Lockdown drinking: The sobering effect of price controls in a pandemic

September 10, 2023

Abstract

Lockdown restrictions in a pandemic may slow viral transmission but disrupt livelihoods and lifestyles that might induce harmful behavior changes, including problematic lockdown drinking fueled by cheap alcohol. Exploiting differences amongst the four constituent countries of the United Kingdom, we use triple difference analysis on alcohol retail sales to examine the efficacy of minimum unit pricing as a price control device to help curb excessive consumption following the outbreak of the COVID-19 pandemic. We find the policy is remarkably effective and well-targeted in reducing demand for cheap alcohol, with minimal spillover effects, and consumers overall buying and spending less.

Key words: pandemic, lockdown, price control, minimum unit pricing, alcohol, excessive consumption

JEL Classification: C54, D04, H23, I12, I18, L81

1. Introduction

Price controls can have good intentions but often poor outcomes in competitive markets (The Economist, 2020). Mandating minimum prices for alcohol may have the good intention of improving public health and reducing alcohol-related crime by reducing the affordability of cheap alcohol to curb high consumption. However, even if applying only to the prices of the very cheapest products in the market, which may be disproportionately linked with harmful consumption, the risk is that the whole market will be affected by price inflation, as higher prices cascade through to higher quality products associated with moderate or light consumption. The inflated prices could then be to the detriment of all consumers, not just those drinking cheap alcohol excessively, where softened competition boosts industry revenue but lowers all consumer surplus if alcohol demand is stubbornly inelastic (The Economist, 2018). Such an outcome would defeat the key argument for minimum prices, over and above taxation and sales restrictions, that they are highly targeted in only affecting cheap alcohol consumption.

This paper examines this prospect with novel analysis and findings on the extent to which minimum prices are targeted with minimal spillover effects. The context is at a time of heightened concerns about the affordability of cheap alcohol fueling problematic lockdown drinking during the COVID-19 pandemic (Anderson et al., 2020, Daly and Robinson, 2020, Finlay and Gilmore, 2020, Chalfin et al., 2021). Our focus is on minimum unit pricing (MUP), as a flat-rate form of minimum prices applying to all alcohol products based on their alcohol content, and we exploit policy differences amongst the four constituent countries of the United Kingdom, where two of the four countries have introduced MUP, to evaluate the efficacy of the policy. Centering on the introduction of MUP in Wales in March 2020, and with the need to disentangle the policy impact from surging demand for take-home alcohol during the pandemic lockdown period, we find that MUP is highly effective in reducing demand for cheap alcohol. We also find little demand spillover towards more expensive products, and consumers overall buying and spending less as desired, indicating that the policy is very well-targeted even in times of heightened demand.

Our approach is to focus primarily on comparing Wales with England (where MUP has been considered but not been implemented) for which we have weekly customer transaction data from the national leading retailer on alcohol purchases for 18 months before and 6 months after the introduction of MUP in Wales. We have two potential controls for a classic difference-in-differences (DD) study design, either contrasting treated products (originally priced below the price floor) with untreated products (priced above the price floor) or the treated country (Wales) with a control country (initially England) for matched products. However, both have complications because demand spillovers in the former would violate the stable unit treatment value assumption (SUTVA), while country lockdown demand differences in the latter would break parallel trends. The latter is a real prospect since the lockdowns closed the entire on-trade for consumption at licensed premises (accounting for 30% of total alcohol consumption), so the scale of the take-home sales uplift could substantially magnify different population responses to the lockdowns (which each country separately controls under devolved powers, with restrictions gradually eased in the last two months of our study period).

For the former, treatment is not binary as the price floor can alter two types of prices – regular prices and promotional prices – suggesting a three-way classification based on the amount of time the products were previously priced below the price floor: never below (untreated), intermittently below (mildly treated), or consistently below (severely treated). Crucially, we find very limited demand spillover to the untreated product group. Specifically, we find that demand spillover from bottom-tier to mid-tier may arise, but MUP curtails the retailer's ability to offer deep discounts (below the price floor) as a promotional tool for mid-tier products, and this seems to curb existing purchases rather than induce consumers to upscale to the top-tier. With this key feature, we use triple difference (DDD) analysis with temporal/country/group comparisons to isolate the price floor impact from differential country lockdown effects, while using other cross-country comparisons for validity testing.

We find overall that the effective price change due to the MUP regulation in Wales is an increase of 14.9% while the quantity decreased by between 17.7% (DD estimate) and 21.4% (DDD estimate). These effects are stronger than those found in the prior studies for Scotland, such as Griffith et al. (2022) finding that MUP increased prices by 5% while reducing alcohol volume by 11% on average. We also find stronger effects than those reported for Wales by Anderson et al. (2021) in their short-period study with household panel data covering just the first six months of 2020, finding a price increase of 8.2% and a quantity reduction of 8.6% due to the introduction of MUP.

Our contribution is threefold. First, we explicitly estimate the demand and substitution patterns between three groups of alcohol which are best viewed as vertically differentiated. To our knowledge, this has not been done in the context of imposing price floors for low-quality alcohol products. The substitution patterns help us better understand if increasing the price of the cheapest and lowest quality alcohol will have a knock-on effect on the price of others in equilibrium (e.g., as in Nash-Bertrand pricing models) or not. Thus, we first estimate own and cross-price elasticities using the non-linear AIDS demand model via instrumental variables. This exercise reveals that demand is very elastic for the cheapest group and that cross-elasticity at the group level is very low with the other groups. In fact, our estimates show that cross-price elasticity is zero between the highest and lowest quality alcoholic products. In turn, this helps us make reasonable assumptions about the lack of potential spillover effects and lends credibility to identification in our main analysis which uses difference-in-differences (DD) and triple differences (DDD) methods.

Our second main contribution is replication. Earlier studies have shown minimum unit price was effective in curtailing demand for the lowest quality alcohol in Scotland. Our replication of the effect of the policy is for a different country, different dataset and data type, different methodology, and different context. The context differs in two important ways: (i) when the minimum unit price was implemented in Scotland, there was already in place a law that prohibited multi-buys like "two for one" or other similar multiple-unit price promotions and it is important to gauge the effectiveness of the policy without the other law; (ii) the minimum unit price was introduced during COVID-19 lockdowns when alcohol consumption at home started surging, and it is not clear ex-ante if the policy of minimum unit price will counter the surge in demand under such conditions. We find that the results of our replication are consistent with the earlier studies and lend support to the success of such a policy for curbing alcohol use.

Finally, our third (and perhaps relatively minor) contribution is methodological. Difference-in-differences is a work-horse method for policy evaluations and is typically employed when there is a single shock to one of the units/groups. In our case, there were two simultaneous shocks. The introduction of the policy and the fact that there was a COVID-19 lockdown-induced surge in the demand for alcohol that could differ by product group and country. This is a complication for the analysis rather than a useful feature. Nonetheless, using data from multiple countries and multiple product groups, our work provides an example of precisely what type of assumptions are necessary to be able to identify the effects of a policy when one is introduced which coincides with other shocks that may be present at the same time.

The paper proceeds as follows. The next section sets out the policy context and our modeling approach as distinct from the extant literature. Section 3 details the data, methodology and econometric specification. Section 4 reports results of the DD and DDD analyses. Section 5 discusses the findings and the wider policy context as to whether there are any emerging indications that reduced alcohol consumption due to MUP as identified in our study may be linked to public health benefits or reduced alcohol-related crime. Online appendices provide additional analysis and testing details.

2. Policy Context and Modeling Approach

Alcohol policy to counter harmful consumption generally relies on taxation along with restrictions on availability and marketing, but with varying success (Marcus and Siedler, 2015, Hinnosaar, 2016, Carpenter and Dobkin, 2017, Griffith et al., 2019, Kueng and Yakovlev, 2021). Such measures can help dampen general demand for alcohol and regulate consumption at licensed premises but may be less effective in restricting consumption at home when consumers can liberally buy heavily discounted cheap alcohol from supermarkets and other stores.[1] This policy shortcoming is magnified in a pandemic when lockdowns entail the suspension of more expensive on-premises consumption, resulting in more home consumption and heightened demand for cheap alcohol.

The concern about cheap alcohol is that the concentration of harm from excessive consumption, and so the bulk of negative externalities, rest with a small number of heavy drinkers who mostly buy cheaper and stronger varieties of alcoholic beverages than lighter drinkers (Griffith et al., 2019). Increasing excise taxes may seem the obvious way to ensure higher prices of such products, but vendors are under no obligation to pass on taxes fully or evenly, with evidence of tax under-shifting in highly competitive markets and for cheap alcohol (Ally et al., 2014, Hindriks and Serse, 2019, Wilson et al., 2021). Instead, mandating a price floor with a set minimum price provides an assured way to reduce the affordability of cheap alcohol, with the benefit of having limited impact on light drinkers buying more expensive alcohol above the price floor (Griffith et al., 2022). Moreover, if expressed in the form of minimum unit pricing then the price floor can be easy to apply with a simple and universal pricing formula based on alcohol content (Calcott, 2019).[2]

Scotland and Wales were amongst the first countries in the world to implement a blanket flat-rate minimum unit price (MUP) policy in 2018 and 2020, respectively.[3] Both countries

[1]In contrast, in highly regulated markets, state control of liquor stores or strict licensing can help ensure high prices (e.g., Miravete et al., 2018, 2020, Conlon and Rao, 2019, 2020, Avdic and von Hinke, 2021).

[2]For instance, Scotland and Wales apply the formula M $\times$ S $\times$ V, where M is the minimum unit price (£0.50 per 10ml ethanol), S is the percentage strength of the alcohol (ABV expressed as a cardinal number), and V is the volume of the container in liters.

[3]The Republic of Ireland introduced MUP in 2022 and other countries continue to evaluate the policy. Other forms of minimum pricing are by liquid volume (e.g. parts of Australia and Canada) and/or product-specific (like high-strength spirits in several former Soviet countries) (WHO, 2020).

used their devolved powers to introduce a common minimum unit price (MUP) at fifty pence per unit (50ppu), i.e., £0.50 (roughly \$0.65 or €0.58) per alcohol unit (10ml pure ethanol), applicable to all beverages. In contrast, England and Northern Ireland, as the other two constituent of the United Kingdom, have so far not adopted such a policy.[4] Apart this policy difference, there is a great deal of similarity in respect of the alcohol markets for these four countries where they all operate with the same U.K. taxation rates (both for excise duties and VAT), with similar proportions of on-trade and off-trade sales and the preponderance of sales through the same set of nationally operating retail chains.[5]

These common market features, but with a difference in policy implementation across the countries, lend themselves to being exploited as a quasi-natural experiment for evaluating policy impact. Several studies have taken this approach in evaluating the impact of MUP, but mostly in respect of Scotland. These studies tend to fall into two types. The first and simplest type focuses on the overall impact on alcohol consumption, whether in aggregate or by broad product type (e.g., beer, wine, spirits, and cider), typically using electronic-point-of-sale (EPOS) scanner data from retailers. For example, Xhurxhi (2020) uses a difference-in-differences approach based on annual data to find that MUP led to an average price increase of 4.4% and alcohol consumption decrease of 4.5%, with a greater impact on cider and beer sales than wine and spirits. Similarly, Robinson et al. (2021), using controlled interrupted

[4]The U.K. government decided in 2013 not to adopt MUP in England following industry lobbying against the policy (Woodhouse, 2020). The policy is still under consideration in Northern Ireland.

[5]Even so, there are some differences in consumption patterns across the four countries, notably with higher consumption in Scotland than than the other three constituent countries. However, the volume gap has narrowed over the past twenty years (Giles and Richardson, 2020). There are also some differences in the composition of sales, such as more spirits but less beer consumed per adult in Scotland compared to England and Wales, but both the long-term trends and weekly sales patterns are very similar (Giles et al., 2019).

time series analysis with weekly sales data, find that MUP led to a 3.5% reduction in off-trade sales per adult.

The second and more insightful study type focuses on household purchases using self-reported household panel data allowing for analysis of the policy impact on different types of households, categorized by their alcohol consumption (e.g., heavy, moderate, or light drinkers) and income levels. For example, both O'Donnell et al. (2019) and Anderson et al. (2021) use controlled interrupted time series analysis and obtain similar findings on the impact of MUP for Scotland, resulting in prices increasing by 7.9% and 7.6%, respectively, and in alcohol consumption reducing by 7.6% and 7.7%, respectively, and being well-targeted with high-consumption households reducing purchases the most. Griffith et al. (2022) use a more sophisticated difference-in-differences approach and find that MUP increased prices by 5% while reducing alcohol volume by 11% on average, but with a 15% reduction for the highest consumption households while leaving the bottom 70% of drinkers unaffected.

Our approach and analysis differ from these studies in several notable respects. First, we focus on the impact of MUP in Wales, which has undertaken fewer prior alcohol policy interventions than in Scotland which might conflate policy impacts. For instance, alongside MUP, Scotland has a ban on multiple-unit discounts (multibuys) and in-store display restrictions on alcohol (Bokhari et al., 2023). It is conceivable that these policies could work in tandem to affect take-home alcohol sales and so isolating the effect of MUP is less straightforward.

Secondly, we study a more rapidly changing demand period than the stable demand period considered in evaluating the impact of MUP when introduced in Scotland in May 2018. Instead, Wales launched its MUP in March 2020, in the very month the WHO declared

COVID-19 a global pandemic and all four U.K. countries simultaneously commenced lockdowns. The timing was a coincidence for Wales but presents an opportunity to compare the effects from the introduction of MUP at the pandemic outset when problems with excessive consumption of cheap alcohol can be more acute, but with the modeling challenge of applying an empirical method that deals with the dynamic situation of surging demand.

Thirdly, rather than examining the effects on product categories in aggregate or by different household consumption types, we examine the impact on product categories by their price tiers to look specifically at the extent of any spillover effects, where MUP has a direct impact on the prices and demand for cheap alcohol but potentially an indirect effect on the prices and demand for more expensive alcohol. Our approach thus provides further insights on how well targeted MUP is beyond the impact on different households.

Fourthly, to facilitate this analysis on price tiers, we use a large matched-products sample as a balanced panel by utilizing customer transaction data on take-home alcohol sales from the market leading retailer in the U.K., as a different data source to existing studies based on EPOS or self-reported household purchase data.[6] Our data cover weekly retail sales over two years at individual item level from each of the four constituent countries. In total, we have a perfect match on over 2,500 alcohol products sold in all four countries, allowing us to analyze in detail the impact of MUP and lockdown drinking on beers, ciders, spirits, wines, and other product types.

[6]The retailer is Tesco which held a consistent national market share of 27% over the study period for both alcohol and total grocery retail spending (based on Kantar Worldpanel FMCG data). Further details are available upon request.

3. Data and Methods

We begin by outlining the data and variables, descriptive statistics, methodology and identifying assumptions, and the econometric specification.

3.1. **Data and Variables.** Our data are drawn from records of alcohol sales from the market leading retail chain Tesco which provides information at the stock keeping unit (SKU) level by country and week. An SKU example would be "COORS LIGHT 6X330ML". For each SKU, we obtained total expenditures and quantity sold (number of pack/bottles, etc.). The data series spans 104 weeks with 78 weeks before MUP implementation and the remaining 26 weeks starting the week of MUP implementation (March/2/2020). We supplemented this with information on alcohol by volume (ABV), measured as the percentage of ethanol for each SKU using internet searches. This allowed us to compute weekly quantities, measured in standard "units" of alcohol (per 10ml ethanol). Similarly, we obtained price per unit of alcohol for each SKU.

The MUP regulation specifies that no product should be sold at a price below 50ppu. However, prices change from week to week, and so a given product may be sold above the MUP threshold in one week, and below it in another week, but chiefly distinguished by regular prices as opposed to occasional or promotional prices below 50ppu. Accordingly, we classified all products into three groups based on cutoffs in the frequency of weeks each item was sold below the MUP price in Wales in the initial 78 weeks. These are:

- MUP1: never below 50ppu (0% weeks) – 1,576 items (share 28.6%);
- MUP2: intermittently below 50ppu (1-79% weeks) – 703 items (share 37.6%);

- MUP3: consistently below 50ppu ($\geq$ 80% weeks) – 276 items (share 33.8%).[7]

For the above classification, we used all 78 weeks rather than a smaller initial period since there is no reason to believe that retailers would start changing prices in anticipation before MUP implementation, and indeed our data confirm this. Importantly, we kept the same classification of the products in other U.K. constituent countries. To be clear, the classification of a product is based on its price in Wales and not in other countries, and hence if "COORS LIGHT 6X330ML" is classified as MUP1 based on Welsh prices and frequencies, it retains the same classification in other countries. This allows us to be able to compare the before/after changes in prices and quantities for the same products. Our final sample consists of 2,555 SKUs (see Appendix A for details on data cleaning). While there are relatively fewer items classified as MUP2 and MUP3, which are the direct target of the price floor, they in fact represent 71.4% of alcohol purchase by quantity.

We aggregated SKU level data to MUP/country/week level and created three different outcomes of interest in log form. These are ln(qnty), which is log of quantity in units (per 10ml ethanol), ln(exp) which is the log of total expenditures on alcohol normalized by the total number of customers visiting the store, and ln(price) which is the log of price per unit of alcohol. The expenditure 'per customer' refers to the total number of customers visiting the

[7] The 80% cutoff represents the clearest break in the distribution of products by the proportion of weeks with prices below 50ppu, see Appendix A. For a robustness check, we also applied an alternative categorization of MUP products based on total sales that fall below the MUP price instead of the frequency of weeks that the price is below 50ppu. The concordance analysis reported in Appendix A shows an almost full overlap of the two categorization approaches.

retailer during the given week and country and not the unique number of persons purchasing alcohol in that category as the latter information is lost in aggregation (since the same person may be purchasing multiple items).

Table 1. Statistics by Country, MUP Group and Before/After Implementation

	MUP3 Group				MUP2 Group				MUP1 Group			
	Before		After		Before		After		Before		After	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Wales												
ln(qnty)	14.62	0.182	14.19	0.091	14.68	0.315	14.85	0.097	14.38	0.390	14.56	0.163
ln(exp)	0.916	0.083	0.994	0.132	1.145	0.183	1.528	0.150	1.205	0.268	1.542	0.159
ln(price)	-0.954	0.037	-0.689	0.002	-0.672	0.044	-0.597	0.009	-0.288	0.028	-0.281	0.014
England												
ln(qnty)	16.98	0.155	17.10	0.099	17.19	0.296	17.31	0.131	16.94	0.372	17.07	0.154
ln(exp)	0.817	0.069	1.063	0.119	1.111	0.172	1.379	0.146	1.211	0.260	1.486	0.146
ln(price)	-0.925	0.028	-0.897	0.012	-0.668	0.042	-0.654	0.027	-0.279	0.028	-0.273	0.021

Means and standard deviations are over the first 78 weeks (before) and following 26 weeks (after). Table A-2 in Appendix A.2 provides the numbers in levels rather than in logs.

3.2. **Descriptive Statistics.** Table 1 gives descriptive statistics by country, product groups, and before/after periods for the main outcome measures (for an equivalent table in levels, see Table A-2 in the appendix). In percentage terms, mean alcohol quantity for MUP3 products decreased in Wales by 34.9% $(= 100(exp(14.19 - 14.62) - 1))$, while it increased for both MUP2 and MUP1 products by 18.5% and 19.7%, respectively. By comparison, the mean quantity increased for all three product groups in England. Expenditures (normalized by total customers visiting the store) increased for all three MUP categories in both countries, albeit least for MUP3 in Wales. This increase in expenditures is driven primarily by the decline in the absolute number of customers for the retailer in all countries during the pandemic, reflecting less shopping around and more one-stop shopping (see Figure A-3).

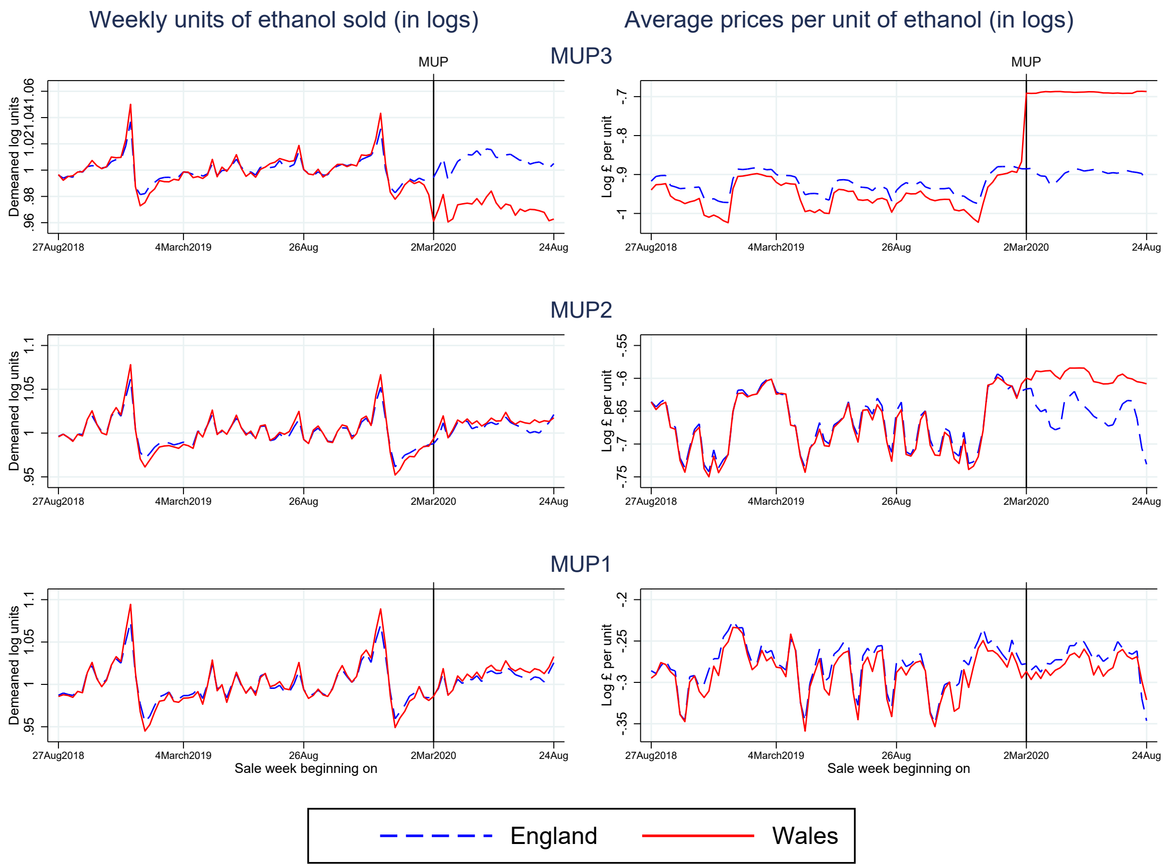
The largest and most obvious change was in the price of MUP3 products in Wales where the mean increased by 30.3%, followed by a smaller increase in the prices of MUP2 products (up 7.8%) with very little change in the prices of MUP1 products. There was also a small increase in prices in England but not as large as observed in Wales (e.g., up 2.9% for MUP3 products). To the best of our knowledge, the regulation does not allow the final price to be below 50 ppu even due to occasional promotions.[8] In our aggregate data series, the observed minimum is 50 ppu in Wales post the MUP regulation for MUP3 products. See Table A-3 for all the minimum prices.

To highlight these changes, we plot the values of log quantity and log price overtime in Figure 1 (and a similar comparison for England and Scotland is shown in Figure A-4 in Appendix A). The left panel shows the trends of log quantity for each of the MUP categories, where they have been demeaned over their own pre-ban averages.[9] Until March/2/2020, the quantity lines were remarkably parallel. Importantly, in the top left panel, we can see a deviation in the paths following MUP implementation in Wales, particularly for MUP3 products (consistently sold below 50ppu). There is also a small decline in quantity in England a little later on after the lockdowns. This may have been due to the easing of initial lockdowns and reopening of the on-trade.

[8]In the raw SKU level data we observed deviations in 0.48% cases where the transaction price was slightly below 50 ppu in Wales in the post-regulation period. This could be an error or some unaccounted bundle purchase.

[9]The adult (18+) populations are Wales 2.5m, England 44.2m, Scotland 4.5m, and Northern Ireland 1.5m. Because of large differences in adult population, in the figures we have demeaned the log quantity over the pre-ban period, i.e., from each log quantity at time t, we subtract the mean value for the specific product group and country in the pre-ban period.

Figure 1. Average Quantity and Price per Week by MUP Group and Country



The right hand side panel in Figure 1 shows trends in log prices. The sharp rise in the prices of MUP3 products in Wales is in contrast to the stable trend of MUP3 products observed for England (top right panel). Similarly, there is a clear deviation in time paths for the prices of MUP2 products after MUP implementation in Wales. In contrast, the prices of MUP1 products follow similar paths in the two countries even after MUP implementation. Moreover, it appears that MUP1 products in both prices and quantities do not seem to be affected much by the MUP implementation, lending some credence to the notion that the spillover effect to MUP1 products is either not present or is very small. Finally, note that quantity paths changed for products sold in England too, presumably due to the lockdown, and especially the price of MUP2 products decreased significantly in England during the lockdown but in keeping with the seasonal pattern.

3.3. **Methodology (Identifying Assumptions).** A standard method of identifying the impact of policy change is to use a difference-in-differences (DD) design. Providing a 'parallel trend' assumption holds in the pre-policy period, we can then compare change on the outcome of the products affected by the MUP policy with the before/after change observed in a control group not affected by the policy (and we test for this in Section 4.4). Two types of control groups are available: same products in another country, or an unaffected set of products in the same country.

For either of the two types of controls, the treatment groups are MUP3 (affecting regular prices) and MUP2 (affecting occasional/promotional prices), while the regulation has no direct impact on MUP1 products.

For DD comparisons within Wales, we allow MUP1 products to form the control group. However, spillover effects are an evident possibility, as MUP1 products are potential substitutes for MUP2 and MUP3 products. For instance, with price competition and upward sloping best-response curves (strategic complementarity) amongst vertically (quality) differentiated products, the raised prices for treated products (previously below the price floor) could prompt an increase in the price of the control group prices as well, and that in turn would affect their demand. Even if prices of non-treated products do not change, the relative change in price for one set of products can affect the demand for products in the control group, unless the cross-price elasticity is almost zero. Thus, we could violate SUTVA.

Alternatively, we can obtain DD estimates by comparing before/after sales of products directly affected by the price floor in Wales with the before/after sales of the same products in England. Since England (neighboring Wales) did not apply MUP, the same products from England may provide a better control as they would not violate the above-mentioned SUTVA. The condition holds as long as there is no (strong) linkage in retail prices across the two countries and there is no significant cross-border purchases of alcohol, i.e., if the markets are segmented at national level. A discussion on the relevance of extensive cross-border shopping activities in our context is given in Appendix D. Based on previous findings and our analysis on administrative traffic data, we do not think cross-border shopping would have a significant impact on our estimates over our window of observation.

Barring any cross-border purchase issues, the second DD estimator sounds more plausible. However, a potential problem is that the U.K.-wide lockdown was initiated almost immediately following MUP implementation in Wales. So while we expect consumption to decrease due to the price floor introduction, this is countered by evidence of a strong surge in retail store alcohol purchases during the lockdown (Anderson et al., 2020). Furthermore, we do not know if the lockdown-effect outcomes were the same across the countries. The cross-country DD estimator would not be valid if the effects of lockdown-induced sales on the treated products differ by countries, as it would imply that the sales in the two countries would follow different trajectories even if there were no policy change in minimum unit price. This could happen, for instance, if the lockdown induces a 30% increase in sales of MUP3 products in Wales but a 50% increase in England. In fact, even the first DD estimator above (i.e., a within-Wales cross-product DD estimator) would not be valid even if there were no spillover effects if the lockdown induced different trajectories for control (MUP1) and treated products (MUP2 and MUP3).

To account for the possibility of differential country lockdown effects, we use a triple difference (difference-in-difference-in-differences, DDD) estimator to identify the effect of MUP implementation on the MUP2 and MUP3 product groups. Essentially, from the cross-country DD estimator for MUP2 and MUP3, we can subtract the cross-country DD estimator for MUP1, which would give us a DDD estimate. This DDD approach is valid under the alternative assumption that the effect of the lockdown on MUP1 versus the treated products is the same across countries. Under this setup, the identifying assumption is as follows. Suppose the lockdown effect on sales in Wales on MUP1 and MUP3 products is 10% and 30% respectively, so that the differential effect in Wales is 20%. Suppose further that the lockdown effect in England on MUP1 and MUP3 products is 30% and 50% respectively. Thus, the differential effect of lockdown between the treated and untreated products is again 20%, i.e., it is the same across the two countries (and we thank an anonymous referee for this example). If this assumption holds, we can isolate the effect on outcomes of the price floor regulation from the effect induced by the country lockdowns. In a later section, we provide some corroborating evidence for such an assumption.

The intuition behind the DDD estimator is as follows. If there are no country differentials arising from the lockdowns and only within-country spillover effects, then the DD estimators by product groups across countries are sufficient for identification. If, though, there is no spillover effect on to MUP1 products, but there is a differential country lockdown effect that is the same the same across product groups (as given in the example above), then subtracting the DD estimator for MUP1 products from the DD estimators for MUP2 and MUP3 products would identify the net impact of the policy on affected products. Moreover, under these assumptions, the DD estimate for MUP1 captures the country lockdown differential between Wales and England for the control group. Appendix A illustrates the relationship between the DD and the DDD estimators using only mean values for total quantity before/after by country and MUP groups.

3.4. **DD and DDD Specifications.** Both the DD and the DDD estimators can be obtained from a single reduced form regression that controls for seasonality and time trends. Let Y be the outcome variable of interest. Then we can estimate

$$\begin{aligned} Y_{it} &= \alpha_1 + \alpha_2 X_{it} + \beta_1 W_{it} + \beta_2 P_{it} + \beta_3 M2_{it} + \beta_4 M3_{it} \\ &+ \beta_5 (W_{it} P_{it}) + \beta_6 (W_{it} M2_{it}) + \beta_7 (W_{it} M3_{it}) + \beta_8 (P_{it} M2_{it}) + \beta_9 (P_{it} M3_{it}) \\ &+ \beta_{10} (W_{it} P_{it} M2_{it}) + \beta_{11} (W_{it} P_{it} M3_{it}) + u_{it}. \end{aligned} \tag{1}$$

In the equation above, P, W, $M2$ and $M3$ are 1/0 indicator variables equal to 1 if the observation refers to a post-MUP legislation period ($t \geq 79$), from Wales, for MUP2, or MUP3 category products, respectively. The variable X consists of time trends and seasonal dummies, a polynomial in time up to power four and dummies for each calendar month. As a robustness check, we also allow the polynomial and monthly fixed effects to be country-specific by including additional interactions terms (see Section 4.4). The DDD estimates of the effect of legislation for MUP2 and MUP3 products are β_{10} and β_{11} respectively, and if by assumption there is no spillover effect on MUP1, then the effect of the MUP enforcement is zero on these products (as mentioned above, the identifying assumption requires that the differential effect of the lockdown across the treated and control groups is the same across countries). The coefficient β_5 in this case represents the differential country lockdown effect on MUP1 products. Under the alternative (stronger) assumption that the lockdown effect is the same for a given product group across countries, but allowing for policy spillover effects on MUP1 products, we can obtain the DD estimates as β_5, $\beta_{10} + \beta_5$ and $\beta_{11} + \beta_5$ for MUP1, MUP2 and MUP3 products, respectively.

For any given outcome variable Y, equation (1) is essentially a comparison of six time series, consisting of three MUP categories in two countries each. Equivalently, it is a long panel of 104 weeks with six cross-sectional units, and hence the usual panel methods that rely on a large number of cross sections for asymptotic inference are not appropriate here. Given the scale difference across the MUP categories and countries, our imposed error structure allows for country-MUP-group level heteroskedasticity. We also allow for errors across the six series to be contemporaneously correlated and hence we specify a heteroskedastic error structure with cross-sectional correlation. Inspection of residuals from initial pooled OLS estimates indicates that error terms are correlated over time, and each time series exhibits an autoregressive process of order one ($u_{it} = \rho_i u_{i,t-1} + \epsilon_{it}$) (see Figure B-1 in Appendix B). Consequently, we estimate the models via Feasible-GLS (F-GLS) allowing additionally for separate AR(1) process for each of the time series (see Greene, 2003, p.320).

3.5. **Demand Specification.** We can check if the SUTVA condition described earlier is violated by estimating cross-price elasticities between the three product groups. In turn that gives us an estimate of the extent of any spillovers across the product groups that are not the direct target of this policy. Importantly, they also tell us if our DD or DDD estimates are likely to be informative about the causal effects of the policy or not. The additional bonus is that we also obtain own-price elasticities for each group of products and can see the extent of vertical differentiation between them.

Since we aggregate the data from individual items to the three groups, a natural starting point is to estimate demand using Deaton and Muellbauer's (1980) 'Almost Ideal Demand System' (AIDS) while recognizing that price is likely to be endogenous and account for it in the estimation. Thus, we estimate the revenue based share equations s_{jt} of the j-th MUP-group class in period t as

$$s_{jt} = \alpha_j + \sum_{k}^{3} \gamma_{jk} \ln p_{kt} + \beta_j \ln(y/P)_t + \tau_j X'_{jt} + \mu_{jt} \tag{2}$$

where p_{kt} is the price of the kth class in that week, y is the total expenditure on all three classes of alcohol, P is the overall alcohol price index and X'_{jt} is a vector of other controls that may or may not be specific to the MUP group j. In our case these include country dummies, month dummies, and a polynomial of degree three in time (where time is measured in weeks). The μ_{jt} is the MUP specific error term. The remaining Greek symbols are the parameters of the model to be estimated and where elasticities are computed using estimates of β_j and γ_{jk} at some selected values of the shares (typically mean values or mean of all values). The price index is also a function of the same parameters and is given by

$$lnP_t = \alpha_0 + \sum_{k}^{3} \alpha_k \ln p_{kt} + \frac{1}{2} \sum_{i} \sum_{k} \gamma_{ki} \ln p_{kt} \ln p_{it}. \tag{3}$$

The model is estimated as a system of share equations and the price index but can be either linear, if the price index is first approximated with a linear version, such as the Stone price index, or is estimated non-linearly. We use the iterated linear least-squares (ILLS) estimator due to Blundell and Robin (1999) which is a conditionally linear estimator. See also Lecocq and Robin (2015). As is typical in such models, we also impose parameter restrictions to make the estimated equations consistent with consumer theory (i.e., shares should add to one, the Slutsky symmetry, homogeneity of degree zero). Thus, we impose $\sum_{j=1}^{J} \alpha_j = 1, \sum_{j=1}^{J} \gamma_{jk} = 0, \sum_{j=1}^{J} \beta_j = 0, \sum_k \gamma_{jk} = 0$ and $\gamma_{jk} = \gamma_{kj}$.

Prices are likely to be correlated with the error terms and so we use two sets of instruments. The first set is variables that may directly affect retail prices for alcohol and include weekly exchange rates between the pound sterling and the US dollar and the euro. Additionally, we also used the average price of diesel as that too can affect delivery costs and hence retail prices. These types of instruments have been used successfully elsewhere as well (e.g., Griffith et al. (2019) and Bokhari et al. (2023)). We also experimented with using ex-factory prices for ciders and fruit wines and beers but they generally did not perform well in terms of first-stage statistics so we did not use them in the final estimates. The second set of price instruments is due to Hausman et al. (1994) where the price of the same product from another geographic region is an instrument. The identifying assumption is that the prices from different areas are correlated via common cost shocks but there are no common demand side shocks. We implemented a version of these instruments by estimating the weekly mean price of MUP group j from the three other countries of the U.K. for the reference country i. The performance of these instruments is further discussed in Appendix C.1.

4. Results

We start in section 4.1 with the results from the demand estimation and focus on own- and cross-price elasticities to understand the likely impact of price changes on own demand for MUP3/MUP2 products and the substitution patterns between the groups of alcohol products. We then discuss the main results from DDD/DD analysis by comparing Wales and England in section 4.2. Section 4.3 provides tests which i) uses data from England and

Northern Ireland as a falsification, and ii) tests the presence of differentiated lockdown effects within MUP1 products only. Next, we describe the results of further robustness checks and parallel trend assumptions in section 4.4. Following that, section 4.5 summarizes the main findings from the analysis by product categories (beers, ciders, spirits, and wines), with full details confined to the appendices. Finally, section 4.6 shows the results of comparisons between England and Scotland, where minimum unit pricing had already been in operation since May 2018.

4.1. **Elasticities.** Table 2 provides uncompensated (Marshallian) elasticities computed at the sample mean as well as income/budget elasticities and the mean expenditure shares. The demand parameters, first-stage statistics and compensated (Hicksian) elasticities are given in appendix C.1 (where first-stage F-stats were all above 20). Two things stand out very clearly from these elasticity estimates. First, MUP3 products have the most elastic demand and hence a policy targeting the price of these products to reduce the quantity is likely to be most effective.[10] While MUP3 products constitute 33.8% by volume (reported earlier), they are 21.0% share of the expenditure on alcohol. On the flip side, the income or budget elasticity of MUP3 products in the lowest at 0.695 of the three groups and that of MUP1 is the largest at 1.204.

[10]At least three earlier papers (Bokhari et al., 2023, Griffith et al., 2022, 2019) that used household-level microdata from the UK have reported elasticities by type of household: low, medium, and high alcohol-consuming households or by income groups. Bokhari et al. (2023, Table 3) report that high-drinking households have the most elastic demand (−1.793) while low-drinking households have the least elastic demand (−1.091). Similarly, the earlier IFS working paper version of Griffith et al. (2022) shows that for both low- and high-consumption groups, the elasticity of alcohol for low-income households is larger in magnitude than that of high-income groups (but not so for the medium-consumption group). To the extent that MUP3 products are more likely to be purchased by low-income and/or high-consumption households, our elasticity measures by product groups are consistent with earlier studies.

Table 2. Marshallian price (η_{jk}) and budget (θ_j) elasticities and shares (s_j)

η_{jk}	p_3	p_2	p_1	θ_j	s_j
q_3	-2.538^a	1.606^a	0.237	0.695^a	0.210
(MUP3)	(0.102)	(0.263)	(0.195)	(0.104)	(0.044)
q_2	0.818^a	-2.296^a	0.526^a	0.951^a	0.386
(MUP2)	(0.065)	(0.166)	(0.123)	(0.009)	(0.032)
q_1	0.016	0.403^b	-1.622^a	1.204^a	0.404
(MUP1)	(0.075)	(0.192)	(0.142)	(0.010)	(0.044)

Uncompensated/Marshallian elasticities given by η_{jk} where j, k entry is the elasticity of product j with respect to the price of product k. Standard errors are in parenthesis. Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively. Budget/income elasticity given under column θ_j and the last column provides the mean expenditure shares and standard deviations of the shares. Full set of regression coefficients are given in Table C-3.

Second, the cross-price elasticity between MUP1 and MUP3 is not statistically different from zero, indicating that there is likely very little spillover effect of a price increase in the MUP3 products due to the MUP policy on the quantity consumed of MUP1 products. There is, though, likely to be some spillover effect on to the quantity consumed of MUP2 products, which seem to be a buffer between the very cheap MUP3 alcohol and the higher priced MUP1 alcohol.

4.2. **Minimum Unit Price in Wales.** Table 3 provides estimates of selected coefficients β_5, β_{10} and β_{11}, as well as of their sums $\beta_5 + \beta_{10}$ and $\beta_5 + \beta_{11}$ for all outcome measures. (See Table C-4 for all full set of regression coefficients). Additionally, for both DDD and DD estimates, the table provides the overall combined effect on MUP2 and MUP3 alcohol products and all alcohol products (MUP1, 2 and 3) combined.

Starting with ln(qnty) (log of total quantity in alcohol units) and MUP3 products (consistently $<$ 50ppu), quantity sold in Wales declined by 44.4% due to the price floor. Further, there was no significant change in quantity of MUP2 products (intermittently $<$ 50ppu).

Table 3. Effect of MUP Implementation in Wales (selected coefficients only)

	ln(qnty)	ln(exp)	ln(price)
	DDD estimates (No spillovers)		
MUP3: β_{11}	-0.587[a]	-0.218[a]	0.225[a]
	(0.014)	(0.010)	(0.005)
MUP2: β_{10}	0.00381	0.0531[a]	0.0553[a]
	(0.011)	(0.007)	(0.005)
MUP1: β_5	0.0453[a]	0.0592[a]	0.00200
	(0.012)	(0.008)	(0.003)
	DD estimates		
MUP3: $\beta_5 + \beta_{11}$	-0.542[a]	-0.158[a]	0.227[a]
	(0.013)	(0.009)	(0.005)
MUP2: $\beta_5 + \beta_{10}$	0.0491[a]	0.112[a]	0.0573[a]
	(0.012)	(0.006)	(0.004)
	Combined effect		
Combined (DDD)	-0.241[a]	-0.0648[a]	0.139[a]
(MUP2 and 3)	(0.009)	(0.006)	(0.005)
Combined (DD)	-0.195[a]	-0.00449	0.139[a]
(MUP1,2 and 3)	(0.009)	(0.007)	(0.005)
Observations	624	624	624
chi2	347661.8	2511.0	34781.6
df	26	26	26

ln(qnty) is log of quantity (in units of alcohol), ln(exp) is log of expenditure per customer and ln(price) is log of price per unit. F-GLS estimates with separate AR(1) process for each country-MUP group, and correlation across groups (robust S.E. in parenthesis). Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively. Full set of coefficients given in Table C-4.

This is somewhat surprising given our earlier demand estimation which points to a positive and significant cross-price elasticity between the MUP3 and MUP2 products. Note that these are both DDD estimates, which assumes that there is no spillover effect on MUP1 products (never $<$ 50ppu). Therefore, β_5, the coefficient for MUP1 products, measures the lockdown country differential between England and Wales that is not attributable to the MUP regulation, indicating 4.6% higher quantity. The combined effect on MUP2 and MUP3 products is an overall net reduction of 21.4% in quantity sold.[11] Under the alternative assumption of a lockdown country differential present between England and Wales, the β_5 estimate represents the DD estimate with a 4.6% increase in MUP1 products due to the spillover effects. Under this assumption, the effect of MUP implementation on MUP3 and MUP2 products are -41.8% and +5.0% respectively, and the combined effect on all three product groups is a decrease of 17.7%.

In terms of expenditure per customer, the DDD estimates indicate a reduction for MUP3 products of 19.6% (where per customer is the total number of customers for this retailer, and not the total number of customers that purchased alcohol products). This reduction in expenditures is driven by a 25.2% increase in the price of MUP3 products. Similarly, for MUP2 products, the increase in expenditure is also driven by 5.7% increase in price (see column 3) as quantity purchased did not change. The assumption of no spillover effect on MUP1 products is corroborated by no change in the price of MUP1 products ($\beta_{11} = 0.002$ and not significant at conventional levels). Overall, the combined effect of the introduction of MUP in Wales is a 14.9% increase in prices and a 6.3% decline in expenditure per customer.

[11] The combined effect was computed using ancillary regressions similar to equation (1), but where MUP2 and MUP3 were combined into a single category. Appendix C, section C.3 provides details and regression outputs. An alternative is to compute the combined effect by multiplying coefficients with pre-MUP means for MUP2 and MUP3 to compute the implied change and convert back to percentages. However, such computations rely on first-order Taylor series expansions and the approximation becomes worse when estimated coefficients are far away from zero (above 0.1 in magnitude), as is the case for our estimates of β_{10} and β_{11}.

Under the alternative assumption of spillover effects on MUP1 products, the DD estimator shows that expenditure per customer decreased for MUP3 products ($\beta_5 + \beta_{11} = -0.158$) and increased for MUP2 products ($\beta_5 + \beta_{10} = 0.112$) and the combined effect on these two products is -0.0648. Finally, the overall effect on expenditure on all the products combined is much more modest at -0.4% with an overall increase in price of 14.9%.

Estimates obtained under the alternative error structure assumptions, i.e., that errors are independent across the six time series (see Table B-1 in Appendix B), lead to similar conclusions.

In the foregoing discussion, the two sets of estimators give bounds to the effect of the price floor under alternative assumptions, and differ by the estimate of β_5, which could be positive or negative. Just to be clear, under the DDD estimation, β_5 measures size of the country lockdown differential, while under the DD estimation it is interpreted as the size of the spillover effect with no country lockdown differentials. Thus if β_5 is significantly different from zero, it is due to (1) a spillover effect on MUP1 products in Wales, and/or (2) a country lockdown differential (or both). We next explore these issues.

4.3. **Falsification and differential lockdown effects tests.** We undertake two analyses in this section. First, we re-estimate the model above using data from England and Northern Ireland. Second, we check if the lockdown affected subgroups of the control MUP1 group equally. The rationale for these tests and the results are discussed below.

England vs Northern Ireland. We use data from England and Northern Ireland – both countries without minimum pricing. This eliminates the possibility of any spillover effects. Thus, if the England/Northern Ireland before/after differential for MUP1 is similar to one observed for Wales/England, it indicates the presence of country lockdown differentials, which, in turn, supports the use of DDD estimator. If, though, this differential does not exist between England and Northern Ireland then it suggests that lockdown effects are similar across countries, and we can use the DD estimates from the initial model. Note also that had there been no lockdown, comparison of England and Northern Ireland data would give coefficients of interest that would not be significantly different from zero, as there is no MUP regulation in either country. Given the lockdown, however, these coefficients can be different from zero, but should be significantly smaller in magnitude compared to those from the England/Wales comparison.

Table 4 shows selected coefficients in DDD estimation as before but using data from England and Norther Ireland. The DDD coefficient for log quantity for MUP1 is 0.0369, statistically significant, and in fact of similar magnitude as that for Wales vs England (0.0453). The coefficients for MUP2 and MUP3 are also statistically significant but considerably different in magnitude from those obtained in the Wales vs England case: the DDD and DD estimates for MUP3 are now −0.081 and −0.044, and sharply compare to previous estimates of −0.587 and −0.542. These large differences for MUP3 coefficients relative to the previous case provide a falsification test of our comparison between Wales and England: if the estimated effect on MUP3 products was not due to legislation, we would have expected a similar sized differential between England and Northern Ireland. Similarly, the combined effect on MUP2 and MUP3, or of all three combined, is in the range of 5.2% (DD) and 8.7% (DDD), and much smaller than those obtained from the Wales/England case, which were 21.4% (DD) and 17.7% (DDD). These results lend support for the country differential hypothesis, and preference for DDD estimates.

Table 4. Northern Ireland vs England (Selected regression coefficients)

	ln(qnty)	ln(exp)	ln(price)
	DDD estimates (No spillovers)		
MUP3: β_{11}	-0.0811^a	-0.0593^a	-0.00976
	(0.027)	(0.018)	(0.006)
MUP2: β_{10}	-0.0882^a	-0.0569^a	-0.00689
	(0.028)	(0.020)	(0.008)
MUP1: β_5	0.0369^c	0.0289^c	0.0199^a
	(0.022)	(0.016)	(0.005)
	DD estimates		
MUP3: $\beta_5 + \beta_{11}$	-0.0442^c	-0.0304^c	0.0101^a
	(0.025)	(0.016)	(0.003)
MUP2: $\beta_5 + \beta_{10}$	-0.0513^b	-0.0280	0.0130
	(0.024)	(0.017)	(0.008)
	Combined effect		
Combined (DDD)	-0.0906^a	-0.0739^a	-0.00918^c
(MUP2 and 3)	(0.020)	(0.014)	(0.005)
Combined (DD)	-0.0538^a	-0.0453^a	0.0104^a
(MUP1,2 and 3)	(0.015)	(0.013)	(0.003)
Observations	624	624	624
chi2	167482.1	1830.6	23229.2
df	26	26	26

ln(qnty) is log of quantity (in units of alcohol), ln(exp) is log of expenditure per customer and ln(price) is log of price per unit. F-GLS estimates with separate AR(1) process for each country-MUP group, and correlation across groups (robust S.E. in parenthesis). Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively. Only selected regression coefficients shown.

Nonetheless, when ignoring cross-series correlations, the Northern Ireland and England differences are no longer statistically different (see Table B-2 in Appendix B), and provide support for a DD estimate. We therefore consider the DDD and DD estimates as the lower and upper bounds for the net impact of the MUP introduction in Wales under alternative assumptions.

Differential effects of lockdown. Next, we test if our assumption for DDD might hold i.e., the differential effect of the lockdown across the treated and control product groups is the same across Wales and England. We cannot directly check this assumption. Instead, we check if the lockdown affected Wales and England similarly in other dimensions. To this end, we divide MUP1 products into two groups, MUP1A and MUP1B depending on if they are below or above the mean price for this group in Wales. Next, for each of these subgroups, we can estimate a DD model comparing England/Wales and before/after. If the DD estimates are β_{1A} and β_{1B}, we can test if these are equal or not. If they are, it shows that the lockdown effect is the same in two subgroups, and lends indirect support to our assumption above. The test is most directly implemented via a three-way interaction term in joint estimation for MUP1A and MUP1B products. Specifically, we estimate

$$\begin{aligned} Y_{it} = \gamma_1 + \gamma_2 X_{it} + \theta_1 W_{it} + \theta_2 P_{it} + \theta_3 M1_{Bit} + \theta_4 (W_{it} M1_{Bit}) + \theta_5 (P_{it} M1_{Bit}) \\ + \theta_6 (W_{it} P_{it}) + \theta_7 (W_{it} P_{it} M1_{Bit}) + u_{it}, \end{aligned} \tag{4}$$

where $M1_{Bit}$ is a 1/0 dummy variable equal to one if the observation refers to MUP1B product, $\beta_{1A} = \theta_6$ and $\beta_{1B} = \theta_6 + \theta_7$, and the equality is tested by significance of θ_7.

Table 5 provides estimates of the triple interaction term as described above. The first row of the table shows the effect on MUP1A products. Note that these coefficients are very similar to MUP1 coefficients listed as β_5 in Table 3. The second row for θ_7 tests if $\theta_A = \theta_B$. Since we do not reject the null, it shows that England/Wales before/after DD estimate for

MUP1A products is same as that for MUP1B products. In turn, this lends support to our identification assumption for DDD estimates provided earlier.

TABLE 5. Falsification test (among MUP1 products only) - Imposing an hypothetical MUP for MUP1 products below (MUP1a) vs. above (MUP1b) the MUP1 median price in Wales (selected coefficients only)

	ln(qnty)	ln(exp)	ln(price)
	DDD estimates (No spillovers)		
MUP1a: θ_6	0.0393^a	0.0404^a	0.000498
($\beta_A = \theta_6$)	(0.012)	(0.006)	(0.002)
MUP1b: θ_7	0.0165	0.0129	-0.00208
($\beta_B = \theta_7 + \beta_A$)	(0.018)	(0.010)	(0.005)
Observations	416	416	416
chi2	302238.1	204.8	1256.0
df	22	22	22

ln(qnty) is log of quantity (in units of alcohol), ln(exp) is log of expenditure per customer and ln(price) is log of price per unit. F-GLS estimates with separate AR(1) process for each country-MUP group, and correlation across groups (robust S.E. in parenthesis). Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively.

4.4. **Robustness and Parallel trends.** We already noted earlier that our results in Table 3 and Table 4 hold when we allow for independence of errors across the six time series (which are given in Tables B-1 and B-2 in Appendix B). So far our specifications are parsimonious and account for common time trends (a polynomial in time to the power four) and common monthly fixed effects. Thus, we next check if the forgoing analysis holds up if allow for country-specific time trends and country-specific monthly fixed effects via additional interaction terms included in the main specification. The results are are given in Table B-3 and Table B-4 and are qualitatively similar but show slightly larger magnitudes for MUP1 products.

Critical to our identification setup is the 'parallel trends' assumption. While Figure 1 shows that the parallel trends assumption holds for log quantity and log price in the pre-MUP period, we conduct two closely related formal tests for parallel trends, with results reported for all outcome variables in Appendix B.4. The first test uses data from the pre-MUP period ($T \leq 78$) to estimate a variant of Equation 1 where the indicator variable P_{it} for pre-post period is replaced by a linear time-trend. We then test for the joint significance of β_5, β_{10} and β_{11} and do not reject the null that these parameters are equal to zero (see Table B-5). This supports the hypothesis of parallel trends in the pre-MUP period. In a second test, we run a placebo test. We again use only the pre-MUP period data but this time keep P_{it} as an indicator variable which is set to one after $T/2$. We then test for the significance levels of key parameters, and in all but one case, they are not statistically significant.[12] The test results are given in Table B-6.

4.5. **DDD Estimates by Product categories.** We also estimated the impact of the MUP regulation in Wales by segmenting alcohol products by the following types: (i) Beers (includes ales, stouts and lagers); (ii) Ciders (including perries); (iii) Spirits; and (iv) Wines (including all wine-based drinks). Estimation details and results are described in Appendix C.4. Briefly, they show a large reduction in quantity sold of MUP3 products for beers and ciders but with considerably less reduction for wines.

4.6. **Lockdown Impact for Existing MUP Regulation.** We next compare the effect of lockdown drinking across Scotland and England, where the former already had its price

[12] The one exception is for ln(qnty) for MUP3 parameter β_{11} in which case the parameter is significantly different from zero at the 10% level. But even here, the magnitude is only -0.0204 in this placebo test, and compares sharply with the non-placebo variant reported in Table 3 where the same parameter was -0.587 and significant at 1% level.

floor in place before the beginning of our time series, while the latter has no price floor. For this analysis, we employed a DD estimator as there are no changes in MUP policy in either country during the study period. We kept the same MUP classification (based on prices observed in England) even though there were no products priced under the MUP floor in Scotland.

The movement over time in (log) quantity and prices is shown in Appendix A. Mean (log) quantity increased in England for all three MUP categories after week 79, by 13.7%, 12.7% and 13.2% for MUP1, MUP2 and MUP3 products, respectively. In contrast, the corresponding increases in quantity in Scotland were 15.8%, 7.6% and 3.5%. Prices also increased in England slightly for all three categories (0.7%, 1.5% and 2.9% for MUP1, MUP2 and MUP3, respectively) while they showed no systematic pattern in Scotland (decreasing by 1.1% for MUP1 products and increasing slightly for MUP2 and MUP3 products by 0.3% and 0.5%, respectively).

We estimated a -9.5% difference in MUP3 products' sales in Scotland compared to England, and the effect is statistically significant. The -5.2% difference estimated for MUP2 products is not statistically significant. Similarly, no significant difference in sales of MUP1 products were found between these two countries. The estimated net combined reduction for all products sold in Scotland was -6.3% and was statistically significant. Similarly, there is a large unadjusted increase in expenditure per customer across MUP categories in both countries post lockdown commencing. This is because of fewer customers with shoppers reducing store visits (see Figure A-3). However, the DD estimates show that while there was no statistically significant difference in expenditure per customer for MUP1 products and a small effect on MUP2 products, expenditures per customer of MUP3 products declined by

Table 6. Scotland vs England (DD Estimates)

	ln(qnty)	ln(exp)	ln(price)
MUP1: β_5	-0.0134	-0.0179	-0.0108
	(0.047)	(0.032)	(0.011)
MUP3: $\beta_5 + \beta_{11}$	-0.100^a	-0.0896^a	-0.00831
	(0.025)	(0.015)	(0.010)
MUP2: $\beta_5 + \beta_{10}$	-0.0533	-0.0380^c	-0.00198
	(0.037)	(0.019)	(0.014)
	Combined effect		
Combined (DD)	-0.0646^a	-0.0676^a	-0.00737
(MUP1,2 and 3)	(0.023)	(0.016)	(0.009)

ln(qnty) is log of quantity (in units of alcohol), ln(exp) is log of expenditure per customer and ln(price) is log of price per unit. F-GLS estimates with separate AR(1) process for each country-MUP group, group level heteroscedasticity and correlation across groups (robust se in parenthesis). Only selected regression coefficients shown. Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively.

8.6% in Scotland. The combined net reduction on expenditure per customer for Scotland was 6.5%. There was no statistically significant difference between the two countries for prices.

Overall, these results imply that while consumption increased with the lockdowns, the relatively lower increase in total quantity and expenditure per customer in Scotland was mainly driven by the considerably smaller increases in demand for MUP2 and MUP3 products, which already had a 50ppu floor in place.

5. Discussion and Conclusion

We find that minimum unit pricing as a price control can be highly effective in reducing demand for cheap alcohol with an overall net reduction in take-home alcohol as a measure to counter harmful drinking which lockdown restrictions could exacerbate. There is the risk that this could be only a short-term effect, where the sudden jump in the cheapest alcohol prices initially put off consumers faced with "sticker shock", but who might later adjust their expectations and start buying the products again. However, as Figure 1 clearly shows, this is not the pattern we observe over the full six months after the MUP introduction in Wales. Similarly, as evident from the comparison involving Scotland, MUP appears to have a persistent demand-dampening effect on cheap alcohol. It is also unlikely that our results are simply driven by an extensive increase in cross-border trade activity given the "stay in place" orders issued by the authorities during COVID-19 that limited the opportunities to make cross-border shopping trips in our context.

Perhaps the most striking aspect is how well targeted is the intervention with very limited spillover effects on sales or prices for more expensive (untreated) alcohol products. Our intuition is that the sharp price hike for the very cheapest alcohol cut its demand sharply but with some spillover as these consumers switched to buying more from the next quality tier up, whose prices had been hovering around the price floor, but in turn whose existing consumers bought less due to less discounted promotional prices. If so, then these opposing demand effects essentially cancelled out each other for this mid-tier, yet with little further spillover to the top tier.

Our results and findings provide some broad welfare insights on the effects on industry revenue and consumer surplus, even if we cannot address equity issues for different household types with our aggregate customer purchase data.

For the industry, we find no windfall revenue gain arising from MUP. The weakness of demand spillover effects across the price tiers means that the sharp reduction in sales for cheap alcohol is not offset by increased sales of more expensive alcohol. The net effect on expenditure is marginally negative, where higher prices (implying higher unit margins) are not enough to compensate for the loss of volume lowering overall revenue. While other papers may have found the same outcome by examining expenditure by different household types (e.g., heavy, moderate, or light drinkers), we provide a different insight by examining the impact on why there is no revenue gain by finding that demand for the cheapest alcohol (MUP3) is surprisingly elastic and that there is no substantial demand gain for the next price tier of products (MUP2). We reason that is because MUP also affected these products partially by curtailing the retailer's ability to offer deep discounts (below 50 ppu) as a promotional tool, so while MUP may have led some consumers to trade-up to the next quality level from the very cheapest alcohol this demand gain was offset by existing customers of this price tier buying less. Meanwhile, the upper price tier for the most expensive alcohol (MUP1) witnessed almost no spillover effect whatsoever.

We have not probed the politics of MUP as a policy choice and industry's position on MUP, but with our finding we can see why industry might have lobbied against the policy's introduction in England (Woodhouse, 2020). However, this goes against the prior view that industry would stand to gain considerably from the introduction of MUP (The Economist, 2018). For instance, back in 2010, the Institute for Fiscal Studies predicted that rolling out MUP across Britain "could transfer £700 million from alcohol consumers to retailers and manufacturers" and "The largest beneficiary in cash terms would be Tesco (which gains around £230 million)" (Griffith and Leicester, 2010). In contrast, our results indicate that Tesco has not gained any revenue from the introduction of MUP.

On the consumer side, we can consider the effect on direct consumers, i.e., those who were consuming MUP3 and MUP2 products, as well as those who could have been affected indirectly via any price effects on MUP1 products. Our analysis suggests that the policy effect is largely limited to those who were consuming low-quality cheap alcohol with little spillover effects to MUP1 products and hence should not change the consumer surplus for those consuming more expensive alcohol, which by volume is only 28.6% of the share. The significantly raised prices and lower consumption of MUP3 products imply substantially reduced consumer surplus for these purchasers in the traditional sense, i.e., area under the demand curve (and leaving aside the own-health benefits from reduced alcohol consumption). While MUP2 purchasers lose out financially through higher average prices given that MUP prevents deep discounting for promotional offers that would otherwise take prices below the MUP (50ppu) price floor.

Beyond the direct economic welfare effects, a natural follow-up question to ask is whether the reduced alcohol consumption arising from MUP identified in our study has led to any broader societal benefits on public health and safety. We do not have any matching micro-data to examine this issue in sufficient detail to complement the study in this paper. However, we have investigated publicly available data on population-level trends. We summarize our findings here and provide the details in Appendix E, documenting the trends on three sets of outcomes: drink driving, alcohol-related deaths and hospitalizations, and domestic violence.

On drink driving, Francesconi and James (2022) find no evidence of a reduction in road crash deaths and drunk driving collisions following the introduction of MUP in Scotland through to December-end 2019. Similarly, our analysis of trends through to 2021 finds no clear indication that the introduction of MUP in Wales led to a discernible change in drink driving occurrences in comparison to the trends observed in England over the same period. Certainly, the COVID-19 lockdowns reduced traffic levels and reduced road traffic collisions, but alcohol impairment continued to feature as a contributory factor in road traffic collisions and the proportion of positive or refused breath tests rose in Wales.

On public health, Wyper et al. (2023) find that the introduction of MUP in Scotland, drawing on comparisons with England through to the December-end 2020, was associated with a significant 13.4% reduction in deaths and a 4.1% reduction in hospitalizations wholly attributable to alcohol consumption, with beneficial effects driven by significant improvements in chronic outcomes, particularly alcoholic liver disease. However, we find no indication that Wales has achieved similar benefits to those in Scotland in reducing the overall alcohol-specific death rate since introducing MUP. The difference might be down to the different trends for Scotland and Wales, especially on deaths linked to chronic conditions, or a delayed impact from the introduction of MUP because of the pandemic. Even so, deaths from accidental poisoning dropped markedly over the pandemic in Wales and Scotland compared to England and Northern Ireland, which is consistent with MUP deterring extreme binge drinking. On hospital admissions, we find the number of alcohol-related hospital admissions declined more in Wales than in England in the two years from March 2020, but so did total hospital admissions, and it is difficult to determine the net effect from the introduction from MUP given the considerable disruption to hospital admissions caused by the pandemic.

Finally, regarding domestic violence, the link between alcohol and domestic violence is well established empirically, and crime surveys from England and Wales show that victims believed offenders were under the influence of alcohol in around one third of domestic abuse incidents. If MUP helps reduce excessive alcohol consumption then that, in turn, might help reduce the incidence of domestic violence. However, we find no information available from public data sources and official statistics that allows us to assess directly whether the introduction of MUP in Wales had a dampening effect on the number of alcohol-involved domestic abuse cases. Nevertheless, based on all domestic abuse incidents recorded by the regional police forces in England and Wales, we find a comparative reduction in domestic abuse cases in Wales during the year when lockdowns occurred, but that such an effect dissipated when lockdowns ceased in the following year, and so any MUP effect may have been short-lived or possibly coincidental and dependent on how incidents were reported during the pandemic.

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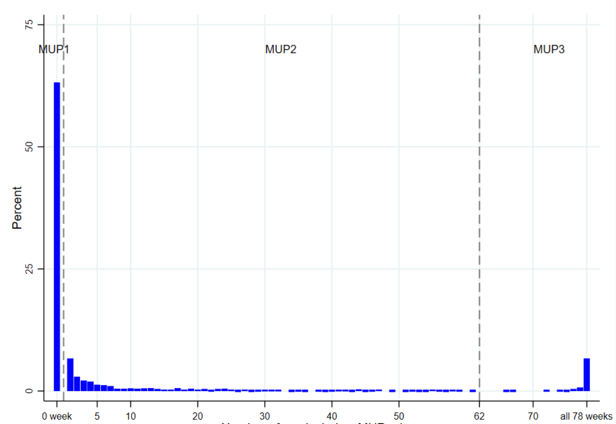
Appendices (online)

These appendices are for the paper titled, “Lockdown Drinking: The Sobering Effect of Price Controls in a Pandemic’ and optionally can be made available as online only.

Appendix A. Further Descriptive Analysis

A.1. **Selection of SKUs.** There were 3,934 item (SKUs) in our data set with any alcohol content. We focused on 2,631 alcohol products with positive sales in Wales in the pre-MUP regulation (weeks 1-78). Of these, we further excluded 46 items that were speciality gift bundles (e.g. sets that include a glass or something else and primarily concentrated around the Christmas period) and another 30 products whose ABV content could not be retrieved with our internet search. This left us with a final sample of 2,555 alcohol products used in our analysis. Of these, 1,576 are classified as MUP1 (those that are never below 50p per unit), 703 as MUP2 (intermittently below 50p per unit) and only 276 items as MUP3 products (consistently below 50p per unit). The cutoff between 'intermittently' and 'consistently' (i.e. between MUP2 and MUP3 products) is if the price was less than 50p per unit 80% of the time or more (i.e. about 62 weeks out of 78) and is based the frequency plot in Figure A-1. As the figure shows, there is a clear break around value of 62 and classifications, and hence results, would not change by much if for instance we changed it to 60 weeks or 70 weeks. While there are relatively fewer items classified as MUP2 and MUP3, which would be the direct target of the regulation, they in fact represent 71.4% of alcohol purchase by quantity (the share by quantity is 28.6%, 37.6% and 33.8% for MUP1, MUP2 and MUP3 respectively).

Figure A-1. Frequency of Prices Below 50p Per Alcohol Unit – Sample 2,555 products



Alternative categorization, e.g. constructing categories based on the percentage of pre-MUP total sales that fall below the MUP price instead of the time prices fall below the MUP, presented an almost identical distribution (Figure A-2). To show this, we also constructed concordance tables in which each row represents the number of products categorized in one of the MUP groups based on the prices approach and each column denotes the frequency of occurrence using the total sales approach. We found that 98.4% of products fall in the same category when the cut-off used for defining MUP3 products based on total sales was set at 80% (Table A-1, panel a) which increases to 99.6% with a cut-off set at 90% (panel b). For instance, 703 products are classified as MUP2 using the original price frequency method. Under the alternative 80% of sales below MUP rule, 666 of these products are classified as MUP while 37 get classified as MUP3. Total number of products classified as MUP2 under this alternative rule is 668.

FIGURE A-2. Alternative categorisation of products based on total sales – Sample 2,555 products

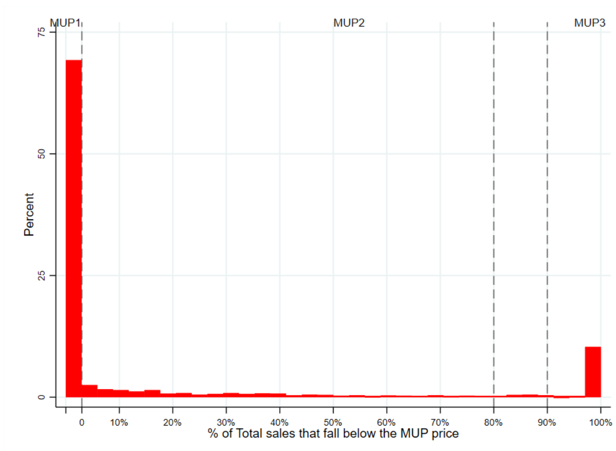


TABLE A-1. Concordance between classification methods

	A. New classification based on 80% of sales below MUP			B. New classification based on 90% of sales below MUP			
	MUP1	MUP2	MUP3	MUP1	MUP2	MUP3	All
MUP1	1,576	-	-	1,576	-	-	1,576
MUP2	-	666	37	-	699	4	703
MUP3	-	2	274	-	6	270	276
Total	1,576	668	311	1,576	705	274	2,555

The last column shows the original classification into MUP categories as in the main text and analysis. The last row shows the number of products in each category based on 80% of total sales below MUP (panel A on the left) or 90% of total sales below MUP (panel B on the right). The cells in the matrix show how many products get classified the same or differently under the alternative methods. Example: 703 products are classified as MUP2 using the original price frequency method. Under the alternative 80% of sales below MUP rule, 666 of these products are classified as MUP2 while 37 get classified as MUP3. Total number of products classified as MUP2 under this alternative rule is 668.

A.2. **Descriptive statistics in levels.** Table 1 in the text provides descriptive statistics for the logs of quantity, expenditures (per customer), and price as the variables are used in log form in the regressions. Table A-2 instead provides the mean and standard deviations for the levels. Note also that the quantity is expressed in millions of units.

TABLE A-2. Statistics by Country, MUP Group and Before/After Implementation

	MUP3 Group				MUP2 Group				MUP1 Group			
	Before		After		Before		After		Before		After	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Wales												
Quantity	2.26	0.47	1.46	0.13	2.51	0.97	2.84	0.26	1.92	1.01	2.12	0.32
Expenditure	1.51	0.23	1.73	0.36	2.20	0.69	3.66	0.67	2.48	1.21	3.73	0.67
Price	0.39	0.01	0.50	0.00	0.51	0.02	0.55	0.00	0.75	0.02	0.76	0.01
England												
Quantity	23.93	4.16	26.87	2.56	30.66	11.00	33.21	4.19	24.64	11.94	26.18	3.90
Expenditure	1.27	0.17	1.91	0.34	2.09	0.61	3.01	0.56	2.49	1.14	3.46	0.59
Price	0.40	0.01	0.41	0.00	0.51	0.02	0.52	0.01	0.76	0.02	0.76	0.02

Means and standard deviations are over the first 78 weeks (before) and following 26 weeks (after). Quantity is in units of ethonol and is divided by 1000,000. Expenditure is divided by total number of customers visiting the retailer in that country and week. Table 1 provides the numbers in the logs of these variables.

Table A-3 provides the minimum observed prices for any of the categories by country and period.

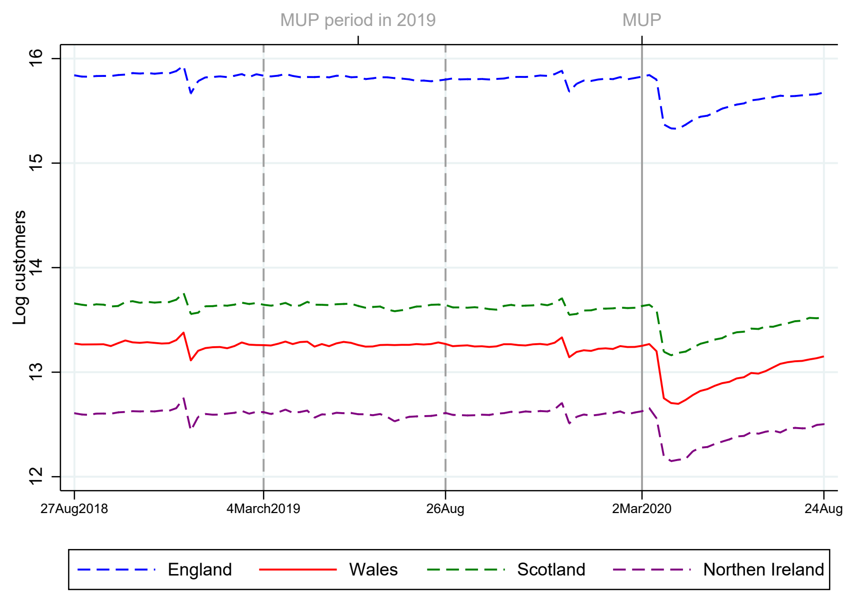
TABLE A-3. Minimum Prices

	MUP3 Group		MUP2 Group		MUP1 Group	
	Before	After	Before	After	Before	After
Wales	0.36	0.50	0.47	0.54	0.70	0.73
England	0.38	0.40	0.48	0.48	0.70	0.71

Minimum prices are over the first 78 weeks (before) and following 26 weeks (after).

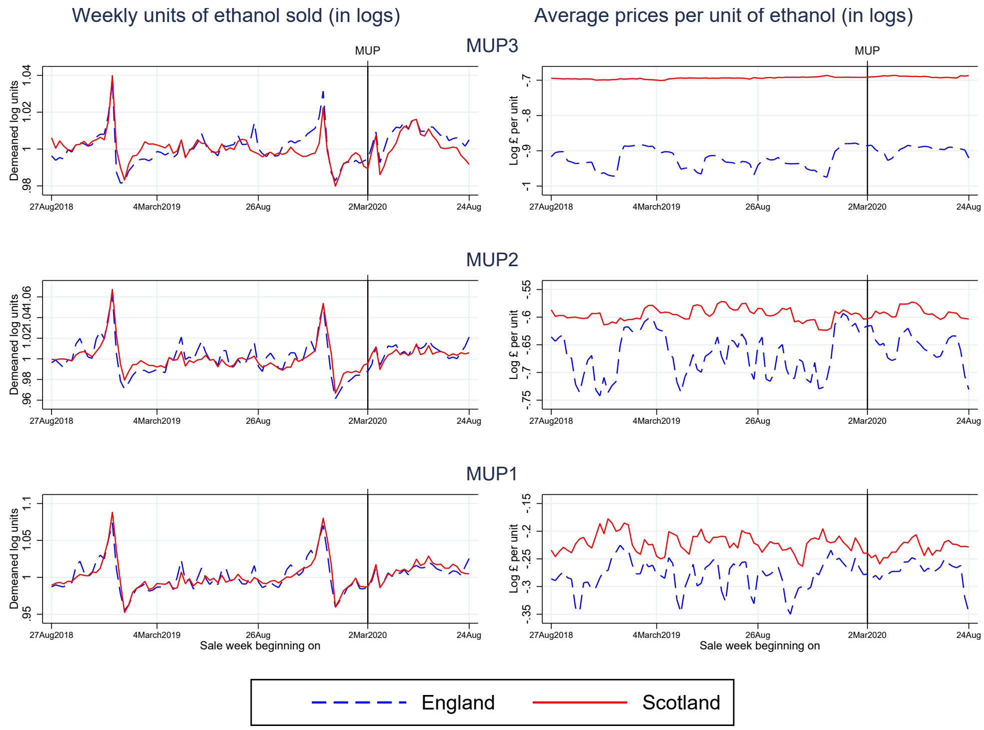
A.3. **Customers over time.** Figure A-3 plots the log of number of customers of the retailer by country. There is a parallel drop in the number of visits in all four countries at the time of the COVID-19 lockdown restrictions.

FIGURE A-3. Weekly Customer Numbers (log values) by Country



A.4. **Quantity and Price for England and Scotland.** Figure A-4 plots the log of quantity (left) and log of prices (right) for England and Scotland overtime and by product groups MUP1, MUP2 and MUP3.

FIGURE A-4. Weekly Average Quantity and Price by MUP Product Group and Country



A.5. **DD vs DDD estimator.** This appendix provides a comparison of DD and DDD estimators. We start by reporting the means for one outcome variable, total quantity (not logged) in a format that highlights our DD and DDD methodology. Table A-4 shows mean values by MUP category, country computed in comparable pre- and post-MUP implementation periods of 26 weeks, from March-August in 2019 and March-August 2020 (whereas in the regression analysis reported in the main paper, we use the full period since we can control for seasonal effects more easily).

TABLE A-4. Quantity (Units of Alcohol) per week

Quantity	Wales		England	
	pre	post	pre	post
MUP1 Products (never < 50ppu)	1.73	2.12	22.12	26.18
% increase	22.90%		18.35%	
DD MUP1:	4.54%			
MUP2 Products (intermittently < 50ppu)	2.49	2.84	30.10	33.21
% increase	14.21%		10.36%	
DD MUP2:	3.85%			
MUP3 Products (consistently < 50ppu)	2.30	1.46	24.19	26.87
% increase	-36.31%		11.12%	
DD MUP3:	-47.42%			
DDD-MUP3: (DD-MUP3 - DD-MUP1)	-51.97%			
DDD-MUP2: (DD-MUP2 - DD-MUP1)	-0.70%			
Overall sales	6.51	6.42	76.40	86.27
% increase	-1.31%		12.91%	
% DD (Combined effect)	-14.23%			

Mean value in millions of alcohol units over 26 weeks before and after March/02/2020.

For products classified as MUP1 (never < 50ppu), the mean value of quantity sold per week in Wales was 1.73 million units of alcohol, and this increased to 2.12 million units in the post period following MUP implementation in Wales, for a total change of 22.9% increase. By comparison, the same products increased by 18.35% in England. Thus, for MUP1 products, the net increase in sales relative to England was 4.54%. Similar calculations for MUP2 products (intermittently < 50ppu) show a relative net increase in Wales of 3.85%, i.e., sales increased by 14.21% in Wales and 10.36% in England. Additionally, looking at the MUP3 products (consistently < 50ppu), we find that quantity sold decreased by 36.31% in Wales and increased by 11.12% in England. Thus, relative to England, *there was a 47.42% reduction in weekly units of alcohol sold for MUP3 products* in Wales, which is equivalent to the DD estimate for MUP3, but without using all the data or controlling for seasonality. Under the alternative assumption that there was no spillover but there was a country lockdown differential of 4.54% in Wales relative to England, the triple difference estimates would be

-0.70% and -51.97% decrease in quantity sold of MUP2 and MUP3 products respectively due to the minimum unit price regulation.

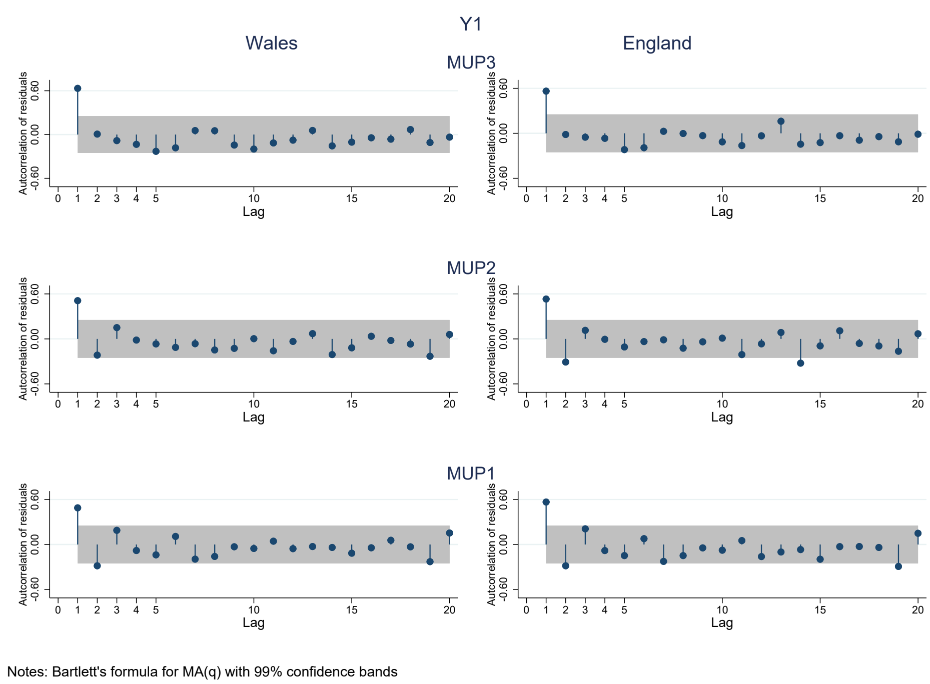
The bottom panel of the table indicates that there was an overall decrease in quantity of 1.31% in Wales, while over the same period, there was a 12.91% increase in England. Thus, the net difference is 14.23% decease in quantity sold in Wales relative to England. This is a DD estimate and inclusive of any spillover effects that may shift demand from MUP2 and MUP3 products to MUP1 products. For all the remaining outcomes, and to control for time trends and seasonality, we use regression analysis.

Appendix B. Robustness checks and Parallel Trends

The main model is estimated allowing for heteroskedastic error structure with cross-sectional correlation across six groups (three MUP categories and 2 countries). Additionally it allows for separate AR(1) process for each of the six time series. This appendix provides: (1) a graphical analysis of partial autocorrelation functions for log of quantity Y1 (Y2-Y4 available upon request); (2) estimates of results in Table 3 and Table 4 under alternative assumption that there is no cross-section correlation across the six series (it still allows for heteroskedastic error structure and separate AR(1) for each group); (3) re-estimate of the main model but with country-specific time trends and country specific monthly trends; (4) two tests for parallel trends, where the second on is via a placebo test.

B.1. **Partial autocorrelation functions.** This section provides partial correlograms for Y1 separated by MUP groups and country. Thus correlograms for six time series (MUP1, MUP2, MUP3 for England and Wales) and displayed for up to 20 lags of the outcome variable. These graphs lend support to using AR(1) process in the estimation. Similar correlograms for Y2 through Y4 also provide support for AR(1) error structure, but are omitted in interest of space (available from authors upon request).

Figure B-1. ln(qnty): log quantity in units (i.e. 10ml of ethanol per unit of alcohol)



B.2. **Estimates under alternative error structure.** The main analysis given in Table 3 and Table 4 assumes the error terms in the six time series are AR(1) and correlated across the six series (MUP1, MUP2, MUP3 Groups for England and Wales). An alternative assumption is that while they are still AR(1), these series are independent of each other.

Results corresponding to Table 3 for the alternative assumption on the error structure are given below in Table B-1.

TABLE B-1. Effect of MUP regulation (non-correlated errors across groups)

	ln(qnty)	ln(exp)	ln(price)
	DDD estimates (No spillovers)		
MUP3: β_{11}	-0.588[a]	-0.218[b]	0.226[a]
	(0.127)	(0.096)	(0.016)
MUP2: β_{10}	0.00339	0.0531	0.0566[a]
	(0.137)	(0.099)	(0.018)
MUP1: β_5	0.0478	0.0586	0.00145
	(0.113)	(0.086)	(0.013)
	DD estimates		
MUP3: $\beta_5 + \beta_{11}$	-0.540[a]	-0.159[a]	0.227[a]
	(0.057)	(0.044)	(0.010)
MUP2: $\beta_5 + \beta_{10}$	0.0512	0.112[b]	0.0580[a]
	(0.078)	(0.050)	(0.014)
	Combined effect		
Combined (DDD)	-0.241[b]	-0.0648	0.138[a]
(MUP2 and 3)	(0.118)	(0.086)	(0.014)
Combined (DD)	-0.193[a]	-0.00455	0.140[a]
(MUP1,2 and 3)	(0.059)	(0.048)	(0.010)
Observations	624	624	624
chi2	347661.8	2511.0	34781.6
df	26	26	26

ln(qnty) is log of quantity (in units of alcohol), ln(exp) is log of expenditure per customer and ln(price) is log of price per unit. F-GLS estimates with separate AR(1) process for each country-MUP group and group level heteroscedasticity but no correlation across groups (robust se in parenthesis). Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively. The main text provides results when errors are also correlated across country-MUP groups in Table 3.

Similarly, results corresponding to Table 4 for the alternative assumption on the error structure are given below in Table B-2.

TABLE B-2. Falsification Test - Northern Ireland/England (non-correlated errors across groups)

	ln(qnty)	ln(exp)	ln(price)
	DDD estimates (No spillovers)		
MUP3: β_{11}	-0.0904	-0.0689	-0.00852
	(0.132)	(0.096)	(0.016)
MUP2: β_{10}	-0.0905	-0.0613	-0.00448
	(0.142)	(0.100)	(0.022)
MUP1: β_5	0.0375	0.0304	0.0188
	(0.113)	(0.083)	(0.014)
	DD estimates		
MUP3: $\beta_5 + \beta_{11}$	-0.0529	-0.0384	0.0103
	(0.068)	(0.048)	(0.009)
MUP2: $\beta_5 + \beta_{10}$	-0.0531	-0.0309	0.0144
	(0.086)	(0.055)	(0.017)
	Combined effect		
Combined (DDD)	-0.0913	-0.0732	-0.00941
(MUP2 and 3)	(0.118)	(0.084)	(0.016)
Combined (DD)	-0.0532	-0.0429	0.0106
(MUP1,2 and 3)	(0.059)	(0.046)	(0.010)
Observations	624	624	624
chi2	20163.9	1128.1	29905.0
df	26	26	26

ln(qnty) is log of quantity (in units of alcohol), ln(exp) is log of expenditure per customer and ln(price) is log of price per unit. F-GLS estimates with separate AR(1) process for each country-MUP group and group level heteroscedasticity but no correlation across groups (robust se in parenthesis). Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively. The main text provides results when errors are also correlated across country-MUP groups in Table 4.

B.3. **Estimates under country-specific trends and monthly fixed effects.** The main analysis given in Table 3 and Table 4 estimates the model with time trends (up to polynomial of degree four) and monthly time trends (dummies for each month) that are common to the countries in question (England and Wales in Table 3 or England and Northern Ireland in Table 4). In this appendix, we relax this assumption further and allow for country-specific time trends as well as country-specific monthly effects.

Results corresponding to Table 3 for country-specific trends and fixed effects is given below in Table B-3.

TABLE B-3. Effect of MUP Implementation in Wales (w/ country specific time trends and monthly effects)

	ln(qnty)	ln(exp)	ln(price)
	DDD estimates (No spillovers)		
MUP3: β_{11}	-0.586[a]	-0.217[a]	0.228[a]
	(0.014)	(0.010)	(0.005)
MUP2: β_{10}	0.00489	0.0532[a]	0.0552[a]
	(0.011)	(0.007)	(0.005)
MUP1: β_5	0.0829[b]	0.0773[a]	-0.00721
	(0.032)	(0.019)	(0.007)
	DD estimates		
MUP3: $\beta_5 + \beta_{11}$	-0.503[a]	-0.140[a]	0.220[a]
	(0.032)	(0.019)	(0.007)
MUP2: $\beta_5 + \beta_{10}$	0.0878[a]	0.131[a]	0.0480[a]
	(0.032)	(0.018)	(0.008)
	Combined effect		
Combined (MUP2 and 3)	-0.240[a]	-0.0645[a]	0.141[a]
	(0.009)	(0.007)	(0.005)
Combined (MUP1,2 and 3)	0.0668[b]	0.0755[a]	-0.00973
	(0.030)	(0.020)	(0.007)
Observations	624	624	624
chi2	537384.3	3056.8	28424.9
df	41	41	41

ln(qnty) is log of quantity (in units of alcohol), ln(exp) is log of expenditure per customer and ln(price) is log of price per unit. F-GLS estimates with separate AR(1) process for each country-MUP group, and correlation across groups (robust S.E. in parenthesis). Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively. The main text provides results when there is a common (across countries) time trend and common monthly fixed effects in Table 3. By comparison, this table allows for country-specific time trends and country-specific monthly fixed effects.

Similarly, results corresponding to Table 4 for the country specific trends and monthly effects is given in Table B-4.

Table B-4. Falsification Test - Northern Ireland/England (country specific trends and monthly effects)

	ln(qnty)	ln(exp)	ln(price)
	DDD estimates (No spillovers)		
MUP3: β_{11}	-0.0820[a]	-0.0604[a]	-0.00930
	(0.027)	(0.018)	(0.006)
MUP2: β_{10}	-0.0858[a]	-0.0562[a]	-0.00564
	(0.028)	(0.020)	(0.007)
MUP1: β_5	0.0350	0.0449	0.00863
	(0.059)	(0.040)	(0.007)
	DD estimates		
MUP3: $\beta_5 + \beta_{11}$	-0.0470	-0.0156	-0.000666
	(0.059)	(0.039)	(0.007)
MUP2: $\beta_5 + \beta_{10}$	-0.0508	-0.0113	0.00299
	(0.059)	(0.040)	(0.008)
	Combined effect		
Combined (MUP2 and 3)	-0.0904[a]	-0.0739[a]	-0.00695
	(0.019)	(0.014)	(0.005)
Combined (MUP1,2 and 3)	-0.00472	0.00288	0.00436
	(0.051)	(0.040)	(0.008)
Observations	624	624	624
chi2	182635.3	2078.0	22133.4
df	41	41	41

ln(qnty) is log of quantity (in units of alcohol), ln(exp) is log of expenditure per customer and ln(price) is log of price per unit. F-GLS estimates with separate AR(1) process for each country-MUP group, and correlation across groups (robust S.E. in parenthesis). Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively. The main text provides results when there is a common (across countries) time trend and common monthly fixed effects in Table 4. By comparison, this table allows for country-specific time trends and country-specific monthly fixed effects.

B.4. **Parallel Trend Assumption.** Critical to the difference-in-differences model is the 'parallel trends' assumption (e.g., as Wing et al. (2018) discuss in the context of public health policy analysis). That is, without the MUP policy, time trends across MUP groups would have been parallel in Wales and England. The graphical inspection of Figure 1 suggests similar trends in the period prior to the MUP implementation (weeks 1-78) and that the common trends is a reasonable assumption. We consider two tests here.

Test 1. We test whether the trends in Y1, Y2, Y3 and Y4 are parallel in the pre-MUP period ($t < T = 78$). We estimate a variant of Equation 1 with a linear time trend (t) interacted with the treatment group dummies ($M2$ and $M3$) and the country indicators (W) instead of the original P_{it} dummy variable. Thus, we estimate

$$\begin{aligned} Y_{it} &= \alpha_1 + \alpha_2 X_{it} + \beta_1 W_{it} + \beta_2 t + \beta_3 M2_{it} + \beta_4 M3_{it} \\ &\quad + \beta_5 (W_{it} t) + \beta_6 (W_{it} M2_{it}) + \beta_7 (W_{it} M3_{it}) + \beta_8 (t M2_{it}) + \beta_9 (t M3_{it}) \\ &\quad + \beta_{10} (W_{it} t M2_{it}) + \beta_{11} (W_{it} t M3_{it}) + u_{it}, \end{aligned} \tag{5}$$

and test whether β_5, β_{10}, and β_{11} are significantly different from zero. Note that X consists of quadratic, cubic and quartic time trends and monthly-dummies. The p-values of the F-test results are reported in Table B-5 for all outcomes. We do not reject the hypothesis that the these coefficients are equal to zero for all outcomes, with p-values always above 0.1. For log prices (Y4) p-values are lower than for other outcomes, notably for MUP3 products. However, the common trend assumption holds at 1% level or below for all outcomes and MUP groups.

Table B-5. Parallel trends test (in pre-MUP period), Wales vs. England

		ln(qnty)	ln(exp)	ln(price)
MUP3	Chi2	2.111	0.599	0.946
	p-value	0.146	0.439	0.331
MUP2	Chi2	0.063	0.118	0.433
	p-value	0.802	0.732	0.511
MUP1	Chi2	1.830	0.243	1.137
	p-value	0.176	0.622	0.286

ln(qnty) is log of quantity (in units of alcohol), ln(exp) is log of expenditure per customer and ln(price) is log of price per unit. F-GLS estimates with separate AR(1) process for each country-MUP group, and correlation across groups.

Test 2. Similar to above, we only use pre-MUP regulation observations ($t < T = 78$). Again we re-estimate equation (1), but place a placebo policy at $T/2$ at week 39 (T/2 is between week 38 and 39). Specifically, in equation (1) we redefine the indicator variable $P_{it} = 1$ if ≥ 39 and otherwise 0. Regression coefficients of interest β_5, β_{10} and β_{11} for all four outcomes are summarized in Table B-6. In all but one case, they are not statistically significant and we do not reject the null hypothesis of parallel trends. The one exception is for $Y1$ for MUP3 parameter β_{11} in which case the parameter is significantly different from zero at the 10% level. But even here, the magnitude is only -0.0204 and compares sharply with the non-placebo variant reported in Table 3 where the same parameter was -0.587 and significant at 1% level.

Table B-6. Falsification test - Imposing an hypothetical MUP in the middle of the pre-MUP period in Wales (selected coefficients only)

	ln(qnty)	ln(exp)	ln(price)
	DDD estimates (No spillovers)		
MUP3: β_{11}	-0.0204^c	-0.0111	0.00213
	(0.011)	(0.009)	(0.004)
MUP2: β_{10}	0.00270	0.00133	-0.0000374
	(0.009)	(0.006)	(0.003)
MUP1: β_5	0.0252^b	0.00810	-0.00175
	(0.012)	(0.008)	(0.003)
Observations	462	462	462
chi2	472661.7	1091.7	20060.6
df	26	26	26

ln(qnty) is log of quantity (in units of alcohol), ln(exp) is log of expenditure per customer and ln(price) is log of price per unit. F-GLS estimates with separate AR(1) process for each country-MUP group, and correlation across groups (robust S.E. in parenthesis). Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively.

C.1. **AIDS model - Detailed results.** This section provides AIDS model regression coefficients, the first-stage statistics and the Hicksian elasticity matrix. The corresponding Marshallian elasticity matrix was reported in the main text in Table 2.

First-stage F-test. For the three first-stage price equations, we used six instruments: three of them are the mean price of the same MUP category products from the other three countries during the same period. For instance for $p_{3_{E1}}$, which is the price MUP3 products in England in week 1, the instrument $zp_{3_{E1}}$ is the mean value of p_3 in week 1 from Scotland, Wales and Northern Ireland. Values for other weeks and countries are obtained the same way and the process is repeated for p_2 and p_1. The other three instruments are the exchange rates between the pound sterling and the US dollar and the Euro and the average price of diesel in the UK in that week.

Table C-1. First-stage F-stats

	lp_3	lp_2	lp_1
F-stat (6,391)	134.69	28.02	20.80

The F-stats are for the joint significance of the six excluded instruments and have 6 degrees of freedom in the enumerator and 391 in the denominator.

Hicksian Elasticities. The table provides the Hicksian (compensated) elasticity matrix.

Table C-2. Compensated Price (η_{jk}) and budget (θ_j) elasticities and mean shares (s_j)

η_{jk}	p_3	p_2	p_1	μ_j	s_j
q_3	-2.393^a	1.874^a	0.519^a	0.695^a	0.210
(MUP3)	(0.101)	(0.265)	(0.193)	(0.104)	(0.044)
q_2	1.017^a	-1.929^a	0.912^a	0.951^a	0.386
(MUP2)	(0.064)	(0.168)	(0.122)	(0.009)	(0.032)
q_1	0.268^a	0.867^a	-1.134^a	1.204^a	0.404
(MUP1)	(0.074)	(0.193)	(0.14)	(0.010)	(0.044)

Compensated/Hicksian elasticities given by η_{jk} where j, k entry is the elasticity of product j with respect to the price of product k. Standard errors are in parenthesis. Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively. Budget/income elasticity given under column θ_j and the last column provides the mean expenditure shares and standard deviations of the shares.

Regression coefficients. Table C-3 provides the coefficients from the system of AIDS equations for 3 equations.

Table C-3. Regression Coefficients - AIDS model

Variable	MUP3	MUP2	MUP1
γ-lnprice3	-0.404[a] (0.020)	0.291[a] (0.024)	0.113[a] (0.029)
γ-lnprice2	0.291[a] (0.057)	-0.512[a] (0.066)	0.221[a] (0.082)
γ-lnprice1	0.113[b] (0.044)	0.221[a] (0.049)	-0.334[a] (0.063)
β-lnx	-0.0638[a] (0.003)	-0.0187[a] (0.003)	0.0825[a] (0.004)
ρ-vprice3	0.0644[b] (0.029)	0.122[a] (0.033)	-0.186[a] (0.040)
ρ-vprice2	0.0507 (0.063)	-0.191[a] (0.073)	0.140 (0.089)
ρ-vprice1	0.0539 (0.051)	-0.00174 (0.059)	-0.0522 (0.072)
α-t	-0.000320 (0.000)	-0.000957[a] (0.000)	0.00128[a] (0.000)
α-t2	0.00000963[c] (0.000)	0.00000953 (0.000)	-0.0000192[b] (0.000)
α-t3	-6.69e-08[c] (0.000)	-4.85e-08 (0.000)	0.000000115[b] (0.000)
α-mon1	0.0462[a] (0.004)	0.0318[a] (0.005)	-0.0780[a] (0.006)
α-mon2	0.0353[a] (0.005)	0.0317[a] (0.005)	-0.0670[a] (0.007)
α-mon3	0.0343[a] (0.004)	0.0456[a] (0.005)	-0.0799[a] (0.006)
α-mon4	0.0319[a] (0.003)	0.0478[a] (0.004)	-0.0797[a] (0.005)
α-mon5	0.0351[a] (0.004)	0.0450[a] (0.004)	-0.0801[a] (0.005)
α-mon6	0.0304[a] (0.004)	0.0363[a] (0.004)	-0.0667[a] (0.005)
α-mon7	0.0301[a]	0.0356[a]	-0.0657[a]

Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively.

continued

Table C-3. Regression Coefficients - AIDS model

Variable	MUP3	MUP2	MUP1
	(0.004)	(0.004)	(0.006)
α-mon8	0.0282[a]	0.0483[a]	-0.0765[a]
	(0.004)	(0.005)	(0.006)
α-mon9	0.0341[a]	0.0350[a]	-0.0691[a]
	(0.004)	(0.004)	(0.005)
α-mon10	0.0298[a]	0.0212[a]	-0.0510[a]
	(0.003)	(0.004)	(0.005)
α-mon11	0.0225[a]	0.0136[a]	-0.0361[a]
	(0.003)	(0.003)	(0.004)
α-country1	0.208[a]	0.0129	-0.221[a]
	(0.010)	(0.011)	(0.014)
α-country2	0.0584[a]	-0.0290[a]	-0.0294[a]
	(0.002)	(0.003)	(0.004)
α-country3	0.0521[a]	-0.0301[a]	-0.0220[a]
	(0.003)	(0.004)	(0.005)
α-cons	1.056[a]	0.687[a]	-0.743[a]
	(0.044)	(0.050)	(0.061)

Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively.

C.2. **Coefficients in Table 3.** This appendix provides detailed regression coefficients reported Table 3 in the main text.

Table C-4. Regression Coefficients - DDD Wales/England/MUP-Group

	ln(qnty)	ln(exp)	ln(price)
β_1 (Wales)	-2.562^a	-0.00572	-0.00871^a
	(0.006)	(0.004)	(0.002)
β_2 (Post)	0.134	0.170^c	-0.0159
	(0.155)	(0.096)	(0.016)
β_3 (MUP2)	0.252^a	-0.0957^a	-0.388^a
	(0.019)	(0.017)	(0.005)
β_4 (MUP3)	0.0410	-0.385^a	-0.645^a
	(0.031)	(0.027)	(0.005)
β_5 (Wales*Post)	0.0453^a	0.0592^a	0.00200
	(0.012)	(0.008)	(0.003)
β_6 (Wales*MUP2)	0.0545^a	0.0397^a	0.00599^b
	(0.005)	(0.004)	(0.003)
β_7 (Wales*MUP3)	0.198^a	0.102^a	-0.0173^a
	(0.007)	(0.005)	(0.003)
β_8 (Post*MUP2)	-0.0169	-0.0196	0.00587
	(0.037)	(0.032)	(0.010)
β_9 (Post*MUP3)	-0.0196	-0.0594	0.0200^b
	(0.061)	(0.051)	(0.010)
β_{10} (Wales*Post*MUP2)	0.00381	0.0531^a	0.0553^a
	(0.011)	(0.007)	(0.005)
β_{11} (Wales*Post*MUP3)	-0.587^a	-0.218^a	0.225^a
	(0.014)	(0.010)	(0.005)
t: time/1000	15.66	17.56	2.926
	(20.441)	(12.336)	(2.163)
$t2$: t^2	-68.94	-85.43^c	-14.37
(coeff/10)	(85.17)	(51.01)	(8.898)

ln(qnty) is log of quantity (in units of alcohol), ln(exp) is log of expenditure per customer and ln(price) is log of price per unit. F-GLS estimates with separate AR(1) process for each country-MUP group, group level heteroscedasticity and correlation across groups (robust se in parenthesis). Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively. Selected regression coefficients from this table appear in Table 3.

continued

Table C-4. Regression Coefficients - DDD Wales/England/MUP-Group

	ln(qnty)	ln(exp)	ln(price)
$t3$: t^3	102.7	134.9^c	22.16^c
(coeff/100)	(126.9)	(75.76)	(13.18)
$t4$: t^4	-49.79	-66.05^c	-10.42^c
(coeff/1000)	(60.44)	(36.09)	(6.272)
month=2	0.0518	0.0421	0.00394
	(0.067)	(0.038)	(0.007)
month=3	0.146	0.108^b	-0.00808
	(0.092)	(0.054)	(0.010)
month=4	0.235^a	0.198^a	-0.0197^b
	(0.088)	(0.053)	(0.009)
month=5	0.317^a	0.247^a	-0.0151
	(0.089)	(0.054)	(0.009)
month=6	0.254^a	0.198^a	-0.00883
	(0.090)	(0.055)	(0.010)
month=7	0.212^b	0.148^b	-0.00995
	(0.100)	(0.060)	(0.010)
month=8	0.261^b	0.198^a	-0.0160
	(0.117)	(0.069)	(0.012)
month=9	0.197^c	0.141^b	-0.00484
	(0.107)	(0.063)	(0.011)
month=10	0.244^a	0.153^a	-0.0271^a
	(0.087)	(0.052)	(0.009)
month=11	0.250^a	0.140^a	-0.0304^a
	(0.076)	(0.046)	(0.008)
month=12	0.266^a	0.142^a	-0.0313^a
	(0.065)	(0.038)	(0.007)
Constant	16.68^a	1.010^a	-0.274^a
	(0.171)	(0.105)	(0.018)
Observations	624	624	624
chi2	347661.8	2511.0	34781.6
df	26	26	26

ln(qnty) is log of quantity (in units of alcohol), ln(exp) is log of expenditure per customer and ln(price) is log of price per unit. F-GLS estimates with separate AR(1) process for each country-MUP group, group level heteroscedasticity and correlation across groups (robust se in parenthesis). Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively. Selected regression coefficients from this table appear in Table 3.

C.3. **Combined effects.** This appendix provides selected coefficients from ancillary regressions used to compute the combined effect of the regulation on MUP2 and MUP3 products. The combined effects were reported at the bottom of Table 3. The combined effect is computed by estimating a variant of the main model in equation (1) with $M23$ being a dummy variable that takes the value of 1 if $M2 = 1$ or $M3 = 1$ and 0 otherwise.

$$
\begin{aligned}
Y_{it} = {} & \alpha_1 + \alpha_2 X_{it} + \beta_1 W_{it} + \beta_2 P_{it} + \beta_{3,4} M23_{it} \\
& + \beta_5 (W_{it} P_{it}) + \beta_{6,7} (W_{it} M23_{it}) + \beta_8 (P_{it} M23_{it}) \\
& + \beta_{10,11} (W_{it} P_{it} M23_{it}) + u_{it}
\end{aligned}
\tag{6}
$$

Table C-5 provides selected estimates of coefficients from the equation given above.

Table C-5. Effect of MUP regulation (MUP2 and MUP3 groups combined in a single group, selected regression coefficients), Wales vs. England

	ln(qnty)	ln(exp)	ln(price)
	DDD estimates (No spillover)		
MUP2/3: $\beta_{10,11}$	-0.241[b]	-0.0648	0.138[a]
	(0.118)	(0.086)	(0.014)
MUP1: β_5	0.0484	0.0603	0.00152
	(0.102)	(0.071)	(0.010)
	DD estimates		
MUP2/3: $\beta_{10,11} + \beta_5$	-0.193[a]	-0.00455	0.140[a]
	(0.059)	(0.048)	(0.010)
Observations	416	416	416
chi2	13695.0	667.8	21654.7
df	22	22	22

ln(qnty) is log of quantity (in units of alcohol), ln(exp) is log of expenditure per customer and ln(price) is log of price per unit. F-GLS estimates with separate AR(1) process for each country-MUP group, and correlation across groups (robust se in parenthesis). Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively. Only selected regression coefficients shown.

C.4. **MUP Effect by Product Type - Details.** This appendix provides a summary of the effects from the MUP implementation on different types of alcoholic beverages.

Table C-6 provides a breakdown by how many products are classified as MUP1, MUP2 and MUP3 by five alcohol product types: (i) Beers (includes ales, stouts and lagers); (ii) Ciders (including perries); (iii) Spirits; (iv) Wines (including all wine-based drinks); and (v) Flavored alcohol beverages (FABs). MUP3 products (consistently < 50ppu) are more common in the ciders category (27%); MUP2 products (intermittently < 50ppu) occur mainly for wines (31%), spirits (28%), and beers (28%). Flavored alcoholic beverages (FABs) are rarely priced below 50ppu.

Table C-6. Number of Items and Alcohol Unit Shares by Product Type in Wales

MUP-types	Item Counts Beers	Ciders	Wines	Spirits	FABs	Total	Shares (Qnty)
MUP1 (never < 50ppu)	426	89	560	368	133	1,576	28.63%
MUP2 (intermittently < 50ppu)	189	35	305	164	10	703	37.55%
MUP3 (consistently < 50ppu)	64	45	114	53	0	276	33.82%
Total	679	169	979	585	143	2,555	100%

Counts of SKUs and quantity shares are based on pre-MUP regulation data from Wales.

We estimate equation (1) by product type using data from Wales and England. We omitted flavored alcoholic beverages as there were no items of that product type in the MUP3 product category and only 10 items in MUP2 category. Impact for each product type is estimated the same way, i.e., by first aggregating the sales data by MUP classification, week and country but including only sales for the appropriate product type (Beers, Ciders, etc.) and then estimating equation (1) for each of them separately.

The DDD estimates (to be interpreted as no spillover effects and coefficient on MUP1 products as due to lockdown differentials) are summarized in Table C-7. The impact of the price floor is not even across all product types. There is a decline in quantity of MUP3 products for all types, but the decline is much larger for beers and ciders than for spirits and wines. There is also an opposite negative and positive effect on MUP2 products for beers and ciders respectively, but no significant effect for spirits and wines groups. Similarly, beers and ciders also show that consumption of MUP1 products increased in Wales relative to England following MUP implementation and the lockdowns commencing ($\beta_5 = 0.120$ and 0.118 respectively, and statistically significant) while there is no similar increase for spirits and wines ($\beta_5 = 0.0391$ and 0.0129 respectively and not statistically significant).

Relative to England before the lockdown, expenditure per customer in Wales decreased for MUP3 products and increased for MUP1 products for all four alcohol types, and there are mixed results for MUP2 products: increase by 5.88%, 3.05%, and 2.19% for beers, spirits, and wines respectively, but no change for ciders.

In terms of prices, MUP3 prices increase for all four types (up 26.7% for beers, 53.1% for ciders, 20.2% for spirits and 13.4% for wines), and a similar but smaller increase in prices for MUP2 products, with increase of 11.3%, 2.7% and 6.6% for beers, ciders and spirits, respectively, but no significant change for wines. MUP1 products do not change much in prices, and where we do see a small but statistically significant change (+1.15% for wines and -0.82% for spirits), we associate these as due to country lockdown differentials.

Table C-7. DDD Estimates by Product Types (Selected regression coefficients)

	ln(qnty)	ln(exp)	ln(price)
	Beers (Ales,Stout & Lager)		
MUP3: β_{11}	-1.104^a	-0.284^a	0.237^a
	(0.024)	(0.009)	(0.008)
MUP2: β_{10}	-0.0392^c	0.0571^a	0.107^a
	(0.023)	(0.009)	(0.011)
MUP1: β_5	0.120^a	0.0573^a	-0.000741
	(0.012)	(0.004)	(0.004)
	Ciders & Perries		
MUP3: β_{11}	-0.764^a	-0.0524^a	0.426^a
	(0.037)	(0.005)	(0.010)
MUP2: β_{10}	0.0884^b	0.00564	0.0266^b
	(0.044)	(0.005)	(0.010)
MUP1: β_5	0.118^a	0.0349^a	-0.000736
	(0.036)	(0.006)	(0.005)
	Spirits		
MUP3: β_{11}	-0.392^a	-0.0759^a	0.184^a
	(0.032)	(0.012)	(0.006)
MUP2: β_{10}	0.00265	0.0300^a	0.0639^a
	(0.033)	(0.009)	(0.010)

ln(qnty) is log of quantity (in units of alcohol), ln(exp) is log of expenditure per customer and ln(price) is log of price per unit. F-GLS estimates with separate AR(1) process for each country-MUP group, group level heteroscedasticity and correlation across groups (robust se in parenthesis). Only selected regression coefficients shown. Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively.

continued

Table C-7. DDD Estimates by Product Types (Selected regression coefficients)

	ln(qnty)	ln(exp)	ln(price)
MUP1: β_5	0.0391	0.0257^a	-0.00827^c
	(0.025)	(0.007)	(0.005)
	Wines (including other wine-based drinks)		
MUP3: β_{11}	-0.172^a	-0.0292^a	0.126^a
	(0.018)	(0.009)	(0.005)
MUP2: β_{10}	0.0200	0.0217^a	0.00461
	(0.014)	(0.008)	(0.004)
MUP1: β_5	0.0129	0.0282^a	0.0115^a
	(0.014)	(0.008)	(0.004)

ln(qnty) is log of quantity (in units of alcohol), ln(exp) is log of expenditure per customer and ln(price) is log of price per unit. F-GLS estimates with separate AR(1) process for each country-MUP group, group level heteroscedasticity and correlation across groups (robust se in parenthesis). Only selected regression coefficients shown. Superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively.

Appendix D. Cross-border purchases

A possible unintended consequence of MUP could be an increase in cross-border trade activity, especially near the border, i.e. consumers living in a country with MUP crossing the border to purchase alcohol at a cheaper price in a country not affected by MUP.

The aggregated nature of our data (i.e., we do not have individual shopper-level data with postcodes for their residence) does not allow us to formally test the relevance of cross-border trade for MUP in Wales. However, there are at least three reasons to believe that the scope for extensive driving to make cross-border shopping trips would have been limited in our context.

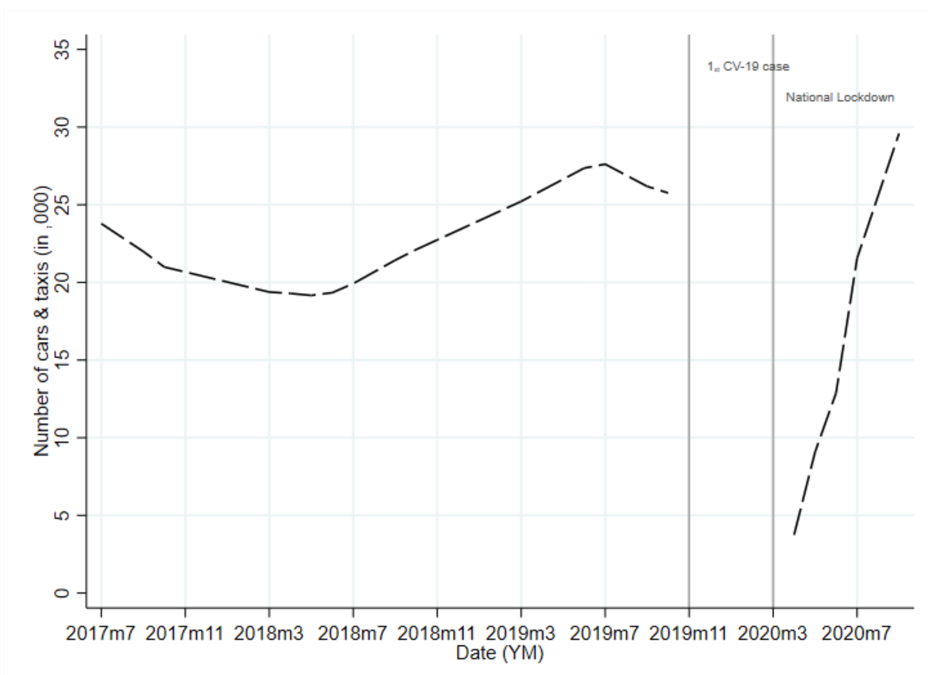
First, several studies have looked at this issue in other contexts. For Scotland (Patterson et al., 2022), official analysis of retail sales, survey data, and qualitative interviews indicated minimal increased cross-border purchasing of alcohol following MUP, at a scale that is unlikely to make any significant impact. Little evidence has been also reported by WHO (WHO, 2022). The limited scope for extensive driving to make cross-border shopping trips to circumvent alcohol policies has been confirmed in the academic literature. Griffith et al. (2022) examined the cross-border issue following MUP in Scotland by computing the straight-line distance from the center of postal sectors to the Scotland-England border. They found a negligible impact of cross-border shopping on their estimated impact of MUP, "*likely due to the low population density around the Scotland-England border* (p.2283)". Similar conclusions were reported by Bokhari et al. (2023) when evaluating the impact of a ban on volume discounts on alcohol introduced in Scotland in 2011.

Second, ex-ante evaluations of MUP in Wales anticipated limited scope for Welsh households to travel over the border to circumvent the price floor. The Welsh MUP impact assessment (WHO, 2022) showed that heavy drinkers – the target population for MUP, mostly do not live close to the Wales-England border (see paras 135-142 and Figure 4). The assessment concluded that "*[a]lthough these cross-border issues may limit the impact [of MUP] on a few individuals, we do not anticipate any significant effect on the projected reduction in consumption or harm (health and cost) (para 141)*". Drawing on this evidence, the Welsh Cabinet Secretary reported his skepticism "*about the likelihood of people making a cross-border booze cruise to collect large amounts of alcohol because we're talking about the very cheap, high-strength end of the market that is likely to be changed*"(Welsh Government, 2015, see section 2.7, paras 83-87).

Third, it should be noted that the MUP policy in Wales was introduced during the COVID-19 lockdown. With the commencement of the COVID-19 lockdown on 23rd March 2020, the Welsh authorities issued a "stay local" guidance, asking people to stay within five miles of home. This guidance remained in force until the 6th of July 2020, after which there were no limits on travel (see https://www.bbc.co.uk/news/uk-wales-58327865). On this lockdown guidance basis alone, the scope for extensive driving to make cross-border shopping trips would have been very much curtailed and instead consumers would have bought alcohol locally to comply with the stay local guidance.

We checked formally the relevance of cross-border trade by analyzing the administrative Welsh Road traffic statistics provided by the Welsh Department for Transport. These are provided in the form of raw monthly data on the number of vehicles that passed about – 2,525 count points located in Wales on an average day of the month in different hours (from 8 am to 6 pm) by their directions of travel (North, South, West, East). Data are also disaggregated by types of vehicles: a) cars and taxis; b) the number of buses and coaches and c) the number of large goods vehicles (LGVs) and d) all vehicles.[13]

FIGURE D-1. Note: Locally weighted regressions (bandwidth = 1.2) on raw Welsh Road traffic statistics.



[13]Raw data are available from Welsh Department for Transport from here:https://roadtraffic.dft.gov.uk/regions/4 (download the "Raw counts" file).

For our analysis, we focussed on the data obtained from the 518 count points located at the four border Welsh Local Authorities (Flintshire, Wrexham, Powys, and Monmouthshire) on the number of cars and taxis that traveled in the period July 2018 to July 2020 towards the east to best identify cross-border movements from Wales towards England. Figure 1 shows the smoothed log number of cars and taxis before and during the COVID-19 period. It shows a sharp reduction in traffic data when the "stay local" guidance was introduced and until it was in force (the 6th of June) when it reached almost the observed pre-COVID-19 levels.

Table D-1. Log of count of cars and taxis past countpoints

	Full Sample	Balanced Sample
Post Lockdown policy	-0.331[a]	-0.323[a]
	(0.023)	(0.023)
Constant	4.381[a]	4.398[a]
	(0.022)	(0.019)
Observations	12,806	12,049

Notes: Full sample reports estimates obtained using the full pre- and post-National Lockdown period while the "Balanced" sample reports estimates obtained using data collected in comparable pre- and post- National Lockdown months from May to October. Robust standard errors are in parentheses and superscripts a, b, c indicate significance at 1%, 5% and 10%, respectively. Both regressions include dummies for the month of the year, the hour of the day, and dummies for count point ids.

We regressed the log of the number of cars and taxis that travel past these count points located in the four border Welsh Local Authorities on a dummy variable for the period of the National lockdown order (one since March 2020 and zero before). Data are far from ideal due to the temporal inconsistency of the timing patterns for when the data are collected at given count points. We partially account for this in our regressions by also including dummy variables for the month of the year, the hour of the day, and the id for each count point in the dataset. Results provided in Table D-1 point towards a significant reduction of 32-33% of traffic during the lockdown period compared with the pre-COVID-19 (pre-MUP) period. We interpret this as the consequence of the "stay local" guidance when the scope for extensive driving to make cross-border shopping trips would have been limited.

Appendix E. MUP impact on public health and safety

E.1. **Drink driving trends.**

E.1.1. *Background.* Francesconi and James (2022) analyze the impact of introducing MUP in Scotland in May 2018 on traffic fatalities and drunk driving accidents. They find no evidence for the MUP policy reducing road crash deaths and drunk driving collisions. Furthermore, they report no evidence in their highly detailed study of effect heterogeneity by income and other predictors of alcohol consumption or cross-border effects.

Their study period spanned November 2009 to December 2019, so prior to the introduction of MUP in Wales. In contrast, our consideration here is on broad trends and through to 2021 using publicly available information to gauge whether the introduction of MUP had an impact on reducing drink driving behavior in Wales, by comparing changes over time and across the constituent countries of the U.K., but mainly focusing on comparisons with England. The data source is the UK Office for National Statistics (ONS) (https://www.ons.gov.uk/), which provides official statistics on traffic data, driving accidents, drink driving collisions and casualties, and breathalyser tests.

Our context is important as traffic levels fell sharply during the COVID-19 lockdowns, with very similar trends across England, Wales, and Scotland, where traffic volume fell by around a quarter in 2020 from 2019, and then only partly recovered in 2021.[14]

Road traffic collisions have been on a downward trend in the last few years, but noticeably a sharper fall in Scotland and Wales compared to England and Northern Ireland. All four U.K. constituent countries saw a sharp drop in road traffic collisions in 2020 compared to 2019, with a modest increase in 2021, in keeping with reduced traffic volume levels.[15]

Drink-driving legislation has been strengthened over the years in the U.K., including tougher penalties for offenders. The drink drive limit introduced by the 1967 Act has been maintained for England and Wales at a maximum blood alcohol concentration ("BAC") of 80mg of

[14]ONS Table TRA8901 https://www.gov.uk/government/statistical-data-sets/road-traffic-statistics-tra.

[15]ONS Table RAS0402 (https://www.gov.uk/government/statistical-data-sets/reported-road-accidents-vehicles-and-casualties-tables-for-great-britain).

alcohol per 100ml of blood, but Scotland reduced the legal BAC limit in December 2014 to 50mg per 100ml of blood.[16]

E.1.2. *Drink-drive collisions and casualties in Great Britain by country.* Overall, 6% of casualties in reported road collisions in 2020 occurred in collisions in which at least one driver or rider was over the drink-drive limit (ONS, 2022a). For 2020, the percentage of all casualties which occurred in drink-drive collisions was the highest in Wales at 8.4% followed by England at 5.5% and Scotland at 5.0%. (Within the English regions, the casualty rates varied from 8.0% in the East Midlands to Greater London at 3.0%).

The proportion of casualties that occur in drink-drive collisions has been higher in Wales than in England or Scotland over the past decade and increased more sharply in 2020 (ONS, 2022a, Chart 10).

The proportion of road traffic collisions where the driver/rider has been impaired by alcohol has risen sharply in Wales over the past five years, overtaking the figure for England in 2019 and with a widening gap to stand at respectively 7.3% and 6.5% by 2021, while the trend for Scotland has remained flat to stand at 3.8% in 2021.[17]

E.1.3. *Breath test statistics.* The U.K. Home Office provides summary statistics for the number of breath tests undertaken by police forces in England and Wales.[18] However, comparisons are difficult over time and across the two countries because the extent of enforcement and resources devoted to breath tests varies markedly over time, both within and across years, and across the different regional police forces. Notably, the use of breath tests in Wales has been double for England, as a proportion of the respective population, for most of the past two decades, but the number of tests has sharply declined in both countries over the past 10 years, yet the rate of decline has been significantly faster in Wales. The result has been that the *number* of recorded positive or refused tests has been falling at a faster rate while the *proportion* of tests being positive or refused has been increasing at a faster rate in Wales than in England.

[16]Studies evaluating the impact of the limit reduction in Scotland, compared to England and Wales, have concluded that lowering the limit was not associated with any reduction in total collision rates or serious and fatal collision rates (Haghpanahan et al., 2019; Cooper et al., 2020; Francesconi and James, 2021).

[17]ONS statistical dataset RAS0705 (`https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1106328/ras0705.ods`)

[18]The police have the right to stop drivers (or riders) at any time and ask them to take a breath test if they suspect they have been driving under the influence of alcohol, have a committed a traffic offence, or been involved in a road traffic accident.

As an illustration, comparing 2019 with 2021, the number of positive or refused tests declined by 37% in Wales (from 4,577 to 2,897) while they declined by 23% in England (from 49,591 to 37,694). However, this was against a backdrop of the number of tests falling by 43% in Wales (from 32,530 to 18,462) and by 23% in England (from 269,661 to 205,700). The net effect was that the proportion of tests being positive or refused rose by 11.5% in Wales (from 14.1% to 15.7%) but only by 0.4% in England (from 18.4% to 18.5%) over these two years. On this basis, it is difficult to conclude whether the introduction of MUP in Wales did have a material impact on reducing positive or refused breath tests.[19]

E.1.4. *Conclusions on drink driving.* Based on these trends from ONS statistics, there is no clear indication that the introduction of MUP led to a discernible change in drink driving occurrences in Wales in comparison to the trends observed in England over the same period. Certainly, the COVID-19 lockdowns reduced traffic levels and reduced road traffic collisions, but alcohol impairment continued to feature as a contributory factor in road traffic collisions and the proportion of positive or refused breath tests rose.

E.2. **Alcohol-related Deaths and Hospital Admissions.**

E.2.1. *Background and data sources.* The most significant and detailed country-wide study so far on the impact of MUP on alcohol-related deaths and hospitalizations is provided by Wyper et al. (2023) using comparisons between Scotland and England over the period January-start 2012 to December-end 2020, so covering a two-and-a-half year (32-month) period after Scotland introduced MUP in May 2018. Their study used controlled interrupted time series regression analysis to assess MUP's introduction in Scotland, using comparative data from England as a control group. Their finding was that MUP in Scotland was associated with a significant 13.4% reduction (95% CI –18.4 to –8.3; p=0.0004) in deaths wholly attributable to alcohol consumption. They also found that hospitalizations wholly attributable to alcohol consumption decreased by 4.1% (–8.3 to 0.3; p=0.064) due to MUP, reporting that the beneficial effects on both deaths and hospitalizations were driven by significant improvements in chronic outcomes, particularly alcoholic liver disease.

Their study does not examine the situation in Wales and only covers the first part of pandemic through to the end of 2020. Here, we do not attempt to extend and replicate their highly

[19]ONS Breath test statistics data tables (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1116963/breath-test-statistics-police-powers-and-procedures-year-ending-31-december-2021.xlsx).

detailed analysis, but instead provide an indication of the pattern of alcohol-related deaths and hospitalizations in Wales compared to the other U.K. constituent countries drawing on annual data through to the end of 2021 (i.e., a further year beyond the Wyper et al. study).

Our data sources are the UK Office for National Statistics (https://www.ons.gov.uk/), which provides a helpful single source for statistics on alcohol-specific deaths covering all four constituent countries, and the individual country statistics departments on alcohol-related hospital admissions from the respective national health service authorities (but noting that straightforward comparisons are not possible due to different data collection and reporting approaches on hospital admissions in each of these countries).

E.2.2. *Alcohol-related deaths.* ONS (2022b) provides comparative alcohol-specific death rate figures for the four U.K. countries, which rose over the pandemic period. However, the largest increases occurred in Wales and England but with negligible difference between them, respectively, up by 27.1% and 27.5% from 2019 to 2021. In contrast, albeit with higher rates, Scotland and Northern Ireland saw increases of 20.4% and 2.7%, respectively, resulting in the gap on rates closing amongst the four countries.

Three main causes account for over 95% of alcohol-specific deaths. The leading cause is alcoholic liver disease, which accounts for around three-quarters of case across the U.K., but for which Wales saw the proportionally highest increase between 2019 and 2021 (from 82.1% to 86.0%), while only Scotland saw a decrease in its rate (from 64.8% to 63.9%). The next most common cause is mental and behavioral disorders due to the use of alcohol, but where the rate in Scotland and Northern Ireland is more than double that compared with Wales and England, and for which only Scotland saw an increasing proportion of cases from 2019 to 2021 (from 26.7% to 28.0%), while decreasing in Northern Ireland (from 22.3% to 19.4%), England (from 9.9% to 9.5%) and Wales (from 9.5% to 7.6%).

In contrast to both these causes, and most other individual causes, resulting from long-term excessive drinking, the third most common cause is accidental poisoning by and exposure to alcohol, which may arise from acute excessive (e.g., binge) drinking. Interestingly, there were sharp declines in the proportion of cases between 2019 and 2021 for Scotland (from 5.8% to 4.4%) and Wales (from 4.9% to 3.2%), while little difference in England (from 6.4% to 6.1%) and Northern Ireland (from 6.3% to 6.6%).

Overall, there is no indication that Wales has achieved similar benefits to those in Scotland in reducing the overall alcohol-specific death rate since introducing MUP. The difference might be down to the different trends for Scotland and Wales, especially on deaths linked to chronic conditions, or a delayed impact from the introduction of MUP because of the pandemic. Yet, the finding that deaths from accidental poisoning dropped markedly over the pandemic in Wales and Scotland compared to England and Northern Ireland is consistent with MUP deterring extreme binge drinking.

E.2.3. *Alcohol-related hospitalizations.* A combination of different reporting methods, changing definitions for alcohol-attributable hospital admissions, different rates of COVID-19 hospitalizations during the pandemic, and changes to mid-year population estimates (due to the 2021 national census) means that cross-country comparisons are not straightforward. For Wales, PHW (2022) reports a sharp decline in the number of alcohol-related admissions in the first year of the pandemic and then an increase the following year, but still lower than the pre-pandemic levels. For instance, alcohol-specific admissions dropped by 11.0% in 2020/21 but increase by 5.3% in 2021/22, leaving an overall decrease of 6.3% over the two years from 2019/20. Similarly, age-standardized admission rates for alcohol-attributable measures declined by 10% between 2019/20 and 2021/22, but for comparison the rate for all hospital admissions dropped by 17% for the same period.[20] Against this backdrop, it is difficult to discern the extent to which the trend in alcohol-related admissions diverged from the pre-pandemic situation in Wales.

For England, mid-year population estimates have not yet been revised in the wake of the 2021 Census, so that while estimated alcohol-related admissions rates are available for 2021/22, there are no directly comparable figures so far available for previous years (LAPE 2023). However, the pattern is similar to that in Wales in respect of the recorded number of admissions but with a less discernible net difference over the previous two years. For instance, alcohol-specific admissions declined by 8.4% from 2019/20 to 2020/21 then increased by 7.6% following year but leaving the level lower over the two years from 2019/20 to 2021/22 by just 1.4%. Similarly, for alcohol-attributed admissions (both broadly and narrowly defined), the net drop was around 3% over these two years.[21] As a comparison, the number of all hospital admissions dropped by 25.5% from 2019/20 to 2020/21 but increased by 24.7% the

[20]Source: https://www.healthmapswales.wales.nhs.uk/data-catalog-explorer/.

[21]These calculations draw on the hospital admission numbers reported in LAPE (2021a, 2021b, 2022, 2023) by three different definitions: (i) "alcohol-specific admissions" where the primary diagnosis or any of the secondary diagnoses are an alcohol-specific (wholly attributable) condition; (ii) "alcohol-related admissions (broad)" where either the primary diagnosis (main reason for admission) or one of the secondary (contributory) diagnoses is an alcohol-related condition (partially or wholly caused by alcohol), which represents a broad measure of alcohol-related admissions but is sensitive to changes in coding practice over time; and (iii) "alcohol-related admissions (narrow)"

following year to leave the net difference over the two years from 2019/20 to 2021/22 down by 7.1%.[22] Thus, while the net drop in alcohol-related admissions in England is lower than in Wales over these two years, so is the number of total hospital admissions.

Respective data for Northern Ireland (NI) are reported only as three-year averages (Russell 2020). The latest update by NISRA (2023) indicates a decline in NI alcohol-related admissions over the last two years, but which appears mostly due to restricted hospital services and admissions during the pandemic.

For Scotland, there has been a longer-term decline in alcohol-related hospital admissions for more than a decade before the pandemic then with a steep drop in 2020/21, and broadly maintained for 2021/22 (PWS 2023). For instance, alcohol-related hospital admissions (stays) in general acute hospitals declined by 9.6% from 2019/20 to 2020/21 and the number held steady for 2021/22.[23] To give some perspective, the total number of hospital admissions in general acute hospital declined by 29.6% from 2019/20 to 2020/21 then increased by 21.7% the following year to leave a net reduction of 14.3% over the two years from 2019/20 to 2021/22.[24]

Given the disruption to hospital admissions during the pandemic, it is difficult to determine from these broad trends whether and to what extent the introduction of MUP in Wales may have had a positive effect in reducing alcohol-related hospital admissions. The number of such admissions has declined more in Wales than in England in the two years from March 2020, but so have total hospital admissions. In Scotland, though, the continuing decline in alcohol-related admissions is more apparent. However, such evidence may only become clearer beyond the pandemic period considered here.

E.3. **Domestic Violence Trends.**

E.3.1. *Context and background.* A range of studies have documented the link between alcohol intoxication and violent behavior (Giancola et al. 2010; Graham and Livingstone 2011;

where the primary diagnosis (main reason for admission) is an alcohol-related condition, which represents a narrower measure.

[22]Source: https://files.digital.nhs.uk/86/9530F0/hosp-epis-stat-admi-time-seri-2021-22-tab.xlsx.

[23]Source: https://publichealthscotland.scot/publications/alcohol-related-hospital-statistics/alcohol-related-hospital-statistics-scotland-financial-year-2021-to-2022/.

[24]Source: https://www.publichealthscotland.scot/media/15092/table-2-inpatient-and-day-case-activity-2021-22.xlsx.

Trendl et al. 2021; *inter alia*). While alcohol may not be the direct cause of violent behavior, it can serve as an aggravating factor by lowering inhibitions.

For England and Wales, more than 2 in 5 surveyed victims of violent incidents believed the offender to be under the influence of alcohol (Bryant 2023). Furthermore, lower socioeconomic groups experience higher prevalence rates of alcohol-related violence overall, and higher incidence and prevalence rates for alcohol-related domestic and acquaintance violence (Bryant and Lightowlers 2021). These lower socioeconomic groups are more likely to drink cheap alcohol where MUP would raise prices and have the greatest effect in reducing consumption, which is consistent with the evidence from Scotland following the introduction of MUP in 2018, especially for high-consumption households (Holmes 2023). On this basis, the introduction of MUP leading to reduced alcohol consumption might help reduce the incidence of alcohol-related domestic violence.

A complicating factor is the coincidence of the introduction of MUP in Wales with the COVID-19 lockdowns, and the resulting increase in alcohol consumption at home (given the closure of on-trade licensed premises for on-site consumption). Increased home consumption of alcohol together with the constraints of being housebound during the lockdowns might be expected to have the effect of raising the incidence of alcohol-related domestic violence. Chalfin et al. (2021) provide evidence of such a link in the U.S., finding that police call outs for domestic violence incidents rose with visits to alcohol outlets during the pandemic, at a time when drinking was broadly confined to the home. As non-domestic assaults did not increase in line with alcohol outlet visits, the evidence is consistent with alcohol purchases driving domestic, but not other forms of violence (such as stranger and acquaintance violence) during this period. Thus far, though, there appears to be no similar studies that relate to the U.K. on such a link despite the potential insights for alcohol policy (Wilson et al. 2022).

A comparison between the incidence of domestic violence in Wales and England before and after the introduction of MUP in Wales may reveal whether and to what extent such a moderating effect may have arisen during the lockdown period.[25] Even so, considerable caution is required in interpreting any such finding, given the reliance on a very strong *ceteris paribus* assumption that the tendency to report incidents remained stable and consistent across the two countries, which may not have been the case.

[25]We focus on comparisons between Wales and England, rather than including Scotland and Northern Ireland, because the same laws apply and police records for domestic-abuse crimes and incidents are in common for Wales and England, so allowing for direct comparability.

E.3.2. *Survey evidence on alcohol-related domestic violence in Wales and England.* The Crime Survey for England and Wales (CSEW) has previously reported on annual basis the proportion of domestic violence incidents where the victim believed the offender(s) to be under the influence of alcohol for both England and Wales jointly. However, the last update on the figure is from 2019/20 with the proportion recorded at 34%, with a broadly stable trend over the preceding decade (ONS 2022e, Table 9f). Following the outbreak of the pandemic, the crime survey switched from face-to-face interviews to telephone-operated interviews using a reduced set of questions and consequently data on alcohol-related domestic violence has not been published for the past two years (ONS 2022d; Bryant 2023).

While there has been no update on the influence of alcohol for domestic violence incidents, ONS (2022f) provides information from the CSEW on the influence of alcohol in incidents of partner abuse (as a subset of domestic abuse) experienced by adults in England and Wales for the year ending March 2022, where 14.5% of offenders and 8.8% of victims were identified as being under the influence of alcohol. The only available comparison data are from the year ending March 2018, with similar levels at 16.6% and 8.1%, respectively.[26]

To give some perspective for how these figures on the influence of alcohol relate to the scale and extent of domestic abuse, the CSEW estimated that 5.0% of adults (6.9% women and 3.0% men) aged 16 years and over experienced domestic abuse in the year ending March 2022 in England and Wales, equating to an estimated 2.4 million adults (1.7 million women and 0.7 million men). Furthermore, approximately 1 in 5 adults aged 16 years and over (10.4 million) had experienced domestic abuse since the age of 16 years (ONS 2022c). For more narrowly defined partner abuse, the CSEW estimate for year ending March 2022 was that 3.5% of adults aged 16 years and over had experienced partner abuse in the last year. There are no CSEW comparisons available for the previous year, but there had been a moderately declining trend over the preceding decade (ONS 2022c, Figure 2).

E.3.3. *Policy-recorded crime statistics on the incidence of domestic violence in Wales and England.* Police-recorded crime (PRC) statistics are available at regional police force level,

[26]In respect of definitions used, domestic abuse is not limited to physical violence and can include a range of abusive behaviors, including physical or sexual abuse, violent or threatening behavior, controlling or coercive behavior, economic abuse, psychological, emotional, or other abuse. Within the CSEW, partner abuse is a subcategory of domestic abuse, which includes non-sexual abuse (physical force, emotional or financial abuse carried out by a current or former partner), sexual assault and stalking.

enabling direct comparisons between Wales and England on the incidence of domestic violence, but without information on whether offenders of victims were under the influence of alcohol.

In respect of PRC data, ONS (2022c) report that the police recorded 1,500,369 domestic abuse-related incidents and crimes in England and Wales in the year ending March 2022.[27] Around two in five (39.3%) of these were domestic abuse-related incidents that cover reports where, after initial investigation, the police have concluded that no notifiable crime was committed. The broad trend has been an increase in crimes but a decrease in incidents over time, with a combined increase over time, which ONS (2022c) suggests "may, in part, be driven by increased willingness of victims to come forward to report domestic abuse."

Examining the annual pattern of domestic-abuse crimes at the regional level reveals an interesting finding that the number of domestic abuse-related crimes declined very slightly by 0.06% in Wales for the year following the introduction of MUP through to March-end 2021, whereas for every region in England the number increased, and increased overall in England by 6.3% (ONS 2022g, Table 8 in March 2022 edition of dataset). However, for the following year, to March-end 2022, the number increased in both Wales and England, resulting in these crimes rising 10.1% in Wales compared to 12.5% in England over the two-year period.

To give a perspective, domestic abuse-related crimes as a percentage of all crimes recorded by the police in Wales and England has been consistently upward for both countries over the past seven years, to represent over a sixth of all crime in both countries. However, over the last two years since the introduction of MUP, the figures have climbed more slowly in Wales than in England, and where the England rate overtook (at 18.5%) the rate in Wales (at 18.3%) in 2020/21 (ONS 2022g, Table 9 in March 2022 edition of dataset).

In respect of violence against the person, the domestic abuse-related violence offences recorded by police forces have been sharply increasing in both Wales and England over the past seven years (ONS 2022g, Table 10 in March 2022 edition of dataset). However, for Wales, the number went down slightly in the year 2020/21 following the MUP introduction, compared to an increase in every region of England. Nevertheless, this decline in Wales did not persist as the following year, 2021/22, witnessed a sharp increase in numbers in Wales but also in England as well. Taken together, over the last two years, the overall increase for Wales and

[27] Domestic abuse related offences are defined as any incidence of threatening behavior, violence, or abuse (psychological, physical, sexual, financial, or emotional) (ONS 2022c).

England has been very similar with an increase of 15.6% in Wales and an increase of 15.9% in England.

In proportionate terms, around one-third of violence offences in both Wales and England have been domestic abuse-related, but with a slight decline in Wales over the past seven years compared to a slight increase in England over the same period (ONS 2022g, Table 10 in March 2022 edition of dataset). In the two years since the MUP introduction, the proportion has declined more in Wales than in England overall, but with significant variation in the extent of changes to the proportion across the English regions.

E.3.4. *Summary and conclusions on domestic violence trends.* Based on public data sources and official statistics, there is no direct evidence available to show that the introduction of MUP in Wales had a dampening effect on the number of domestic abuse cases. The link between alcohol and domestic violence is well established empirically, and crime survey evidence reported here shows that victims believed offenders were under the influence of alcohol in around one third of domestic abuse incidents. However, the 18-month break in interviews for the CSEW, following the outbreak of the COVID-19 pandemic and lockdowns commencing in March 2020, means that there is no available information to indicate whether that proportion changed immediately following the introduction of MUP in Wales.

Instead, the only reliable and consistent evidence available on changes over time is for the number of domestic abuse incidents recorded by the regional police forces in England and Wales, but without any details of whether offenders were under the influence of alcohol. The pattern interestingly shows that there was a reduction in domestic abuse cases in Wales in the year following the introduction of MUP, which also coincided with the lockdowns, but then the number rose sharply the year after. Whether and to what extent this pattern is due to the introduction of MUP is not clear, and there could be many other reasons linked to geographic differences during the pandemic altering reporting behavior that could equally explain the observed patterns. Nevertheless, and accepting these caveats and the need for caution in any interpretation, the pattern is consistent with the hypothesis that MUP did have a dampening effect on domestic abuse cases in Wales during the year when lockdowns occurred, but that such an effect dissipated when lockdowns ceased, as evident from the sharp increase in case numbers in the subsequent year.

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