

Sweet Diversity: Overseas Trade and Gains from Variety after 1492*

Jonathan Hersh
The Wharton School
University of Pennsylvania

Hans-Joachim Voth
UPF and CREI, Barcelona

Abstract: When did trade start to matter for living standards? Traditional real-wage indices show broadly constant living standards in Europe before 1800. In this paper, we argue that welfare rose substantially, but surreptitiously because of the growing availability of new goods resulting from overseas trade. Colonial luxuries such as tea, coffee, and sugar transformed European diets after the discovery of America and the rounding of the Cape of Good Hope. These goods became household items in many countries by the end of the 18th century. We use the Greenwood-Kopecy (2009) method to calculate welfare gains based on data about price changes and the rate of adoption of new colonial goods. Our results suggest that by 1850, the average Englishman would have been willing to forego 15% or more of his income in order to maintain access to sugar and tea alone. These findings are robust to a wide range of alternative assumptions, data series, and valuation methods.

JEL: D12, D60, F10, F15, N33

Keywords: Gains from Variety, Columbian Exchange, Trade, Economics of New Goods, Age of Discovery, Living Standards.

* We thank Karen Kopecy for help with the estimation procedure, Greg Clark for sharing his price data, Joel Mokyr and Emily Oster for encouragement and advice, and Ryan Wang for outstanding research assistance. Seminar audiences at Chicago, Northwestern University, Princeton, the 2009 Economic History Association meetings in Tucson, and at UPF provided helpful feedback. We thank Albert Carreras, Anne Case, Janet Currie, Angus Deaton, George Grantham, Jeremy Greenwood, Phil Hoffman, Tim Leunig, Chiaki Moriguchi, Nathan Nunn, Sam Schulhofer-Wohl and Kurt Schmidheiny for their comments.

I. Introduction

By 1800, Europeans could see the Age of Discovery's impact everywhere. Spices from Asia added flavor to meals; tomatoes transformed Mediterranean diets; and potatoes provided a new and cheap source of calories. Silver originally imported from the Americas was used for coins, serving as a medium of exchange for purchases all over the continent. Salted cod from Newfoundland arrived on European tables by the boatload. European fleets and armies fought each other in the furthest corners of the earth in a struggle for global supremacy. Many scholars thus concluded that globalization began in 1492 (Bentley 1999).

At the same time, the Age of Discovery apparently did not affect European living standards, according to the dominant view in the literature. Profits from trade with the Americas were far too small to influence the transition to self-sustaining growth (O'Brien 1982, Engerman 1972), and overseas trade did not change factor prices decisively before the 1830s (O'Rourke and Williamson 2002).¹ The world economy remained poorly integrated until 1800 (Menard 1991). Nunn and Qian (2008) conclude that the introduction of the potato increased agricultural productivity and led to higher urbanization rates. They do not argue that its introduction improved living standards.² The supply of raw materials from the New World was also unimportant (Clark, O'Rourke, and Taylor 2008). Thus, Europeans lived none the better as a result of the discoveries.

In this paper, we argue that the New World improved European living standards directly and importantly through gains from new goods. Global trade after 1500 mattered not because the quantities involved were large, but because of the nature of the goods traded. Growing diversity

¹ One exception is Acemoglu, Johnson, and Robinson (2005), who emphasize the *indirect* consequences of profits from Atlantic trade, leading to greater constraints on the executive in Europe.

² Potato consumption may not have improved the quality of life by much – consumers remained sceptical of its appeal for a long time, and only ate it when no other source of calories was available (Schivelbusch 1992).

as a result of intercontinental exchange improved living standards directly. The ‘Columbian Exchange’ made life better by offering access to sugar, tea, chocolate, tobacco, and coffee.³ Aggregate consumption of these colonial luxuries grew rapidly during the early modern period. Starting either from zero (for tea, tobacco, and coffee) or from very low levels of consumption (sugar), English imports per head surged to 23 pounds of sugar, almost 2 pounds of tea, 1 pound of tobacco, and 0.1 pound of coffee by 1804-06.⁴ The rise of hot, sweetened beverages transformed meals and forms of social interaction (Braudel 1988, Cowan 2005). Breakfast changed beyond all recognition. Taking a hot, caffeinated drink in company became an established form of social interaction.

Living standards over the long run are typically analysed through real wage indices based on an unchanging consumption basket.⁵ Focusing on England from 1600 to 1850, we use detailed historical data on the price and consumption of increasingly affordable colonial goods to estimate welfare gains from their introduction. To put a value on tea, sugar, and coffee in early modern consumption baskets, we use standard economic techniques that have been developed for analysing the utility gains of new products, from Apple Cinnamon Cheerios to minivans and computers.⁶ We begin with an examination of historical data on prices and consumption shares of new goods. Adopting a model for the value of new goods (Greenwood and Kopecky 2009), we derive welfare gains from a calibration exercise. The results suggest that by 1850, English welfare had increased by at least 15 percent as a result of the availability of these goods alone. Other colonial luxuries such as chocolate, spices, and tobacco probably increased consumer welfare even more. These findings add further weight to the argument that trade boosts living

³ For an overview of the Columbian Exchange’s effects, see Nunn and Qian (2009).

⁴ Mokyr (1988).

⁵ Phelps-Brown and Hopkins (1981), Allen (2001). Clark (2005) uses a changing consumption basket but new goods such as tea are added at a late stage of adoption.

standards through gains from greater variety, as highlighted documented for the US by Broda and Weinstein (2006).⁷

Contemporaries noticed how important new colonial luxuries were for rich and poor alike. In 1797, Sir Frederick Eden described how “in the South of England, the poorest labourers are habituated to the unvarying meal of dry bread and cheese...: and in those families, whose finances do not allow them the indulgence of malt liquor, the deleterious produce of China [tea] constitutes their most usual and general beverage. [...] In poor families, tea is not only the usual beverage in the morning and evening, but is generally drank [sic] in large quantities even at dinner.” (Eden 1797). During the 1790s, a period of unusually high prices and severe downward pressure on lower-class living standards, as much as seven percent of household income—and roughly 10% of a household’s food budget—was spent on tea, coffee, sugar and treacle by poor, working-class households.⁸ This illustrates the high value assigned to these new commodities, despite economic stress.

Incorporating the value of variety in welfare analysis has a long tradition in economics (Hotelling 1929, Lancaster 1975). Papers in the development literature have examined the demand for calories relative to the demand the demand for food.⁹ In models of consumer choice in the Dixit and Stiglitz (1977) and Spence (1976) tradition, variety adds directly to consumer welfare. Models of the Dixit-Stiglitz-Spence type are widely used in international trade, macroeconomics, and economic geography (Krugman 1979, Grossman-Helpman 1991, Helpman

⁶ Hausman (1996); Bresnahan (1996); Greenwood and Kopecky (2007); Petrin (2002).

⁷ They recently investigated the issue empirically, and concluded that between 1970 and 2000, variety growth alone added 2.2-2.6 percent to US real income. Feenstra (1994) and Romer (1994) had earlier suggested that trade liberalizations may be welfare enhancing because they raise the range of goods available.

⁸ Feinstein 1998, table 1. Sugar and treacle absorbed 7%, and tea and coffee another 3%. Horrell (1996) gives a slightly lower figure for working-class households in the 1790s (6.2% of total expenditure).

⁹ Behrman and Deolalikar (1987), Strauss and Thomas (1995) and Deaton (1997) examine the demand for food variety versus the demand for calories in the Third World. Jensen and Miller (2008) analyse the consumption of Giffen goods, i.e. tradeoffs between calories and variety when food is scarce.

and Krugman 1985, Fujita et al. 1999). At the same time, the majority of papers examining living standards over the long run focus on an unchanging basket of goods (Allen 2001, Phelps-Brown and Hopkins 1981). This is likely to be problematic when consumption habits change dramatically. If expanded choice was one of the New World's main contributions to living standards in the Old, standard measures of purchasing power will fail to capture the true change in welfare. Already before onset of the Industrial Revolution itself, diets had been transformed by the arrival of new goods and the declining costs of once exclusive luxuries. As a result, we argue, overseas expansion had a markedly larger impact on European living standards than previously thought.¹⁰

Our findings contribute to the literature examining the value of increased variety and of new goods. Because the calculation of welfare gains from new goods is not straightforward, a variety of methods have been used and applied in recent years.¹¹ Some follow the work by Hausman (1996) who estimated that the introduction of Apple-Cinnamon Cheerios increased welfare by the equivalent of 0.002% of 1992 consumption expenditure.¹² More recently, scholars have estimated gains from the introduction of the minivan (Petrin 2002), online booksellers (Brynjolfsson et al. 2003), the internet (Goolsbee and Klenow 2006), and satellite TV (Goolsbee and Petrin 2004). These methods typically rely on household level data for adoption rates and price variation across consumers. Data requirements are exacting. The same is true of the method used by Broda and Weinstein (2006), who show how expanding variety as a result of more trade after 1970 raised US living standards.

¹⁰ O'Rourke and Williamson (2002) argue that "the only irrefutable evidence that globalisation is taking place is a decline in the international dispersion of commodity prices or what might be called commodity price convergence". We contend that for globalization to matter, global trade should affect living standards significantly. It can do so in one of two ways – through changes in quantities (with an associated change in prices), or through the value of variety.

¹¹ See Bresnahan and Gordon (1996).

¹² This finding is controversial. Cf. the comment by Bresnahan (1997).

Greenwood and Kopeccky (2009) introduce a method that makes less stringent demands of the data. Their approach is more macroeconomic, and requires aggregate data on prices and take-up rates of a new consumption item. For working with historical data, this is an advantage. That is why we use their method. Data on the characteristics of consumers, as well as take-up rates, as required for analysis in the style of Berry et al. (1995), is not readily available in our setting. In particular, panel data on consumption patterns is conspicuous by its absence.¹³ Greenwood and Kopeccky use a modified model of consumer demand where initial marginal utility of new good consumption is bounded, allowing gains in consumer surplus to be calculated. Increases in welfare are calculated as moving from an initial state with an infinite new good price to a state with observed prices and consumption. The authors find welfare gains from the introduction of personal computers up to 4% of consumption expenditure.

Other related literature includes papers in unified growth, as well as papers on the historical significance of 1492. Adam Smith called the discovery of America and Vasco da Gama's rounding of the Cape of Good Hope "the two most important events in recorded history." Scholars like Bentley (1999) and Frank (1998) agreed with the proposition, arguing that a worldwide trading system emerged quickly. Wallerstein (1974) concluded that a Europe-centric mode of capitalist production emerged from the 16th century onwards. These papers are at variance with contributions in the economic history literature arguing that the overall impact of the discoveries as negligible.

Unified growth papers such as Kremer (1993), Galor and Weil (2000), Jones (2001), and Hansen and Prescott (2002) emphasize the transition from millennia of stagnation to rapid growth. That a period of gradual acceleration preceded "take-off" is central to the model in Galor

¹³ For some years, there is some scattered data on cross-sectional consumption, at least for some of our goods. Yet the principal source of variation is over time. Here, data available on consumer characteristics vary over time at a

and Moav (2002), and has been explored in terms of implications for the cross-section of economic growth (Voigtländer and Voth 2006). However, there is disagreement about the extent to which living standards remained broadly constant before 1800. Nordhaus (1996) examines the history of lighting to suggest that cost of living indices have vastly underestimated the decline in the cost of many goods over the last 200 years.¹⁴

We proceed as follows. First, we discuss the historical background and context – how did sugar, tea, and coffee enter European consumption? In section III, we discuss our data sources. Section IV presents our methodology and main findings. In section V, we examine the robustness of our findings to alternative data sources and calibration assumptions, as well as alternative methods of calculating the value of new goods. Section V concludes.

II. Historical Background and Context

In this section, we summarize the existing literature on living standards over the long run. We also describe how sugar, tea, and coffee and tobacco became items of mass consumption in Europe.

Living standards in England before 1850

Measures of per capita income and of living standards broadly suggest stagnation until 1800.¹⁵ Figure 1 presents two real wage series for the period of this study, one by Phelps-Brown and Hopkins (1981) and a more recent series by Clark (2005). Phelps-Brown and Hopkins used a Laspeyres index for the seven centuries covered by their index, with a weight of 70% for food. Grain prices are the single biggest determinant of how the Phelps-Brown Hopkins index moves over time. Results suggest that Englishmen saw their living standards surge by almost 200%

much lower frequency than prices and quantities do.

¹⁴ Hulten (1996) questions the plausibility of Nordhaus's result.

after the Black Death in the middle of the fourteenth century. After 1500, a long period of decline set in. By 1600, much of the gain in living standards from the plague had disappeared. The 17th and 18th centuries then saw a recovery. Nonetheless, by 1800, living standards were still 25%-50% lower than they had been in 1450. Loschky (1980) reworked the Phelps-Brown and Hopkins series, using Paasche and chain weighted price indices. His findings are markedly more optimistic, showing a less-marked decline during the early modern period. This is mainly due to changes in the relative price of manufactured goods, which became cheaper. For example, his Paasche index recovers its post-Plague peak by the middle of the 18th century, a full 100 years before the date given by Phelps-Brown and Hopkins.

Clark (2005) offers a new, improved real wage index, drawing on a host of additional information. He changed both the wage series and price index. His expenditure weights come largely from the end of the period. The results of his calculations are shown in Figure 1. Since the Clark price index tracks many more items, it is less volatile. The real wage index surges and falls less sharply. Clark confirms the earlier, pessimistic results by Phelps-Brown and Hopkins for the period after 1500—it wasn't until 1850 that the average Englishman had a real wage that was greater than his counterpart's in 1500.

The question if living standards improved after 1750 – the classic period of the industrial revolution – has been hotly debated since the days of Marx and Engels. For period 1770-1850, Clark (2005) finds larger increases than earlier authors had suggested. Initially, estimates by Lindert and Williamson (1983, 1985) implied large wage gains. Their cost-of-living indices were comprehensively revised by Feinstein (1998), who expanded the range of commodities covered. By doing so, he found markedly smaller wage gains – a plus of 30% between 1780 and 1850,

¹⁵ According to Maddison (2001), English GDP per capita rose at a rate of less than 0.3% between 1500 and 1700.

instead of Lindert and Williamson's gain of close to 90%. Recent analysis suggests a range of improvement between 40% (Allen 2007) and 50% (Clark 2005).¹⁶

None of the existing indices of living standards during the early modern period incorporate the value of new goods. Loschky (1980) changed the weight for manufactured goods by using a different definition of the consumption basket. Apart from this, the radical transformation of consumption patterns and diets between 1500 and 1850 has left little trace in economists' analysis of trends in the standard of living. We turn to these changing patterns next.

The adoption of colonial goods after 1492

Tea and coffee were new to Europe in the early modern period, while sugar had only been available in very limited quantities before 1500. We summarize how each was first brought to Europe, how it was consumed, and the corresponding changes overseas.

Sugar can be derived from a variety of sources—sugarcane, sugar beets, sorghum, honey, and other products. Early forms of sugar were available in small quantities at prohibitive prices. From the twelfth century onwards, medieval court records show that English kings consumed sugar.¹⁷ Europe's first taste of sugar derived from sugar cane came courtesy of Arab conquerors. Sugarcane production had reached Valencia and Sicily by the 10th century (Mintz 1985). The Crusaders are said to have encountered Egyptian sugar when they advanced into Syria. From there, cultivation of sugarcane spread to Cyprus. It was also grown in the Azores, the Canary Islands and on Madeira before reaching Brazil in the 1520s (Braudel 1988). By 1572, a French

¹⁶ Clark's (2005) index, based on additional data and a rebalanced consumption basket, suggests that living standards increased by more than allowed for by Williamson -- a rise by 50%. Allen's latest reworking of the wage and price information again yields a more pessimistic view -- a plus of 40%.

¹⁷ It is mentioned in the pipe rolls of Henry II (1154-89). Cf. Mintz (1985).

observer commented that “people devour it out of gluttony... What used to be a medicine is nowadays eaten as a food.”¹⁸

The introduction of sugar to the New World facilitated large increases in output. Sugar refining became technically more sophisticated, producing a whiter, more consistent product. As Europe’s taste for sugar developed, ‘sugar barons’ in the Caribbean and elsewhere became rich. Using imported slave labor, sugar cane was eventually cultivated in most European colonies with a suitable climate. Rum was produced as a by-product. While medieval Cyprus produced no more than an estimated 50-100 tons of sugar per year, Santo Domingo in the 18th century alone produced 3,500 tons. England in 1700 imported approximately 10,000 tons; a century later, this figure had risen to 150,000 tons, according to some estimates (Braudel 1988).

As the price of sugar declined, consumption spread to the lower classes. It was frequently used as a substitute for a protein source, consumed in the absence of meat when and where meat was too expensive. Though the simple carbohydrates from sugar do not have all the nutritional qualities of a protein source, its consumption offered access to readily digestible calories at a time where energy availability may have constrained labor input (Fogel 1994). In addition, sugar was used to add sweetness and calories to food and drink, especially to tea or coffee, or added in liquid or powdered form to a whole range of foods.¹⁹ It further had decorative value, as an ornament for other foods or in large-scale models of everything from houses and castles to human figures.²⁰ Jam largely consists of sugar. The industrial production of marmalade (after 1797) made the taste of fruit available year-round (Mintz 1985). Sugar was also used in medicines.

¹⁸ Cit. acc. to Braudel (1988).

¹⁹ Sugar in liquid form is called treacle, a byproduct that remains after the sugarcane is crushed, boiled and processed through a centrifuge. Being dark in color and retaining more impurities than white sugar, it was sold at a lower price and was popular amongst the lower classes.

Combining caffeinated drinks with sugar was a European innovation, as was the adding of milk (Goodman 1995). Sweetened tea became popular amongst all classes in England. Tea and sugar (or coffee and sugar) were therefore complementary goods. For the poor, a cup of sugary tea could reduce feelings of hunger, and give energy for a short time. Tea could serve as a substitute for a hot meal, especially where heating fuel was in scarce supply. Tea reached Europe from China in 1606.²¹ By the 1630s, it had spread to France; by the 1650s, to England via Holland. The English diarist and naval administrator Samuel Pepys describes trying it for the first time in 1660.²² Establishing direct trade links with China was crucial for boosting the volume of imported tea. Until the East India Company imported tea from China, it was normally exported to Batavia first, from where it would be shipped in Dutch vessels. Tea consumed in England initially was shipped on Dutch vessels (Goodman 1995). However, by the middle of the 18th century, the English had overtaken the Dutch as principal traders. Over the course of the 18th century, English tea consumption increased by a factor of 400 – much of it smuggled from the continent to avoid high customs duties. Outside the British Isles, tea was only consumed in substantial quantities in Holland, Russia, and parts of Northern Germany. Production in English colonies took some time to become quantitatively important. It was only after the 1850s that the East India Company began production on the subcontinent on any scale. No tea produced in India reached Britain before 1850 (Forrest 1973).

Coffee was probably consumed as early as AD 800-1000 in Yemen and Ethiopia. It spread throughout the Middle East, before reaching Europe via Venice by 1615. By the middle of the 17th century, coffeehouses were springing up in many larger European cities (Schivelbusch 1992). By the 18th century, Paris alone had 600-700 cafés (Braudel 1988).

²⁰ Mintz (1985).

²¹ Goodman (1995).

Initially, most coffee reached Europe via the Mediterranean, having been grown in Yemen. Consumption surged after European powers took control of cultivation and distribution. The Dutch plantations in Java and Surinam started production shortly after 1700. In a few years, they had replaced all imports from the Arabian Peninsula. France began production on Martinique and Saint Domingue, and half a century later, England did the same on Jamaica. Production increases were swift. By 1789, Saint Domingue produced 40m pounds. Braudel (1988) estimates that some fifty years earlier, total European consumption had amounted to a mere 4m pounds.

Europeans first encountered tobacco during the voyages of discovery. Columbus noted the smoking of tobacco by Native Americans on Cuba in November 1492. Afterwards, it took almost a century for consumption to grow significantly. The plant was largely treated as a botanical curiosity. It was only in the 1570s that the medical writings of Nicolas Monardes, who wrote a compendium on the plants of the New World, gave a push to tobacco use. Europeans used it as snuff, as chewing tobacco, and in pipes. The use of cigarettes first became common in Spain, and then spread to other countries. Initially produced by Native Americans, Spanish settlers in the New World eventually learned to produce it themselves. It was cultivated in Spain from the 1550s, and then spread to Italy, the Balkans, Java, the Philippines, and India. However, production in the North American colony of Virginia overtook all other sources of tobacco. By 1700, almost all European imports came from either Virginia or Brazil. England imported it on a vast scale, only to re-export it to the continent. By the early 18th century, Virginia tobacco exports alone filled 200 boatloads per year (Braudel 1988). As early as 1690s, consumption reached over two pounds per capita according to Shammas (1990).

The spread of hot, caffeinated drinks transformed eating habits. Over the course of the early modern period, breakfast was changed completely. It went from a relatively heavy meal,

²² Entry for 25 September 1660, cit acc. to Pepys (1854).

often consisting of porridge or other grains, with some cold cuts, combined with wine or beer, to the modern-style, often light meal. Tea and coffee, more likely than not sugared, were combined with bread or pastry. As an English observer in 1722 noted: “before the use of tea, breakfasts were more substantial; milk in various shapes, ale and beer, with roast cold meat... sack and wines for the higher orders of mankind”.²³ A French visitor to England agreed: “[t]hroughout the whole of England the drinking of tea is general. You have it twice a day and, though the expense is considerable, the humblest peasant has his tea twice a day just like the rich man; the total consumption is immense’.²⁴ Something similar occurred in France. A Parisian observer noted the change in consumption amongst all classes:

Consumption has tripled in France; there is no bourgeois household where you are not offered coffee, no shopkeeper, no cook, no chambermaid who does not breakfast on coffee with milk in the morning. In public markets and in certain streets and alleys in the capital, women have set themselves up selling what they call *café au lait* to the populace.²⁵

Even at the very bottom of the social hierarchy, tea and sugar were consumed regularly. By the middle of the 19th century, Friedrich Engels (1844) commented in his *The Condition of the Working Class in England* on the importance of tea for all groups:

Tea is regarded in England, and even in Ireland, as quite as indispensable as coffee in Germany, and where no tea is used, the bitterest poverty reigns.

By the end of the 18th century, what had once been luxury goods, enjoyed by the few, was being consumed *en masse*. In 1800, the European continent as a whole imported 120 m. pounds of coffee, 125 m. pounds of tobacco, 40 m. pounds of tea, and 13 m. pounds of chocolate (Braudel 1988). Table 1 shows colonial goods consumption in a number of countries.

²³ Cit. acc. to Goodman (1995).

²⁴ Quoted in Macfarlane and Macfarlane, 2003

²⁵ Braudel (1988).

In combination, the introduction of coffee, tea, and sugar transformed European consumption habits. Production sites had been established around the globe, mostly in European colonies. A vast trade of slaves provided the labor force necessary to satisfy European appetites, producing the kegs of molasses, sacks of coffee and bales of tobacco that sailed to the old continent in thousands of ships. The reliability of the supply system was remarkable. One historian argued that, by the late 18th century, European “consumers could often rely on the availability of sugar, tea, or tobacco more certainly than on the supply of dairy products and some cereals.” (Shammas 1990).

Smuggling

Data on consumption of new goods in Britain comes from official import statistics. These will underestimate true consumption if goods arrive via an illegal channel. At various times, smuggling was rife in Britain during the early modern period. Tariffs and excise taxes were high, especially for tea and tobacco. A standard way to smuggle goods into the country was to officially ‘re-export’ colonial goods, and then land them illegally.²⁶ Tea and especially, tobacco, were easy to smuggle. Sugar and coffee were affected much less because the weight/value ratio was less favorable.²⁷ Mokyr (1988) estimated that between half and over 90 percent of all tobacco consumed in Great Britain had been smuggled.

Standard statistics on retained imports deduct re-exports fully from the import figures, some of which may have returned as smuggled goods to Great Britain. Tariffs in general declined during our period. For example, duty on tea fell from a high of 125 percent of net cost in 1736-40 to a mere 12.5 percent in 1787-91 (Cole 1958). The incentive to smuggle therefore declined markedly over time (though by the 1820s, tea duty had returned to 100 percent of net

²⁶ This required forging the landing documents from a foreign port, or bribing an official to provide them (Hoh-Cheung and Mui 1975).

cost); the share of smuggled goods in final consumption probably fell.²⁸ Since we examine the value of new goods in the light of how quickly their consumption rises, the legal import figures may paint too optimistic a figure – real consumption may have risen much less during the periods of tariff reductions. The extent to which one can correct for smuggling in British import statistics is controversial (Cole 1958, Hoh-Cheung and Mui 1975, Cole 1975). In the main data section, we will use the ‘official’ statistics on retained imports. We will examine the issue of smuggling, and its impact on our results, in the robustness section.

III. Data

In calculating welfare gains for colonial luxuries, we use three types of data: consumption, price and income. For price data we rely on the recent work by Clark (2004) and Allen (1992) who have computed detailed price series for the period. Since his price series extend back to the medieval period, and tracks a larger number of products, we use Clark as the primary source. Allen’s data serve as a robustness check for sugar and tea; he does not provide price data for coffee. Consumption data is from a combination of sources. A continuous series would be preferable, but is unfortunately not available. The consumption data we use comes from five sources: Mokyr (1988), Mitchell & Deane (1962), Deerr (1950), Cole (1958), and Davis (1979), all estimated using retained imports (imports minus re-exports) per capita. Finally we use daily workers’ wages from Clark (2005) for income.

Figure 2 presents the Allen and Clark series for the real price of sugar on the left panel with sugar consumption in pounds per year on the right, from 1600 to 1850. The real price of sugar, as for all of these series, is derived by taking the nominal price and dividing it by the CPI.

²⁷ Mokyr (1988).

²⁸ In figure A1 in the appendix, we plot legal imports and the tariff rate side-by-side.

The Clark series shows the price of sugar in real terms (plotted as circles) declining dramatically over a relatively short period. It falls in real terms from a high of over 32 pence per pound in 1600 to less than 15 by the 1650s, before declining to 5.7 pence per pound in 1850. The Allen series (x-marks), begins later, and shows a less dramatic price decline, starting at 10 pence in 1660 and ending at 6 by 1850.

Sugar consumption is derived from retained imports: total imports into Britain minus re-exports. We obtained per capita consumption by dividing total retained imports by population.²⁹ Our sugar consumption quantity data combines two series: Deerr (1950) for the years 1700-1789 and Mokyr (1988) for the years 1794-1796 to 1854-1856. Deerr estimates 4 lbs. of sugar consumed per capita in 1700, growing to 12 lbs. in 1780. Mokyr estimates retained imports of 16 lbs. per capita in 1794-96 growing to 33 lbs. in 1854-56. Retained imports for sugar are not available for the 17th century. Historical descriptions (Deerr 1950) suggest that consumption increased slowly during the 17th century. We set an initial point of zero consumption of sugar at 1600, and interpolate between 1600 and 1700.³⁰

Figure 3 shows the real price of tea (left panel) and consumption per capita (right panel). The price of tea, compared to sugar, shows an even more dramatic price decline. The Clark series falls from a high of 614 pence per pound in 1690 to 54 pence in 1850, a price decline of 91%. The Allen price series begins in 1760 and shows a high degree of co-movement (correlation coefficient 0.89) with the Clark series. Our consumption series for tea is derived from three sources, Forrest (1973) for the years 1700 to 1770, Davis (1979) for 1784-86, and Mokyr for 1794-96 to 1854-56. Forrest calculates 0.01 lbs. per capita of tea consumption in 1700 growing to 0.74 in 1770. Davis estimates 1.36 lbs. for 1784-86, and Mokyr calculates 1.6 lbs. in

²⁹ Population figures are from appendix tables A5.2, A5.3 and A6.1 in Wrigley et al. (1997).

1794-96 growing to 2.43 for 1854-56. The combined consumption series show tea consumption increased rapidly over the period. We set a point of zero consumption for tea at the year 1690; qualitative historical accounts, such as the existence of tea houses starting in 1660s in London, (Forrest, 1973) suggest there is some consumption before that period. We can infer from retained imports beginning in 1700 that what was consumed remains very small in per capita terms, suggesting 1690 to be an appropriate starting point.

Finally, changes in the price of coffee (left panel) as well as quantities consumed (right panel) are shown in Figure 3. The price of coffee, only available from Clark, declined from a high of 137 pence per pound in 1710 to a low of 22 pence per pound in 1850. This is a reduction of 84% -- smaller than in the case of tea, and similar to the one for sugar. Per capita consumption comes from two sources: Mitchell and Deane (1962) for the years 1700 to 1770 and Mokyr (1988) for 1784-86 to 1854-56. Retained imports from Mitchell and Deane show small amounts of consumption, starting at 0.002 lbs. per capita in 1700 and growing to about 0.02 lbs. per capita in 1770. Mokyr estimates 0.01 lbs. per capita of coffee consumed in 1784-86 growing to 1.59 lbs. per capita in 1844-56 and declining again to 1.39 lbs/capita in 1854-56.³¹

As a percentage of household spending, coffee was not as important as tea. By 1850, the English consumed a full pound of tea more than of coffee. This is partly because the price of coffee was 2.5 times higher than that of tea. Coffee briefly became fashionable for a period in the mid-17th century. However, its consumption across Britain never took hold until the 19th century, and all indications suggest overall consumption remained low (Cowan 2005). We assume zero consumption of coffee in 1690, motivated by small aggregate consumption per capita in the years immediately after.

³⁰ We experimented with different assumptions about the year to which we attribute zero consumption, and with leaving out interpolated values in our welfare calculations. Results are broadly unchanged (available upon request).

Income data comes from three series in Clark (2007). Clark provides daily wages for ‘farm’, ‘craft’, and ‘building laborer’ in pence per day. Table 2 reports daily (nominal) wages for a subsection of our period and the budget shares of tea and sugar implied by the consumption per capita data discussed earlier.³²

To translate Clark’s daily wages into annual per capita incomes we calculate days of work per year via implied budget shares for new goods. Since we know annual spending on them, and know daily wages and the budget share, we can simply solve for the number of days implied. This method suggests approximately 140 days of work per year.³³ Feinstein (1998) shows sugar accounting for 4.8% of a household’s budget in 1788-92 (column 5). Using consumption per capita of sugar from retained imports, our estimated incomes show sugar to be 4.89% of income in 1790, a very close match to Feinstein’s estimate. For 1830 our estimated incomes show sugar accounts for 3.9% of a household’s budget (column 3), below the 4.6% estimated by Feinstein in 1828-32. (column 5). With regard to tea, in 1790 using our income estimates we calculate tea to occupy 4.9% of a household’s budget share, slightly overestimating Horrell’s estimate of 3% for 1787-96. We estimate tea to be 2.8% of a household’s budget in 1850, slightly above Horrell’s estimate of 2.1% for 1840-54. Overall our per capita income estimates do not consistently overestimate or underestimate actual budget shares.³⁴

Consumption of colonial luxuries rose with incomes (Horrell 1996). However, heterogeneity should not be exaggerated. Mokyr (1988) found that colonial goods had positive income elasticities that decreased with income; consumption per capita reached a saturation

³¹ Mokyr (1988) attributes the unstable consumption patterns of coffee to changing preferences.

³² Table A2 presents the full wage data.

³³ The number for adult males was probably much higher (Clark and van der Werf 1998, Voth 1998, 2001). Note that we are estimating the number of working days per Englishman, from infant to the elderly, in adult male wage equivalents.

³⁴ Aggregate consumption of these new goods implied through our data corroborates with total value of sugar and tea consumed in 1801 from Appendix 2 in Horrell (1996).

level, which Mokyr estimates to be between 2 to 3 times the average level of consumption in 1855. Because of this, we can be fairly certain that welfare gains did not just accrue to a few upper-class families consuming the new goods. The qualitative historical literature emphasizes how the consumption of tea and sugar spread throughout most social classes. The only exception to this is the earliest part of the period, when consumption was limited to the wealthy.

IV. Method and Results

How should we value the spread of new, hot, caffeinated drinks and other new goods from the New World? In this section, we briefly summarize the methodology developed by Greenwood and Kopecky (2009), which we then apply to tea, coffee, and sugar. We also examine the sensitivity of our results.

Method

Consumers purchase two types of products: new and old. $U(c)$ describes the utility they derive from the latter; $V(n)$ the one from the former. The parameter θ is the share of expenditure on the old good, and $(1-\theta)$ the share of the new good. Consumers maximize

$$W(y, p) = \max_{c, n} [\theta U(c) + (1-\theta)V(n)] \quad (1)$$

with $0 < \theta < 1$; $c, n \geq 0$; and subject to $c + pn = y$

where c is consumption of the “old good”, n is consumption of the “new good”, c serves as a numeraire, p is the relative price of new goods, and y is income. Both the consumption of new and old goods follow standard CRRA preferences, with one important qualification in the case of new goods:

$$U(c) = \frac{c^{1-\rho}}{1-\rho}, \text{ with } \rho \geq 0 \quad (2)$$

and

$$V(n) = \frac{(n+v)^{1-\rho}}{1-\rho}, \text{ with } V(0) = \frac{v^{1-\rho}}{1-\rho} > -\infty \text{ and } V_1(0) = v^{-\rho} \quad (3)$$

Adding v to the CRRA preferences ensures that the marginal utility of the first item of a new good is not infinitely large. This is achieved by shifting the standard utility function by the parameter v .³⁵ At zero consumption of the new good, marginal utility of the first unit is $v^{-\rho}$.

This leads to a threshold price, \hat{p} for the new good where $\hat{p} \geq \hat{P}(y)$ and

$$\hat{P}(y) = \frac{1-\theta}{\theta} v^{-\rho} y^\rho. \text{ If the price of the new good is higher than this threshold price, consumption}$$

of the new good will be zero. Greenwood and Kopeccky show that below the threshold price consumption of the new good is given by

$$\hat{n} = \frac{y + p v}{p + [(1-\theta)/\theta]^{-1/\rho} p^{1/\rho}} - v \quad (1)$$

In our analysis, we take price changes as exogenous. As the historical background section argued, they largely reflect changes in the production system in European colonies. Introducing the slave system, the introduction of coffee plants, sugarcane, and tea into overseas possessions, and improved production methods drove the steep decline in prices. That is why we can identify the welfare gains from analysing (1).

Welfare changes are calculated from the indirect utility functions with and without access to the new good. Greenwood and Kopeccky (2009) define two measures of the welfare gain from

new goods –equivalent variation (EV) and compensating variation (CV). Suppose there are two states of the world: In state 2, consumers have access to the good; in state 1, they do not. State 1 can be considered as a special case of state 2 where the price of the new good is infinite. The equivalent variation is the increase in income needed (λ) to give the consumer in state 1 (without access to the new good) the same level of utility as a consumer in state 2 (with access). This can be written as

$$W((1 + \lambda_{EV})y_2, \infty) = W(y_2, p_2) \quad (2)$$

where $W(y_t, p_t)$ is the indirect utility function which has as inputs current prices p_t and income, y_t . EV is expressed in percent of income in state 2.

Compensating variation is defined as the amount of income a consumer would be willing to lose, provided he kept access to the new good. We can think of this as the amount of income a consumer would be willing to forego in state 2 in order to maintain access to the price p_2 as opposed to facing an infinite new good price. We can formally describe this as

$$W((1 - \lambda_{CV})y_2, p_2) = W(y_2, \infty) \quad (3)$$

CV is similarly expressed as a percentage of income in state 2. With quasi-linear preferences, the results for both will be identical. We next calculate how much consumers would have been willing to forego of their income in 1850 to keep access to tea, sugar, and coffee.

³⁵ As Greenwood and Kopecky (2009) note, the indirect utility function can very well have a solution with $n=0$, since the marginal utility from old goods at low consumption levels can near infinity (due to habit formation), whereas that for new goods is possibly lower.

Main results

The welfare measures for the introduction of new goods from overseas can be calculated by using observed data on income (y), prices (p) and new good consumption (n) to calibrate the preference parameters. The preference parameters are the coefficient of relative risk aversion (ρ), the weight on utility of non-new good consumption (θ), and the utility shift parameter (v) that corresponds to the marginal utility of zero new good consumption, given by $v^{-\rho}$. To calculate these preference parameters, we follow Greenwood and Kopeccky, and use a two-step procedure. The utility functions predict a mapping of income and price of old and new goods to quantities consumed, for any set of values for p , y , v , θ , and ρ . Using equation (1) to calculate \hat{n} , we calibrate v , θ , and ρ to minimize the sum of squares of differences between observed new goods, n , and the predicted new goods, \hat{n} .³⁶ As in Greenwood and Kopeccky, we constrain consumption in the beginning of the period to zero. Due to the nonconvex nature of the equation (1), a Nelder-Mead nonlinear optimization algorithm is used for the sum of squares minimization.

Greenwood and Kopeccky (2009) obtain parameter values of $\rho=0.993$, $\theta=0.994$, and $v=6 \times 10^{-4}$. We deviate from the calibration procedure used by G&K and use a composite index of sugar, tea, and coffee to estimate the value for ρ that best predicts new good consumption jointly. The reason is that we think of ρ as an underlying parameter that should govern the adoption of all colonial goods. With CRRA preferences, ρ measures risk aversion, and $1/\rho$ the intertemporal elasticity of substitution. There is little reason to assume that consumers should have different rates of time preference in the context of different overseas luxuries. We therefore estimate ρ

³⁶ In one of our robustness tests, we also use an alternative estimator that uses absolute deviations. Results are broadly unaffected.

with data for all the goods for which we have information. This yields an estimate of ρ of 0.9395.

Using the jointly-calibrated value for ρ , we estimate the remaining preference parameters and their resulting welfare estimates for the new goods separately. The results are shown in panel A of Table 3. The welfare estimates are large. The results for both sugar and tea each show an equivalent variation of more than 7%. Had they disappeared in 1850, consumers would have had to receive an extra 15.9% in income to make up for the loss. The compensating variation is also large, and of a very similar magnitude – 14.9%. This is how much 1850s consumers would have been willing to have their incomes cut to retain access to tea and sugar. To this, we also have to add the gains from coffee, which brings the total to 17.33% for EV, and 16.4% for CV. This suggests that the introduction of these three ‘small luxuries’ had big consequences for the well-being of the English population.³⁷ The R^2 for these goods varies between 0.77 and 0.85, a lower degree of fit with the restriction on ρ , but still high considering the likely noise in the historical data.

If we replicate the Kopeccky-Greenwood approach exactly and estimate ρ separately for each new good, we obtain broadly similar results. The parameter values and estimates of EV and CV for our set of goods shown in panel B of Table 3. We constrain ρ to lie in the interval (0, 2]. The estimation procedure finds minima for the function at $\rho = 0.72$ for sugar, 1.49 for tea, and 2 for coffee. Compared to the results in panel A, we see that ρ from joint estimation produces marginally lower R^2 values for each good. The CV and EV for tea and coffee rise, while the ones for sugar decline. The total welfare gains are now even larger (20-23%).

³⁷ It may be argued that at such low levels of income no expenditure is small.

With logarithmic preferences, $1-\theta$ should converge to the budget share for novel goods. The sum of $1-\theta$ for panel A of Table 3 is 11%. This is similar to the historical data. Sugar, tea, and coffee accounted for approximately 10% of food expenditure of working class households in 1790s England (Feinstein 1998), or 7% of total expenditure. Given that consumption of these goods was greater amongst middle and upper class households (not included in the Feinstein estimate), the results for θ seem to be in line with historical evidence. The values for v also appear reasonable, perhaps even conservative, as the utility derived from new goods is strictly decreasing in v . The marginal value of the first quantity of a new good is given by $v^{-\rho}$. This suggests values of 8.8 for sugar, 14.7 for tea, and 7.03 for coffee. In Greenwood and Kopecky (2009), computers have a marginal value of 1582. In effect, because consumption was not exactly zero at the beginning of the period for which we have data, we are likely to underestimate v . This also implies that the welfare gains derived are a lower bound of the true increase.

Figures 5-7 illustrate the goodness of fit achieved by the estimation procedure. We plot predicted and actual expenditure on new goods for the specification in panel A of Table 3. The predicted *expenditures* from equation (1), using the calibrated parameter estimates, do a good job in tracking actual values. In all cases, the predicted series is neither consistently above nor below the actual consumption path. As one would expect with historical data spanning centuries, the fit of our calibration exercise is not as high as with modern data; the R^2 values for these graphs are 0.85 for coffee, 0.77 for tea and 0.85 for sugar. This compares with a value of 0.999 in the Greenwood-Kopecky study. If there is one regularity in the pattern, it is that the procedure overpredicts initially, and then underpredicts. This may reflect the fact that hours probably rose over the period (Voth 1998, 2001). If so, annual incomes increased not just because of wage

rises, but because hours work changed. This may explain why we underpredict towards the end of the period.

Our baseline results, summarized in Table 3, suggest that colonial luxuries made consumers better off by a little more than one-sixth of final-period consumption. Far from a side-show in the history of living standards, the introduction of caffeinated hot beverages and sugar contributed substantially to the welfare of the first industrialized country. Before we conclude that that the history of living standards needs to be modified in the light of these findings, we examine the robustness of our result.

V. Robustness and Extensions

We first examine the robustness of our findings to changing our implementation of the Kopecky-Greenwood method. We then use alternative data series, and examine the potential impact of smuggling on our estimates. Finally, we use a different method altogether, introduced by Hausman, to obtain estimates of the welfare gain from new goods. All alternatives suggest that our main result is plausible, perhaps even conservative – tea, sugar, and coffee raised European welfare substantially.

Alternative parameter values

Table 4 uses alternative values for ρ and v . Since in a CRRA utility function, ρ is also the degree of risk aversion, it may be instructive to experiment with higher values – similar to those used in the finance literature. Panel A of Table 4 examines this scenario. If we use $\rho=2$, we obtain values for the equivalent compensation of about 20% each for sugar and tea, and close to 3% for coffee. We find these values too high to be plausible. The overall budget shares implied by this approach also seem too low in this specification, and the implied values for v are large.

If we use a lower value for ρ than in our benchmark estimate ($\rho=0.7$, shown in panel B), we find smaller values, but not markedly so. The sum of welfare gains from new hot beverages and sugar is 12.9%, compared to the 17.3% when we used $\rho=0.9395$ in the baseline specification. Finally, since v in our calibration/estimation exercise is on the high side, we constrain it to a value of 0.01 (panel C). While giving sensible results for coffee and sugar, this raises the welfare gain of tea to an implausible 22-30%. Moreover, setting v to 0.01 would also imply that we violate the restriction of zero consumption in the initial period. Overall, we conclude that our results are robust to alternative parameter values: Modifications tend to raise estimated welfare gains.

Alternative functional form

The standard Greenwood-Kopeccky specification assumes full separability between new and old goods in the utility function. This assumption may be too restrictive, especially since colonial goods were often combined with old goods when consumed. To relax this assumption, they experiment with a CES specification that allows them to measure the implied elasticity of substitution between new and old. Consumers then maximize

$$U(c, n) = \left[\theta c^{\frac{\sigma-1}{\sigma}} + (1-\theta)(n+v)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

where σ is the elasticity of substitution between new and old goods. They find an elasticity close to unity for the case of computer purchases. We repeat their exercise as an additional robustness check. Table 5 gives the results.

We find largely unchanged results for sugar and coffee, while tea now shows larger gains. This is especially true for equivalent variation. Because the estimation procedure suggests that the elasticity of substitution is less than unity for tea, v is also large. According to the results

from the CES estimation, by 1850 at the latest, there was simply no good alternative for tea in the eyes of Englishmen and -women.

Alternative data series

Next, we examine the robustness of our findings with respect to the data series used. We use alternative price series, and also derive welfare gains for the case of combining sugar and tea into a single, composite commodity.

Clark's price series are not the only ones that can be used. Allen (1992) offers alternative series for sugar and tea. The data generally start later than the Clark series we use for our baseline estimates. Hence, the impact of new goods is bound to be lower – the initial, rapid fall in price, when gains in consumer surplus must have been largest, is not covered by the data. Table 6 summarizes the results, and compares them with the baseline findings (for the full sample period). We use the value for ρ calibrated from the joint estimation procedure. To show the impact of the data source separately, we also re-estimate the baseline specification with Clark data to match the date range in the Allen series. The Allen price data, using a shorter time period, gives only slightly lower welfare gains. For sugar, estimated from 1650 to 1850, equivalent variation falls from the baseline estimate of 8% to 5.3%, while compensating variation remains essentially unchanged, declining from 7.6% to 7.2%. If we compare this with the Clark data, but matched for the same time period, results are very similar.

The welfare difference for tea is small as well, showing a small decline. CV is 6% with the Allen data, instead of the 7.3% for the Clark data. EV for Allen's estimates implies a gain of 5.5% instead of 7.9% from Clark. The implied budget shares derived from the results for the Allen dataset are quite large, amounting to over 15% of income spent on new goods. This is because the optimization procedure derives lower values for θ . The Allen data imply a high

value for the parameter ν – 0.44 for sugar, and 0.24 for tea. The R^2 values using the Allen data are also much lower than the Clark series—0.55 for sugar and 0.41 for tea. It is because of these shortcomings, and the longer period covered, that we ultimately preferred the Clark series. Nonetheless, it is important that the overall size of welfare gains estimated is not affected by switching to the Allen dataset.

In assessing the overall impact of new goods, we have until now proceeded as if the welfare gains from individual goods are additive. This is not necessarily true. Our estimation and calibration procedure chooses parameter values that explain the rate of uptake of a new commodity, given a known path for its price and overall income. However, assume that there is a second new good that is highly complementary to the consumption of the first new commodity. If the former declines sharply in price, take-up of the first new good may rise quickly, while its price remains relatively high. We may therefore be overestimating the value that consumers attach to the new commodity. We would attribute the rapid rise in consumption to a strong preference, while it is really the decline in the complementary good's price that explains the take-off in consumption. For the goods in question, the key question is if sugar and either coffee or tea were complementary to each other.

Table 7 gives the results for estimating welfare gains from sugar and tea jointly. The procedure used to estimate sugar and tea jointly is identical to the one used to estimate sugar, tea and coffee. Consumption is the sum of sugar and tea consumed in a given year, and we use as a price vector a Laspeyres price index with a base year of 1850. Even over the short period 1690-1850, using data on the consumption of sugar and tea jointly generates consistently larger estimates of welfare gains, using the preferred calibration of ρ . Compared to the baseline estimates, EV now rises from 12.4% to 16.8%, and CV from 13.4 to 14.2%.

Correction for smuggling

English consumers drank more tea and coffee, and used more sugar, as the price of these goods fell. The price decline was driven by three factors – lower tariffs, greater competition amongst producers, and improvements in production technology. As tariffs were cut, smuggling probably declined. Some of the measured increases in consumption may thus not be the result of consumers responding enthusiastically to small declines in the price of tea and the like. Instead, legal sales as a share of the whole may have increased. It could be argued that, by using data on legal imports, we are effectively stacking the odds in favor of finding a large welfare gain.

To correct for this problem, we estimate the legal quantity of tea sold as a function of the price of tea, and the duty levied (details are presented in Appendix 1). The corrected series gives higher predicted values than the official series for those periods with very high duties. The opposite is true of periods under moderate tariffs. For our calibration of welfare gains, we effectively abstract from the increases in ‘legal’ consumption that coincide with lower tariff rates. Based on the corrected series, we obtain estimates of EV (CV) of 7.6% (7.8%).³⁸ This is between one and two percentage points higher than under our baseline calculation. This is probably because much of the initial take-up of tea occurred in a context of high import duties.

Comparison with alternative methods

Hausman (1999) suggested a simple method for estimating welfare gains from the introduction of new goods:

$$CV = \frac{1}{2} S \eta^{-1}$$

where CV is the welfare gain measured in compensating variation, S is the share of the new good in expenditure, and η is the price elasticity of demand. We use the estimates of price elasticities

and budget shares from Horrell (1996), and combine this with the average budget share for her two benchmark sets of years 1787-1796 and 1830-1839 (Table 8). For sugar, tea, and coffee combined, we estimate a total gain (compensating variation) of 13.5% of expenditure.³⁹ This is somewhat lower than the results reported above, under most scenarios, but it is broadly similar in overall magnitude – gains from colonial luxury goods were substantial, adding more than 10% to English living standards by the early nineteenth century. When we use the price elasticities estimated by Mokyr (1988), we obtain a very large effect for sugar, and a much smaller one for tea and coffee.⁴⁰

Modern-day estimates of the demand elasticities suggest that these figures are plausible. Gemmill (1980), in a comprehensive survey of data from 73 countries, estimates the price elasticity of demand for sugar to be between -0.25 and -0.38 in the short run. Schmitz et al. (2008) argue that in the present-day US, $\eta = -0.14$. Kanayama et al. (1999) estimate the demand elasticity for sugar to be between -0.13 and -0.16. In the most pessimistic case (using -0.45), we still obtain a welfare gain of 4 percent. For the highest contemporary estimates, the welfare gains range as high as 13 percent of household income. The highest absolute value of the elasticity in modern-day studies (-0.45) in the case of sugar is the long-run elasticity estimated by Gemmill (1980). This would reduce the welfare gain for tea and coffee from 7 to 4 percent. Overall, we conclude that the orders of magnitude for welfare gains are robust to a wide range of alternative values for the calibration/ optimization exercise, data sources, and the use of an altogether different technique.

³⁸ This is the result using $\rho=0.9395$. With unrestricted ρ , we find gains of 5.7% for both CV and EV.

³⁹ We use the own-price elasticity for tea and coffee for sugar and treacle as well. This is because Horrell derives a questionable estimate of 0.48 for the latter, possibly because she is ignoring complementarities in the consumption of sugar and tea. Note that our figure is similar to the lower bound in Mokyr and O'Grada (1988), who use values ranging from -0.3 and -0.7 for tea and sugar.

Tobacco

Tobacco is similar to the other new goods – it arrived in Europe from the Americas, it has no close substitute amongst native plants, the import price fell rapidly, and consumption became a mass phenomenon. We nonetheless do not treat it on par with the other goods because of its addictive properties. Tobacco in some ways is not a “good”, but a “bad” – the health effects can be strongly negative, even if life expectancy was perhaps too low for the full carcinogenic effects to make themselves felt. Becker and Murphy (1988) define a good as addictive if tolerance increases over time, users find it ever harder to stop consuming it, and suffer from unpleasant feelings ranging from cravings to withdrawal symptoms. By this definition, sugar, tea, and coffee are probably not addictive in the strict sense, while tobacco clearly is.⁴¹

Table 9 gives the results for both the Greenwood-Kopecky and the Hausman method.⁴² We use $\rho=0.9395$, derived from estimating joint takeup of the other three colonial goods in our dataset. Explanatory power overall is acceptable, and $1-\theta$ is in line with historical estimates of expenditure on tobacco. For the period as a whole, from 1630-1850, we find a welfare effect of approximately 3.3%. This slightly higher than the results for coffee, but not as high as the values for sugar and tea. Consumption per capita declined somewhat after a mid-18th century peak. Estimated for the first 130 years, the implied welfare gains are even somewhat larger.⁴³ As an additional robustness check, we use the Hausman method. With a (lower bound) budget share of 2.6%, we estimate welfare gains of 3.2%.

⁴⁰ We use the results from his generalized inverse log specification. If used the estimates from the logistic function the implied CV would rise to 0.294.

⁴¹ This could be a problem for our method because we implicitly assume time separable utility. Because the pleasure of consuming an addictive good today depends on the history of personal consumption, this is not strictly correct. However, we analyse tobacco use over a long period in which several generations of users are born and die. This allows us to abstract from the non-separability of utility for each of them, and apply the basic method for estimating welfare gains.

⁴² Details of the data handling are described in Appendix II.

Leisure lost

Some authors have argued that the length of the working day increased after 1750 (Voth 1998, 2001). This has been interpreted as a sign that backward-bending labor supply curves declined (DeVries 2004) – people worked more as more consumer goods became available. It could be argued that the introduction of new goods led to a decline in leisure. This would imply that while utility from the new goods increased, our calculations might be upward-biased because we fail to account for the negative effects of longer hours.

Correcting for changes in leisure would be mistaken, in our view. First, the evidence that hours increased is controversial (Clark and Van der Werf 1998). Second, many of the gains in consumer welfare from new goods materialized long before work intensification became (potentially) an issue – by 1750, take-up rates were high. Third, as long as households set the number of hours supplied to the market in a utility-maximizing way, their revealed preference in the early, low-hours period was for leisure. This implies that the shadow value of time was low. If the availability of new goods by 1850 lead households to supply more labor, this suggests that that working was now worthwhile because the shadow value of time increased.⁴⁴ Deducting the value of leisure lost – when it was clearly of low value initially – would be inappropriate.

VI. Conclusions

There is a broad consensus that living standards stagnated for millennia before the transition from “Malthus to Solow” (Hansen and Prescott 2002, Galor 2005). Clark (2007) concluded that Englishmen in 1800 lived no better than their ancestors on the African savannahs. Long-run wage series suggest that life in England under Queen Victoria was hardly better than it had been

⁴³ We also experimented with picking ρ endogenously. This resulted in values of θ very close to unity, which is not in line with evidence on expenditure patterns.

under Henry VIII.⁴⁵ We argue that stagnating long-run real wage indices largely reflect measurement error. Life in early modern Britain got better – much better. Standard real wage series simply divide the nominal wage by the price of an unchanging consumption basket.⁴⁶ This is inappropriate for the period after the Discovery of America. By the eighteenth century at the latest, consumption habits had undergone a profound transformation. Trade brought new goods to Europe. These offered variety where monotony had reigned. Just as in the US in the last decades of the 20th century, trade had a direct and important impact on living standards due to gains from variety (Broda and Weinstein 2006). We use recently-developed methods to estimate the value of these gains for English consumers, and conclude that they are substantial – adding the equivalent of at least 16% (and possibly 20% or more) of household income to welfare.

Consumption of overseas ‘small luxuries’ spread quickly. Consumers voted with their pocketbooks in favor of coffee, tea, and sugar. Initially, high prices stood in the way of rapid adoption. As soon as cheaper supplies became available, consumption surged. By the 18th century, the regular use of tea and coffee had spread to all strata of society. Sugar was the second-biggest import of the UK by value in 1850, after cotton, and ahead of all grain including wheat. Tea was fourth, and coffee, sixth. Even the poorest groups of society spent 6-7% of household income on these colonial goods. By 1800, breakfast had changed from porridge and cold meat consumed with beer, to the morning meal we still consume today – bread or pastry, combined with a sugary hot beverage full of caffeine (Schivelbusch 1992; Braudel 1988; Mintz 1985).

⁴⁴ This is the approach favored by Usher (1980).

⁴⁵ Clark (2005).

⁴⁶ Even where new goods are eventually incorporated in the consumption basket, the welfare gains from their introduction will be largely overlooked if this occurs at a relatively late stage of adoption.

Our results suggest that existing real wage indices for early modern Europe may be too pessimistic. Traditional real wage measures suggest that, after 1500, wages either stagnated (England and Holland) or fell (rest of Europe). Allen (2001) documents the extent to which nominal incomes bought ever less in terms of a constant consumption basket. Our findings suggest that stagnation or apparent decline in early modern living standards owes more to mis-measurement than to immiseration. Consumption baskets typically used in studies of changes of living standards after 1500 give a weight of 50% to bread and beer (Allen 2001), and none to new colonial goods. It is therefore not surprising that many authors find Malthusian stagnation before 1800 (Clark 2007). We argue that this reflects difficulties of measurement, and not an absence of genuine improvements in the quality of life. Living standards improved by “stealth”. Traditional real wage indices have missed these changes because they are not designed to measure the impact of new goods. These findings also have implications for the period of the Industrial Revolution. While sugar, tea, and coffee were no longer “new”, their use spread far more widely -- and even Engels had to concede that tea was an integral part of lower class consumption patterns in England. The latest estimates by Clark (2005) and Allen (2007) suggest that real incomes probably increased by no more than 40-50% between 1780 and 1850. This study suggests that this is too pessimistic. Increases in consumer welfare by 1850 from the availability of coffee, tea, and tobacco, as derived from the Greenwood-Kopeccky and alternative methods, are substantial.⁴⁷

Our results for tea, sugar, and coffee constitute a lower bound on the discoveries’ overall effect. They stand *pars pro toto* for a wider range of ‘new goods’ that arrived on European

⁴⁷ Ideally, we would calculate welfare gains for the equivalent period, 1780-1850. Since the method relies on the assumption that the good is “new”, and hardly consumed in the beginning, this is not strictly possible for the goods discussed here. It is certainly possible for a different set of goods that entered the English consumption basket after 1780.

shores as a result of overseas expansion. The addition of tomatoes, potatoes, exotic spices, polenta, and tobacco transformed consumption habits in even more fundamental ways than sugar, tea, and coffee did. If the rise in consumption of all of these colonial goods was measured accurately, welfare gains for European consumers after 1492 would have been even larger than our findings suggest.

Compared to the introduction of new goods today, the welfare gains from introducing new overseas goods in the past were large. In Table 10, we compare the impact of recently invented new goods with our results. Even for the single biggest items, such as personal computers and the internet, welfare gains (while substantial) pale compared to historical precedent. Goolsbee and Klenow (2006) derive a gain of approximately 2% for the internet. For the good with the biggest estimate, personal computers, Greenwood and Kopecky (2009) show gains equivalent to 3.5-4% of income. Compared to these results, our findings suggest welfare gains that are orders of magnitude larger compared to all modern goods (except personal computers).⁴⁸ Other studies of gains from trade through increasing variety also show smaller increases than the ones we derive. Broda and Weinstein (2009) found welfare gains of 2.2-2.6%, approximately 1/6 of the improvement from sugar, tea, and coffee analysed in this paper.

Relatively large(r) gains in the past are to be expected. Introducing a new good mattered more – welfare gains were bigger, because the pre-existing range of goods was smaller than it is today.⁴⁹ Put another way – adding Apple Cheerios to the range of choices for breakfast cereals may improve welfare. However, being able to replace beer soup, porridge and cold cuts with

⁴⁸ In a similar vein, the findings in Nordhaus (1996) and Leunig (2006) also suggest large welfare gains from new goods introduced in the past.

⁴⁹ The second reason is that adoption took place over a much longer period – hundreds of years. Yet even if we restrict ourselves to the period up to 1750, we find welfare gains for coffee, tea and sugar of 3-4%, equal to the gains from computers estimated by Greenwood and Kopecky. By 1790, the gains from tea alone had reached a level of 7%.

milky, sugary coffee and bread with jam was much nicer. Exotic new goods from the Americas and the Far East – pepper and nutmeg, tea and sugar, coffee and tobacco, chocolate and cloves – improved living standards by far more than modern consumers, sated by an ever-expanding range of new goods, can readily appreciate. The reason why seemingly mundane goods like sugar, coffee and tea made a big difference to living standards is that life was not just ‘nasty, brutish, and short’ in Hobbes phrase at their time of introduction – it was also (at least in culinary terms) grey, boring, and bland.

References:

- Acemoglu, Daron, Simon Johnson, and James Robinson (2005) "The Rise Of Europe: Atlantic Trade, Institutional Change, And Economic Growth." *American Economic Review*, 95:546-579.
- Allen, Robert C. (1992). *Enclosure and the Yeoman*. New York: Oxford Press.
- Allen, Robert C. (2001). "The Great Divergence in European Wages and Prices from the Middle Ages to the First World War." *Explorations in Economic History* 38(4): 411-447.
- Allen, Robert C. (2007). "Engel's Pause: A Pessimist's Guide to the British Industrial Revolution", Nuffield working paper.
- Behrman, Jere and Anil Deolalikar (1987). "Will Developing Country Nutrition Improve with Income? A Case Study for Rural South India", *Journal of Political Economy* 95: 108-38.
- Berry, Steven, James Levinsohn, and Ariel Pakes (1995). "Automobile Prices in Market Equilibrium", *Econometrica* 63(4): 841-90.
- Bentley, J. H. (1999). "Asia in World History," *Education About Asia* 4: 5-9.
- Braudel, Fernand (1988). *The Structures of Everyday Life*. London: Phoenix.
- Bresnahan, Tim F. (1997). "The Apple-Cinnamon Cheerios War: Valuing New Goods, Identifying Market Power, and Economic Measurement". Available at <http://www.stanford.edu/~tbres/>
- Bresnahan, Tim F. and Robert J. Gordon (1996). "The Economics of New Goods: Introduction" In *The Economics of New Products*, eds., T. Bresnahan and R. Gordon, Chicago: University of Chicago Press: 1-26
- Broda, Christian, and David Weinstein (2006). "Globalization and the Gains from Variety", *Quarterly Journal of Economics* 121(2): 541-85.
- Brynjolfsson, Erik, Hu, Yu Jeffrey and Michael Smith (2003). "Consumer Surplus in the Digital Economy: Estimating the Value of Increased Product Variety at Online Booksellers". MIT Sloan Working Paper No. 4305-03.
- Cheung, Hoh and Lorna Mui (1975). "Trends in Eighteenth-Century Smuggling Reconsidered" *Economic History Review* 28(1): 28-43.
- Clark, Gregory, Kevin H. O'Rourke and Alan M. Taylor (2008). "Made in America? The New World, the Old, and the Industrial Revolution," NBER Working Papers 14077.
- Clark, Gregory (2007). "The Long March of History: Farm Wages, Population and Economic Growth, England 1209-1869." *Economic History Review* 60(1): 97-136.
- Clark, Gregory (2004). "The Price History of English Agriculture, 1209-1914." *Research in Economic History* 22: 41-124.
- Clark, Gregory (2005) "The Condition of the Working Class in England, 1209-2004." *Journal of Political Economy* 113 (6): 707-36.
- Clark, Gregory and Ysbrand Van Der Werf (1998). "Work in Progress? The Industrious Revolution." *The Journal of Economic History* 58(3): 830-843.
- Cole, W. A. (1958). "Trends in Eighteenth-Century Smuggling." *Economic History Review* 10(3): 395-410.
- Cole, W. A. (1975). "The Arithmetic of Eighteenth-Century Smuggling: Rejoinder" *Economic History Review* 28(1): 44-49.
- Cowan, Brian (2005). *The Social Life of Coffee: The Emergence of the British Coffeehouse*, New Haven: Yale University Press.

- DeVries, Jan (2008). *The Industrious Revolution: Consumer Behavior and the Household Economy, 1650 to the Present*. Cambridge: Cambridge University Press.
- Davis, Ralph (1979). *The Industrial Revolution and British Overseas Trade*. Leicester: Leicester University Press.
- Deaton, Angus (1997). *The Analysis of Household Surveys: A Microeconomic Approach to Development Policy*. Baltimore, Maryland: The Johns Hopkins University Press.
- Deerr, Noel (1950). *History of Sugar*. London: Chapman & Hall.
- Dixit, Avinash K. and Joseph E. Stiglitz (1977). "Monopolistic Competition and Optimum Product Diversity." *American Economic Review* 67(3): 297-308.
- Dowell, Stephen (1888). *A History of Taxation and Taxes in England from the Earliest Times to the Year 1885*. London: Longmans and Green.
- Eden, Sir Frederick (1797). *The State of the Poor*. London.
- Engels, Friedrich (1844). *The Condition of the Working Class in England*. New York: Penguin Classics, 1987.
- Feenstra, Robert C. (1994). "New Product Varieties and the Measurement of International Prices." *American Economic Review* 84(1): 157-77.
- Feinstein, Charles H. (1998). "Pessimism Perpetuated: Real Wages and the Standard of Living in Britain during and after the Industrial Revolution." *Journal of Economic History* 58(3): 625-58.
- Fogel, Robert F. (1994). "Economic Growth, Population Theory, and Physiology: The Bearing of Long-Term Processes on the Making of Economic Policy." *American Economic Review* 84(3): 369-95.
- Forrest, Denys (1973). *Tea for the British*, London: Chatto & Windus.
- Frank, Andre Gunder (1998). *ReOrient: Global Economy in the Asian Age*. Berkeley, CA: University of California Press.
- Fujita, Masahisa, Paul Krugman, and Anthony Venables, *The Spatial Economy: Cities, Regions, and International Trade* (Cambridge, MA, and London, UK: MIT Press, 1999).
- Galor, Oded (2005). "From Stagnation to Growth: Unified Growth Theory", in Philip Aghion and Steven Durlauf, eds., *Handbook of Economic Growth*, Vol. 1A. Amsterdam: North-Holland.
- Galor, Oded and Omer Moav (2002). "Natural Selection and the Origins of Economic Growth." *Quarterly Journal of Economics* 117(4): 1133-1192.
- Galor, Oded and David Weil (2000). "Population, Technology and Growth: From Malthusian Stagnation to Demographic Transition and Beyond." *American Economic Review* 90(4): 806-28.
- Gemmill, Gordon (1980). "Form of Function, Taste, and the Demand for Sugar in Seventy-Three Nations", *European Economic Review* 13: 189-205.
- Goodman, Jordan (1995). "Excitantia: or, How Enlightenment Europe Took to Soft Drugs", in: Jordan Goodman, P. E. Lovejoy and Andrew Sherratt (eds.), *Consuming Habits: Drugs in History and Anthropology*. London.
- Goolsbee, Austan, and Peter J. Klenow (2006). "Valuing Consumer Products by the Time Spent Using Them: An Application to the Internet." *American Economic Review* 96(2): 108-113.
- Goolsbee, Austan and Amil Petrin (2004). "The Consumer Gains from Direct Broadcast Satellites and the Competition with Cable TV." *Econometrica* 72: 351-381

- Greenwood, Jeremy and Kopecky, Karen A. (2009). "Measuring the Welfare Gain from Personal Computers." *Economie d'avant garde Research Report No. 15*.
- Grossman, Gene, and Elhanan Helpman (1991). *Innovation and Growth in the Global Economy*. Cambridge, MA, and London, UK: MIT Press.
- Hansen, Gary D., and Edward C. Prescott (2002). "Malthus to Solow." *American Economic Review*, 92 (4): 1205-1217.
- Hausman, Jerry (1996). "Valuation of New Goods Under Perfect and Imperfect Competition." In *The Economics of New Products*, eds., T. Bresnahan and R. Gordon, Chicago: University of Chicago Press: 209-237.
- Hausman, Jerry (1999). "Cellular Telephone, New Products, and the CPI." *Journal of Business and Economic Statistics* 17(2): 188-194.
- Helpman, Elhanan, and Paul Krugman (1985). *Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition, and the International Economy*. Cambridge, MA, and London, UK: MIT Press.
- Horrell, Sara (1996). "Home Demand and British Industrialization." *Journal of Economic History* 56 (3): 561-604.
- Hotelling, H. (1929). "Stability in Competition," *Economic Journal* 39: 41-57.
- Hulten, Charles (1996). "Comment" In *The Economics of New Products*, eds., T. Bresnahan and R. Gordon, Chicago: University of Chicago Press: 66-70.
- Jensen, Robert and Nolan Miller (2008). "Giffen Behavior and Subsistence Consumption." *American Economic Review* 98(4): 1553-1577.
- Jones, Chad (2001). "Was an Industrial Revolution Inevitable?" *Advances in Macroeconomics* 1(2).
- Kanayama, Toshihisa, Caldas, Eduardo, Manabu Sawada, and Tokihisa Doi (1999). "A Study on Changes in the Demand for Sugar and the Sugar Industry in Japan", Obihiro University of Agriculture and Veterinary Medicine wp.
- Kremer, Michael (1993). "Population Growth and Technological Change: One Million B.C. to 1990." *Quarterly Journal of Economics* 108: 681-716.
- Krugman, Paul (1987). "Increasing Returns, Monopolistic Competition, and International Trade," *Journal of International Economics*, IX (1979), 469-479.
- Lancaster, K.J. (1975). "Socially Optimal Product Differentiation." *American Economic Review* 65(4): 567-585.
- Leunig, Tim (2006). "Time is Money: A Re-Assessment of the Passenger Social Savings from Victorian British Railways." *Journal of Economic History* 66(3): 635-73.
- Lindert, Peter H., and Jeffrey G. Williamson (1983) "English Workers' Living Standard During the Industrial Revolution: A New Look." *Economic History Review* 36: 1-25.
- Lindert, Peter H. and Jeffrey G. Williamson (1985). "English Workers' Real Wages: Reply to Crafts," *Journal of Economic History* 45: 145-153.
- Loschky, D. (1980). "Seven Centuries of Real Income per Wage Earner Reconsidered", *Economica* 47: 459-465.
- Maddison, Angus (2001). *The World Economy: A Millennial Perspective*, Paris: OECD.
- Menard, Russell (1991). "Transport Costs and Long-range Trade: Was there a European 'Transport Revolution' in the Early Modern Era?". In: J. D. Tracy (ed.), *Political Economy of Merchant Empires*. Cambridge: Cambridge University Press.
- Mintz, Sidney W. (1985). *Sweetness and Power: The Place of Sugar in Modern History*. New York: Viking Penguin.

- Mitchell, B. R. and P. Deane (1962). *Abstract of British Historical Statistics* Cambridge.
- Mokyr, Joel (1988). "Is There Still Life in the Pessimist Case? Consumption during the Industrial Revolution, 1790-1850." *Journal of Economic History* 48(1): 69-92.
- Mokyr, J., and C. Ó Grada (1988). "Poor and Getting Poorer?: Living Standards in Ireland. Before the Famine," *Economic History Review*, 41:209-35.
- Nordhaus, William D. (1996). "Do Real-Output and Real-Wage Measures Capture Reality? The History of Lighting Suggests Not", In *The Economics of New Products*, eds., T. Bresnahan and R. Gordon, Chicago: University of Chicago Press, 27 - 70.
- Nunn, Nathan and Nancy Qian (2008). "Columbus's Contribution to World Population and Urbanization: A Natural Experiment Examining the Introduction of Potatoes," mimeo, Harvard University.
- Nunn, Nathan and Nancy Qian (2009). "The Columbian Exchange: A History of Disease, Food, and Ideas", mimeo, Harvard University.
- O'Brien, Patrick (1982). "European Economic Development: The Contribution of the Periphery", *Economic History Review* 34 (1): 1-18.
- O'Rourke, Kevin and Jeffrey Williamson (2002). "When Did Globalization Begin?", *European Review of Economic History* 6: 23-50.
- Pepys, Samuel (1854). *Diary and Correspondence of Samuel Pepys, F.R.S.* Hurst and Blackett.
- Petrin, Amil (2002). "Quantifying the Benefits of New Products: The Case of the Minivan." *Journal of Political Economy*, 110(4): 705-729.
- Phelps Brown, Henry and Sheila V. Hopkins (1981). *A Perspective of Wage and Prices*. London: Methuen.
- Romer, Paul M. (1994), "New Goods, Old Theory, and the Welfare Costs of Trade Restrictions." *Journal of Development Economics* 43(1): 5-38.
- Schivelbusch, Wolfgang (1992). *Tastes of Paradise: A Social History of Spices, Stimulants, and Intoxicants*. Trans. David Jacobson NY: Vintage.
- Shammas, Carole (1990). *The Pre-industrial Consumer in England and America*. Oxford: OUP.
- Schmitz, Andrew, Schmitz, Troy, and James Seale (2008) , "CAFTA and US Sugar", *University of Florida Research Report*.
- Spence, Michael (1976). "Product Differentiation and Welfare," *American Economic Review*, American Economic Association, 66: 407-14.
- Strauss, John and Duncan Thomas (1995). "Human Resources: Empirical Modeling of Household and Family Decisions," in Behrman, Jere R. and T.N. Srinivasan, eds., *Handbook of Development Economics*, Volume 3, Amsterdam: North-Holland.
- Usher, Dan. *The Measurement of Economic Growth*. New York: Columbia University Press.
- Vanderlint, Jacob. (1734) 1914. *Money Answers All Things*. Edited by Jacob H. Hollander. Baltimore: Johns Hopkins University Press.
- Voigtlaender, Nico and Hans-Joachim Voth (2006). "Why England? Demographics, Living Standards and the First Industrial Revolution." *Journal of Economic Growth* 11(4): 319-61.
- Voth, Hans-Joachim (1998). "Time and Work in Eighteenth-Century London", *Journal of Economic History* 58 (1): 29-58.
- Voth, Hans-Joachim (2001). *Time and Work in England, 1750-1830*. Oxford: Oxford University Press.

Wallerstein, Immanuel (1974). *The Modern World-System, vol. I: Capitalist Agriculture and the Origins of the European World-Economy in the Sixteenth Century*. San Diego, CA: Academic Press.

Wrigley, E.A., Ruth Davies, Jim Oeppen, and Roger Schofield (1997). *English Population History from Family Reconstitution*. Cambridge: Cambridge University Press.

FIGURES

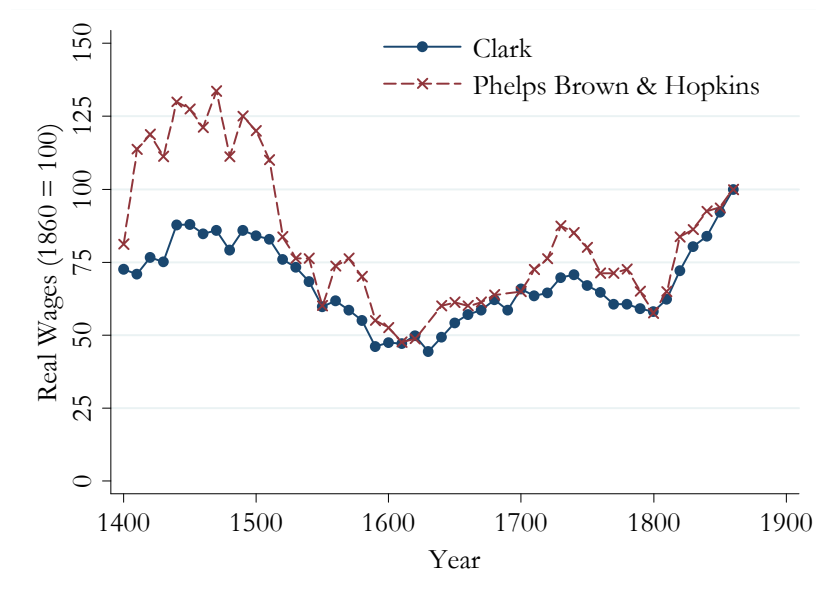


Figure 1: Real income in England, 1400-1850

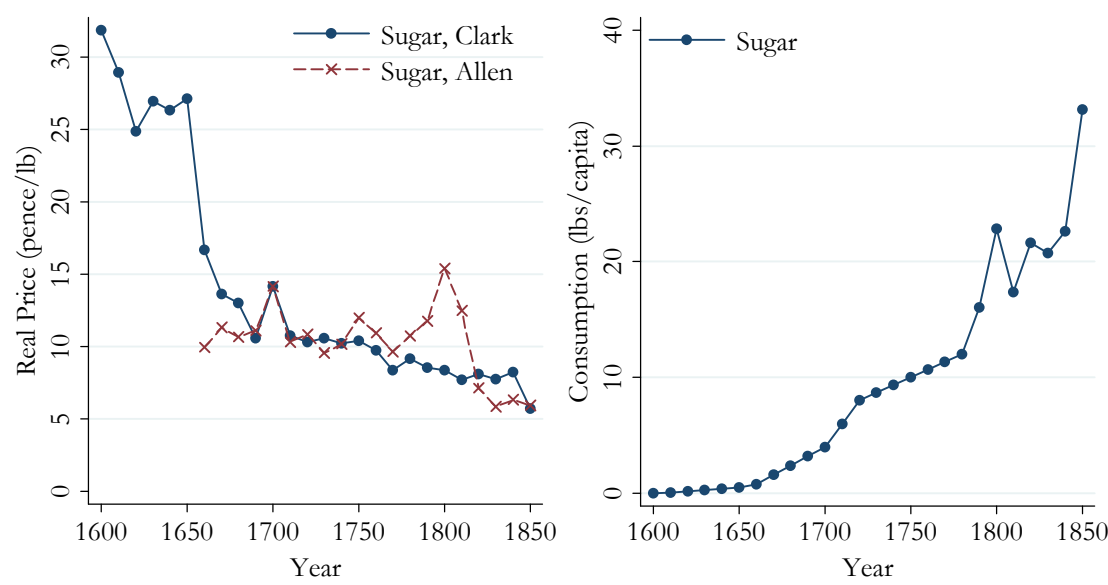


Figure 2: Real Sugar Prices and Sugar Consumption Per Capita in England, 1600-1850

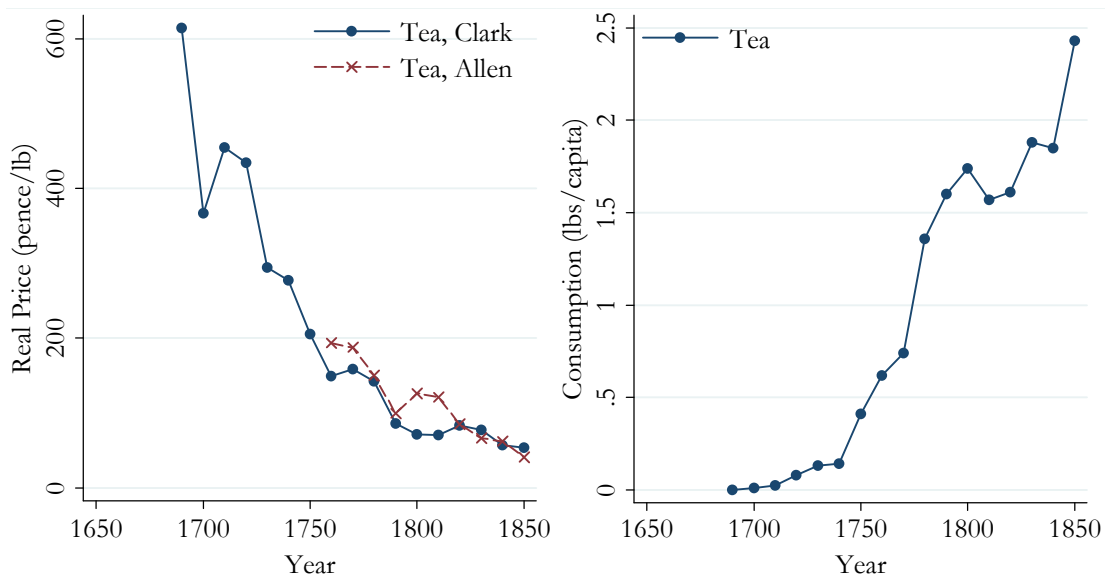


Figure 3: Real Tea Prices and Consumption Per Capita in England, 1600-1850

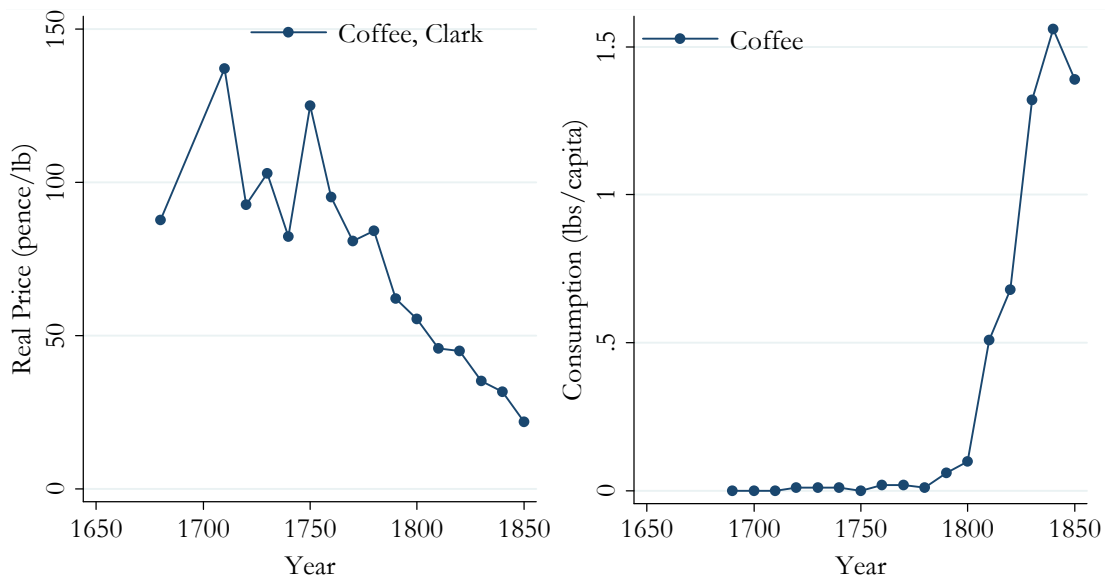


Figure 4: Real Coffee Price and Consumption Per Capita in England, 1600-1850

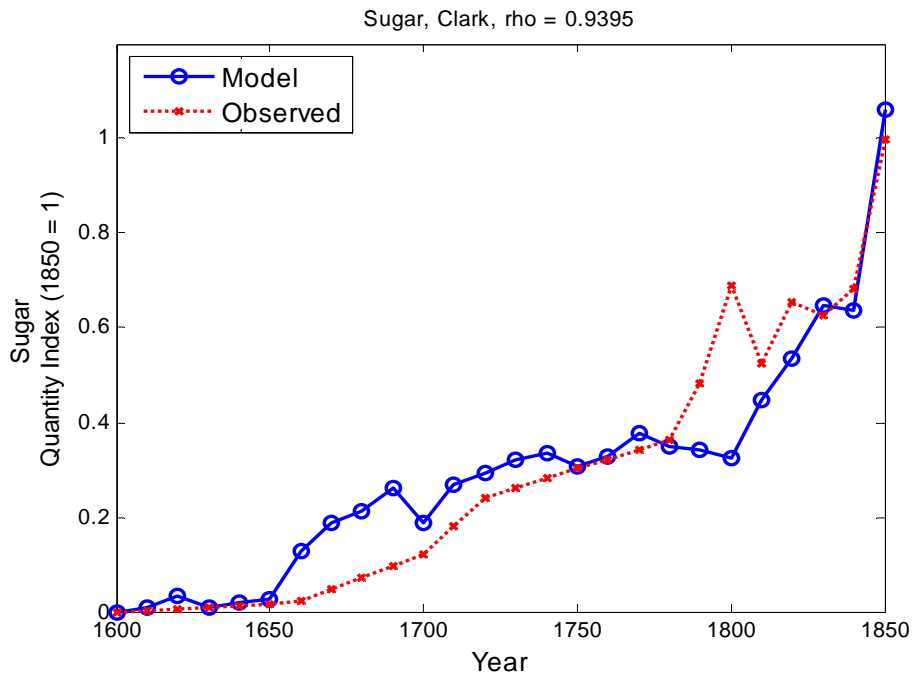


Figure 5: Predicted vs actual values for sugar consumption in England, 1600-1850

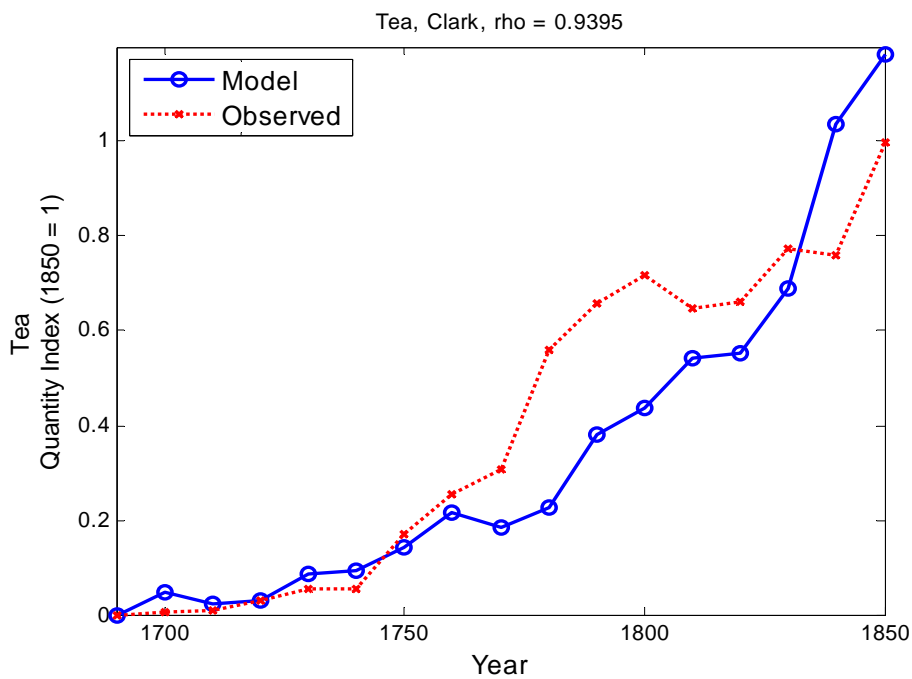


Figure 6: Predicted vs actual values for tea consumption in England, 1690-1850

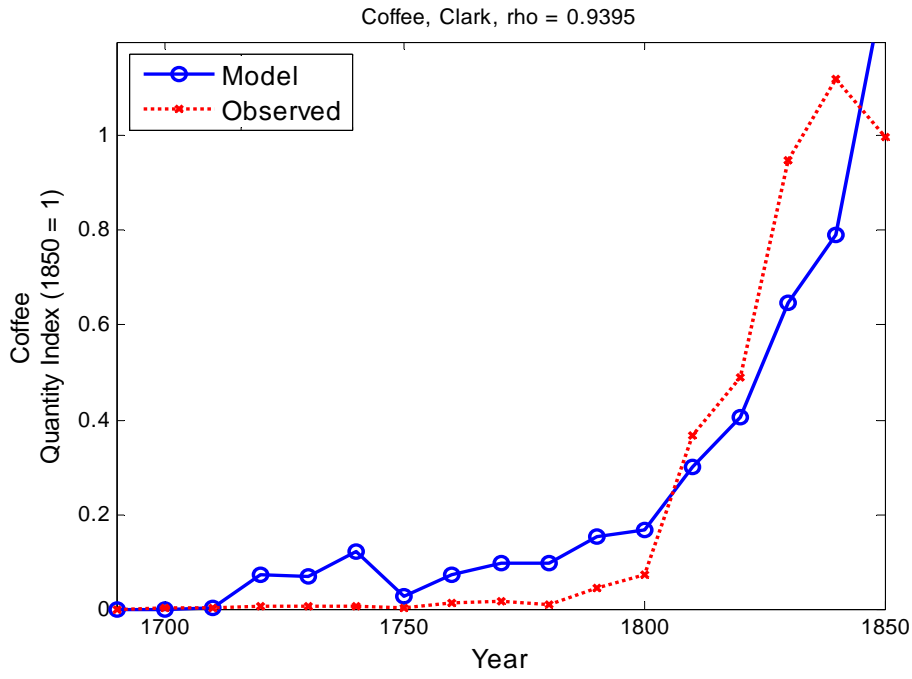


Figure 7: Predicted vs actual values for coffee consumption in England, 1690-1850

TABLES

Table 1: Consumption of colonial luxuries in Europe, early modern period (lbs per head and year)

	Sugar		Coffee		Tea	
England	1670s	2.2	1699-1701	0.1	1722	0.6
	1700-9	5.7	1749-51	0.1	1750-9	1.1
	1750-9	11.0	1801	0.1	1804-6	1.7
	1770-9	23.1	1841	0.5	1844-6	1.8
Belgium	1800	3.6	1790	0.1	1720-9	0.1
	1850-4	6.6	1850-4	8.8	1850-4	0.02
France	1730-4	1.0	1781-9	0.5		
	1788-90	2.1	1815-24	0.5	1825-34	0.1
	1830	4.4	1825-35	0.6	1835-44	0.1
Austria	1780	0.3	1780	0.1		
	1800	0.9	1800	0.1		
	1830	2.2				

Source: adapted from DeVries (2008)

Table 2: Wages and Budget Shares

Year	Daily Wages (pence)	Estimated Using Daily Wages		From Historial Records of Budget Shares	
		Sugar (Budget %)	Tea (Budget %)	Sugar - Feinstein (Budget %)	Tea - Horrell (Budget %)
1780	17.17	3.63%	6.36%		
1790	18.41	4.89%	4.93%	4.83% ^a	3.02% ^c
1800	23.01	7.33%	4.80%		
1810	30.47	4.32%	3.58%		
1820	30.60	4.63%	3.57%		
1830	30.14	3.90%	3.55%	4.55% ^b	
1840	30.79	4.30%	2.42%		
1850	31.29	4.07%	2.82%		2.13% ^d

Notes: Sources discussed in text. Daily wages are in nominal terms. Some individual years of data have been adjusted to closest matching decade: ^a1788–92. ^b1828–32. ^c1787–96. ^d1840–54

Table 3: Baseline Results – welfare gains from sugar, tea, and coffee, England (1600-1850)

New Good	Year Range	<i>EV</i>	<i>CV</i>	ν	ρ	θ	R^2
Panel A. Results with ρ calibrated at 0.9395							
Sugar	1600–1850	8.0%	7.6%	0.0993	0.9395	0.9435	0.8517
Tea	1690–1850	7.9%	7.3%	0.0572	0.9395	0.9590	0.7718
Coffee	1690–1850	1.5%	1.5%	0.1255	0.9395	0.9875	0.8508
Welfare Gain		17.3%	16.4%				
Panel B. Results with $0 < \rho \leq 2$							
Sugar	1600–1850	6.4%	6.2%	0.0590	0.7216	0.9268	0.8596
Tea	1690–1850	13.6%	11.3%	0.1550	1.4894	0.9711	0.8066
Coffee	1690–1850	2.9%	3.0%	0.3857	2	0.9991	0.8871
Welfare Gain		22.9%	20.40%				

Notes: The parameter values of ν , ρ , and θ are calibrated by choosing values that minimize sum of squared error between predicted and actual new good consumption. In panel A, ρ is fixed at 0.9395 and only ν and θ are chosen. *EV* refers to equivalent variation and *CV* to compensating variation. The parameter θ is the weight on utility from new good consumption, $\frac{1}{\rho}$ is the intertemporal elasticity of substitution, and ν is the new good utility shift.

Table 4: Robustness – alternative parameter values

New Good	Year Range	<i>EV</i>	<i>CV</i>	ν	ρ	θ	R^2
Panel A. Robustness of results using $\rho = 2$							
Sugar	1600-1850	20.3%	14.4%	0.2792	2	0.9806	0.8045
Tea	1690-1850	20.9%	14.5%	0.2494	2	0.9774	0.7963
Coffee	1690-1850	2.9%	3.0%	0.3857	2	0.9991	0.8871
Welfare Gain		44.1%	31.9%				
Panel B. Robustness of results using $\rho = 0.7$							
Sugar	1600-1850	6.2%	6.0%	0.0551	0.7	0.9248	0.8595
Tea	1690-1850	5.5%	5.3%	0.0237	0.7	0.9510	0.6990
Coffee	1690-1850	1.1%	1.2%	0.0646	0.7	0.9763	0.8057
Welfare Gain		12.9%	12.5%				
Panel C. Robustness of results using $\nu = 0.01$							
Sugar	1600-1850	6.8%	6.4%	0.0100	0.6199	0.9199	0.8531
Tea	1690-1850	30.8%	21.7%	0.0100	1.2126	0.9707	0.8209
Coffee	1690-1850	2.0%	1.9%	0.0100	0.7880	0.9828	0.8054
Welfare Gain		39.6%	30.00%				

Notes: *EV* refers to equivalent variation and *CV* to compensating variation. The parameter θ is the weight on utility from new good consumption, $\frac{1}{\rho}$ is the intertemporal elasticity of substitution, and ν is the new good utility shift.

Table 5: Robustness – alternative functional form

New Good	Year Range	<i>EV</i>	<i>CV</i>	ν	σ	θ	R^2
Sugar	1600-1850	6.4%	5.9%	0.06	1.4	0.93	0.86
Tea	1690-1850	13.6%	10.8%	0.155	0.67	0.97	0.88
Coffee	1690-1850	1.6%	1.6%	0.126	0.98	0.99	0.85
Welfare Gain		21.6%	18.3%				

Notes: EV refers to equivalent variation and CV to compensating variation. The parameter θ is the weight on utility from new good consumption, σ is the elasticity of substitution, and ν is the new good utility shift. In order to ensure convergence of our estimation procedure, we set ν in the case of coffee to the same value as in the baseline calibration.

Table 6: Robustness – alternative data series

New Good	Year Range	<i>EV</i>	<i>CV</i>	ν	ρ	θ	R^2
Baseline - Clark price data							
Sugar	1600–1850	8.0%	7.6%	0.0993	0.9395	0.9435	0.8517
Tea	1690–1850	7.9%	7.3%	0.0572	0.9395	0.9590	0.7718
Clark - date range matched to Allen							
Sugar	1650–1850	7.7%	7.4%	0.1150	0.9395	0.8063	0.8134
Tea	1690–1850	7.9%	7.3%	0.0572	0.9395	0.9590	0.7718
Allen price data, $\rho = 0.9395$							
Sugar	1650–1850	5.3%	7.2%	0.4348	0.9395	0.8984	0.5536
Tea	1690–1850	5.5%	6.0%	0.2441	0.9395	0.9410	0.4103

Notes: The parameter values of ν and θ are calibrated by choosing values that minimize sum of squared error between predicted and actual new good consumption. EV refers to equivalent variation and CV to compensating variation. The parameter θ is the weight on utility from new good consumption, $\frac{1}{\rho}$ is the intertemporal elasticity of substitution, and ν is the new good utility shift.

Table 7: Robustness – sugar and tea estimated jointly

New Good	<i>EV</i>	<i>CV</i>	ν	ρ	θ	R^2
Sugar & Tea Composite Good, 1690–1850						
$\rho = 0.9395$	16.8%	14.2%	0.1075	0.9395	0.8984	0.8407
$0 < \rho \leq 2$	19.1%	15.6%	0.1418	1.0705	0.9024	0.8433
Sugar, 1690–1850						
$\rho = 0.9395$	4.6%	6.1%	0.4445	0.9395	0.9162	0.4178
$0 < \rho \leq 2$	4.8%	6.3%	0.4685	0.9902	0.9226	0.4183
Tea, 1690–1850						
$\rho = 0.9395$	7.9%	7.3%	0.0572	0.9395	0.9590	0.7718
$0 < \rho \leq 2$	13.6%	11.3%	0.1550	1.4894	0.9711	0.8066

Notes: EV refers to equivalent variation and CV to compensating variation. The parameter θ is the weight on utility from new good consumption, $\frac{1}{\rho}$ is the intertemporal elasticity of substitution, and ν is the new good utility shift.

Table 8: Welfare Results using Hausman Methodology

New Good	<i>S</i>	η	<i>CV</i>	Source
Historical elasticities				
Tea & coffee	3.2%	-0.25	6.4%	Horrell 1996
Sugar & treacle	3.6%	-0.25	7.2%	Horrell 1996
<i>Sum</i>	0.068		0.135	
Tea & coffee	3.2%	-0.644	2.5%	Mokyr 1988
Sugar & treacle	3.6%	-0.099	18.2%	Mokyr 1988
<i>Sum</i>	0.068		20.7%	
Contemporary elasticities				
Tea & coffee	3.2%	-0.22	7.3%	Cramer 1973
Sugar & treacle	3.6%	-0.14	12.9%	Schmitz et al. 2008
Sugar & treacle	3.6%	-0.13 to -0.16	11.3 to 13.8%	Kanayama 1999
Sugar & treacle	3.6%	-0.25 to -0.45	4 to 7%	Gemmill 1980

Table 9: Welfare Results - Tobacco

Greenwood-Kopeccky method; $\rho = 0.9395$						
period	<i>EV</i>	<i>CV</i>	ν	ρ	θ	R^2
1630-1760	4.6%	4.4%	0.044	0.9395	0.9753	0.65
1630-1850	3.27%	3.3%	0.067	0.9395	0.9748	0.38
Hausman method						
period	<i>S</i>	η	<i>CV</i>	Source		
1790	3.11%	-0.411	3.78%	Mokyr 1988		
average 1630-1850	2.64%	-0.411	3.21%	Mokyr 1988		

Table 10: Impact of new goods on welfare

Good	Welfare Gain	Year	Source
Modern Goods			
Apple Cinnamon Cheerios	0.002%	1992	Hausman (1996)
Personal computers	3.5–4%	2004	Kopeccky & Greenwood (2009)
Minivans	0.03%	1988	Petrin (2002)
Satellite TV	0.04–0.06%	2001	Goolsbee & Petrin (2004)
Internet	2-3*%	2005	Goolsbee & Klenow (2006)
Mobile phones	0.46–0.9%	1996	Hausman (1999)
Foreign varieties	2.2-2.6**%	2001	Broda & Weinstein (2006)
Colonial Luxuries			
Sugar	7.58–8.03%	1600–1850	this study
Tea	7.28–7.85%	1690–1850	this study
Coffee	1.45–1.54%	1690–1850	this study

Notes: Welfare results from this study are generated using Clark data with preferred ρ calibration.
 * for linearization case ** imported to the US.

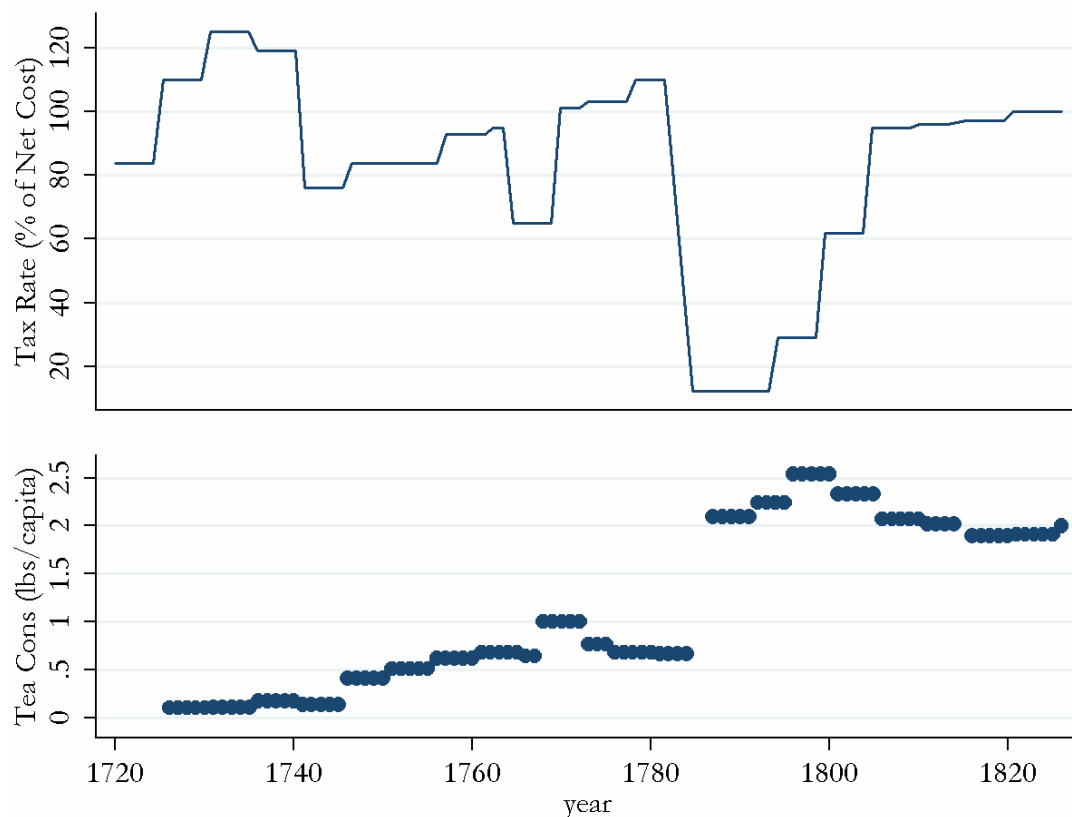
Appendix 1

We briefly set out our methodology for correcting the quantity of tea consumed in Britain for the effect of smuggling. Figure A1 demonstrates the problem – legal imports jump around the date of the big duty reduction. To eliminate the effects of tariff changes, we estimate

$$Q_t = C + \beta p_t + \gamma D_t + \varepsilon_t \quad (\text{A1})$$

where Q is the (legal) quantity of tea imported, p is the retail price, D is the duty charged on tea imports, and ε is the error term. Since naval wars and weather events were responsible for most of the short-term variation in prices, we think of this basic relationship as tracing out the (short-term) demand curve. By adding a control for the tariff, we incorporate information about incentives to smuggle. Estimating eq. A1 yields coefficient (t-statistic) estimates for C , β , and γ of 3.05 [25.9], -0.008 [13.7], and -0.008 [5.8]. This suggests that years with high imports were on average associated with low retail prices. Over and above the effect from low retail prices, lower duty charged also coincides with greater imports.⁵⁰

⁵⁰ To the extent that the regression picks up a common trend, we will be *overcorrecting* for smuggling, thus biasing results against our claim that new goods added substantially to welfare.



Source: Cole (1958)

Figure A1

To adjust for the effect of smuggling, we want to know how large total imports would have been had it not been for a (time-varying) incentive to smuggle. To calculate a constant-smuggling series for tea, we hold the tariff rate constant at the period average. We then use the estimated relationship from A1 to predict tea demand in the absence of tariff changes. To fully correct for the effects of smuggling, we also want to correct for the effect of tariffs on prices. Years with high tariff rates also saw high prices. If we want to estimate quantities of tea imported in a constant tariff setting, we need to adjust actual prices for the effect of the tariff. We estimate corrected demand for tea from equation A1, using the predicted price in a constant-tariff scenario. Overall, these corrections reduce growth in the British demand for tea. Adjusted tea imports in the (early) years of our sample are now markedly higher. Figure A2 illustrates the

change. During the period of the highest tariffs, the middle of the 18th century, there is substantial divergence between the corrected and uncorrected series. Then, as tariffs are cut drastically after 1784, the predicted series falls below the ‘legal’ import series. Overall, the variability of the new, predicted series is lower than that of the official imports. It could be argued that it is not plausible that actual imports were below official ones, since the incentive to smuggle was either positive or zero. In our smuggling robustness check, insofar as the true import series showed greater growth than our corrected series, we will underestimate the welfare gain. Since we argue that gains were large, this only biases results against our hypothesis.

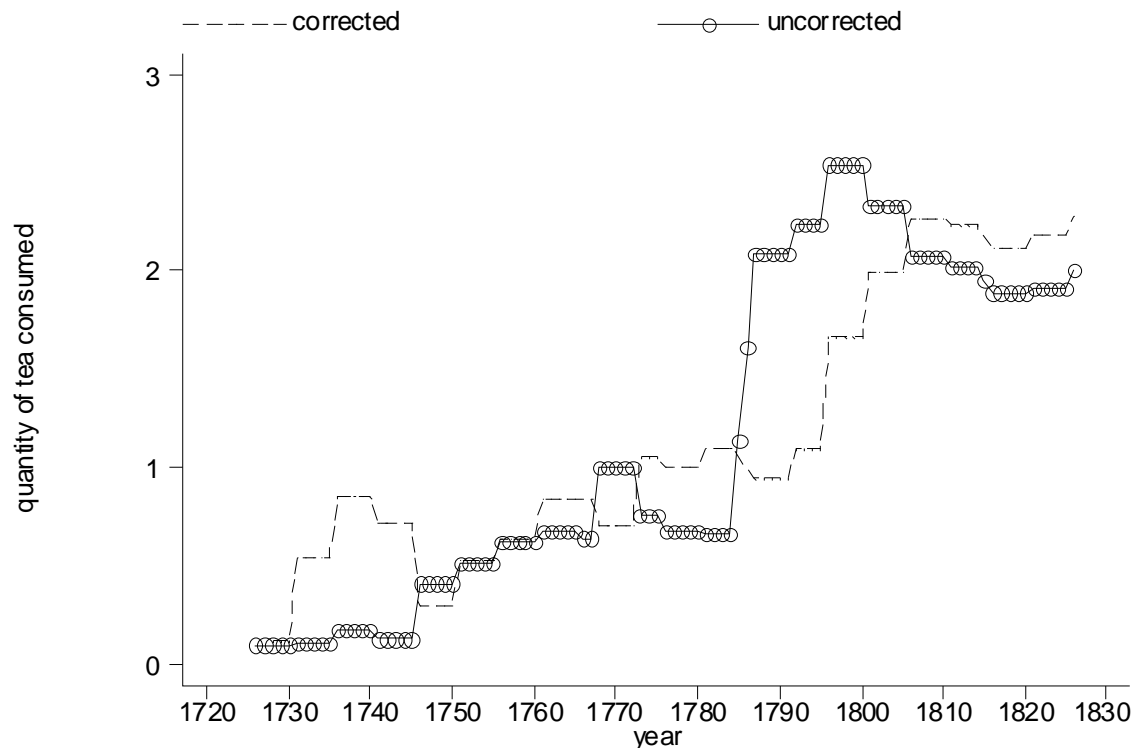


Figure A2

Appendix II

We use a variety of sources to track the price of tobacco and the volume consumed. For the early years, 1630-1693, we rely on Rogers (1887).⁵¹ At the beginning of our period, there is confusion in the price series about the quality for which prices are being quoted. Spanish tobacco was several times dearer than colonial tobacco. Price fluctuations may be driven by overall changes in the price of tobacco, or by its origin. To sidestep the issue, we adjust the prices of Spanish tobacco by the average price difference between both types.

Smuggling was a major issue in the case of tobacco. We use series that attempt to adjust for it. Shamma (1990) gives consumption figures for 1618-1694. Tariffs only started to impinge significantly from the late 17th century onwards (Dowell 1888). We take advantage of the corrected series in Shamma (1990), which is based on Nash (1958) where available.

⁵¹ For the interval 1700-1740, there is data in Clemens (1980). It is for colonial America, and the price trend is different from the one in the UK. We decided not to use it in our estimation procedure since there is no direct way of matching Clemens' data with the Rogers and Clark series.