Will Brexit raise the cost of living?

Stephen Clarke[a)], Ilona Serwicka[b)] and L. Alan Winters[b),*]

Abstract

This paper considers two aspects of this question. First, Brexit has already induced a devaluation of sterling of around 14 per cent since June 2016, which has started to work through to consumer prices: between June 2016 and July 2017 consumer prices increased by around 2.5 per cent. Second, while it is not government policy, nor the desire of the UK public, that the outcome of negotiations is a 'MFN Brexit', this remains a distinct possibility. Thus we ask how the imposition of tariffs on imports from the EU will work through into consumer prices. Making very conservative assumptions, we conclude that 'MFN Brexit' will increase the average cost of living by around 1 per cent and increase it for 8 per cent of households by 2 per cent or more. We present results for different groups of households according to their employment and structural characteristics and show that the impact will generally be largest on unemployed, single parent and pensioner households.

Keywords: Brexit; consumption; international trade; tariffs; partial equilibrium model.

JEL codes: F100, F150, F400.

Acknowledgements

The authors are grateful to Michael Gasiorek and Alasdair Smith of University of Sussex, who developed a partial equilibrium multi-market model used for this analysis; to Agnès Cimper from the OECD for sharing the OECD, Bilateral Trade in Goods by Industry and End-Use ISIC Rev.4 Conversion Key; to Fellows of UK Trade Policy Observatory (UKTPO) for comments; and to Oliver Winters for his excellent research assistance. The authors thank the anonymous referee for their comments and suggestions, which helped to improve the paper. None is responsible for the paper's remaining infelicities.

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1. Introduction

The point of economic policy is to increase citizens' welfare, and while individuals' real incomes are not the only criterion on which we might judge this, they are certainly the dominant one. Most of the analysis of Brexit has concerned its effects on exports, production and earned incomes, and this is undoubtedly the main way in which it will ultimately impinge on UK residents. However, it will also have direct effects on the cost of living which are of interest both *per se* and particularly to people whose incomes are sticky, such as those on benefits or pensions. Our question, therefore, is to what extent Brexit will increase the UK cost of living.

We analyse two forces that influence the cost of living, and consider their effects on households with different family and employment profiles. First, Brexit has already had a significant effect on the exchange rate, with a devaluation of sterling of around 14 per cent since June 2016. This has started to work through to consumer prices and so we analyse the incidence of actual price changes since June 2016. There will, of course, have been other influences on prices, but there is little doubt that the Brexit-induced devaluation has been the major one over this period.

Second, we consider future trade policy. Although UK government policy is to seek a deep and special relationship with the EU, which would preserve many of the features that render current UK–EU trade costs so low, this is, at present, very far from being assured. Negotiations have to finish by about October 2018 in order to allow any agreement to be signed and ratified. The UK has only started to spell out its negotiating objectives in August 2017, but these often lacked concreteness and were poorly aligned with the negotiating objectives in the rest of the EU.[1] UK politics remain as fractured as ever over Brexit, with divisions at every level from the Cabinet downwards and in the opposition Labour Party; the government lacks a majority and there are several veto points that could delay (and hence prevent) an agreement. Thus while it is not policy, nor the desire of the public, a Brexit with little cooperation on trade between the UK and EU remains a distinct possibility.

Under such a Brexit, the UK and the EU will be obliged by WTO rules to impose the same tariffs on their mutual trade as they impose on imports from the countries with which they currently have no free trade agreements.

Given the UK government's intention not to change tariffs from current levels, we model this as levying the current EU most favoured nation tariffs on UK imports from the EU, for which reason we term it a 'MFN Brexit'. By limiting ourselves to just one dimension of Brexit we cannot comment on the overall costs or benefits of the policy. Moreover, for several technical reasons, which we outline below, our estimates of the cost of living effects are certainly too conservative.

Clearly, Brexit is a sufficiently large shock that it will have general equilibrium implications for the UK economy, whereby trade shocks affect production and incomes as well as prices, and in an ideal world we would wish to take the former into account as well as the price effects. However, computable general equilibrium models require high levels of aggregation across

commodities if they are to be manageable, which means that they cannot take account of the necessary (and available) detail on both prices and consumption, on the one hand, and international trade and tariffs, on the other. Thus in this paper we opt for a different approach and undertake a series of partial equilibrium simulations that better exploit the disaggregated data on consumption and trade policies.

We take trade and tariff data on over 5,000 trade headings, distil them into 18 fresh-food and 122 other commodity groups, for each of which we model the trade-offs in UK consumption between five broad sources of supply. When tariffs are imposed on goods from the EU, consumers can avoid some of the impact by switching to other sources; taking this into account we see how the overall price of consumption varies for each of these groups. We then disaggregate these estimates into the 215 categories of goods recognised in the consumer expenditure data and finally apply the price changes at this level to the baskets of consumption typical of different groups of households.

The trade-off between the economic completeness of general equilibrium and the policy and behavioral detail available in partial equilibrium cannot be resolved *a priori*. We also note that in this exercise we have to combine data from several different sources and classifications and that this introduces multiple opportunities for inaccuracy. Nonetheless, we believe that this exercise, the most detailed available to date, provides useful insight even if the results should not be viewed as precise point estimates.

The next section analyses the impact of devaluation of sterling and the incidence of consumer price changes since June 2016. The third section discusses the model and the data used for simulating the impact of tariff changes on consumer prices. Section 4 discusses the results and looks at the distributional impact of 'MFN Brexit'. Section 5 concludes.

2. Devaluation

Before we attempt to model what impact future price changes will have on living standards we first look at how consumer prices have changed since the referendum. In particular, we will trace out how the devaluation of sterling has fed through into price changes for different goods and how, as a result of this, different groups have been affected.

The value of sterling impacts on the price of most goods, particularly those which are heavily imported. The speed at which changes in the exchange rate feed through into import prices and the degree to which domestic prices for specific goods are affected depends on a number of factors, including what is driving movements in the exchange rate.[2]

There have been two large devaluations of sterling in the past decade. The first between December 2007 and December 2008 saw sterling decline by 23 per cent (on a trade-weighted basis).[3] The second, following the EU Referendum, saw sterling decline by 14 per cent between 23 June 2016 and mid-August 2017. In both periods we can look at the change in the prices of various consumer goods.

Table 1 shows the change in the Consumer Prices Index including owner occupiers' housing costs (CPIH) in the two periods and the change in the inflation rate of various categories of goods. Although the impact of a devaluation on prices is likely to persist beyond 14 months we analyse 14-month periods here, because at the time of writing we do not have data beyond

August 2017 and we wish to be consistent across cases. Notwithstanding this important caveat, it is clear that while inflation increased in both periods the prices of products reacted differently. Annual food and drink inflation, which, based on import intensity, is relatively sensitive to changes in the value of sterling, rose by between 6 and 5 percentage points in both periods. By contrast in the earlier period transport inflation fell by 7 percentage points whereas in 2016–17 it rose by 3 percentage points. Such differences speak to the fact that as well as a devaluation, other forces also influence consumer prices. In the first period the price of oil (an important component in transport costs) fell by 50 per cent, whereas in the second period it rose by 4 per cent.

Table 1: Change in CPIH, December 2007-08 and June 2016-17

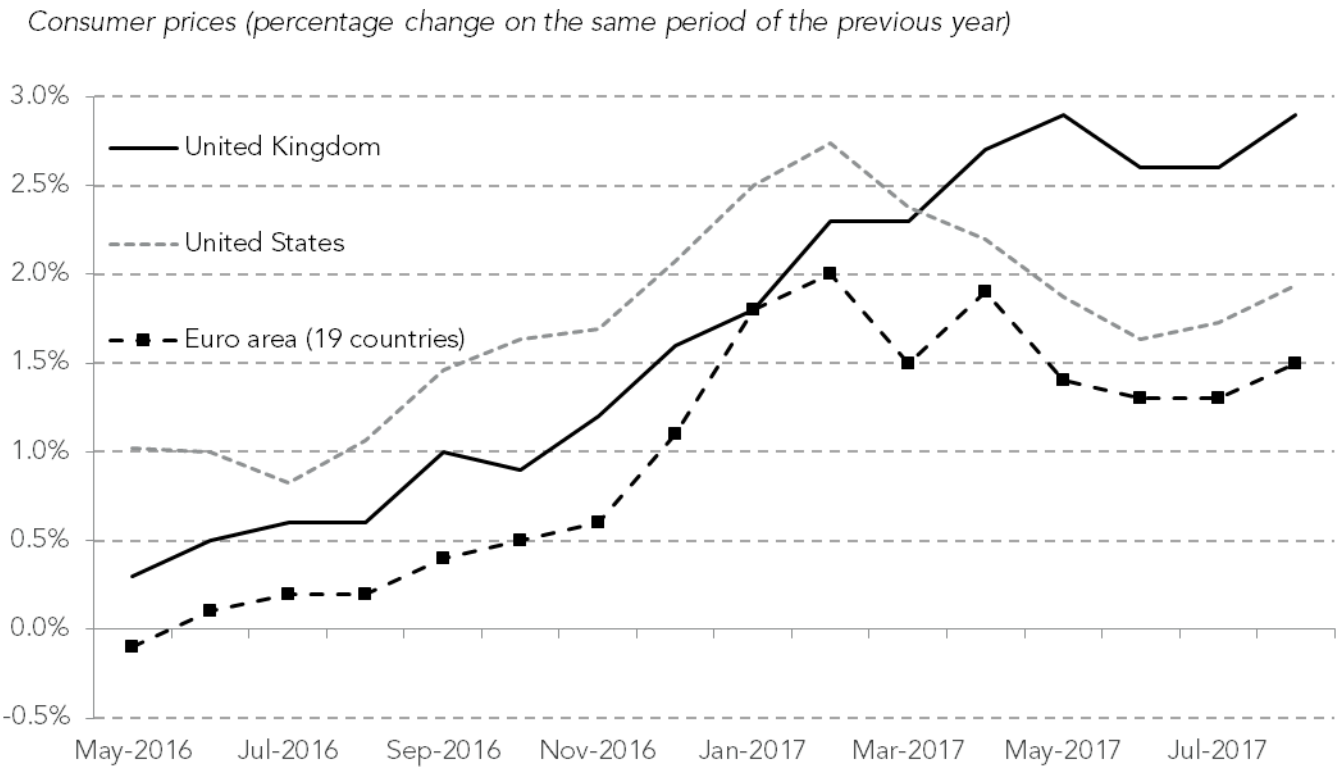
	Ppts change in annual CPIH inflation		
	December 2007 - February 2009	June 2016 - August 2017	Average import intensity
Food and non-alcoholic beverages	6.0%	5.2%	28.6%
Alcoholic beverages and tobacco	3.0%	4.0%	5.4%
Clothing and footwear	-5.5%	5.3%	41.4%
Housing, water, electricity, gas and other fuels	2.7%	0.5%	0.2%
Furniture, household equipment and maintenance	2.5%	4.8%	24.5%
Health	-0.9%	-0.3%	16.6%
Transport	-6.8%	3.4%	15.4%
Communication	3.1%	-1.5%	37.3%
Recreation and culture	1.6%	1.0%	19.5%
Education	-4.5%	-0.4%	0.5%
Restaurants and hotels	0.1%	1.2%	0.4%
Miscellaneous goods and services	1.2%	0.9%	11.3%
CPIH (overall index)	0.8%	1.9%	

Source: ONS, UK Consumer Price Inflation.

We cannot completely isolate the impact of the decline in the value of sterling, but the devaluation that followed the vote to leave the EU provides a good natural experiment for what can happen to prices following an exchange rate change that is not linked to broader economic change. Unlike the devaluation in 2007, the recent decline was not associated with a decline in the prospects for the global economy and there was no obvious cause other than the result of the referendum.

Figure 1 below shows how the experience of the UK differed from other advanced economies in this regard. Although the UK, US and the Eurozone experienced rising consumer prices between May 2016 and February 2017, inflation subsequently fell back in the US and Eurozone in the first half of this year. By contrast inflation has continued to rise in the UK. All three economies were affected by the rising oil price in the second half of 2016, but only the UK experienced a sharp drop in its effective exchange rate and as a result inflation has continued to rise while it stalled in the US and Eurozone.

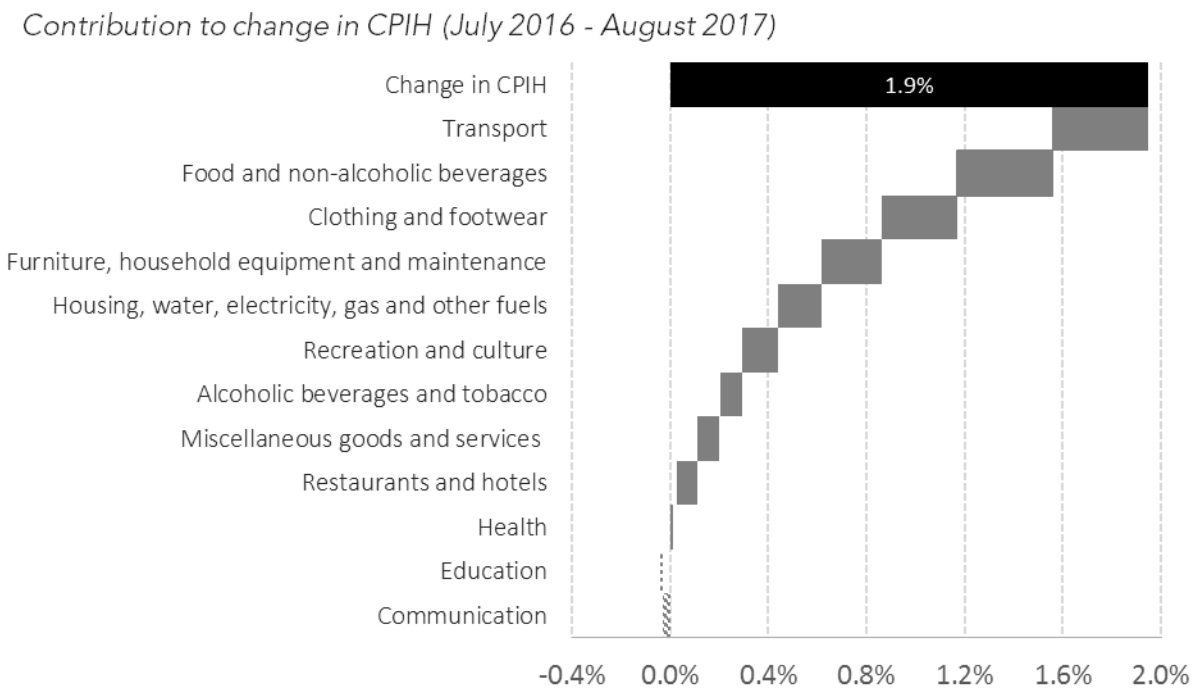
Figure 1: Consumer price inflation for selected comparator economies



Source: OECD, Consumer Price Inflation.

Figure 2 shows what has been driving the rise in inflation since the referendum. The biggest single contributor – in large part because of the rise in the oil price in the second half of 2016 – has been transport. However, the prices of food, drink and clothing have risen faster and despite each comprising a smaller share of typical household spending each has contributed a similar amount to the rise in CPIH as transport. Together they have accounted for 37 per cent of the rise in inflation.

Figure 2: Contributions to annual change in CPIH inflation rate, July 2016-August 2017



Source: ONS, UK Consumer Price Inflation.

Differences in the inflation rates of different items determine which groups of households are most affected. Table 2 below provides a detailed look at the differences in spending between households distinguished by their employment status, household composition and whether they are headed by a working-age person or a pensioner.

Households headed by an unemployed person spend a significantly larger share of their total spending on food and drink (20 per cent), as do pensioner households (17 per cent), compared to those headed by someone in full-time work (12 per cent) and are thus more seriously affected when the price of food and drink rises. By contrast, the recent rise in the cost of clothing and footwear has hit couples with children and those in full- or part-time work harder.

Table 2: Composition of consumers' expenditure by household type

	Economic status of the HRP			Household composition				Age		
Share of total spending	Employed full-time	Employed part-time	Unemployed	Single	Single parent	Couple	Couple with children	Working age	Pensioner	Average working-age household
Food and non-alcoholic beverages	9.2%	10.9%	15.3%	13.8%	11.3%	13.6%	10.2%	10.5%	13.6%	10.5%
Alcoholic beverages and tobacco	3.1%	3.7%	5.2%	4.0%	4.7%	3.8%	3.3%	3.7%	3.8%	3.7%
Clothing and footwear	4.4%	4.5%	3.4%	3.0%	3.4%	3.3%	4.8%	4.4%	3.3%	4.4%
Housing, water, electricity, gas and other fuels	19.9%	23.5%	29.6%	26.2%	29.1%	21.5%	18.5%	21.5%	21.5%	21.5%
Furniture, household equipment and maintenance	5.3%	4.9%	4.7%	6.6%	4.9%	6.5%	5.2%	5.1%	6.5%	5.1%
Health	1.0%	1.3%	0.6%	1.8%	0.9%	1.7%	1.1%	1.0%	1.7%	1.0%
Transport	15.0%	11.8%	9.6%	7.6%	10.0%	9.7%	14.6%	13.3%	9.7%	13.3%
Communication	2.7%	3.0%	3.9%	3.4%	3.4%	2.9%	2.7%	2.9%	2.9%	2.9%
Recreation and culture	13.3%	12.7%	10.0%	12.0%	11.4%	14.1%	13.5%	12.9%	14.1%	12.9%
Education	0.8%	0.7%	0.0%	0.0%	0.3%	0.1%	1.0%	0.8%	0.1%	0.8%
Restaurants and hotels	11.0%	9.3%	6.2%	6.5%	8.6%	8.1%	11.0%	10.3%	8.1%	10.3%
Miscellaneous goods and services	14.4%	13.7%	11.5%	15.2%	12.1%	14.8%	14.3%	13.7%	14.8%	13.7%

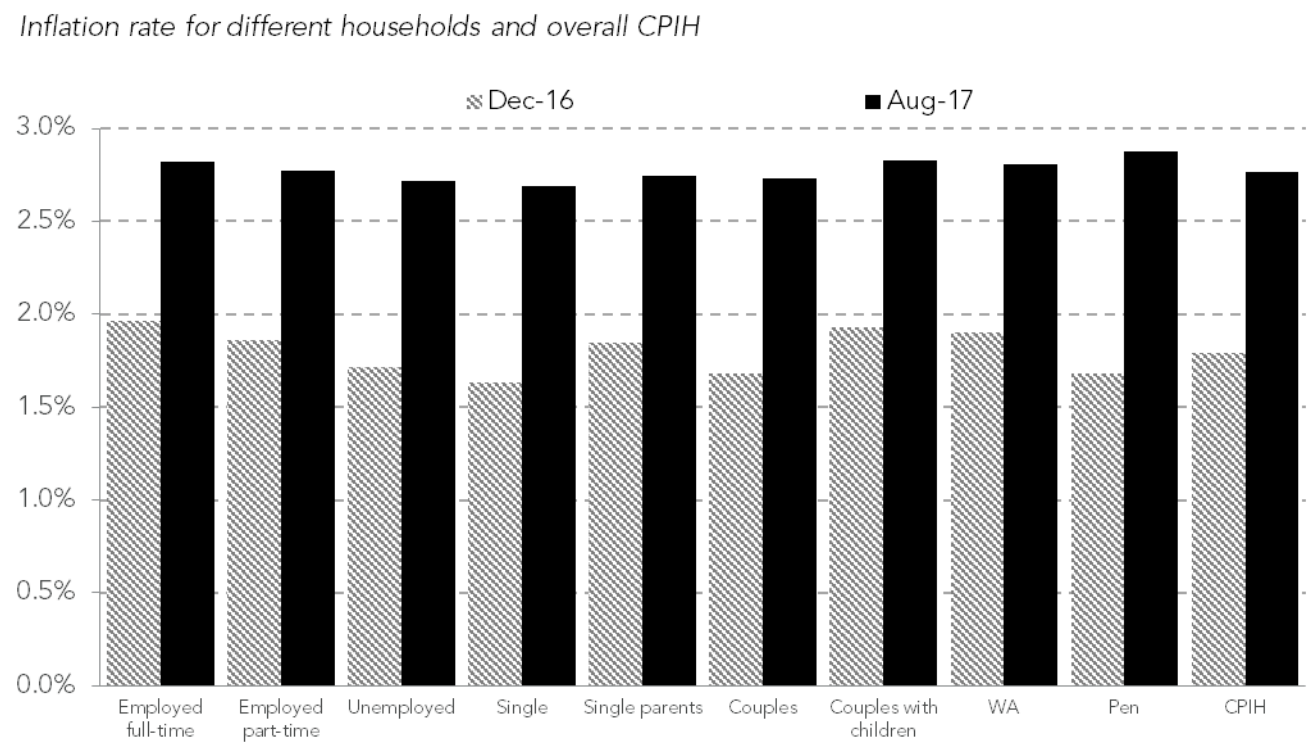
Source: Authors' calculations of ONS, Living Costs and Food Survey 2015-16.

To derive inflation rates for different types of household, we merge the price data provided by the Office for National Statistics (ONS) as part of their Consumer Price Inflation series and the

data on the consumption patterns of different groups from the Living Costs and Food Survey (LCFS). The LCFS is an annual household survey that provides detailed information on weekly spending across over 400 goods and services coupled with a range of demographic and economic indicators. The price data are available for the same goods and services. In combining the data, we assume that all households face the same price changes. That is to say that if the price of beef rises by 2 per cent we assume all households that consume beef pay 2 per cent more for it. In reality households consume different types of beef, from different outlets and some may change their consumption of beef as a result of price changes. However in the absence of price information by household assuming homogeneity is unavoidable.

Figure 3 shows the inflation rates for different groups of households six months after the referendum and as of August 2017. Since the referendum the various groups of households have experienced broadly similar increases in inflation (between 2.7 and 2.9 per cent). In the first six months after the referendum households with children and those headed by someone in work were experiencing greater inflation; however, over the course of the past six months, unemployed and pensioner households have been most affected as the prices of essentials such as food, drink and clothing have risen fastest.

Figure 3: Inflation experienced by different households and overall CPIH inflation rate



Source: Authors' calculations.

The relatively rapid increase in inflation since the referendum has had a measurable impact on living standards. Although different households have experienced similar rates of inflation, income growth for these groups has differed. Nominal wage growth in the year to July 2017 was 2 per cent, the state pension was uprated by 2.5 per cent in April 2017, the disability element of Employment Support Allowance was uprated by 1 per cent and most other working-age benefits were frozen. Working-age households who get most of their income from earnings or working-age benefits have experienced inflation significantly above their income growth. Unemployed households, for whom benefit income is likely to be particularly important, are likely to have seen the lowest real income growth. By contrast pensioner households – who on average receive 45 per cent of their income through benefits, predominantly the state pension – will have fared slightly better as their pension is likely to have kept pace with the inflation they have experienced.

The recent rise in consumer prices has been driven, in large part, by the Brexit-induced devaluation in sterling. It is not inconceivable that an 'MFN Brexit' would induce further exchange rate changes, but rather to speculate we now consider the effect of the tariff changes that will occur if the UK were to exit the EU without a free trade agreement – a so-called 'MFN Brexit'.

3. Modelling 'MFN Brexit'

As noted in the introduction, a 'MFN Brexit' in which the UK imposes MFN tariffs on imports from the EU and manages rather little co-operation on other aspects of trade remains a possibility even if not an objective. In this section we describe how we trace the effects of these tariffs through to the prices of final consumption goods in the UK.

3.1. The Multi-Market Simulation Model

This analysis is built around a multi-market model that allocates demand for a product in several markets across several sources according to their relative prices.[4] Since our concern is with UK consumption alone, however, we do not exploit the full capability of this model, but rather focus just on the allocation of UK demand across five groups of suppliers. These are the UK, the remainder of the EU (EU27), the rest of High-Income countries (RHIC – comprising Canada, Iceland, Israel, Japan, Norway, South Korea, Switzerland and the United States), Emerging Markets (EM – China, India, Indonesia, Mexico and Turkey) and a residual Rest of the World (RoW). The RHIC and EM groups are limited by data availability because the full model requires production data by sector and the listed countries are the only ones for which these are available.[5]

Across all the sectors we model, domestic suppliers satisfy 44 per cent of total UK demand – and 56 per cent of total UK demand is met by overseas suppliers: 35 per cent from the EU, 5 per cent from RHIC, 9 per cent from the EM and 6 per cent from the rest of the world.

As in most trade models, demand is assumed to derive from an Armington structure (Armington, 1969), in which products are differentiated by place of production (so that UK washing machines are slightly different from EU27 ones) and demand for any product is

allocated across the varieties from different sources according to a constant elasticity of substitution (CES) utility function. This implies that taken as a group, UK consumers like a mix of all the different suppliers' varieties of any given product – a 'love of variety' assumption.

The model estimates the expected impact of a change in tariffs on prices, recognising that the shares of suppliers in final sales will change. In principle, starting from actual purchases of a particular product in a base year, we change the tariffs imposed on supplies from the EU, allow consumers to substitute between different sources, and then calculate the change in the aggregate price index of supplies of this product. In fact, we can do all this in one step to derive the change in the price index directly.

The critical parameters of this set-up are the elasticity of substitution between different varieties of the same product and the price elasticity of demand for each product in aggregate. The elasticity of substitution is set at –5 for all manufacturing industries, a fairly common value used in the literature (Fujita *et al*., 2000). For fresh foodstuffs, we use an elasticity of substitution of –10 to reflect the strong substitutability for primary products. The elasticities of demand at the product level are set at –1.5, where most models use a value of between –1 and –1.5 (Kee *et al*., 2008).

On the supply side, we assume that each variety is supplied by a perfectly competitive industry that is subject to (mildly) rising marginal costs.[6] The supply elasticity of UK suppliers to the UK market is set at 6 for manufacturing industries and 3 for fresh foodstuffs to reflect land and labour constraints. The elasticities for foreign suppliers to the UK market are set equal to 15 – the larger elasticities reflecting the relatively small size of the UK market compared to these regions' overall supply.

The assumption that the supply curves for imported goods are not affected by Brexit is appropriate for non-UK sources, because the Brexit shock is so minor relative to the other determinants of their costs. It is less innocuous for the UK, however. While we capture movements along the supply curve as output levels change, the imposition of tariffs on inputs into UK production and the general equilibrium consequences of Brexit are likely to raise UK production costs – i.e. to shift UK supply curves upwards. Imported intermediates account for 5–10 per cent of the gross value of output in most UK industries and omitting the effects of tariffs on these leads us unambiguously to understate the increases in consumer prices.[7] Thus, for example, tariffs on cotton are likely to affect the cost of clothing, but we model only the effect of the tariff on articles of clothing *per se*.

3.2. Data

The modelling is based on several detailed datasets, including the OECD Structural and Demographic Business Statistics (SDBS) and the UNIDO INDSTAT4 for production data, the UN COMTRADE (trade), the UNCTAD TRAINS (tariffs), the FAO database (agricultural production and trade data), the UK Input- Output Tables and the UK Living Costs and Food Survey (LCFS, which has been described above). Each of these datasets is based on its own classification and these need to be reconciled with each other. This process inevitably involves a good deal of approximation (see section 3.3 below) and while it undoubtedly leads to

inaccuracies in individual estimates, it probably does not affect the overall estimate of the effect of Brexit on the cost of living too much.[8]

3.2.1. Production Data

For manufactured products, including manufactured, processed and preserved foodstuffs (such as bread, butter, cheese, bacon and ham), production data (in US dollar terms) have been collected at the 4-digit level of ISIC Revision 4 (ISIC4) from the OECD Structural and Demographic Business Statistics (SDBS) database and the UNIDO INDSTAT4 database.[9] The former is restricted to the OECD member countries, but contains production data up to 2015. The latter has a more comprehensive country coverage (79 countries) but only up to 2013. To match the consumption data available at the outset of the exercise, we need production for 2014, which we can take directly from SDBS for OECD countries. For non- OECD countries, we collect INDSTAT4 data for 2013 (occasionally earlier) and gross them up by the growth in those countries' exports between 2013 and 2014.

The OECD and UNIDO data do not include fresh foodstuffs, such as fresh fruit and vegetables or rice, which require only minimal processing before consumption. For these products we use agricultural production data from the FAO.[10] These data are reported according to the FAOSTAT Commodity List, from which we constructed commodity groups corresponding as directly as possible to those in the UK consumption data. To minimise the effects of agricultural price distortions, we work with the volume of production for these fresh foods. Since the latest FAO production data refer to 2013, the fresh food models has to use this year as base.[11]

3.2.2. Trade and Tariff Data

The trade and tariff data required to analyse 'MFN Brexit' have been collected from the World Bank's World Integrated Trade Solutions (WITS) website which gives access to several trade-related databases.[12]

Imports of manufactures come from the United Nations COMTRADE database. They refer to 2014, are disaggregated by source, and are reported at the 6-digit level of Harmonised System 2007 (HS2007).[13]

For fresh foodstuffs trade data (in volume terms) have been collected from the FAO.[14] These data are not, however, disaggregated by origin and destination, and so we allocated them across non-UK sources using COMTRADE data, aggregated from HS2007 trade sub- headings to FAO's agricultural commodity classification using FAO's converter.

Data on tariffs come from UNCTAD's Trade Analysis Information System (TRAINS) database. They are reported at the 6-digit HS Combined nomenclature and so have to be converted to HS2007 using WITS' in-built product concordance.[15] The model requires percentage, ad valorem, tariffs, which is the legal form of the majority of tariffs. In agriculture, however, a number are defined as specific duties.[16] WITS converts specific duties to ad valorem equivalents using the average prices of imports.[17] Given that the EU is typically a high cost supplier, the use of average import prices may lead to some over-statement of the *ad valorem* equivalent of the tariff for EU suppliers.

The base tariffs employed in the modelling are WITS' effectively applied (AHS) rates, which allow for preferential agreements: they are import-weighted averages across suppliers on the assumption that all trade eligible for preferences takes advantage of them. When no preferential trade agreement is in place, they are the applied Most Favoured Nation, MFN, rates.

The simulation tariffs were essentially identical to the base tariffs, with the exception of the UK applying tariffs on goods imported from the EU27. In the 'MFN Brexit' scenario – where the UK is assumed to trade with the EU on so-called 'WTO terms' – these are the current EU28 applied MFN tariffs.[18] Implicit in this is that imports from the countries with which the UK currently has Free Trade Agreements via its membership of the EU, continue to receive these preferences (as the government hopes, but has not yet ensured). In 2014, 13.6 per cent of UK imports came from these sources (UKTPO, 2016), and if the UK were not able to maintain the preferences, we will be further understating the price effects of 'MFN Brexit'.

It has been argued – for example, by Minford and Miller (2017) – that rather than increase tariffs on the EU, the UK should unilaterally remove all its tariffs. This is not currently UK policy and, for a variety of reasons, we believe that it should not be in the immediate future.[19] Thus we do not model removing tariffs in this paper, although we will do so elsewhere.

It is important to stress that our estimates make no allowance for the effects of the almost inevitable increase in non-tariff frictions to UK–EU trade, such as the need for separate testing and certification processes, the possibility of imposing anti-dumping duties on trade and the transactions costs and delays resulting from the increased border formalities – recording and inspections – that will be necessary on the border. Especially if Brexit is to be a 'hard' one, with little UK–EU cooperation, these are likely to be quite significant – see, for example, Stojanovic and Rutter (2017). Thus our estimated impact of 'MFN Brexit' on the prices of consumption goods is very conservative.

3.3. Conversions

Because trade data are typically available at a highly disaggregated level, it is the availability of the production data that determines the level of sectoral disaggregation to which the model can be applied (Brenton and Winters, 1992). Most of the modelling is done at the 4-digit ISIC4 level, so the trade and tariff inputs have to be aggregated from 6-digit HS2007 to ISIC4 using an OECD converter.[20] We use imported weighted average tariffs at the ISIC4 level.

As noted, we model fresh foodstuffs in categories defined directly in the consumer classification (which we refer to hereafter as COI+). The output and trade data for these are aggregated up from the FAOSTAT Commodity List data.[21] The average tariffs are based on HS-level tariff data from UNCTAD TRAINS, but according to our own conversion from HS2007 directly to COI+ rather than FAO's commodity definitions.[22]

At the other end of the exercise, following the simulations, we need to disaggregate the manufacturing price effects from the ISIC4 groups into COI+ categories. We proceed on the basis that the price change of an ISIC4 group is the weighted average of the price changes of its component COI+ categories (i.e. ignoring certain complications about coverage and valuation that are spelt out in the Appendix) and that the price change for a category will be greater the larger the share of imports in its total consumption and the larger the tariff change

induced by 'MFN Brexit'. The following 'disaggregation formula' which disaggregates the price change at group level into the changes at its component COI+ categories respects these three features (details in the Appendix):

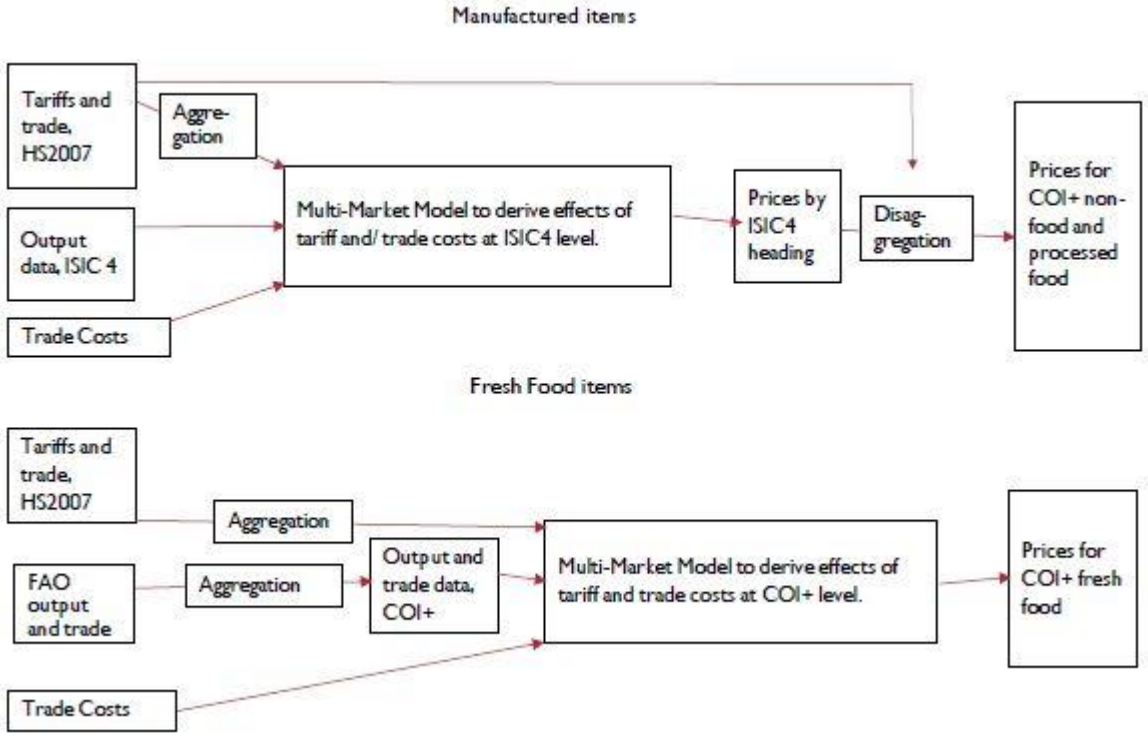
$$\hat{p}_i = \gamma \frac{s_i^m}{s_i^c} \hat{t}_i \qquad (1)$$

where p_i is individual category price, t_i is (1 + tariff on i), ^ denotes proportionate changes, γ is the elasticity of the group level price with respect to the group level tariff factor (1+ the tariff), s_i^m is the share of category i in group imports and s_i^c the share of i in group consumption. That is, the price change for category i depends positively on the group level price change, the share of i in group imports and i's tariff change, and negatively on i's share of group consumption (because this reduces the importance of imports in total sales of i).

The full flow of the tariff exercise is laid out schematically in

Figure 4. The conversions and the unavoidable approximations involved in this process clearly reduce the reliability of any individual result, but, overall, we believe that the results are a reasonable reflection of the very conservative set of price effects we model for a 'MFN Brexit'. We must also recognise, however, that, although our analysis of Brexit's price effects is more detailed than any other we know of, each product is an average across many different sub-products and varieties each of which may have different prices, tariffs and origins.

Figure 4: Data and disaggregation schema



4. The Simulations

As noted above, we take trade and tariff data on over 5,000 trade headings, distil them into over one hundred commodity groups, for each of which we model the trade-offs in UK consumption between five broad sources of supply (including domestic supplies). When tariffs are imposed on goods from the EU, consumers can avoid some of the impact by switching to other sources; taking this into account we see how the overall price of consumption varies for each of these groups.

Of the 137 4-digit ISIC4 groups covering manufacturing, we model 122 for which reliable production data exist of which 65 map directly in to the personal consumption basket. That is, we make no further use of the results for the (57) groups that refer exclusively to intermediate inputs or capital goods used only by industry.[23]

These excluded groups account for around 29 per cent of UK production. In addition, we have simulated a further 18 groups for fresh foodstuffs, whose coverage is defined directly in terms of COI+ categories.

These 83 groups feed into the calculation of price changes for 215 COI+ categories referring to goods. The COI+ data distinguish 425 categories in total and the fact that we have to ignore any Brexit-induced price changes for services is another source of understatement. Finally, we take the 215 price changes and apply them to the baskets of consumption for different households, of which we have 5,000 (representative of the total UK population) in all.

4.1. Tariff Pass-Through to the Consumer Prices

Table 3 presents the main results on prices summarised in terms of 18 summary product groups.[24]

Column 1 shows the considerable variation in the size of the EU's MFN tariffs by group – which means that 'MFN Brexit' will impact on the prices of different consumption goods very differently. The largest tariff increase is for 'dairy products' for which an average tariff of 44.6 per cent will be applied to imports from the EU, followed by 'meat', and 'oils and fats' – 37.0 and 18.1 per cent respectively. Based on purchases reported by super- markets, the British Retail Consortium (2017) estimates that the weighted average tariff on food imports from the EU would be 22 per cent, which is in line with these estimates. Manufacturing and other non-food items, on the other hand, face more modest tariff increases. Tariff change after Brexit will be smallest for 'medical goods' (0.1 per cent), and 'fuel and energy' an increase of 1.8 per cent on average. Tariffs on 'transport vehicles and accessories', including cars, motorcycles and bicycles, will see an average tariff rise of 7.7 per cent.

The second determinant of the price increases caused by 'MFN Brexit' is the share of UK consumption that derives from the EU, which may be expressed in terms of the share of consumption that is imported and the share of imports from the EU. The data reported in column 2 refer to the share of imports in domestic sales that we have used in our modelling, passed, of course, through a series of converters and aggregators to get into these summary product groups. These estimates of import penetration differ slightly from those given in UK Input-Output Tables for total sales (which are broader in coverage than ours) or for households'

purchase (which are narrower).[25] The most open groups include 'clothing and footwear', 'audiovisual equipment', 'fruit', and 'medical goods'.

Turning to column 3's EU share of imports we observe, again, considerable variation. EU shares are high in many food sectors – partly reflecting the high tariffs and other barriers levied by the EU against imports from the rest of the world – and also in 'medical goods' and 'transport vehicles and accessories'. In all these sectors, standards are important determinants of the right to sell in the UK so the high shares may reflect the effects of the Single Market. The product of the two ratios is the share of UK sales that comes from the EU. It is highest (above 50 per cent) for 'medical goods' and 'transport vehicles and accessories'. Tariffs applied to EU goods will have the largest pass- through to UK consumer prices in these sectors.

One last determinant of price change, not shown in table 3, is the way in which substitution between sources changes suppliers' prices according to the elasticities of supply reported above. Demand is switched towards non-EU sources and, particularly for the UK where we assume lower elasticities of supply, this will drive up these sources' supply prices to some extent. The opposite will happen to purchases from the EU: the decline in demand will slightly lower their supply price, so that the net effect is to increase their 'landed' price in the UK by a little less than the newly imposed MFN tariff. We model this, but there is one supply price effect that we cannot currently model. In a number of agricultural commodities the EU has excess supply and, in the absence of export subsidies, this tends to force the EU's internal price (at which the UK currently buys) below the 'world' price plus the EU's tariff. When the UK exits, it will have excess demand in most of these commodities and will purchase at the 'world' price plus that tariff; hence the actual increase in the price of its imports from the EU could exceed the newly imposed MFN tariff.

Table 3: The derivation of the price effects of 'MFN' Brexit

	Change in tariff and trade costs	Import penetration	EU share of imports	Price Change
	%	%	%	%
Food:				
Bread and cereals	18.0	13.2	92.7	1.8
Meat	37.0	29.5	78.4	5.8
Fish	13.3	47.2	28.3	1.5
Dairy products	44.6	27.5	98.1	8.1
Oils and fats	18.1	79.7	56.7	7.8
Fruit	10.6	85.7	44.1	3.1
Vegetables	14.8	49.8	71.6	4.0
Sugar, jam and confectionery	10.6	28.6	89.9	2.3
Other food products	9.5	53.7	83.6	5.5
Beverages and tobacco	9.7	39.9	74.2	2.0
Clothing and footwear	10.2	98.0	28.9	2.4

Fuel and energy	1.8	43.1	47.2	0.4
Household articles	2.8	65.3	57.7	0.8
Medical goods	0.1	81.6	73.2	0.5
Transport vehicles and accessories	7.7	78.6	85.4	5.5
Audio-visual equipment	2.3	88.4	46.3	1.1
Items for hobbies and activities	2.1	30.7	54.1	0.4
Miscellaneous	6.8	54.6	62.5	1.6

Source: Authors' calculations.

If supply prices did not change and consumers could not mitigate the price increases imposed on EU goods by substituting away from them, the net effect on prices would merely be the product of the EU share of consumption and the EU price increase (i.e. the tariff). The substitution we permit reduces the price increase below this notional level, but this effect is potentially offset by any increases in the supply price that are induced.[26]

The net effects on prices after the substitution between sources are shown in column 4 of table 3. The largest predicted price change is in 'dairy products', followed by 'oil and fats' 'meat', 'other foods' and 'transport vehicles and accessories'. The ability to substitute away from EU sources once they pay the same tariffs as other suppliers allows consumers to avoid up to one third of the cost of the tariff increases, the effect being strongest where the tariff is largest. Overall, we estimate that a 'MFN Brexit' would increase the consumer prices of goods by 2.7 per cent.

It is worth re-iterating that the price increases in column 4 are under-estimates of the effect of 'MFN Brexit' on goods prices. We make no allowance for:

- Tariffs going up for countries currently in FTAs with the UK;
- The effect of tariffs on the costs of inputs into UK production;
- Any frictions arising from exit from the Single Market, such as increased testing and certification costs;
- The costs of increased border formalities;
- The fact that the reduction in competition in the UK market might allow other suppliers to ease their prices up, an effect that Winters and Chang (2000) and Chang and Winters (2002) identified in Spain and Mercosur, and
- Any tendency for the EU to sell certain agricultural products in the UK at world prices plus the MFN tariff rather than at the internal EU prices that prevailed before Brexit.

And, of course, no estimate is made at all of the export, production and income effects of Brexit. That is, the 2.7 per cent is a price change, just one component of the real income changes that may follow Brexit.

Clearly the results above depend on the elasticities that we have assumed in this exercise. But it turns out that they are pretty robust to changing the assumed values. Halving supply

elasticities lowers the average increase in consumer prices to 2.6 per cent, while halving the substitution elasticities pushes it up to 2.8 per cent and neither changes the pattern across commodities materially.

4.2. Impact of Price Changes on Different Groups

Two factors determine how a household is affected by an increase in tariffs. The first is the price changes outlined above, which range from around 8 per cent for 'dairy products' to around 0.4 per cent for 'fuel and energy'. The second is the consumption pattern of the household. The latter is derivable from consumption data drawn from the 2014 Living Costs and Food Survey (LCFS).[27] As with the estimates of the exchange rate effects of the EU Referendum, we assume that all households face the same price changes.

Table 4 reports the consumption patterns of a range of different household types by the 18 summary product groups used above, but the actual calculations are conducted on the 215 COI+ categories of consumption referring to goods.[28] The calculated price changes cover up to 40 per cent of consumption for the average household. Columns 2 to 10 detail how much different households spend on these product groups as a proportion of their total spending. For instance households headed by someone who is unemployed spend 15.7 per cent of their total weekly expenditure on food, whereas households headed by someone in full- time work spend just 9.8 per cent. Column 11 provides the average for all households. It is important to bear in mind that the figures below are averages and many households will spend very little, or often nothing at all, on many non-essential items. Although mean household spending on household articles (such as furniture and homeware) is 4.5 per cent, the typical (median) family spends just 2.8 per cent of their total expenditure on such items. Even for essential items, families with highly concentrated expenditure pull up the average. Mean spending on food is 12.5 per cent, whereas the median family spends 10.9 per cent. As we shall see below, this has an impact on the extent to which different families are affected by price rises.

These consumption patterns determine how much each household is affected by price rises. Table 5 estimates the change in spending as a proportion of each household's original (pre-tariff rise) spending on each product group. Thus, spending on clothing is expected to rise by 2.2 per cent for a single person household, below the average rise of 2.6 per cent (detailed in column 11). However, spending on clothing for households headed by an unemployed person is expected to rise by 2.9 per cent.

Table 4: Spending on key categories of goods as a share of total household spending

	Economic status of HRP			Household composition				Age		
	Employed Full-time	Employed Part-time	Unemployed	Single	Single parent	Couple	Couple with children	Working-age	Pensioner	All
Share of spending										
Total food	9.8%	12.1%	15.7%	13.5%	15.0%	11.8%	12.0%	12.3%	16.3%	12.5%
Bread and cereals	1.1%	1.5%	1.9%	1.5%	1.9%	1.2%	1.5%	1.4%	1.7%	1.4%
Meat	2.4%	2.8%	4.8%	3.4%	3.7%	2.9%	2.8%	3.1%	4.1%	3.1%
Fish	0.4%	0.5%	0.5%	0.7%	0.5%	0.6%	0.5%	0.6%	0.8%	0.6%
Milk, cheese and eggs	1.2%	1.6%	1.9%	1.8%	2.0%	1.5%	1.7%	1.6%	2.3%	1.7%
Oils and fats	0.1%	0.2%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%	0.2%
Fruit	0.8%	1.0%	0.9%	1.2%	1.1%	1.1%	1.0%	1.0%	1.4%	1.1%
Vegetables	1.5%	1.9%	2.5%	1.9%	2.3%	1.8%	1.8%	1.9%	2.2%	1.9%
Sugar, jam and confectionery	1.4%	1.9%	1.7%	2.0%	2.3%	1.7%	1.8%	1.8%	2.7%	1.8%
Other food products	0.7%	0.8%	1.2%	0.7%	1.1%	0.7%	0.9%	0.8%	0.7%	0.8%
Beverages and tobacco	3.1%	4.0%	6.2%	4.1%	3.7%	3.7%	3.2%	3.8%	3.2%	3.8%
Clothing	4.1%	4.4%	3.3%	2.4%	6.3%	3.7%	4.7%	3.8%	2.8%	3.8%
Fuel and energy	5.1%	4.9%	3.0%	3.3%	3.9%	5.0%	5.1%	4.6%	3.4%	4.5%
Household articles	4.2%	4.4%	3.6%	3.9%	5.5%	4.7%	4.6%	4.5%	4.2%	4.5%
Medical goods	0.6%	0.7%	0.4%	0.7%	0.4%	0.8%	0.6%	0.7%	0.7%	0.7%
Audiovisual equipment	0.9%	0.7%	0.6%	0.4%	0.3%	0.8%	1.0%	0.8%	0.1%	0.7%
Transport vehicles	5.0%	4.1%	2.0%	3.1%	2.7%	4.9%	4.5%	4.3%	2.4%	4.2%
Items for activities	0.9%	1.1%	1.2%	1.5%	1.1%	1.4%	1.0%	1.3%	1.9%	1.3%
Miscellaneous	1.6%	1.7%	1.1%	1.8%	1.5%	2.2%	1.5%	1.8%	2.1%	1.8%
Sum of included groups	35.3%	38.1%	37.2%	34.6%	40.4%	39.0%	38.2%	37.8%	37.2%	37.8%
Excluded spending	64.7%	61.9%	62.8%	65.4%	59.6%	61.0%	61.8%	62.2%	62.8%	62.2%

Source: Authors' calculations using the Living Costs and Food Survey 2014

Table 5: Overall impact of price changes on household spending power and for key categories of goods

	Economic status of HRP			Household composition				Age		
	Employed Full-time	Employed Part-time	Unemployed	Single	Single parent	Couple	Couple with children	Working-age	Pensioner	All
Change in the value of spending per product group										
Total food	4.3%	4.3%	4.8%	4.3%	4.2%	4.3%	4.4%	4.3%	4.2%	4.3%
Bread and cereals	1.8%	1.9%	1.8%	2.0%	1.8%	1.9%	1.8%	1.9%	2.1%	1.9%
Meat	5.5%	5.6%	5.7%	5.4%	5.3%	5.6%	5.5%	5.5%	5.7%	5.5%
Fish	1.6%	1.6%	1.6%	1.6%	1.6%	1.5%	1.6%	1.6%	1.6%	1.6%
Dairy products	7.9%	7.7%	8.8%	7.3%	7.8%	7.6%	8.3%	7.8%	7.0%	7.7%
Oils and fats	7.3%	6.5%	5.4%	5.9%	5.9%	7.0%	6.7%	6.8%	6.0%	6.7%
Fruit	2.9%	3.1%	2.9%	3.2%	2.8%	3.1%	2.9%	3.0%	3.4%	3.1%
Vegetables	3.9%	3.7%	3.3%	4.0%	3.2%	4.0%	3.7%	3.9%	3.7%	3.8%
Sugar, jam and confectionery	2.4%	2.5%	3.2%	2.5%	2.5%	2.5%	2.6%	2.5%	2.4%	2.5%
Other food products	5.5%	5.5%	6.4%	4.6%	6.0%	4.7%	5.6%	5.2%	3.4%	5.1%
Beverages and tobacco	2.0%	2.0%	2.0%	2.0%	2.2%	1.8%	2.1%	1.9%	2.2%	2.0%
Clothing and footwear	2.6%	2.8%	2.9%	2.2%	3.5%	2.3%	3.2%	2.6%	2.4%	2.6%
Fuel and energy	0.2%	0.3%	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Household articles	0.8%	0.9%	0.9%	0.9%	0.9%	0.8%	0.9%	0.8%	0.9%	0.9%
Medical goods	0.2%	0.1%	0.2%	0.1%	0.2%	0.2%	0.2%	0.2%	0.1%	0.2%
Audiovisual equipment	0.8%	0.6%	2.9%	1.4%	1.1%	0.8%	0.7%	0.8%	0.5%	0.8%
Transport vehicles	4.9%	5.2%	4.7%	4.8%	5.1%	4.7%	4.9%	4.8%	4.4%	4.8%
Items for hobbies and activities	0.2%	0.2%	0.3%	0.1%	0.3%	0.1%	0.3%	0.2%	0.1%	0.2%
Miscellaneous	2.0%	2.1%	2.1%	2.1%	2.1%	2.0%	2.0%	2.0%	2.1%	2.0%
Overall impact of prices changes										
Expenditure impacted by tariffs	2.5%	2.6%	3.0%	2.7%	2.7%	2.4%	2.7%	2.6%	2.8%	2.6%
Total expenditure	0.8%	1.0%	1.1%	0.8%	1.0%	0.9%	1.0%	0.9%	1.0%	0.9%
Annual increase in cost of living	£318	£273	£178	£121	£157	£286	£349	£263	£128	£257

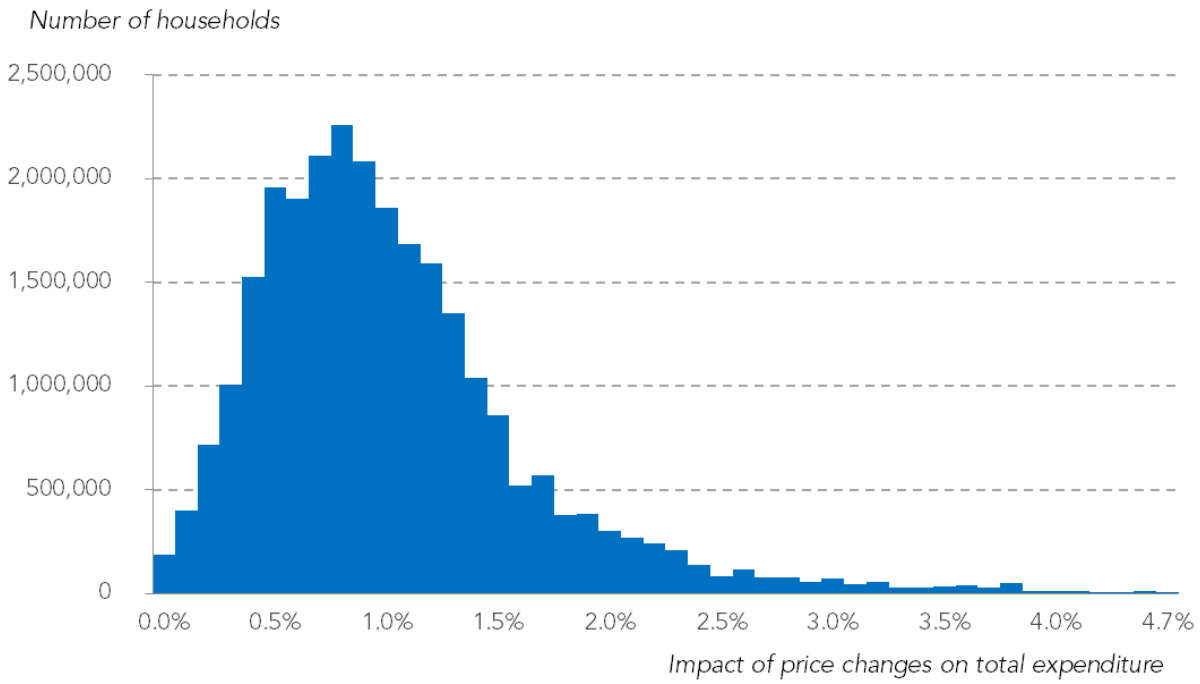
Source: Authors' calculations using the Living Costs and Food Survey 2014.

The last three rows of table 5 detail the overall impact of tariff rises on household spending, first as a share of spending on the goods affected by tariff rises, second as a share of total expenditure and then in terms of the annual impact in monetary terms. Some households – those headed by someone in full-time employment or by a single person with no children – see spending rises below the average, but others – particularly those headed by someone who is unemployed, those with children or retired households – fare worse than the average.[29]

The cross-household variation in the effect of tariff rises is far greater for the individual product groups than in terms of overall expenditure: large increases in spending in one product category are often offset by a smaller increase in another.[30] Across groups as broad as those above there will be households that allocate a significant share of their spending to products that are particularly affected by tariff changes, but the majority will consume tradeable goods in similar proportions to the rest of the population.

When we look at the distribution of price impacts by household (within the LCFS sample) we get a better sense of the number of households that allocate a significant proportion of their spending to heavily traded goods and so are particularly vulnerable to tariff changes. Figure 5 shows the distribution of UK households by increases in weekly expenditure. Thirty per cent of households experience spending increases similar to those experienced by the groups above of between 0.8 and 1.1 per cent. For the majority of households (71 per cent) spending increases by between 0.5 and 1.5 per cent. However, there is a sizeable minority, representing 2 million or 8 per cent of the households in the UK that experience increases in their weekly expenditure of between 2 and 4.7 per cent.

Figure 5: Distribution of price changes as a share of total expenditure for UK households



Source: Authors' calculations using the Living Costs and Food Survey 2014.

Within this group there will be many higher income families for whom such an increase has little impact on their living standards. Yet there will also be many for which an increase of between 2 and 4.7 per cent represents a significant chunk of their weekly expenditure. For instance, based on the real (2016–17 prices) median level of total weekly consumption expenditure in the UK in 2016–17, a 2 to 4.7 per cent rise would equate to an increase in the cost of living of £400 to £930, which, if incomes were held constant, would translate into a loss of real income of these magnitudes.[31]

5. Conclusion

This paper is the most detailed attempt we know of to calculate the cost of living consequences of Brexit. We have tackled it first by looking at the price inflation that followed the Brexit-induced devaluation that started the day after the EU Referendum. Inflation increased by 1.9 percentage points over the following year.

Second, we examined the case in which the UK starts to levy tariffs on its imports of goods from the EU. The overall increase in price in the affected goods is estimated to be 2.7 per cent and this translates into an increase in the overall cost of living of 0.8 to 1.1 per cent for a typical family, with the unemployed and families, those with children and pensioners hit hardest. This may seem a small number, but in a country in which the real incomes of ordinary families have been stagnant for several years, a loss of this order would have a significant effect on welfare. Moreover, it is a *very conservative estimate*: we deal only with goods, not the over 60 per cent of expenditure on services; we ignore increases in UK costs of production; we ignore the probable increase in other suppliers' prices as EU suppliers suffer a decline in competitiveness, and we ignore the inevitable increase in non-tariff frictions in UK–EU trade. Moreover, prices are only one part of the shock to real incomes that a 'MFN Brexit' would entail.

Notes

1 On 21 August 2017, ahead of the third round of Article 50 negotiations in Brussels, the Department for Exiting the European Union published the position papers outlining the UK's negotiating approach to goods on the market, and to confidentiality and access to official documents. The UK position papers published to date are available at: https://www.gov.uk/government/collections/article-50-and-negotiations-with-the-eu.
The position papers and other negotiating documents published by the European Commission – as part of the European Commission's approach to transparency on Article 50 negotiations with the UK – are available at: https://ec.europa.eu/ commission/brexit-negotiations/negotiating-documents-article- 50-negotiations-united-kingdom_en.

2 Kristin Forbes, Ida Hjortsoe and Tsvetelina Nenova, 'The shocks matter: improving our estimates of exchange rate pass-through', External MPC Unit Discussion Paper 43, November 2015.

3 This refers to the narrow effective exchange rate index published by the Bank of England.

4 See Gasiorek *et al*. (2017) for details.

5 Among the losses to data unavailability are Australia and New Zealand in the RHIC group,

and South Africa, Brazil and Russia in the EM group.

6 We also have versions of the model allowing for different types of oligopolistic behaviour in supply, but because these rely on a larger set of parameters for which we have no estimates we use the simpler version here.

7 The ONS provides data on the indirect import content embodied in elements of final domestic demand for different products classified according to Classification of Product by Activity (CPA). These data can be mapped to Classification of Individual Consumption According to Purpose (COICOP). See Levell *et al*. (2017) for further details.

8 Following collection, data also needed to be 'cleaned'. Data cleaning processes involved in the preparation of final data matrices are discussed in the Appendix.

9 The OECD SDBS database is available at: http://stats.oecd. org/Index.aspx?DataSetCode=SSIS_BSC_ISIC4. The UNIDO INDSTAT4 database is available at: https://stat.unido.org/.

10 The FAO database on agricultural production is available at: http://www.fao.org/faostat/en/#data/QC.

11 The difference in base-year for the manufacturing and agricultural groups is probably of little consequence because price changes depend fundamentally on the shares of different suppliers in the market and these evolve only slowly.

12 The WITS website is available at: http://wits.worldbank.org/.

13 The native classification for 2014 was HS2012, but WITS provides for easy conversion between different product nomenclatures, enabling us to collect trade data in HS2007 which we can more readily relate to the other classifications.

14 The FAO database on agricultural trade is available at: http:// www.fao.org/faostat/en/#data/TP.

15 HS Combined combines all revisions of the HS.

16 For example, in 2014 fresh bananas imported to the EU incurred a specific duty of €132/1000kg over and above *ad valorem* duty of 16 per cent.

17 The calculation is outlined in: https://www.wto.org/english/ res_e/publications_e/wto_unctad12_e.pdf.

18 On 23 January 2017, the UK government announced its intention to replicate current EU tariffs to the maximum extent possible; see: https://blogs.fco.gov.uk/julianbraithwaite/2017/01/23/ ensuring-a-smooth-transition-in-the-wto-as-we-leave-the-eu/.

19 See: https://blogs.sussex.ac.uk/uktpo/2017/04/19/will- eliminating-uk-tariffs-boost-uk-gdp-by-4-percent/.

20 OECD, Bilateral Trade in Goods by Industry and End-use ISIC Rev.4 conversion key.

21 To the best of our knowledge, an official conversion key that links FAOSTAT's commodity categories to COI+ does not exist, so we linked both classifications manually. In most cases, we established 1:1 links between FAOSTAT and COI+ categories. In a small number of cases, however, data had to be apportioned across categories. For example, FAO's 'mangoes, mangosteens, guavas' could be mapped to COI+ 'Stone fruits – fresh' and COI+ 'Other fresh, chilled or frozen fruits'.

22 There is some tension here because FAO is concerned to measure only the output of crops whereas the related COI+ definition also includes the consumption of lightly processed products. We have no output data for the latter, but it is frequently the tariffs on such products that affect consumers most directly. As an example, FAO rice refers to rice in the

husk, whereas the consumer category rice also includes husked, milled and broken rice. Mixing the definitions seems to be the best compromise.

23 For example, '2660 Irradiation / electromedical equipment,etc'. and '3020 Railway locomotives and rolling stock' are among the manufacturing ISIC4 groups that do not match to any COI+ category.

24 These are not standard groups from any official publication, but have been designed by the authors to best summarise the consumption and trade policy issues we are dealing with.

25 If imports do figure less prominently in direct consumption than in total UK purchases of the goods we model, we may thus slightly overstate the vulnerability of consumers to tariff changes. However, identifying precisely where consumers' purchases come from is not possible.

26 In addition, the numerical effects of pushing the results at the ISIC level through the converters and aggregators described above to reach the summary product groups, results in some spill-over between categories. This makes it difficult to see the price reducing effect of substitution directly in some summary product groups.

27 The data for 2015/16 were not available when the exercise was started.

28 There are two minor adjustments to the estimates of price changes before they enter the household stage: first, seven COI+ categories refer to hire or rent of goods and for these we assume that their prices increase by three-quarters of the amount by which the goods they hire increase; second, alcohol and fuels are subject to excise taxes which we assume are unchanged, so that the percentage increases in the prices experienced by consumers are correspondingly smaller than the increases in import prices.

29 Those where the household reference person is retired or of minimum NI pension age.

30 This results from the fact that expenditure shares have to sum to one. At this point we model no explicit substitution by consumers away from goods that have become relatively more expensive.

31 Typical (median) total household consumption spending in 2015–16 was £19,500, uprated to 2016–17 prices is £19,770.

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