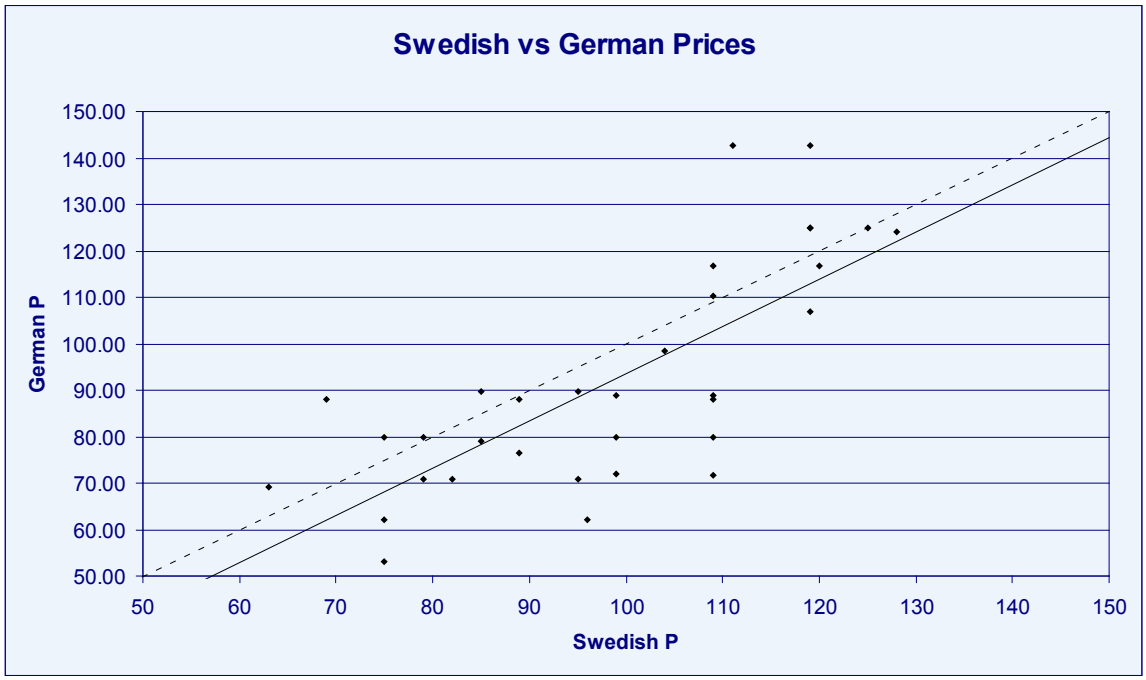


Figure 6. Distribution of prices. Group 1

Table 6. Group 1 statistics

| | | | |
|---|---|---|---|
| β | 1.014816757 | α | -7.94807 |
| SE β | 0.161459689 | SE α | 16.12756 |
| $R^2$ | 0.560312017 | SE ($P_{DE}$) | 16.11335 |
| f | 39.50454227 | df | 31 |
| SS(reg) | 10256.96189 | SS(resid) | 8048.842 |
| t-stat β | 6.285263898 | t-stat α | -0.49282 |
| p-value β=0 | 5.46357E-07 | p-value α=0 | 0.625609 |
| t-stat β-1 | 0.09176753 | | |
| p-value β=1 | 0.927473197 | | |

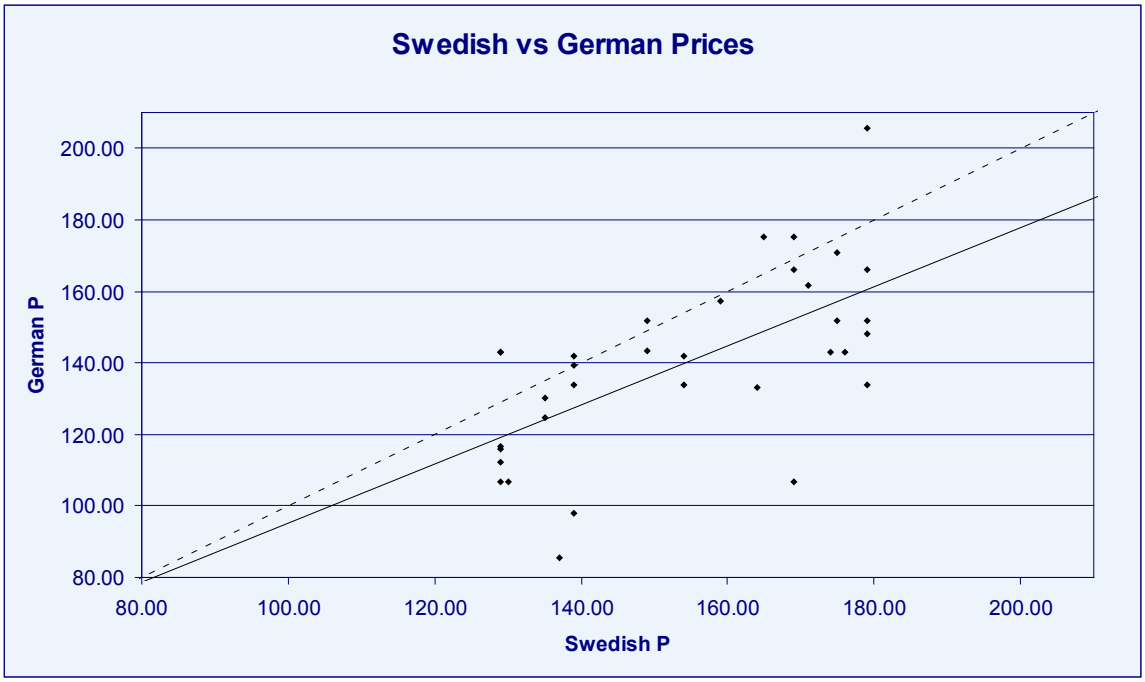


Figure 7. Distribution of prices. Group 2

Table 7. Group 2 statistics

| | | | |
|---|---|---|---|
| β | 0.826409346 | α | 12.68493 |
| SE β | 0.17656367 | SE α | 27.38857 |
| $R^2$ | 0.406387756 | SE ($P_{DE}$) | 19.65169 |
| f | 21.9072439 | df | 32 |
| SS(reg) | 8460.334075 | SS(resid) | 12358.04 |
| t-stat β | 4.680517482 | t-stat α | 0.463147 |
| p-value β=0 | 5.01741E-05 | p-value α=0 | 0.646394 |
| t-stat β-1 | -0.983161788 | | |
| p-value β=1 | 0.332903308 | | |

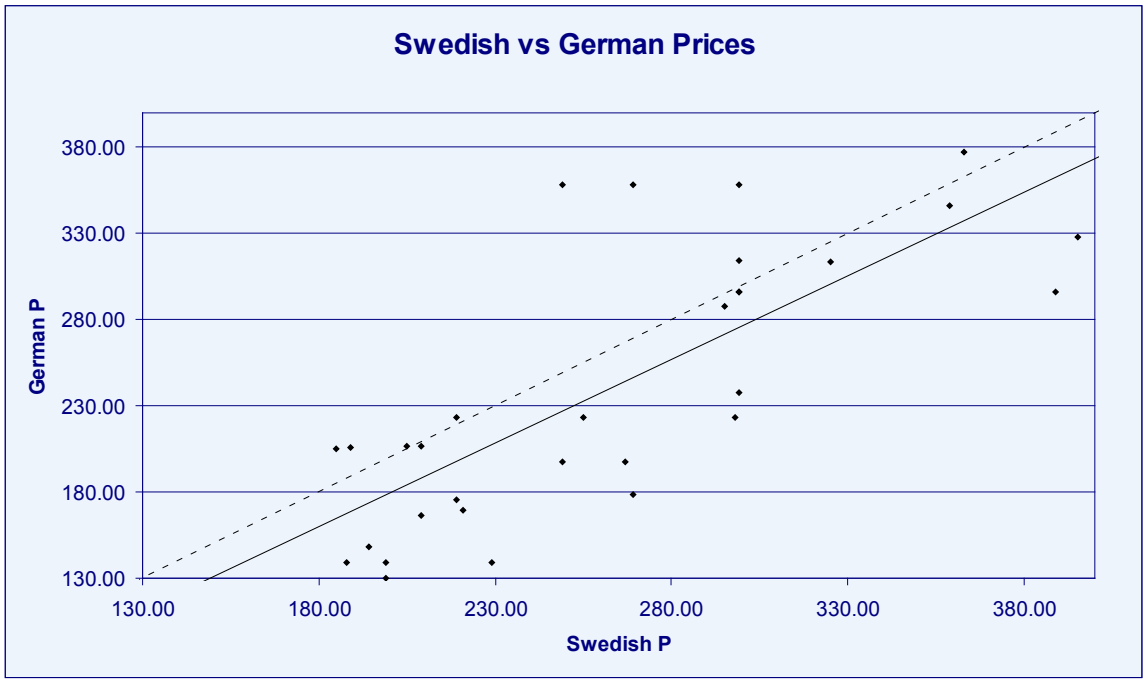


Figure 8. Distribution of prices. Group 3

Table 8.Group 3 statistics

| | | | |
|---|---|---|---|
| β | 0.971647265 | α | -15.0755 |
| SE β | 0.152457901 | SE α | 41.07531 |
| $R^2$ | 0.583440424 | SE ($P_{DE}$) | 50.96636 |
| f | 40.61789297 | df | 29 |
| SS(reg) | 105507.809 | SS(resid) | 75329.52 |
| t-stat β | 6.373216846 | t-stat α | -0.36702 |
| p-value β=0 | 5.75179E-07 | p-value α=0 | 0.716268 |
| t-stat β-1 | -0.185970911 | | |
| p-value β=1 | 0.853762313 | | |

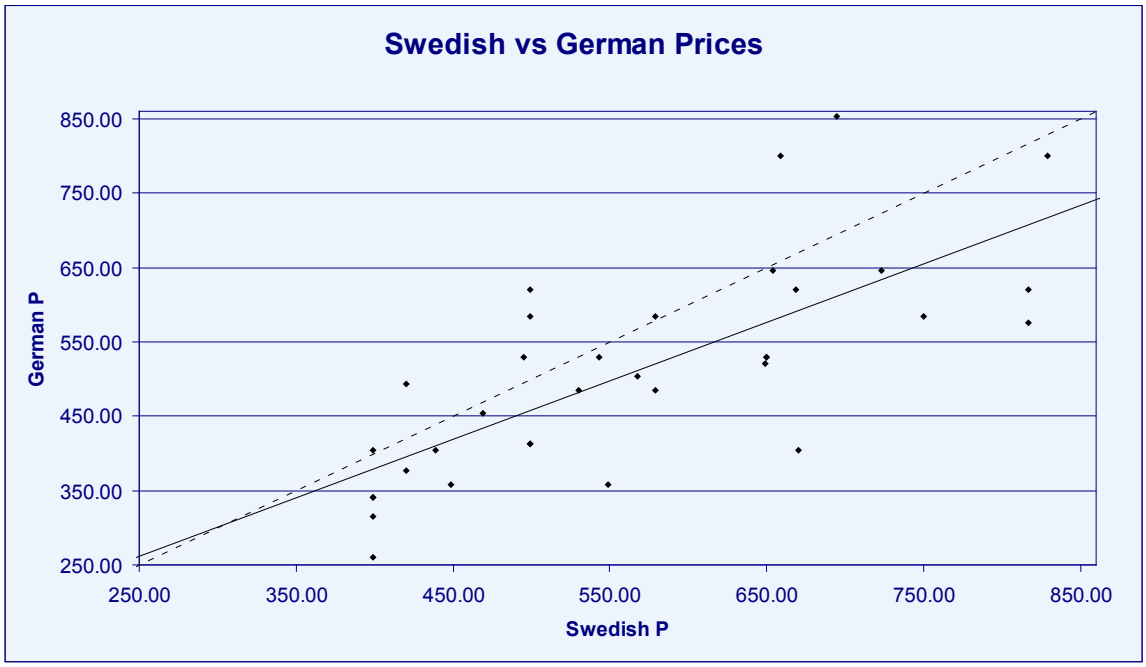


Figure 9. Distribution of prices. Group 4

Table 9. Group 4 statistics

| | | | |
|---|---|---|---|
| β | 0.78625866 | α | 65.69357578 |
| SE β | 0.128476086 | SE α | 74.68501917 |
| $R^2$ | 0.539256581 | SE ($P_{DE}$) | 97.4965375 |
| f | 37.45297245 | df | 32 |
| SS(reg) | 356012.032 | SS(resid) | 304178.3944 |
| t-stat β | 6.119883369 | t-stat α | 0.879608475 |
| p-value β=0 | 7.67514E-07 | p-value α=0 | 0.385629461 |
| t-stat β-1 | -1.66366635 | | |
| p-value β=1 | 0.105943694 | | |

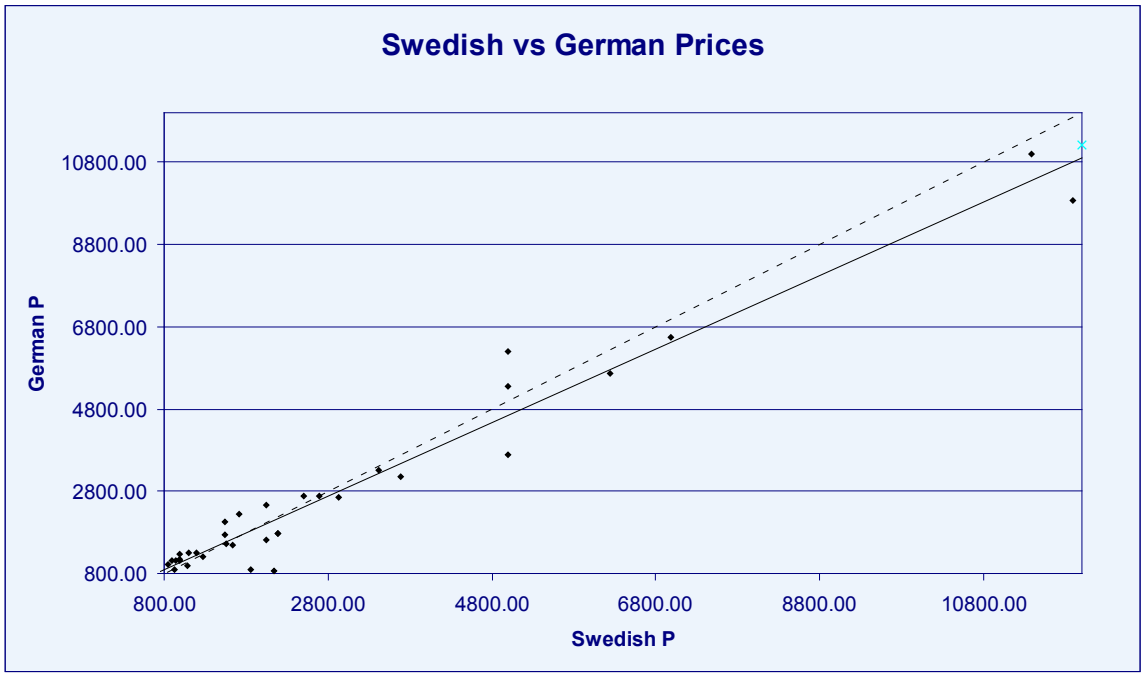


Figure 10. Distribution of prices. Group 5

Table 10. Group 5 statistics

| | | | |
|---|---|---|---|
| β | 0.8930537 | α | 172.1861 |
| SE β | 0.0342015 | SE α | 135.2523 |
| $R^2$ | 0.9551704 | SE ($P_{DE}$) | 537.0168 |
| f | 681.81332 | df | 32 |
| SS(reg) | 196626155 | SS(resid) | 9228387 |
| t-stat β | 26.111555 | t-stat α | 1.273074 |
| p-value β=0 | 3.805E-23 | p-value α=0 | 0.212163 |
| t-stat β-1 | -3.12695 | | |
| p-value β=1 | 0.0037463 | | |

Table 11. Group 5 statistics excluding top 2 points

| | | | |
|---|---|---|---|
| β | 0.924700465 | α | 105.3802 |
| SE β | 0.055785907 | SE α | 159.2333 |
| $R^2$ | 0.901561814 | SE ($P_{DE}$) | 511.3764 |
| f | 274.7597794 | df | 30 |
| SS(reg) | 71851277.92 | SS(resid) | 7845174 |
| t-stat β | 16.57587945 | t-stat α | 0.661798 |
| p-value β=0 | 1.19742E-16 | p-value α=0 | 0.513153 |
| t-stat β-1 | -1.349794955 | | |
| p-value β=1 | 0.187179469 | | |

Table 12. Entire range without VAT statistics

| | | | |
|---|---|---|---|
| β | 0.99157556 | α | 14.40553 |
| SE β | 0.012764533 | SE α | 18.53003 |
| $R^2$ | 0.973542012 | SE ($P_{DE}$) | 213.6798 |
| f | 6034.506152 | df | 164 |
| SS(reg) | 275529950.8 | SS(resid) | 7488088 |
| t-stat β | 77.68208386 | t-stat α | 0.777415 |
| p-value β=0 | 2.8136E-131 | p-value α=0 | 0.438034 |
| t-stat β-1 | -0.659988 | | |
| p-value β=1 | 0.510187 | | |

Table 13. Entire range without VAT statistics excluding top 2 points

| | | | |
|---|---|---|---|
| β | 1.026961058 | α | -1.812205 |
| SE β | 0.017344438 | SE α | 17.9875 |
| $R^2$ | 0.95583187 | SE ($P_{DE}$) | 196.4114 |
| f | 3505.803005 | df | 162 |
| SS(reg) | 135244896.2 | SS(resid) | 6249545 |
| t-stat β | 59.20982186 | t-stat α | -0.100748 |
| p-value β=0 | 1.1482E-111 | p-value α=0 | 0.919875 |
| t-stat β-1 | 1.55445 | | |
| p-value β=1 | 0.122029 | | |

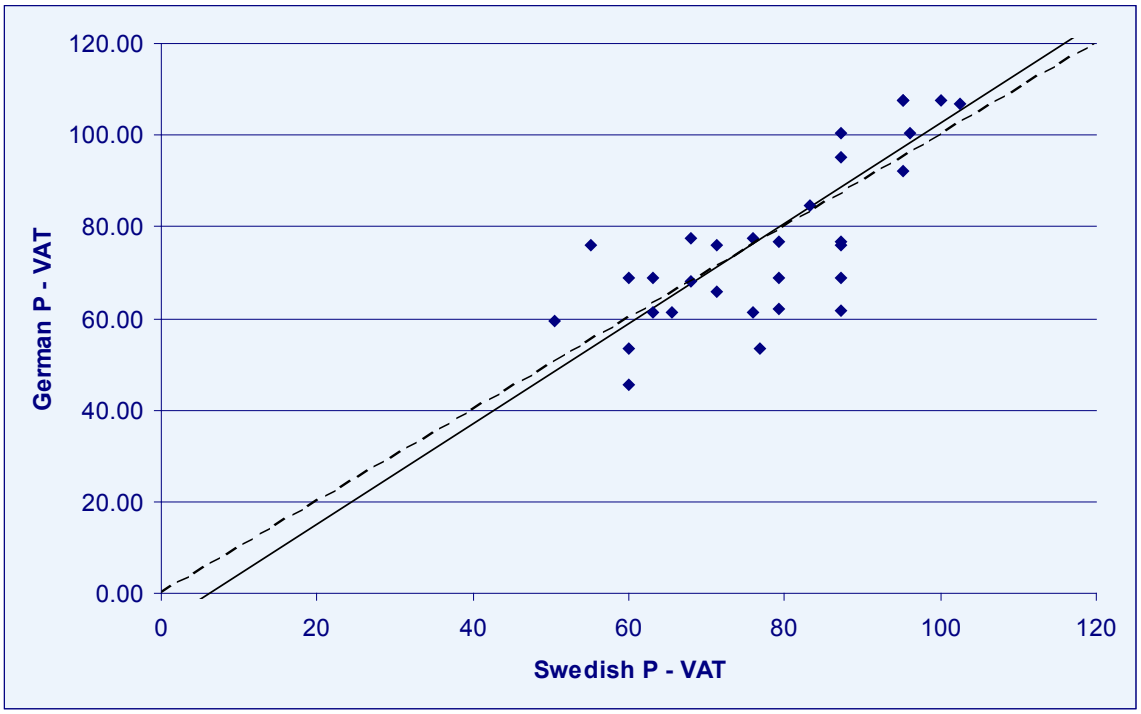


Figure 11. Distribution of prices without VAT. Group 1

Table 14. Group 1 without VAT statistics

| | | | |
|---|---|---|---|
| β | 1.09355254 | α | -6.85178 |
| SE β | 0.173986734 | SE α | 13.90307 |
| $R^2$ | 0.560312017 | SE ($P_{DE}$) | 13.89082 |
| f | 39.50454227 | df | 31 |
| SS(reg) | 7622.593554 | SS(resid) | 5981.601 |
| t-stat β | 6.285263898 | t-stat α | -0.49282 |
| p-value β=0 | 5.46357E-07 | p-value α=0 | 0.625609 |
| t-stat β-1 | 0.537699 | | |
| p-value β=1 | 0.594624 | | |

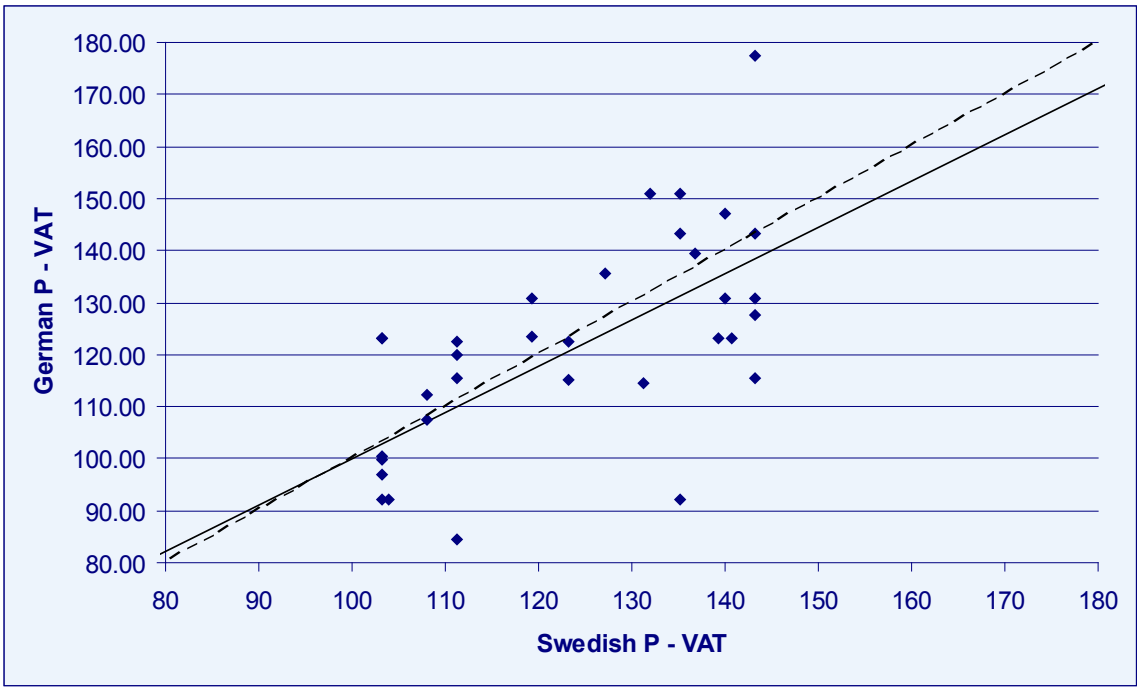


Figure 12. Distribution of prices without VAT. Group 2

Table 15. Group 2 without VAT statistics

| | | | |
|---|---|---|---|
| β | 0.890527313 | α | 10.93528 |
| SE β | 0.190262576 | SE α | 23.61083 |
| $R^2$ | 0.406387756 | SE ($P_{DE}$) | 16.94111 |
| f | 21.9072439 | df | 32 |
| SS(reg) | 6287.406418 | SS(resid) | 9184.04 |
| t-stat β | 4.680517482 | t-stat α | 0.463147 |
| p-value β=0 | 5.01741E-05 | p-value α=0 | 0.646394 |
| t-stat β-1 | -0.57538 | | |
| p-value β=1 | 0.569061 | | |

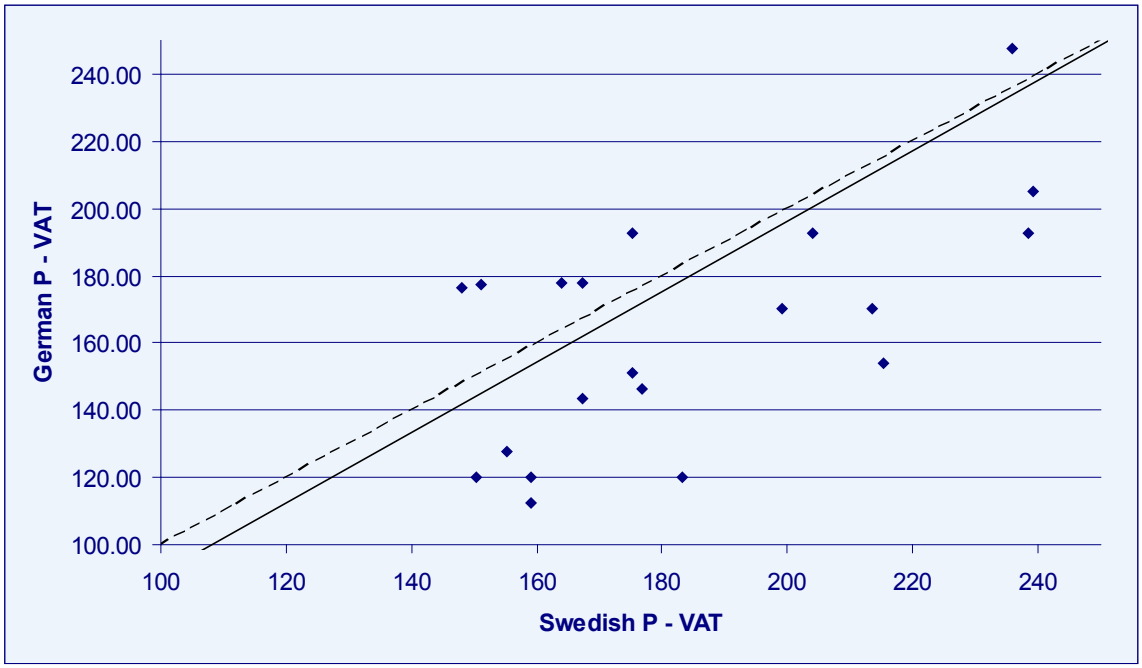


Figure 13. Distribution of prices without VAT. Group 3

Table 16. Group 3 without VAT statistics

| | | | |
|---|---|---|---|
| β | 1.047033691 | α | -12.9961 |
| SE β | 0.164286532 | SE α | 35.40975 |
| $R^2$ | 0.583440424 | SE ($P_{DE}$) | 43.93652 |
| f | 40.61789297 | df | 29 |
| SS(reg) | 78409.48941 | SS(resid) | 55982.11 |
| t-stat β | 6.373216846 | t-stat α | -0.36702 |
| p-value β=0 | 5.75179E-07 | p-value α=0 | 0.716268 |
| t-stat β-1 | 0.286291 | | |
| p-value β=1 | 0.776691 | | |

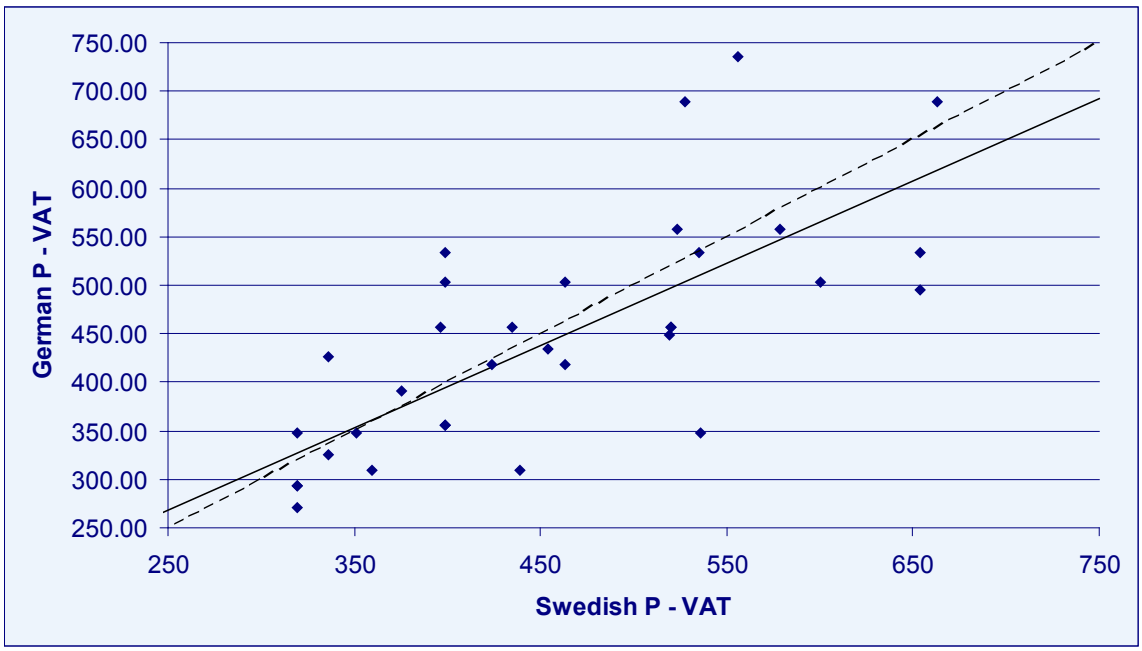


Figure 14. Distribution of prices without VAT. Group 4

Table 17. Group 4 without VAT statistics

| | | | |
|---|---|---|---|
| β | 0.847261487 | α | 56.63239 |
| SE β | 0.138444058 | SE α | 64.38364 |
| $R^2$ | 0.539256581 | SE ($P_{DE}$) | 84.04874 |
| f | 37.45297245 | df | 32 |
| SS(reg) | 264574.9346 | SS(resid) | 226054.1 |
| t-stat β | 6.119883369 | t-stat α | 0.879608 |
| p-value β=0 | 7.67514E-07 | p-value α=0 | 0.385629 |
| t-stat β-1 | -1.10325 | | |
| p-value β=1 | 0.278146 | | |

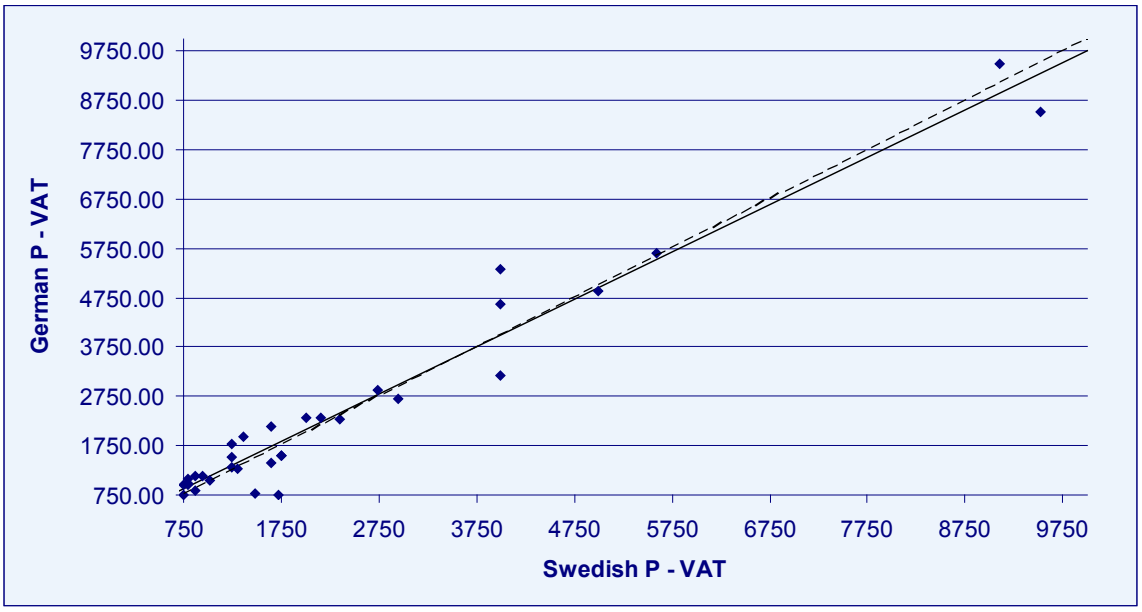


Figure 15. Distribution of prices without VAT. Group 5

Table 18. Group 5 without VAT statistics

| | | | |
|---|---|---|---|
| β | 0.962342342 | α | 148.4363 |
| SE β | 0.036855037 | SE α | 116.5968 |
| $R^2$ | 0.955170352 | SE ($P_{DE}$) | 462.9455 |
| f | 681.813321 | df | 32 |
| SS(reg) | 146125263.5 | SS(resid) | 6858195 |
| t-stat β | 26.11155532 | t-stat α | 1.273074 |
| p-value β=0 | 3.80522E-23 | p-value α=0 | 0.212163 |
| t-stat β-1 | -1.021778 | | |
| p-value β=1 | 0.314549 | | |

Table 19. Group 5 without VAT statistics excluding top 2 points

| | | | |
|---|---|---|---|
| β | 0.996444466 | α | 90.84503 |
| SE β | 0.060114124 | SE α | 137.2701 |
| $R^2$ | 0.901561814 | SE ($P_{DE}$) | 440.8417 |
| f | 274.7597794 | df | 30 |
| SS(reg) | 53397204.16 | SS(resid) | 5830242 |
| t-stat β | 16.57587945 | t-stat α | 0.661798 |
| p-value β=0 | 1.19742E-16 | p-value α=0 | 0.513153 |
| t-stat β-1 | -0.05915 | | |
| p-value β=1 | 0.953228 | | |