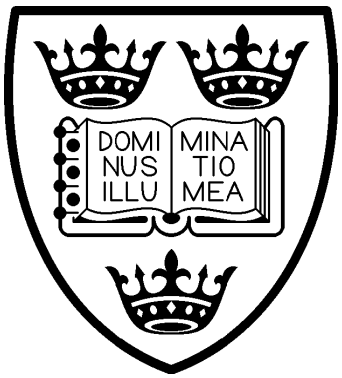

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THE PRICE OF TIME AND LABOUR SUPPLY: FROM THE BLACK DEATH TO THE INDUSTRIOUS REVOLUTION

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Abstract

In pre-industrial economies labour supply curves often bend backwards at very low levels of income. This changed prior to the industrial revolution: total working hours increased (De Vries (1993, Voth (1998,2000). This paper examines this industrious revolution using a model of labour supply where consumption takes time. This analytical framework enables us to draw a distinction between a pessimistic account of the industrious revolution as suggested by Van Zanden (2006) and an optimistic account advanced by de Vries (2008) of an industrious revolution driven by changing patterns of demand. This formulation clarifies the importance of new consumption opportunities in driving hours worked.

Key words: labour supply, industrious revolution, consumption, time allocation
JEL classification: N23, J22

‘So visibly is this Kingdom degenerated from the great Atchievements of Vertue and Industry, into all the soft indulgences of Sloth, and of an effeminate and luxurious course of Life . . . ’

A discourse upon the Necessity of Encouraging Mechanic Industry
JOHN POLLEXFEN, 1690

‘Give to an Irish labourer a taste for the comforts and enjoyments which habit has made essential to the English labourer, and he would be then content to devote a further proportion of his time to industry, that he might be enabled to obtain them.’

The Principles of Economics
DAVID RICARDO (1950, 1817)

1 Introduction

The two quotes at the top of this page indicate an important change in perceptions. John Pollexfen (1690) echoed a view, common in the seventeenth century, that the labour supply curve bent backwards at a very low level of income, and that idleness was the most pressing impediment to economic development. Ricardo (1950, 1817) writing a century and a quarter later, however, took the industriousness of the English worker for granted. He argued that a taste for consumption goods was responsible for this industriousness, and that if a similar ‘habit’ could be acquired by the Irish, it would help to improve living standards in that country.

This paper addresses the disparity posed by the two views by using a theoretical model that builds on Becker’s (1965) model of time use to examine the supply of labour in the period prior to the industrial revolution. This analytical framework enables us to draw a distinction between a pessimistic account of the industrious revolution as suggested by Van Zanden (2006) and an optimistic account advanced by de Vries (2008) of an industrious revolution driven by changing patterns of demand. Consider the following three puzzles.

Puzzle I: High productivity and low output in the Middle Ages

The first puzzle is posed by high recorded levels of agricultural productivity in parts of medieval Europe. Until recently, land and particularly labour productivity levels were thought to be low throughout the high middle ages [1100-1350], and an agricultural revolution was held to

have been necessary in order to raise productivity levels in the centuries before the industrial revolution (Postan, 1966).[1] Recent work, however, has demonstrated that medieval farms were capable of achieving high yields and, in certain circumstances, high levels of labour productivity.

Campbell and Overton (1993) found crop yields in medieval Norfolk to be comparable to those recorded in the late seventeenth century. Similarly, Karakacili (2004) estimated that farmers in the Ramsey manors recorded higher levels of labour productivity than have been found typical for seventeenth and eighteenth century farmers.[2] This is supported by Grantham (1978, 1980, 1989, 1999) whose work on French agriculture suggests that, where urban demand was high enough, medieval agricultural technology was capable of producing both high yields and relatively high levels of labour productivity. If medieval agriculture was capable of achieving high crop yields and high levels of labour productivity, this raises the question: why does aggregate output appear to have remained low?

Puzzle II: High wages and the industrial revolution

Another puzzle concerns the emergence of a 'high wage economy' in eighteenth century England. Harley (1982) and Crafts (1985) established that growth was slower than had previously been thought on the basis of earlier estimates made by Deane and Cole (1969).[3] Total factor productivity growth was confined to a few 'mushroom-like' sectors like cotton textiles and coal mining. These sectors, though undoubtedly dynamic, had only a small impact on total output. Other forms of manufacturing and services saw little growth (Crafts and Harley, 2000). Slower growth during the industrial revolution proper means that the pre-industrial English economy was richer and more developed that had hitherto been thought.

The distinctive feature of the English economy in the eighteenth century was high wages, and these high wages shaped the incentives innovators and entrepreneurs faced. Allen (2009) argues

[1] For a discussion of this view see Campbell and Overton (1993, 38–50).

[2] She notes that '[h]igh out was achieved under conditions that were thought would result in the lowest levels of agrarian labor productivity rates: much of the work was performed by serfs, in open fields, using medieval technology, during a time in which population pressures on land resources reached their peaks' (Karakacili, 2004, 43).

[3] Recent work in economic growth theory has focused on providing an explanation of the onset of modern economic growth during the industrial revolution (see Galor and Weil, 2000; Galor and Moav, 2002; Jones, 2001; Lucas, 2002; Hansen and Prescott, 2002; Doepke and Zilibotti, 2008; Acemoglu, 2008). Economic growth is viewed as a 'great discontinuity' around 1800 much as it was by Max Hartwell (1971). But as Hans-Joachim Voth notes '[j]ust as growth theorists have begun to model the Industrial Revolution as a dramatic discontinuity, economic historians have found more and more evidence that growth was slow' (Voth, 2003, 222).

that, alongside cheap energy, it was this feature of the economy that made it worthwhile for inventors to invest in developing labour-saving technological innovations.[4] This argument takes high wages as its starting point, but from another perspective, high wages are an outcome to be explained. Wages cannot be taken simply as parameters. We need to ask: what does it mean for an economy to have high wages?

Allen (2009) accounts for high English wages in the context of the comparative commercial success achieved by England during the seventeenth and eighteenth centuries. This is clearly an important casual factor, but the high urban labour demand that this commercial success created had to be mediated through labour markets. Wages can be high because labour is scarce (as was the case in post-Black Death Europe), without necessarily leading to innovation.[5] Many of the gains made by workers in the late fourteenth and fifteenth centuries were consumed in the form of shorter working hours and longer holidays. The situation in eighteenth century England was quite different; it was not a labour scarce economy, and wages were high, despite the fact that the population and the labour force were expanding. Allen (2009) provides a story about labour demand alone; a corresponding, and complementary story about the supply of labour is required to explain the persistence of high wages.

Puzzle III: The elasticity of labour supply?

The third puzzle concerns the elasticity of labour supply. Lewis (1954) identified an elastic supply of labour as a critical precondition for economic growth. He suggested that rapid growth could be realized in societies where an unlimited 'hidden reserve' of labor could be drawn from agricultural into manufacturing (Lewis, 1954).[6] Lewis (1954) suggested that an infinite

[4]In a similar fashion, Broadberry and Gupta (2009) show that wage differentials between England and India in the eighteenth century explain why the cotton industry in England became mechanized while the Indian industry did not. Allen (2009) employs a two-stage account of technological progress that is based on the framework introduced by David (1975). He compares two economies with access to the same fundamental production function, but with different factor endowments, and hence different factor prices. In the first stage, initial relative factor prices determine the initial choice of technology or technique, with the economy where labour is relatively expensive choosing a technology which is labour-saving and capital intensive, relative to the economy where labour is cheap. In the second stage, there is relatively rapid technological progress in the capital intensive technology; in cotton textiles this meant that by the 1830s English cotton textiles were more competitive than Indian cotton textiles, even though English wages were four to five times as high in nominal terms. (see Allen, 2009, 151–155). C.f. Broadberry and Gupta (2009, 295–298).

[5]There were some labour saving innovations and there was an important shift in land use. However, in this context, it is difficult to distinguish movements along a production function from shifts in the underlying technology as Temin (1966) observed.

[6]Lewis emphasized the importance of shifting labour from agriculture into industry.

elasticity of labour supply was a general condition, common to all poor countries, because it appeared true of economies like Egypt and India at the time that he wrote. But Lewis's observation does not apply to all pre-industrial economies.[7] In most pre-industrial societies labour supply was comparatively inelastic. Weber observed that '[a] man does not "by nature" wish to earn more and more money, but simply to live as he is accustomed to live and to earn as much as is necessary for that purpose' (Weber, 1930, 24). Across pre-industrial Europe before the eighteenth century, the elasticity of supply of labour was not 'effectively infinite'; increases in real wages could result in fewer not more hours worked. Weber noted that '[w]herever modern capitalism has begun its work of intensifying the productivity of human labour by increasing its intensity, it has encountered the immensely stubborn resistance of this leading trait of pre-capitalistic labour' (Weber, 1930, 24).

Britain during the industrial revolution did have an elastic supply of workers. Phyllis Deane described a reserve army consisting of 'an almost inexhaustible low-priced labour-supply' (Deane, 1968, 100). This was half-right. Labour supply in eighteenth century England was elastic, as Deane notes, but it was elastic at — what Allen and others have shown to be — high real wage rates. How then did this combination of high wages and an elastic supply of labour arise in pre-modern Britain? What factors were responsible for generating the industrious workforce of the industrial revolution? Answers to this question not only shed new light on the British economy before the industrial revolution but also illuminate some of the conditions that are necessary for economic development to take place more generally.

Contributions of the paper

Economic theory suggests two distinct explanations for why workers might supply more hours of work to the market. Falling real wages might induce workers to work harder to order to maintain current levels of consumption. Alternatively, a consumption revolution, of the kind that many historians have observed in eighteenth century England, might lead to workers working harder to order to consume more, or more expensive, goods. Both hypotheses contain assumptions about how time was allocated in pre-industrial households, each carry different implications for welfare. The first explanation suggests a pessimistic interpretation of the industrious revolution that occurred before, and during, the industrial revolution. The second hypothesis, developed by

[7]Perhaps the responsiveness of labour supply, Lewis described, was a consequence of the demographic impact of modern medicine in reducing mortality, and increasing fertility in the developing world. It is not a general condition defining pre-industrial countries. Nor is it necessarily the case that the size of the effective labour force is determined by the size of the population as Lewis supposed (Lewis, 1954, 141).

Jan de Vries (1993, 1994, 2008), however, supports a more optimistic reading of the evidence on working hours.

The benefit of a model is that it enables a comparison between the predictions associated with each hypothesis. It establishes that the relevant criteria for a consumption driven account of the industrious revolution is the elasticity of labour supply. The model clarifies the debate over the welfare implications of the rise in working hours associated with the industrial revolution. It proposes an unified explanation that accounts for why in most pre-industrial societies labour supply curves bend backwards at low wages rates and why this phenomenon disappeared in England in the period prior to the industrial revolution. This explanation identifies the arrival of new consumption opportunities in the form of colonial goods such as tea and sugar as playing a crucial role in changing the labour/leisure calculus faced by workers. This change drove the industrious revolution highlighted by de Vries (1993, 2008) and Voth (1998, 2001) and helped to make sustained economic growth possible.

The backwards-bending labour supply curve

Late medieval England was a 'golden age' for wage earners because labour was scarce. Real wages series for England suggest that a worker's purchasing power in the fifteenth century was higher than it would be at any time until the middle of the nineteenth century (Brown and Hopkins, 1955; Allen, 2001; Clark, 2005).[8] A considerable proportion of this increase appears to have been consumed in the form of leisure (Blanchard, 1978, 1994*b*).[9] Contemporary writers thought that labour supply was highly inelastic. The labour supply curve was believed to bend backwards at very low levels of income.[10] As Hill (1967, 216) put it '[i]rregularity of labour was built into the system' and it 'brought its own attitude to labour'. The view of the elite is well reflected in the following quote from Bishop Pilkington in the early sixteenth century:

'The labouring man will take his rest long in the morning; a good piece of the day

[8]Penn and Dyer (1990) also find that working conditions in general improved. Workers demanded hot dishes of meat and fish, and they obtained the same rates of pay throughout the year rather than receiving different summer and winter pay rates. They also received pay on feast days and other holidays. They note that the 'demands for improvements, strengthened by threats to move elsewhere if unsatisfactory rewards were offered, run as a continuous thread through all of our sources, from the manorial accounts, through the court cases, to the comments of contemporary moralists' (Penn and Dyer, 1990, 117). C.f. Munro (1994).

[9]It should however be borne in mind that much of this leisure may have been involuntary due to the capricious nature of wage employment as Munro (1994) suggests.

[10]Surveys of this view are provided by Coleman (1956); Hill (1964); Appleby (1976); Blanchard (1978); Rule (1981); Himmelfarb (1984); Hatcher (1998).

> is spent afore he comes at his work; then must he have his breakfast, though he have not earned it, at his accustomed hour, or else there is grudging and murmuring . . . At noon he must have his sleeping time, then his beaver in the afternoon, which spendth a great part of the day; and when his hour cometh at night, at the first stroke of the clock he casteth down his tools, leaveth his work, in what need or case soever the work standeth' (quoted in Thomas, 1964, 61).

Writing in 1625, John Hagthorpe declared that it was 'the nature and condition of the English' to rather 'liue at ease by the sweat of others, than to sweate thrice a weeke to liue well by the labour of themselves' (Hagthorpe, 1625, 24). Thomas Mun held English workers enjoyed the 'fruit of idleness' and drew unfavourable comparison with the 'endeavours of the industrious Dutch' (Mun, 1664, 72). In the same vein, writing in 1658, William Temple argued that to become prosperous England had to emulate the working habits of the Netherlands (Temple, 1740, 61–64).

This advice neglected the comparatively high wages that obtained in the Netherlands. Instead low wages were held to be the solution to the problem of idleness.[11] With the exception of a few writers, notably Daniel Defoe and Sir Thomas Culpepper, most commentators on economic affairs argued that after satisfying their subsistence needs, workers would choose play and pleasure over further work. Sir Joshua Childs argued that the poor 'just work so much and no more, as may maintain them in that mean condition to which they have been accustomed' (quoted in Hutchinson, 1988, 59). Bernard Mandeville observed of the mass of workers, that 'if by Fours Days Labour in a Week they can maintain themselves, will hardly be persuaded to work the fifth' (Mandeville, 1924, 1723, 509). According to this view industriousness was driven by poverty, and the high wages identified by Allen (2009) were a source of economic weakness, not strength. Sir William Petty advocated government intervention to keep wages down. The anonymous author of *The Trade of England Revived; and the Abuses of Thereof Rectified* (1681) went so far as to argue in favour of regressive taxation on food and drink in order to encourage the poor to work more (Appleby, 1976, 513).[12]

[11]This view is summarized by Weber (1930) who commented that 'For centuries it was an article of faith, that low wages were productive, i.e. that they increased the material results of labour' (Weber, 1930, 24). According to Walter Ralegh '[h]unger and poverty make men industrious' (quoted in Hill, 1964, 122). Similarly Mun argued that 'penury and want do make a people wise and industrious' (quoted in Hatcher (1998, 77).

[12]The Poor Law was similarly condemned for encouraging idleness by both Petty and Richard Coke. See, for instance, *A Discourse of Trade* by Coke (1670). Petty argued in the *Political Arithmetick* that the law 'must punish the Lazy by Labour' (Petty, 1690, 21).

These views were based on an economic rather than a moral theory. Writers with widely varying views on other matters, from Mun to Mandeville, agreed that workers had a strong preference for leisure. This theory also appears consistent with available evidence. Until the eighteenth century, the number of official holidays followed a similar pattern to real wages. Before the Black Death there were between 20 and 27 holidays, which did not fall on a Sunday. After the Black Death real wages rose, and by the mid-fifteenth century, there were 46 official holidays, of which between 38 and 43 fell on days other than Sundays. This number was reduced in 1552 (though this was repealed soon after and only re-enacted in 1604), and again in 1649. Blanchard (1978) found the typical miner in early fifteenth century Mendip had a target monetary income 'conditioned by his desire to cover the cash outlays concomitant upon him as a villager' which he sought to achieve with a minimum amount of effort. The variance of per capita output indicates that work intensity varied inversely with wages, as workers either took longer holidays, or worked variable hours each day. Hatcher (1998) found that the labour supply curve of miners in the late seventeenth century bent back at comparatively low levels of income. In Gatherick Colliery in Northumberland workers worked 273 days on average per year; the hours they worked varied between 4 an 6 hours a day; moreover those workers who earned the most, worked the least.

The views of the mercantilist writers were highly plausible given the opportunities available to most of the working poor. Underemployment, and the idleness it entails, were 'a normal part of the backward economy in which the volume and variety of cheap consumer goods is small [and] in which economic horizons are strictly limited on the demand side and on the supply side' (Coleman, 1956, 291). Pre-industrial workers naturally display strong preferences for leisure.[13] Mercantilist writers saw no way of stimulating industriousness beyond poverty because, until the eighteenth century, the 'possibility that at all levels of society consumers might acquire new wants and find new means to enhance their purchasing power which could generate new spending and produce habits capable of destroying all traditional limits to the wealth of nations was unthought of, if not unthinkable' (Appleby, 1976, 501).[14]

[13]Clark (2007) summarizes the findings of a number of anthropologists, who have found similarly strong leisure preferences in contemporary hunter-gather societies such as the Hiwi of Venezuela and the Yanomamo of the Amazon basin, who spend three hours or less hunting or foraging.

[14]Hill (1964, 122) noted the potentially 'vicious circle' that barred economic growth: 'So long as there were few consumer goods within the purchasing power of the mass of population, there is little incentive to earn more than the subsistence minimum wage' but '[u]ntil men work harder there will be no cheap consumer goods' and hence no incentive to induce labour.

The industrious revolution

This attitude towards work changed in the century prior to the classic industrial revolution (1770- 1830). Work by de Vries (1993, 2008); Voth (1998, 2001); Allen and Weisdorf (2008) has established that an 'industrious revolution' took place in the seventeenth and eighteenth centuries.[15] Contemporaries were aware of the transformation taking place before them. The classical economists have been accused of missing the industrial revolution (see Wrigley, 1989, 1981, 1988). But, as de Vries (2003, 45) notes, 'many of the influential writers of time, both in Britain and on the Continent were convinced that consumer behaviour was undergoing fundamental changes, and that these changes were full of meaning for society as a whole.'

Writing in the 1750s, Jacob Vanderlint was the first economist to argue that high wages would stimulate rather than depress effort (Coats, 1992, 64–65). The most prominent advocate of high wages was Adam Smith. In *The Wealth of Nations*, he argued that 'the liberal reward to labour, therefore, as it is the necessarily effect so it is the symptom of increasing natural wealth' (Smith, 1776, I, vii). Low wages were not required to stimulate labour because workers' own wants and desires were already stimulated by the growth of commercial society: 'The wages of labour are the encouragement of industry, which, like every other human quality, improves in proportion to the encouragement it receives' (Smith, 1776, I, vii).[16]

E.P. Thompson (1967) collected a large body of anecdotal evidence indicating an intensification in work effort which he attributed to industrialization. But it was not clear when this intensification occurred. Voth (1998, 2001) provided a new source of quantitative information on working hours by using time-use data taken from court records in London and in the North (the Old Bailey Sessions Papers and the Northern Assize Depositions). He found that workers worked

[15]Issues of definition remain. Hayami (1977) contrasted the British industrial revolution with a contemporaneous Japanese industrious revolution. De Vries (1993) first applied the term in a different context to early modern Europe. In this sense that he uses the term, it describes a uniquely 'European phenomenon'. Others disagree. Kenneth Pomaranz argued that a similar industrious revolution took place in the Yangzi Delta during the eighteenth century. This is part of Pomeranz's general thesis that Smithian growth occurred in Europe, China, and Japan during the early modern period and Europe only achieved faster growth once the industrial revolution enabled it to escape from otherwise binding resource constraints (Pomeranz, 2000)

[16]Himmelfarb (1984, 53) goes so far as to argue that the doctrine of high wages, and the progressive model of the economy, into which it was embedded, was Smith's 'chief claim to originality'. Certainly one feature of the writings of Smith is that the interests of employers and employees were not diametrically and necessarily opposed; the possibility of economic progress lifting the living standards of both workers and merchants had been opened up for perhaps the first time. By the middle of the nineteenth century Nassau Senior could argue that '[t]o complain of our high wages is to complain that our labour is productive—to complain that our workpeople are diligent and skillful' (quoted in Coats, 1966, 114). One of aims of this paper is to uncover the economic changes that occurred over the course of the eighteenth century that made this new vision appear possible.

ANNUAL WORKING HOURS FOR LONDON AND THE NORTH			
	Estimate	Upper bound	Lower bound
1760	2576	2868	2284
1800	3328	3596	3060
1830	3356	3956	2784

Table 1: Estimated hours of work in London and the North from time-use data obtained from court records. Source Voth (1998)

extraordinarily hard during the industrial revolution, and that working hours peaked around 1830.[17] Table 1 reports Voth's estimates. The number for 1830 translates into 65 hours per week on average, which, while comparable to figures obtained for other industrializing countries in the nineteenth century, is much higher than the norm for developed countries today as Figure 1 indicates.[18] These finding do not reveal the extent to which working hours changed in the period immediately preceding 1750. An increase in working hours may have already occurred in the seventeenth and eighteenth centuries.[19] If this was the case however, it may have been a smaller increase than the one that took place between 1760 and 1800.

2 Consumer Revolutions, Falling Real Wages, or a Change in Relative Prices

De Vries (1993, 2008) argued that the industrious revolution in early modern Europe was driven

[17]Participation of women and children in the labour force *may* have declined (partly due to regulations and social pressure) between 1800 and 1830. Information on child labour is difficult to assess for the period before 1830, and it is understated in the censuses conducted in 1851 and 1871. As a result of this, it is not clear whether the total amount of child labour increased during the first part of the nineteenth century, or whether child labour merely became more visible as it became concentrated in factories (Horrell and Humphries, 1995, 487). If child labour did decline, then an increase in male working hours may have been required to compensate for lost earnings. Therefore *household* labour may not have increased as much as this between 1800 and 1830. Furthermore, the exact estimates presented by Voth (2001) may be sensitive to his assumptions as Clark (2001) observes. While this means that the magnitudes of increase in annual working hours may be overestimated, it does not change the significance of this increase for our purposes.

[18]It is also higher than that recorded in contemporary developing countries. In 1985, the average working week in Sri Lanka was 47.4 hours, in Kenya it was 42 hours, in Poland it was 38.8, and in Thailand it was 48.6 (Maddison, 2005). The figure for England in 1760 suggests that the average working week was at 50 hours, already longer than that obtained for any contemporary developing countries.

[19]For the Netherlands de Vries and van der Woude (1997) find evidence that the average number of working days increased for day labours between 1550 and 1650 by one quarter.

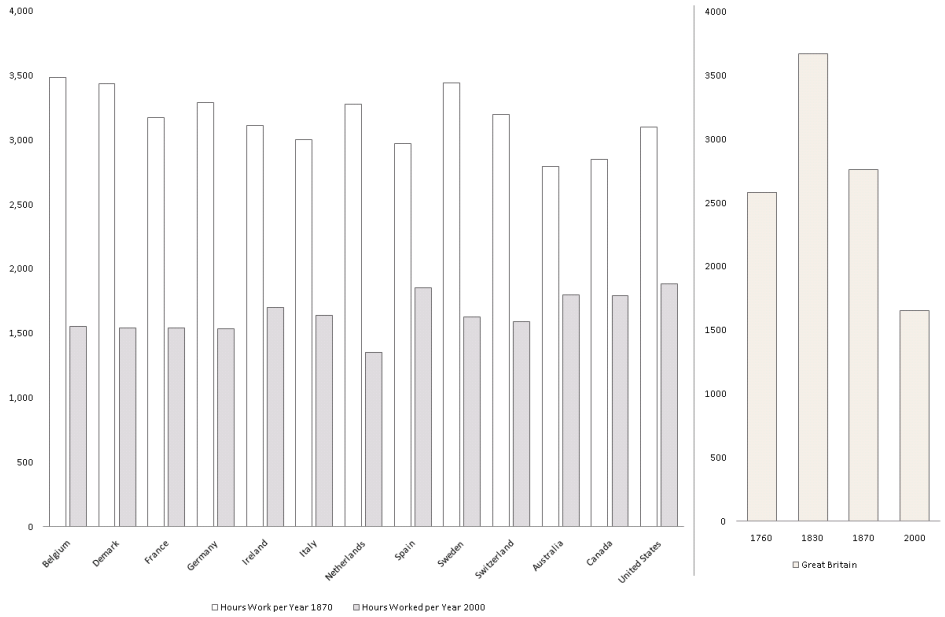

Figure 1: Hours worked in 1870 and 2000 in a selection of OECD countries verses working hours in the UK during the industrious revolution. Data from Voth (2001); Huberman (2004)

by a consumer revolution. The idea of a consumer revolution taking place in eighteenth century England was first advanced by McKendrick et al. (1982) and Brewer and Porter (1993). De Vries indicates that this revolution actually originated in the Netherlands in the seventeenth century, and spread to England and other parts of the Atlantic economy over the course of the later seventeenth and early eighteenth centuries. Households became more active participants in the market economy. Fewer goods were produced within the household economy and instead household members became increasingly specialized; they began to purchase goods that had no domestic substitute. Instead of consuming their surplus income as leisure, they spent it on a increasingly wide range of consumption goods.[20]

A gradual evolution of the concept of luxury accompanied this process (de Vries, 2008, 44–45).[21] Goods once reserved for those with social standing became widely available. Contemporaries argued that consumption fashions were driven by social emulation. For instance, long-standing 'luxury debates' now featured as stock characters tradesmen and craftsmen, who now spent

[20] Voth (2001, 192–210) examines and finds considerable support for the thesis that consumer spending drove the industrious revolution in England.

[21] 'The Old Luxury, striving for grandeur or exquisite refinement, could be emulated only by distinctly inferior adaptations. The New Luxury, striving more for comfort and pleasure, lent itself to multiplication and diffusion' (de Vries, 2008, 44).

evenings at ‘public diversions,‘ and whose spouses now keep card-tables, and dressed and furnished their houses accordingly in an attempt to imitate their social superiors. (Berg, 2004, 373).

This consumer revolution provides an ‘optimistic’ perspective on the industrious revolution. For de Vries (2008), the dramatic shift in consumption patterns and the increase in the work hours this brought about, ‘cannot be understood simply as so many marginal adjustments to changes in relative prices. Nothing in the movement of wages and prices experienced by the affected societies made inevitable the new consumption regime observable by the second half of the eighteenth century’ (de Vries, 2008, 177). This reading is optimistic because it views the industrious revolution as the outcome of individual volition. According to de Vries, ‘the dominant theme is one of households redeploying their productive resources to secure new consumption goals’ (de Vries, 2008, 121). The increase in hours supplied to the market reflects a substitution away from household production to market production; it cannot therefore be used to infer that living standards had fallen simply because leisure had been reduced.

The narrative advanced by De Vries is based on the idea of workers gradually acquiring a new set of preferences through engagement with the market. Economists think in terms of stable preferences, but over long stretches of historical time, it may make sense to at least consider the possibility of preferences evolving or changing. De Vries does this by making reference to the idea of consumption clusters. Goods take on value in relation to particular consumption bundles and life-style choices, and the bundles or clusters determine the level of complementarity that exists between different types of goods. For De Vries, then, the consumer revolution of the early modern period can be thought of as a movement from a ‘traditional’ consumption cluster to a more recognizably ‘modern’ consumption cluster. The change was a discontinuous one and it was occasioned by the ‘new aspirations of the “active searching consumer” (de Vries, 2008, 37).

Furthermore, this consumer revolution was itself a powerful stimulant for economic growth because increased market participation expanded the size of the market through the process of Smithian growth. De Vries describes a ‘peasant who bought a pair of shoes or cotton calicoes in the market’ and who therefore ‘ceased making their equivalents himself. He not only entered the market to buy, he also entered the market to sell because a portion of his household’s labour was diverted from self-provision of crafts to market provision of food’ (de Vries, 1976, 181). Demand and supply were symmetrical in the sense that each supplier becomes an additional component of aggregate demand, increasing the effective size of the market. This, in turn, increased the returns to specialization, creating a still finer division of labour, and could initiate a virtuous cycle of development. ‘Commerce encreases industry’ as David Hume put it (Hume,

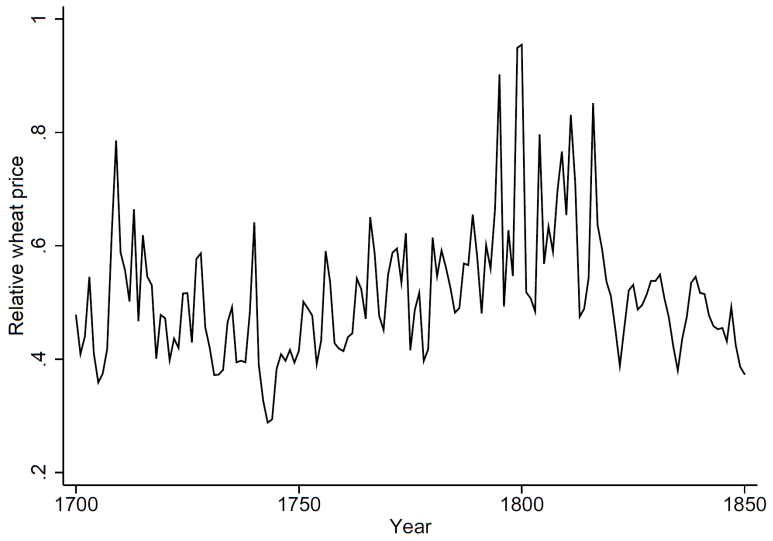

Figure 2: The relative price of wheat. Obtained by dividing the price of wheat [in silver] by the price of a representative consumption bundle. Data from Allen (2003)

1955, 1755, 55).

Falling real wages?

Van Zanden (2006) advances a more pessimistic reading of the evidence. He argues that the industrious revolution may have been a response to relative price changes, and falling real wages—a possibility de Vries explicitly rules out. If an increase in food prices obliged workers to supply more hours to the market, simply in order to purchase the same amount of food that they could previously earn with less effort, then the increase in working hours indicates a fall in their living standards. The increase in demand for textiles, colonial groceries, and manufactured goods can be accounted for by a relative price change since grain prices increased in the sixteenth and in the eighteenth centuries, as did the price of land and housing, whilst the price of textiles and manufactured goods fell.

Support for this proposition can be found by looking at wheat prices. The late eighteenth and early nineteenth centuries were the 'high price years of the French wars' (Thompson, 1963, 241).[22] Steep increases in grain prices hurt labourers in particular, and could have driven them into working longer and longer hours. The rise in the relative price of wheat can be charted

[22]The war increased the relative price of bread. The main channel for this was a rise in the costs of importing grain (Hueckel, 1973). In addition to this the harvests of 1795, 1800 and 1812 were recorded by contemporaries as being unusually bad.

by dividing Allen's wheat price series by the cost of a representative basket of consumption goods.[23]. The result, plotted in Figure 2, confirms the view that the relative price of bread, though highly volatile, was particularly high between 1790 and 1820, at the height of the industrious revolution found by Voth.

Van Zanden's critique appears relevant for the years of the Revolutionary and Napoleonic wars. But does it undercut the concept of an industrious revolution more generally? The answer to this question is no. Had the increase in working hours been solely driving by falling real wages, then southern Europe, rather than northern Europe, would have been the centre of the industrious revolution. Figure 3 contrasts labourers real wages from London with equivalent real wage series taken from Florence and Milan taken from Allen (2003). This illustrates the mini-divergence with Europe that occurred during the early modern period. Allen (2003) provides real wage series for a large number of European cities, but the contrast between London and the Italian cities taken here, is sufficient to indicate that real wages across Europe rose together during the demographic crisis of the fourteenth century; they diverged in the early modern period when, as populations recovered in the sixteenth century and seventeenth centuries, wages fell in southern Europe, but remained more or less constant in England and the Netherlands.

The industrious revolution was located in the high wage economies of north Western Europe. This, in itself, suggests that the phenomenon was not primarily driven by falling real wages. A further indication, that is difficult to reconcile to this proposition, is the finding that the increase in working hours was largely an urban development. Voth's evidence is for urban workers and the rise in industriousness he uncovers is more marked for London than elsewhere.

Subsequent work confirms the view that the industrious revolution may have been a predominantly urban phenomenon. Clark and van der Werf (1998) found little evidence of an industrious revolution amongst agricultural workers during the period. Allen and Weisdorf (2008) estimate the number of working hours workers in London and the rural South-East would had to have worked in a year to obtain a basket of basic consumption goods for a period of five and a half centuries. This estimate can approximate independent estimates of labour hours for the rural workers, but cannot explain the observed hours worked by urban workers based in London, indicating that urban must have purchasing goods outside of basic consumption basket. This suggests that a consumer revolution took place among urban workers in the capital, but not among agricultural workers. This is in accordance with the predictions of the consumer revolution hypothesis, since cities like London and Amsterdam were the main centres of fashion

[23]This bundles contains bread prices but also include the prices of eggs, beer, fuel, soap, and candles etc. Precise details on its composition can be found in Allen (2001, 421).

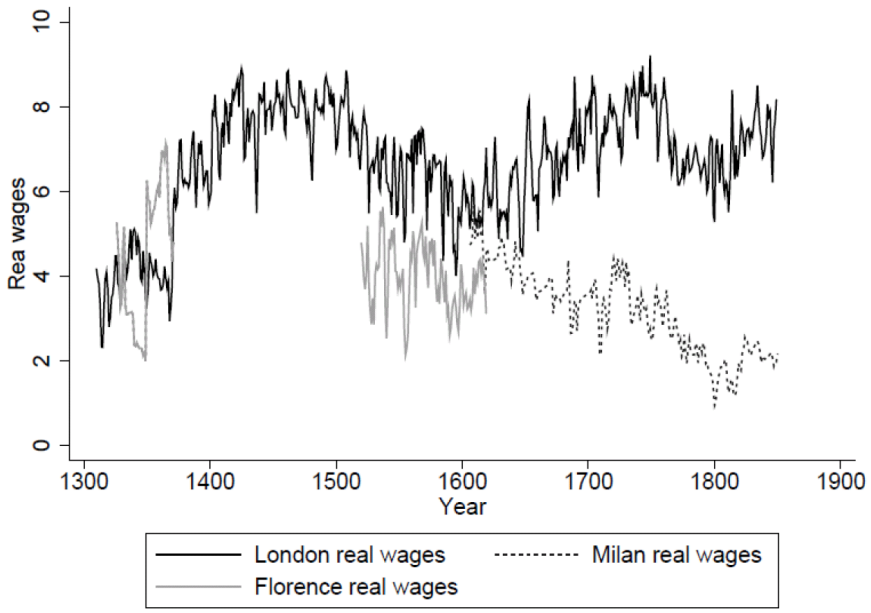

Figure 3: Real wages in London, Milan and Florence from 1300 to 1850. Data from Allen (2003)

and consumption. An increase in working hours driven by falling real wages, on the other hand, should have affected agricultural and urban workers alike.

This discussion points to a number of different and even contrary trends, which may have been at work in determining working hours in industrial revolution Britain. It also indicates why a theoretical model can perform useful work in separating out and distinguishing the various factors and concepts at work. The theoretical framework presented here focuses on the role of consumption and time. Before presenting the model, the next section firsts sets out the intuition behind the model in a non-technical fashion.

A Change in the relative price of time

According to standard treatments of labour supply, the labour supply schedule bends backwards at the point where the income effect associated with high wages outweighs the substitution effect that a higher price of labour has in inducing more hours to be supplied. This requires the income effect to be sufficiently large, and is thus unable to explain why poor people have labour supply curves that often bend backwards at very low levels of income. A different model is required to examine this phenomenon, and this paper presents such a framework.

Consider a household which supplies labour to the market. Their economic problem concerns the allocation of time between consumption and market work. The combined budget constraint they face consists, not only of the total income available to the household, but also comprises the total amount of time available. The prices they face, likewise, consist, not only of the monetary price of each good, but also the temporal price of a good. The temporal price of a good is the amount of time it takes to consume it, multiplied by the per unit opportunity cost of time, or the hourly wage that a worker could be earning if that hour of time had been supplied to the market.

An increase in hours supplied to the market could be driven by either a consumer revolution or a fall in real wages. The idea that consumption takes time as this allows us to incorporate the idea that in pre-industrial societies the potential consumption bundles available to consumers were characterised by an inverse relationship between the monetary price of an activity and its temporary price. Cheap consumption activities were generally comparatively time intensive. Momentary pleasures, perfumes, spices, the purchasing of fashionable items of consumption were relatively expensive in monetary terms.[24] Those households that had to labour for a living preferred additional free time to additional income, once their basic subsistence needs were met, because the majority of their consumption activities were cheap in monetary terms, but relatively time consuming. An increase in hours supplied to the market can be explained by both a fall in real wages and a consumer revolution, but only the latter can lead to the labour supply schedule becoming more sensitive to increases in the wage rate.

The consumer revolution De Vries describes can be thought of as a shift in the relative price of time. Late medieval workers consumed traditional consumption bundles (see Wrightson, 2000). Their consumption activities can be thought of as leisurely consumption activities, costly in terms of time rather than money; for the majority of the population 'the things money could buy were few in kind and limited in quantity' (Davis, 1966, 3). Other kinds of consumption opportunities—what we will call *intensive* consumption experiences were either unavailable or unimportant. Exotic goods such as spices or fine clothes were luxuries, which played a minor role in the consumption of most of the population.

In a traditional economy, a household will work enough to purchase necessities that it cannot itself efficiently produce at home. Once these wants are met, it will choose to consume the additional time available to it in time-consuming, but cheap leisure activities. Since *intensive* consumption experiences are not available or are very expensive, the household has no incentive to supply additional labour to the market beyond a certain point. This point is determined

[24]Time-saving devices were expensive, since saving time in the pre-industrial world meant using the labour time of others. An affluent household freed up consumption time by hiring more domestic servants.

by the price of the basket of commodities it purchases from the market. If this price rises relative to nominal wages, the household will respond by supplying more labour to the market. An industrious revolution in this context could occur as a response to a fall in the real wage. Conversely, increases in the real wage will lead to a fall in labour supplied to the market. This is the world described by mercantilists.

In an economy characterized by modern consumption opportunities, a change in the relative prices of leisurely and intensive consumption can induce the household to change the amount of labour supplied. A fall in the price of income-intensive, time-cheap consumption opportunities, increases the relative cost of leisure time, and, as result, the household now has a genuine choice between time-intensive consumption and income intensive consumption.

3 A Model

3.1 Setup

The model employed is a specific variant of the generalization of Becker's (1965) model developed by Atkinson and Stern (1979, 1980, 1981). This model begins with the insight that consumption takes time. Consumption activities, like going for a walk, are cheap or free in money terms but quite costly in terms of time. Other activities (like drinking a fine wine) may be pricey but over quickly. A billionaire's consumption opportunities are limited by the fact that he has the same amount of time as the rest of us. Both constraints therefore matter: each possible consumption activity has a monetary price and a price in terms of time (a temporal price) which combine to form its total price.

Individuals derive utility from the characteristics of goods rather than the goods *per se* (Lancaster, 1966). Consumption **c** is a m-dimensional vector of activities available . This vector specifies the m different consumption activities. This vector corresponds to a matrix of input costs as each activity c_j has monetary cost p_j and time cost t_j. In other words, the consumption of activity j at level c_j requires purchasing $p_j c_j$ worth of goods and uses $t_j c_j$ of time. The effective price per unit of this activity is thus $(p_j + wt_j)$ if they earn a wage w. From this formulation, it is evident that higher wages increase the effective cost of time-intensive activities. Conversely, when wages are low, time-consuming activities are relatively cheap. This means that, not only is the total price of leisure determined by the wage, but also that the relative monetary price of various consumption activities have an effect on the amount of time an individual allocates for work and for leisure.

Individuals or households face a time constraint T in addition to a budget constraint. Following Atkinson and Stern (1981) activity $j = 0$ and good c_o are both called 'work' and are denoted by l. The price of work is the negative of the wage rate $-w$. Labour does not enter the utility function. The maximization problem facing a representative worker is therefore to maximize: $\max u(c_1, \ldots, c_m)$, subject to:

$$\begin{aligned} \sum_{j=1}^{m} p_j c_j &\leq M + wl \,, \\ \sum_{j=1}^{m} t_j c_j &\leq T - l \,, \\ l, c_1, \ldots, c_m &\geq 0 \,, \end{aligned}$$

where M is non-labour income. At the optimum both the time and money constraint bind. Therefore it is possible to combine them and write the constraint as follows:

$$\begin{aligned} \sum_{j=1}^{m} q_j c_j &\leq M + wT \\ c_1, \ldots, c_m &\geq 0 \,, \end{aligned}$$

where $q_j = p_j + wt_j$ is the total price of consumption activity j.

3.2 labour supply

The labour supply curve can take on a variety of different shapes when consumption takes time. In order to develop our argument, we use Stone-Geary utility function of the form:

$$u(c) = \sum_{i=1}^{m} (c_i - \gamma_i)^{\beta_i} \,,$$

where $\sum_{i=1}^{m} \beta_i = 1$. In order to obtain specific results, the analysis is restricted to the case where there are three consumption activities in addition to labour ($m = 3$).

Activity 1 is a time consuming consumption activity. Activity 2 is a comparatively intense consumption activity. For convenience we set $\gamma_1 = \gamma_2 = 0$ such that $\gamma_3 = \gamma$. Activity 3 is therefore assumed to involve the consumption of basic necessities and γ represents the basic level of food, clothing and shelter that all individuals need to consume in order to survive. This basic consumption requirement need not be biologically determined as we can also think of it as being influenced by social variables. Therefore the specific utility function function used is:

$$u(c) = c_1^{\beta_1} + c_2^{\beta_2} + (c_3 - \gamma)^{\beta_3} \,, \tag{1}$$

where the the subscript $-$ indicates that individuals obtain no utility from consuming more of the basic good than is required for subsistence. The budget constraint faced by a worker is as follows:

$$p_1 c_1 + p_2 c_2 + p_3 c_3 \leq M + wl\,. \tag{2}$$

The subsistence goods requirement means that the effective non-labour income an individual has is therefore $M' = M - p_3 \cdot \gamma$. Similarly, the time each individual has available for consumption is $T' = T - t_3 \cdot \gamma > 0$. The labour supply curve can be written as follows:

$$l = T' - (M' + wT') \sum_{i=1}^{m} \beta_i \frac{t_i}{p_i + wt_i}\,, \tag{3}$$

where $i \in \{1, 2, 3\}$. This equation is assumed to be twice-continuously differentiable, in which case the first order condition of labour supply with respect to non-labour income is given by:

$$\frac{\partial l}{\partial M'} = -\frac{\beta_1 t_1}{p_1 + wt_1} - \frac{\beta_2 t_2}{p_2 + wt_2}\,. \tag{4}$$

The effect of unearned effective non-labour income M' on labour supply is unambiguously negative so long as all consumption activities take time. This means that an increase in either the price of basic goods p_3 or in the minimum consumption requirement γ will have a positive effect on labour supply.

Differentiating l with respect to the p_1, p_2, t_1 and t_2 indicates how the labour supply curve is influenced by the underlying parameters of the model.

$$\frac{\partial l}{\partial p_1} = \frac{t_1 \beta_1 (M' + wT')}{(p_1 + wt_1)^2} > 0\,, \quad \frac{\partial l}{\partial p_2} = \frac{t_2 \beta_2 (M' + wT')}{(p_2 + wt_2)^2} > 0\,, \tag{5}$$

$$\frac{\partial l}{\partial t_1} = -\frac{p_1 \beta_1 \left(M' + \mathrm{w\,T'}\right)}{\left(p_1 + wt_1\right)^2} < 0\,, \quad \frac{\partial l}{\partial t_2} = -\frac{p_2 \beta_2 \left(M' + \mathrm{wT'}\right)}{\left(p_2 + wt_2\right)^2} < 0\,. \tag{6}$$

An increase in the time cost of either consumption activity has a negative effect on labour supply, and an increase in the price of either activity has a positive effect on labour supply, all else equal. These results can be summarized as follows.

Proposition 1 *Labour supply l is:*

1. *increasing in the monetary price of consumption activities p_1 and p_2;*
2. *decreasing in the temporal price of consumption activities t_1 and t_2;*
3. *increasing in the minimum consumption requirement γ and in the price of basic commodities p_3.*

4. falling in non-labour income M.

In order to examine the shape of the labour supply schedule further let us turn to look at the effect of the wage rate on labour supply. The first order condition with respect to the wage w is given by:

$$\frac{\partial l}{\partial w} = -(M' + T'w)\left(-\frac{\beta_1 t_1^2}{(p_1 + wt_1)^2} - \frac{\beta_2 t_2^2}{(p_2 + wt_2)^2}\right) - T'\left(\frac{\beta_1 t_1}{p_1 + wt_1} + \frac{\beta_2 t_2}{p_2 + wt_2}\right).$$

This can be simplified as follows:

$$\frac{\partial l}{\partial w} = \frac{\beta_1 t_1 \left(M' t_1 - T' p_1\right)}{(p_1 + wt_1)^2} + \frac{\beta_2 t_2 \left(M' t_2 - T' p_2\right)}{(p_2 + wt_2)^2}. \tag{7}$$

Writing the first order condition like this indicates that the sign of both these terms and therefore the direction of the effect of wages on labour supply depends on the sign of $t_i(M' t_i - p_i T)$. In order to interpret this expression, the following assumption can be made.

Assumption 1 *Activity 1 is defined as the leisurely consumption activity while activity 2 is defined as the intense consumption activity.*

1. *Activity 1 is comparatively time consuming:* $t_1(M' t_1 - p_1 T') > 0$.
2. *Activity 2 is comparatively time cheap:* $t_2(M' t_2 - p_2 T') < 0$.

Following Stern (1986) for interpretive purposes this can be written as follows:

$$\frac{p_2}{M'} > \frac{wt_2}{wT'}, \qquad \frac{p_1}{M'} < \frac{wt_1}{wT'}. \tag{8}$$

This formulation makes it clear that it requires good 1 to have a comparatively low monetary cost and a comparatively high time cost, and for good 2 to have a low time cost relative to money cost. Under this assumption, the expression $[\beta_2 t_2(M' t_2 - T' p_2]/[(p_2 + wt_2)^2]$ is always positive, and $[\beta_1 t_1(M' t_1 - T' p_1]/[(p_1 + wt_1)^2]$ is negative.

The standard expression for the point elasticity of labour supply ϵ is:

$$\epsilon = \frac{\partial L}{\partial w}\frac{W}{L},$$

where L is the quantity of labour supplied and w is the wage rate. Labour is inelastically supplied when for a given point on the labour supply curve the labour supply function is steeply sloped. The labour supply curve bends backwards where $\epsilon = 0$, at the point at which the wage w equals w^*, and w^* solves the following first order condition:

$$\frac{\beta_2 t_2 \left(M' t_2 - T' p_2\right)}{(p_2 + w^* t_2)^2} = -\frac{\beta_1 t_1 \left(M' t_1 - T' p_1\right)}{(p_1 + w^* t_1)^2}. \tag{9}$$

This gives a unique maximum for the quantity of labour supplied if the second order condition is always negative.[25] This requires:

$$|\frac{2\beta_2 t_2^2 \left(M' t_2 - T' p_2\right)}{\left(p_2 + w t_2\right)^3}| > |\frac{2\beta_1 t_1^2 \left(M' t_1 - T' p_1\right)}{\left(p_1 + w t_1\right)^3}|. \tag{10}$$

This condition can support two interpretations. Either activity 2 is more 'intensive' than activity 1 is 'leisurely' i.e. $|t_2 M' - p_2 T'| \gg |t_1 M' - p_1 T'|$, or the total price of activity 1 is sufficiently high relative to the total price of activity 2 i.e. $q_1 \gg q_2$ where $q_i = p_i + w t_i$ for $i \in \{1, 2\}$.

3.3 Different industrious revolutions

The theory provided above can generate a variety of industrious revolutions, and it can accommodate a number of different historical interpretations. Distinguishing between these different explanations requires us to keep separate (i). movements along a given labour supply schedule; (ii). shifts in the labour schedule; (iii). changes in the shape of the labour supply schedule.

The industrious revolution described by van Zanden (2006) can be explained in terms of movements along the labour supply schedule. In general, a fall the wage rate w has different effects depending on where one is on the labour supply curve. A fall (rise) in w can have two contrary effects:

1. A fall (rise) in w causes a rise (fall) in hours supplied to the market if $w > w^*$.
2. A fall (rise) in w causes a fall (rise) in hours supplied to the market if $w < w^*$.

In other words, a labour supply curve of the kind depicted in Figure 4 can be divided into two segments: an upwards-sloping segment below w^* and a downwards-sloping above w^*.

Evidence for a movement along the labour supply curve can be found for late medieval England. Blanchard (1994*a*) documents how peasants used the "dead–time" they had left over, after they had completed the tasks associated with agricultural work, varied according to macro-economic pressures. In 'periods of high population pressure and weak labour markets, as in late-thirteenth century England ... peasants fully utilized the 140 or so days of "dead-time" available to them, working the full complement of 264 days'. On the other hand, '[w]ith a reduction of population,

[25] This rules out the interesting case of an s-shaped labour supply schedule in favour of a curve that bends just once. This is justifiable because the paper is concerned with a representative worker. An s-shaped labour supply function as employed by Sharif (2000) and Dessing (2002) is a plausible specification for workers who face large fixed time costs such as individuals looking after children, but is unlikely to be relevant for the labour force as a whole. Considering more esoteric specifications for labour supply would complicate the comparative statics.

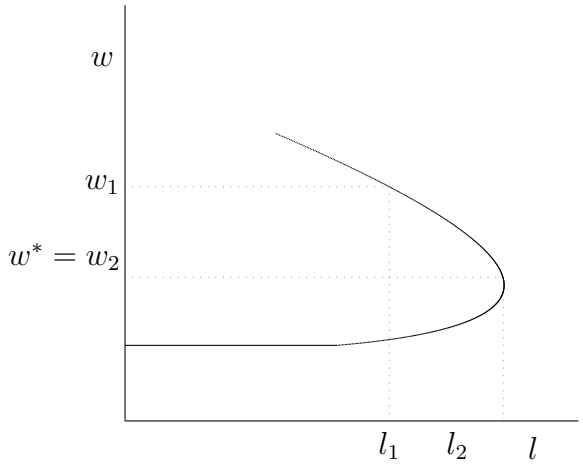

Figure 4: Movements along a given labour supply curve.

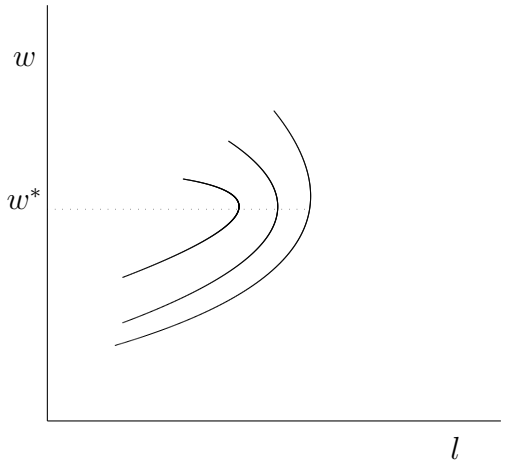

Figure 5: Shifts in the labour supply curve with w^* constant.

and resultant rise in wages and fall in rents in fifteenth-century England and the Netherlands, however they worked only some 80–100 days, reducing their total work-load to 200–210 days a year' (Blanchard, 1994*a*, 18).[26] In terms of a standard backwards bending labour supply diagram such as Figure 4, workers during the late Middle Ages were earning wages w_1 and supplying labour equal to l_1. Increases in the wage rate w led to them supplying less labour. This inverse relationship between real wages and number of days or hours worked a year helps to explain why high productivity does not appear to have been correlated with high income in medieval England (Puzzle 1).

The gains made by workers in the post-Black Death period were gradually eroded over the course of the subsequent centuries. In Figure 4, a fall in the real wage rate from w_1 to $w_2 = w^*$ induces workers to increase the amount of labour that they supplied from l_1 to l_2. Miners in Mendip maintained their living standards during the sixteenth century by working harder and longer (Blanchard, 1978, 10). These developments reflected movements along the supply schedule. There were two types of miners—independent miners who sold their output and contract miners who were paid a fixed wage. When lead prices began to increase after 1580 this enabled the independent miner to 'steadily decrease the level of his labour intensity. Accordingly, by 1600 whilst he earned a higher cash income than in 1520, he actually performed slightly less work

[26]Urban workers followed the work tempo set by agricultural workers, and, in the period after the Black Death, took 'the same 140 or so holidays a year,' and participated in the same festivals as the peasantry, enjoying 'periods of equally intense leisure' in the months prior to harvest time (Blanchard, 1994*a*, 25).

than earlier' (Blanchard, 1978, 10). Miners who were dependent on wage payments did not benefit as much from the rise in lead prices and thus were not able to reduce the amount of hours they worked.

Declining real wages across Europe during the early modern period obliged workers to either cut back on consumption, consume lower quality produce, or increase labour inputs. In Italy, workers moved from bread consumption to polenta, which is a cheaper source of calories (Allen, 2009, 30–31). In France, according to Braudel (1973, 66) , 'Men's diet between the fifteenth and the eighteenth centuries essentially consisted of vegetable foods'.[27] On this reading evidence of an industrious revolution across parts of Europe in the early modern period supports the claim that living standards fell. It is in keeping with the depiction of a European economy on the brink of a Malthusian subsistence crisis in the period immediately prior to the industrial revolution.[28]

The kind of economy in which labour hours are rising because real wages are falling cannot have been a conducive environment for economic growth. As real wages rose, workers would cut back hours and consume more leisure. Labour supply would act as a brake on the expansion of industry. In the long run working hours did fall as wages increased, but this the process did not begin until the late nineteenth century, and the most dramatic fall in hours came in the first half of the twentieth century, as labour saving technological improvements allowed households to cut back on non-market production.[29] The industrious revolution that took place in eighteenth century England, described by de Vries (2008) and Voth (2001), cannot, therefore, be understood in terms movements along a given labour supply curve, but should, rather, be thought of in terms of either shifts in, or changes of, the shape of the labour supply schedule.

A shift in the labour supply schedule can have a variety of different implications for the issue with which we are concerned with here. For instance, an outward shift in the labour supply schedule might leave w^* unchanged as Figure 5 illustrates. In order to proceed further the factors that change the shape of the labour supply curve need to be examined. The model can be used to examine the effects of a change in non-subsistence income M', on the shape of the labour supply curve, and on the point at which it begins to bend backwards w^*. The first order

[27]The process of substituting in favour of ever cheaper sources of calories inevitably faced a lower bound. The caloric intake of workers could eventually fall to a level that meant that long hours of work could not be maintained and workers required long periods of rest in order to recover their strength (Freudenberger and Cumimins, 1976). According to Fogel twenty percent of the population in eighteenth century France would not have had to energy to work for more than 3 hours a day (Fogel, 1994, 373). This interaction between wages and *ability* to supply to supply labour is not in the model.

[28]This is a view of the European economy advanced by Pomeranz (2000) and in places by Clark (2007).

[29]See Greenwood and Vandenbroucke (2005); Aguiar and Hurst (2006); Huberman (2004).

conditions implicitly define a function $w^* = w(\cdot)$. Comparative static results can be obtained by writing out the first order conditions in terms of a function g such that equation 9 holds. This equation can be totally differentiated with respect to M' to obtain:

$$\frac{dg}{dM'} = \frac{\partial g}{\partial M'} + \frac{\partial M'}{\partial w^*}\frac{dw^*}{dM'}\,. \tag{11}$$

Using the implicit function theorem we have:

$$\frac{dw^*}{dM'} = -\frac{\partial g}{\partial M'}\Big/\frac{\partial g}{\partial w^*}\,.$$

The numerator of the RHS is equal to

$$\frac{\partial g}{\partial M'} = \frac{2t_1\beta_1}{(p_1 + t_1 w^*)^2} + \frac{2t_2\beta_2}{(p_2 + t_2 w^*)^2} > 0\,. \tag{12}$$

The denominator is

$$\frac{\partial g}{\partial w^*} = -\frac{4t_2\beta_1\left(t_2M' - p_2T'\right)}{(p_2 + t_2 w*)^3} - \frac{4t_1\beta_2\left(t_1M' - p_1T'\right)}{(p_1 + t_1 w*)^3}\,. \tag{13}$$

The sign of this equation is positive under assumption 1. Therefore we have the following proposition.

Proposition 2 *The turning point in the labour supply curve w^* is increasing in non-subsistence income M'.*

Conversely, a fall in the amount of subsistence income makes w^* fall. A fall in real wages induces an increase in labour hours supplied to the market but it also causes the labour supply curve to bend backwards at a still lower level of income. This is illustrated in Figure 6. This phenomenon can be characterized as an industrious revolution, but its predictions are qualitatively distinct from those associated with de Vries's argument.

Finally, consider what happens when the price of the intensive consumption activity 2 rise or falls. As before, the implicit function theorem states:

$$\frac{dw^*}{dp_2} = -\frac{\partial g}{\partial p_2}\Big/\frac{\partial g}{\partial w^*}\,.$$

The numerator on the right-hand-side can be obtained by differentiating equation 9 with respect to p_2 to obtain:

$$\frac{\partial g}{\partial p_2} = -\frac{2t_2\left(-T'p_2 + M't_2\right)\beta_1}{(p_2 + wt_2)^3} - \frac{T't_2\beta_1}{(p_1 + wt_2)^2}\,. \tag{14}$$

This is unambiguously negative. By assumption 1, $\partial g/\partial w^*$ is also negative. Therefore w^* is falling in p_2. With this the following can be obtained.

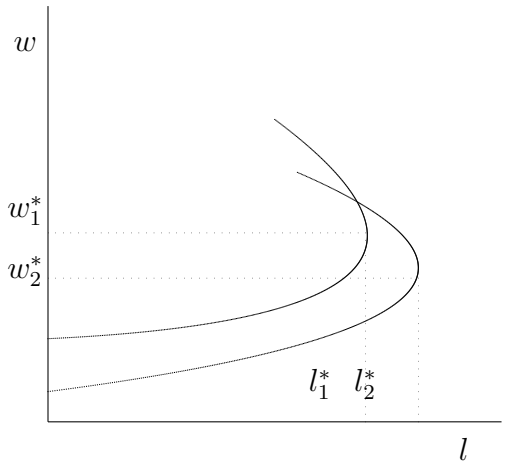

Figure 6: A fall in non-subsistence income M' causes an increase in l and a fall in w^*.

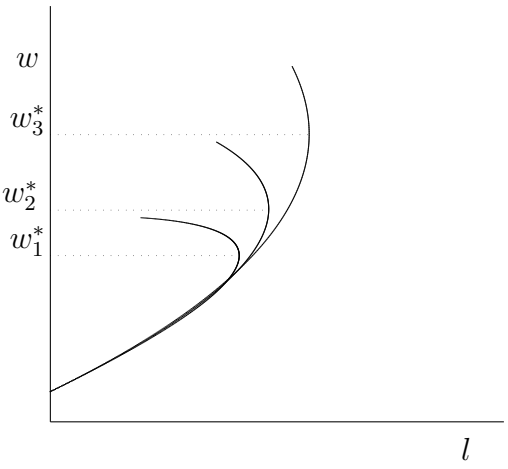

Figure 7: A fall in p_2 causes an increase in l and an increase in w^*.

Proposition 3 *The turning point in the labour supply curve w^* is falling in p_2.*

This proposition follows from the fact that $dw^*/dp_2 < 0$. We have seen that an increase in p_2 decreases w^*, the point at which the labour supply curve bends backwards. The corollary of this is that an exogenous fall in the price of activity 2 will led to an increase in w^*. This is important because the industrious revolution described by de Vries (2003, 2008) involves an increase in the responsiveness of labour supply to increases in the wage rate. This involved, not only an increase in labour supplied to the market, but an increase in w^*. Proposition 3 establishes that w^* can be shifted by changes in the price of the consumption activities available to workers and thus lead to an increase in the sensitivity of labour supply to increases in the wage rate. This is shown in Figure 7.

The model consequently has the following testable predictions:

1. A fall in the price of the intensive consumption activity p_2 can cause the labour supply curve to bend backwards at a higher wage rate i.e. it causes w^* to rise.

2. An increase in the price of the basic commodities causes l to rise and w^* to fall.

Rising prices and falling non-labour income can by themselves induce workers to supply more labour for a given wage rate. Yet they do not necessarily increase the wage rate at which the labour supply curve begins to bend backwards. But it is precisely this characteristic that distinguishes modern from pre-modern labour markets.

The intuition behind these results can be explained in more detail. In traditional economies

intensive consumption experiences were only available to the elite. The monetary price of intensive consumption activities p_2 is high relative to the total available income $M' + wT'$. No matter how much extra income a day labourer could realistically earn, it would never enable him to access the intensive consumption experiences enjoyed by the rich. Traditional consumption activities were cheap in money terms but time consuming: i.e. p_1 was low relative to t_1. In this setting, a labour supply curve that bends backwards at low levels of income is implied by the budget constraint that workers face. Once their subsistence needs were catered for, they could more effectively 'spend' their free time, than they could spend additional earnings.

Falling prices for certain goods changes the trade-off workers face between labour and leisure (consumption time). Workers now want to work for longer in order to purchase these goods and they are prepared to sacrifice leisure time in order to do so because these new consumption activities are less time consuming. This means that a 'modern' budget constraint containing reasonably priced 'intensive' consumption activities is steeper in wage-labour hour space. This generates a straitening out of the labour supply curve as illustrated in figure 7.

3.4 From individual labour supply curves to aggregate labour supply

Thus far we have dealt with individual labour supply schedules. It is also possible to discuss how these considerations affect the aggregate labour supply curve. Theoretically, the aggregate labour supply curve is simply the sum of all individual supply curves.[30]

An aggregate labour supply curve that comprises the sum of a set of individual labour supply curves that bend backwards at low levels of wages will be highly inelastic. A downwards-sloping labour demand curve intersects labour supply at a comparatively high wage level. This can be thought of as corresponding to the situation in late medieval England. Conversely, an aggregate labour supply curve consisting of the individual labour supply curves of individuals who consume modern consumption bundles will be flatter at a given real wage.

Figure 8 depicts two different individual labour supply curves. The first corresponds to a representative individual in a medieval economy, and w^*_{med} is the solution to equation 9 under a medieval configuration of relative prices. The second labour supply curve corresponds to a representative individual in a modern economy and w^*_{mod} solves equation 9 for an individual facing a modern configuration of relative prices

[30]Historically there is some controversy over whether or not it makes sense to describe eighteenth century England as having a single labour 'market' in the sense that the word is used by economists but this important caveat does not affect the point we wish to make.

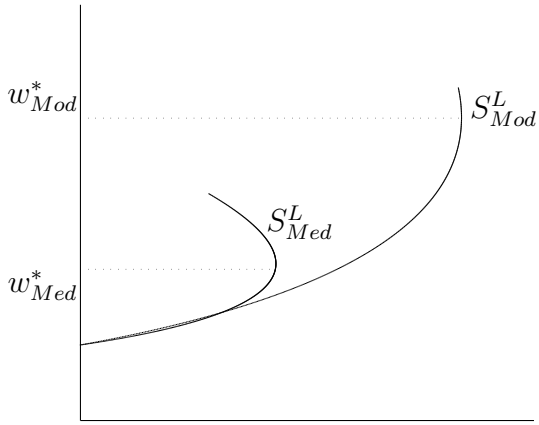

Figure 8: Elastic and inelastic individual labour supply curves.

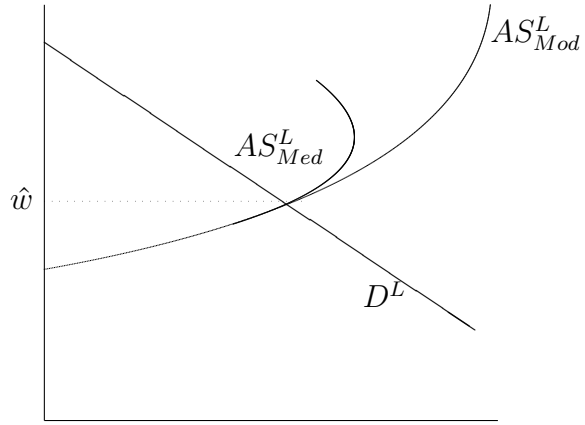

Figure 9: Elastic and inelastic aggregate labour supply curves.

Augmenting the model with a labour demand curve is straightforward. The market wage $\hat{w}$ is determined by the intersection of the labour demand curve D and the aggregate labour supply schedule as depicted in Figure 9. The medieval equilibrium w^*_{med} was low relative to the market wage. This means that the wage intersects the downwards-sloping segment of the individual representative worker's labour supply curve. As a result the aggregate labour supply curve drawn in Figure 9 is comparatively inelastic at the market wage level. In the modern configuration w^*_{mod} is high compared to the market wage $\hat{w}$.

$$w^*_{Med} < \hat{w} < w^*_{Mod}\,.$$

This means that labour demand intersects the upwards-sloping section of an individual's labour supply curve and that aggregate labour supply in Figure 9 is elastic at the market wage. In the equilibrium depicted the same market wage clears the labour market but if the demand for labour were to increase then it is evident that this would led to a large increase in the wage and a small increase in labour supplied in the case where supply is inelastic and a large in labour supplied combined with a small rise in wage if supply is elastic. In short, both high wage equilibria could be characterized by different incentives to supply labour.

The consequences of the difference between the high wage environment of fifteenth century England, and the high wage environment of eighteenth century England, can be understood by examining the difference between an aggregate labour supply curve that is inelastic at a given real wage, and an aggregate labour supply curve that is elastic at that wage. An inelastic labour

supply curve provides an inhospitable environment for investment in new technologies [even labour-saving technologies] because increases in labour demand led to rapidly increasing labour costs. Conversely an elastic labour supply curve is conducive to an increase in investment, because as Lewis (1954, 142) put it, it ensure that 'shortage is of is no limit to the creation of new employment'.[31] The fall in the price of intensive consumption activities meant labour was supplied elastically at relatively high wage rates; and it was these two factors together that were particularly conducive to economic growth (Puzzles 2 and 3).

The formal analysis supports De Vries's contention that the industrious revolution and the consumer revolution were two-sides of the same coin. The industrious revolution helps reconcile the divergent real wage data and per capita income estimates during this period and therefore explains how consumers were able to pay for these new goods.[32]

4 New Consumption Patterns

Historians, like McKendrick et al. (1982) and Brewer and Porter (1993), have detected a 'consumer revolution' taking place in eighteenth century England. A new consumer culture brought with it new leisure activities and new spending patterns, which manifest themselves in the rise of shops, the increased purchase of consumer durables, and the rising demand for colonial beverages like tea.

Contemporaries attributed the new industrious habits of the labouring classes to their desire to obtain consumption goods and affordable luxuries. Mandeville had already, in likening workers to bees, planted the notion that opportunities for vices and luxury could stimulate desire and appetite, and thus drive on industry. Sir James Steuart argued that insatiable consumer wants had replaced poverty in forcing workers to work (Steuart, 1966 (1767). In the 1st edition of the *Principles of Political Economy*, David Ricardo argued that indolence, like 'vicious government'

[31] One important reason for this is scale. Innovation involves high fixed costs which can only be recovered if the innovation is utilized on a large enough scale. If the supply of labour is very inelastic then even labour-saving innovations may not be worthwhile because labour supply bottlenecks may prevent them from being employed on an efficient scale.

[32] Van Zanden (2005) ran a simulation of England's economy based upon real wage and price data. To mimic the trend of actual GDP, he needed to assume that working hours per year increased linearly from 200 in 1500 to 350 by 1800 - an increase of three quarters. C.f. (van Zanden, 2009, 244–256). Angeles (2008) shows that falling or stagnant real wages can be accompanied by growth in per capita GDP if the share of labour in income is falling, if labour supply per capita is rising or if there are relative large prices rises in sectors that form a small part of total output or are growing slowly. Angeles (2008) calculates that the increase in working hours between 1760 and 1800 found by Voth (2001) can account for three quarters of the observed difference between per capita GDP growth and real wage growth.

produced poverty and misery: the remedy was 'to stimulate exertion, to create new wants, and to implant new tastes' (Ricardo, 1950, 1817, 100).[33] He argued the 'friends of humanity cannot but wish that in all countries the labouring classes should have a taste for comforts and enjoyments, and that they should be stimulated by all legal means in their exertion to procure them' (Ricardo, 1950, 1817, 100).

Mui and Mui (1989) examine the rise of retail shopping in the eighteenth century. The growth of small retail shops facilitated the new consumption culture. The emergence of local retail shops for instance enabled customers to purchase goods immediately, on a whim, as opposed to putting in bulk orders to merchants. The Excise had attempted to assess the number of shops in England for taxation purposes during the Seven Years War (1756-1763) and identified 141,700 shops that were large enough to warrant taxing. This means that in the middle of the eighteenth century there was at least one shop per 43.3 people (Flanders, 2006, 43).[34] A historian describes these shops as 'bulging with cheeses, sweetmeats, coffee, tea, table linens, dry goods, gadgets, pictures and prints,' and catering for 'the lower sort' (Appleby, 1993, 167). Probate inventories indicate that as more goods were accumulated in the early modern period, the absolute value of these goods often fell. It seems that goods lost value quicker than they had done before; items of clothing were more likely to be discarded; and some goods became less durable than before.

Weatherill (1988) documents the rise in number of households owning durable goods in the inventories of the London's Orphans' Court. The frequency of saucepans, cutlery, clocks, china, pewter and earthenware, and utensils for hot drinks increased dramatically between 1675 and 1725. Utensils for hot drinks were almost completely absent from seventeenth century inventories but they were found in 80 percent of inventories by 1725. It became common to buy ready-made garments rather than have clothes made-to-measure. By the late eighteenth century '[i]nexpensive, brightly printed cotton textiles attracted evermore consumers'.[35] Fashion was now affordable. Lemire (1991) notes that servants could save up the 'six or seven shillings needed to purchase sufficient cotton cloth to make a gown, or the eight shillings for a ready-made gown'. This created 'a potentially vast market among working-women, for whom these prices

[33]There were still adherents to the old view. Arthur Young held to the old view that the poor must be kept poor in order to be industrious (*Farmer's Tour through the East of England*, iv 361.)

[34]By way of comparison in 1950 there was one shop per 92 people (Flanders, 2006, 44).

[35]This was partly driven by changing relative prices. The real price of textile goods fell in the early modern period. Shammas (1990) details how the price of woollens and linens fell dramatically in real terms between the late sixteenth century and the early eighteenth century. The price of a yard of fine Holland linen fell from 86 d to 32 d. A yard of heavy broadcloth that cost 138 d in the late sixteenth century would have cost 54 d a hundred and fifty years later.

meant perhaps one week's wages or less' (Lemire, 1991, 97).[36]

Tea and sugar I: changing consumption patterns

Tea and sugar , coffee and tobacco, porcelain, linen shirts, cotton calicos were all 'new luxuries'. Initially available only to the well-to-do, they soon became affordable even for middling folk– yeoman, artisans and even labourers. Trade, and particularly trade with Asia and the West Indies, played a crucial enabling role in this consumer revolution. Shammas (1990, 77) found that the value of colonial groceries as a proportion of total imports increased by 400 per cent between 1559 and 1800 even as the prices of these commodities fell. The bulk of this dramatic increase occurred after 1700. Falling relative prices made it possible for a new form of affordable luxuries to emerge. Tobacco was among the first goods to undergo this transformation (Zahedieh, 1994). By the late seventeenth century tobacco had been transformed from a product consumed in small quantities by gentlemen into a mass consumption good. In 1686, tobacco made up over 68 per cent of the value of all imports from North America and was valued at £141,606.

The most dramatic rise in consumption was the rise in tea and sugar consumption in eighteenth century England as illustrated in Table 2. Tea was initially associated with Oriental luxury. At the beginning of our period it was drunk by wealthy households in porcelain cups. Over the course of the eighteenth century, as its price fell, it became first popular with the middle classes, and then from the 1730's and 1740's onwards, a drink of mass consumption. As Berg puts it, '[t]he history of these colonial groceries is one of the transformation of exotic luxuries into necessities' (Berg, 2004, 365).[37] The remainder of this section documents the rise of tea and sugar consumption, but a similar story can be told for a number of other commodities; for instance, the consumption of gin increased sixfold between 1700 and 1743.

Tea rapidly became popular after 1720. Rochefoucauld observed in the late eighteenth century that '[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' (quoted in Macfarlane and Macfarlane, 2003,

[36]McKendrick (1974) argued that women's tastes drove the consumption trends of eighteenth century. Berg (2004, 380-83) criticizes this for portraying women's desires for consumer as generic and driven by vanity. She notes that '[c]onsumer aspirations across class and gender stimulated the rapid and extensive proliferation of new commodities from the later seventeenth century onwards'.

[37]This is not as unlikely as it seems. Tea became such an important 'necessity' that apparently 'families that were too poor to buy it begged once-used tea leaves from neighours, or even stimulated its colour by pouring boiling water over a burnt crust' (Thompson, 1963, 351).

71). Tea dealers played a particularly important role in stimulating the fashion for hot drinks. By 1793 there were 52, 292 licensed tea dealers in the country (Mui and Mui, 1989, 161). The prevalence of tea consumption amongst working households can be seen by the survival of tea making equipment in probate inventories. Calculating the actual amount of tea consumed in Britain in the eighteenth century is complicated by the fact that high excise duties meant that smuggling was common, but it seems that perhaps average per capita consumption was as high as 2 pounds per person by the end of the eighteenth century as shown in Table 2.[38] This meant that the median individual could have at least two cups of tea a day. The scale of increase in consumption can be gauged by the fact that it is estimated that in 1722 average consumption was an ounce a head per year, but by 1822 it was approximately an ounce a week (Davis, 1966).[39]

It was not tea alone that transformed the consumption patterns of British workers; it was tea combined with sugar . During the eighteenth century sugar became the single most important import into the British economy.[40] Tea was initially drunk without sugar . Combined they were a particularly potent combination. Consuming sugary tea conferred momentary pleasure; it was short and sweet. 'Moreover, for products such as tea and coffee, which carried only minimal caloric loads (from their accompaniment sugar) while acting as physiological stimulants, the potential scope for increase demand was not so quickly limited by satiation as for most other foodstuffs' (McCants, 2007, 461). Tea enabled households to increase their consumption of sugar without reaching satiation. In order to purchase tea and sugar households had to supply labour to the market since both were produced abroad and had no direct domestic substitutes. Furthermore, tea and sugar were more conducive to work and to industriousness than were traditional alcoholic beverages.

[38]Tea was often adulterated by shop keepers. This meant that a pound of tea recorded by customs officers might become one and a half pounds of tea by the time it retailed.

[39]A similar process occurred simultaneously in the Dutch Republic. McCants (2008) documents the rise of coffee and tea consumption amongst even the poor in eighteenth century Amsterdam. Inventories left after death indicate that the equipment required to make tea and coffee was widespread by the 1730s. The records of the Amsterdam Municipal Orphanage shows that the working classes also drank tea and coffee. Coffee wares appear in over fifty percent of the inventories. Teapots or tea infusers appear in between forty and fifty percent of inventories of households, who left orphans to the care of the city authorities. Across Britain and the Dutch Republic, demand for tea and coffee stimulated demand for complementary consumption experiences for porcelain cups, kettles, silver tea cutlery, and mahogany coffee tables.

[40]In France according to Braudel, in 1788 'sugar was still a luxury item despite public favour and the relative fall in price' (Braudel, 1973, 157) . He reports an estimate that average consumption per year could have been around 1 kilogram or 2.2 pounds of sugar per person. This was approximately a tenth of the per capita sugar consumption estimated for England in the 1780s. Tobacco consumption was four times as high in Great Britain than in France (de Vries, 2003).

	SUGAR : IBS PER CAPITA	TEA : IBS PER CAPITA
1631		
1669	2.13	
1690,1698-99	4.01	
1700's	5.81	0.01
1710's	8.23	0.05
1720's	12.02	0.10
1730's	14.90	0.17 (0.50)
1740's	12.73	0.29 (1.00)
1750's	16.94	0.49 (1.10)
1760's	20.20	0.81 (1.60)
1770's	23.02	0.70 (1.40)
1780's	21.14	1.26 (2.00)
1790's	24.16	2.00 (2.10)

Table 2: Sugar and tea imports 1631-1800. Total legal and illegal tea imports are in brackets. Source: Shammas (1993).

Tea and sugar II: changing relative prices

Falling relative prices explain much of the rise of tea and sugar consumption in eighteenth century Britain. According to the price index constructed by Cole (1958) the real price to tea fell by seventy-five percent between 1720 and 1800. The inverse relationship between tea prices and tea consumption in the eighteenth century is illustrated in Figure 10.[41] Colonial luxuries not only become more affordable in absolute terms, the relative price of these commodities also fell. This was particularly true in the latter part of the eighteenth century when the price of basic foodstuffs rose.[42] Tea cost £3 $10s$ per pound in the 1660s when Mrs Pepys drank it. By 1670 the price had fallen to £2 per pound. Until the 1720s the price of tea fluctuated heavily because

[41] Official statistics of the number of tea imports retained for domestic consumption are misleading because of the amount of tea smuggling varied over the course of this period. The work of Cole (1958) suggests that smuggling was particularly prevalent in the 1740s and then again the 1760s and 1770s. This means that the trend depicted in Figure 10 understates the true rise in consumption in the middle decades of the century. Mui and Mui (1975, 1989) argue that Cole's estimates are too low. They suggest that between 1773-1783, the amount of smuggled tea imported in the country was double the official numbers. Nevertheless, the upward trend in consumption is unmistakable.

[42] Davis (1979) describes how 'Sugar , tea and other important products of the warm lands were becoming cheaper as fresh sources of supply were developed' but the 'prices of temperate foodstuffs, on the other hand, were stable or even rising, since they came from crowded Europe, where the resources of the land were strained by the universal growth of population' (Davis, 1979, 37). Partly as a result '[t]here was a shift from diets dominated by oatmeal, milk, and cheese to bread, tea, sugar and butter' (Berg, 2004, 367).

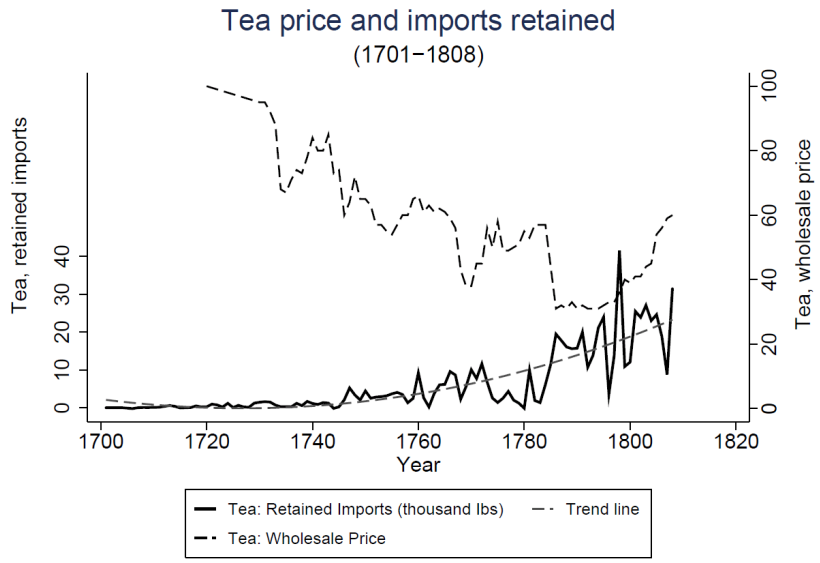

Figure 10: Tea prices and retained imports: average real tea prices from Cole (1958); the number of retained imports from Schumpeter (1960). The volume of smuggled tea was significantly higher.

it was only available indirectly via Dutch traders at Batavia but from 1720 onwards, when the direct route to Canton was opened up by the British, it began a sustained decline (Smith, 1992).

The price of sugar halved between 1630 and 1680 and thereafter fell little during the eighteenth century as Figure 11 documents. In the 1630s the price of sugar fluctuated around 1s $3d$ per pound. By the 1680s this had fallen to around $8d$ per pound (Davis, 1954). It rose again thereafter and in late seventeenth century a pound of sugar could cost between 11 and $14d$. By the mid-eighteenth century it had fallen to back to roughly $8d$ per pound. During the 1760s and 1770s a pound of sugar cost $7d$. This meant that while in 1695 $1d$ would buy you about 24 grams of sugar or six tea spoon-fulls, by 1770, a penny would buy you 64 grams worth of sugar or 16 spoon-fulls worth.[43] The increase in sugar consumption over the course of the eighteenth century cannot therefore be explained in terms of a falling price. Rather it appears as if sugar consumption was driven up by a fall in the price of a complementary product, tea. This hypothesis is supported by the fact that there is a negative correlation of -0.55 between Cole's tea price index and sugar imports between 1720 and 1808. Therefore in order to establish the

[43]Sugar was less profitable than tea and shopkeepers used the low price of sugar to entice customers into purchasing tea. For example in 1756 'Thomas Fletcher, the Twinning's former shopman, appended a short note to his advertisement: "N.B. And to oblige those who are pleased to favour him with their commands for tea, he will sell all sorts of Refined Sugars at Prime Cost"' (quoted in Mui and Mui, 1989, 250).

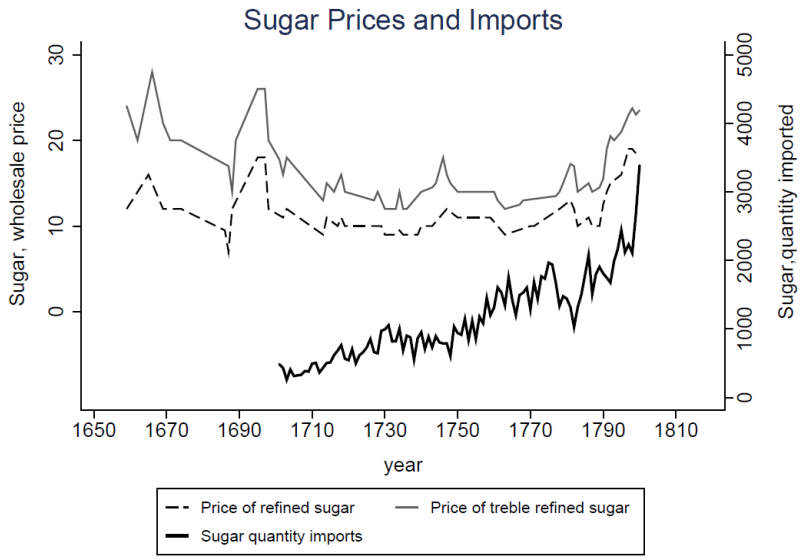

Figure 11: Sugar imports and prices: price data from Beveridge (1939); import data from Schumpeter (1960) and Mitchell and Deane (1962).

claim that the price of intensive consumption activities (p_2) we need to see how much the price of a cup of sweetened tea fell.

Calculating a figure for the price of a cup of tea is complicated by the fact that the price of different types of tea varied significantly.[44] The exact cost of a cup tea also depends on how strongly it is made. Cole reports that a pound of tea can produce 196 cups of tea, which means that in decimal measures, one cup of tea required 2.3 grams of tea leaf (Cole, 1958, 403). But Macfarlane and Macfarlane (2003) claim that a pound of tea can stretch to up to 300 cups of tea, and there are certainly plenty of reports of poor families pouring hot water over used tea leaves, to suggest that this larger figure is probably more plausible.[45] Table 3 summarizes a number of different estimates of the cost of a cup of tea at three dates 1686, 1708 and 1784 based on prices taken from Beveridge (1939) and Davis (1966). It shows that the price of a cup of (unsweetened) tea fell by between 50 and 80 percent between 1708 and 1784. The fall in the

[44]There were the cheaper dark teas like Common Bohea or Common Green and the more refined and expensive Gunpowder tea, Hyson tea and Congo tea. David Davies observed that "tea (with bread) furnishes one meal for a whole family every day at no greater expense than about one shilling a week at an average." He distinguished between 'fine hyson tea sweetened with refined sugar , and softened with cream,' noting that this was 'not the tea of the poor' who consumed 'Spring water, just coloured with a few leaves of the lowest-price tea and sweetened with the brownest sugar" (quoted in Mintz, 1985, 115). The price of the cheapest Black tea in 1745 was about $5s$ per pound. The price of smuggled tea was between $4s$ and $5s$ (Cole, 1958, 406). Expensive tea could retail for $16s$ per Ib or more in the mid-eighteenth century.

[45]In many households, servants were usually allowed the second brewing of the tea leaves.

Price of a Cup of tea (in pence)						
		1686	**1708**		**1784**	
Sugar	N. cups	30 s per Ib	24 s per Ib	Black tea 5s per Ib	Green tea 8 s per Ib	Hyson tea 12.33 s per Ib
0 sp.	196	1.84	1.47	0.3	0.49	0.76
	300	1.2	0.96	0.2	0.32	0.49
1 sp.	196	1.9	1.56	0.38	0.57	0.84
	300	1.26	1.05	0.28	0.4	0.57
2 sp.	196	1.96	1.6	0.46	0.65	0.92
	300	1.32	1.14	0.36	0.48	.65
3 sp.	196	2	1.73	0.54	0.73	1
	300	1.39	1.22	0.44	0.56	0.72

Table 3: The price of a cup of tea. Source: Beveridge (1939); Davis (1966). For details of the calculations see text.

price of sugary tea was less dramatic than that because the price of sugar fell less than the price of tea did between 1708 and 1784.

5 Conclusion

The question this raises is whether or not this change in relative prices was large enough to generate an industrious revolution? Could it have caused worker's supply curves to 'straighten out'? The quantitative importance of tea and sugar in the economy of eighteenth century does appear large enough. Shammas (1983) found that in the seventeenth and early eighteenth centuries labourers devoted around 60 percent of their budgets to food and drink. Poor house diets in the sixteenth and seventeenth centuries seldom or never mentioned sugar or spices, but in the eighteenth century both were frequently cited. Potatoes and rice also appeared during this period, as did tea and distilled liquors like gin. By the 1780s, households on average spent at least as much on tea, sugar, and potatoes, as they did on meat, both accounting for around 12–13 percent of food and drink expenditures (Shammas, 1983, 100).

Davis (1966) found that a middle class family in 1734 might be expected to spend $1d$ per head per day on tea and sugar . For a household of 7, including one servant, this worked out at as $4s$

$1d$ per week in total or £10 $12s$ $4d$ a year. This was twenty-five percent more than they spent on bread. The amount that a labourer's household might spend on tea and sugar is perhaps more surprising. A family of five was recorded in 1775 as spending $2s$ $4d\frac{1}{4}$ on sugar and tea each week. This outlay comprised $2\frac{1}{2}$ ounces of cheap tea a week at $4\frac{1}{2}d$ per ounce and 1 Ib of lump sugar and 2 pounds of coarse sugar at the total cost of $17d$. This would have enabled them to enjoy between 31 and 46 cups of tea in total or at least a cup a day through the week. It is unlikely that all the sugar that the household purchased would be consumed with tea, but had this been the case, then they bought enough sugar to have had more than seven spoon-fulls of it with each cup of tea.

The rise of tea represents a dramatic shift in the consumption patterns of labourers and tradesmen as well as the middle classes. It represents exactly the kind of shift in relative prices that could led to a straightening out of the labour supply curve in the model. However, the change in relative prices alone does not seem large enough to occasion the change in patterns of demand. The price of tea and sugar fell during the eighteenth century but this only explains some of the increasing demand as sugar and tea claimed an increasing share of the *value* of imports (Shammas, 1990). Furthermore, even as the price of tea and sugar rose at the end of eighteenth and during the first part of the nineteenth century, the quantity consumed increased. The reason for this appears to be a simple one: as McCants puts it 'in the case of colonial beverages, once someone was hooked on the sweetened and caffeinated brews, it was hard to find a substitute at any price' (McCants, 2008, 199).[46]

[46] An extension of the model in which individuals form consumption habits can be considered. In Becker and Murphy (1988) consumers acquire 'consumption capital' x from having consumed a particular good in the past and this increases the utility they acquire from consuming that good in the present.

$$U_\tau = u(c_\tau(x_\tau))\,.$$

Consider a two-period version of the model in section 3. The utility an individual gets from consuming a new good can be normalized such that $c_\tau(0) = 0$. Consumption capital is acquired according to: $x_{\tau+1} = \eta(c_\tau)$ where η is an increasing function of c. The effects of this consumption capital on the marginal utility of consumption is straightforward to assess:

$$\frac{\partial U_\tau}{\partial c_\tau} = u'(c_\tau)\,, \qquad \frac{\partial U_{\tau+1}}{\partial c_{\tau+1}} = u'(c_{\tau+1}) + \eta'(c_\tau)\,.$$

Consumption in period $\tau + 1$ is therefore higher than in period τ due to the habits acquired in the first period. Certain goods are more liable to induce habit formation than others; they are more 'addictive'. The introduction of habits shifts the consumption bundle purchased in period $\tau + 1$ towards the addictive good. Furthermore, a fall in the price an habit forming good can have an additional effect on consumption, over and above the direct price effect through the channel of habit formation. To see this, suppose an individual has preferences over two consumption goods c_1 and c_2, where c_2 is an additive good: $U_\tau = u(c_{1,\tau} + c_{2,\tau}(x_\tau))$ and faces a budget constraint of the form: $p_1 c_1 + p_2 c = M$ where M is the total income available to the individual in question. The optimality conditions in period τ require that the ratio of marginal utilities is equal to the price ratios. A fall in the price of good 1 induces

A pessimistic reading of the industrious revolution is difficult to reconcile with the evidence for increased levels of consumption amongst the working population in eighteenth century England. It is more applicable to the experience of continental Europe during the eighteenth century, where as real wages fell, workers were forced to work longer, and harder in order to earn the same real wage. This increase in industriousness represented a fall in welfare. But, this process cannot explain the observed increase in working hours in North-Western Europe, because the industrious revolution was strongest where real wages fell the least—in eighteenth century England.

The principle caveat regarding the welfare implications of this analysis concerns the significance of other household labour inputs such as child labour. During the industrial revolution Britain was unusually dependent on child labour relative to other countries at similar levels of per capita income (Humphries, 2003, 181).[47] Increased possibilities for consumption activities could have induced households to supply more labour to the market. Under the assumption of intra-household altruism this is welfare improving. Dropping this assumption raises the 'spectre of avaricious parents,' exploiting their children in order to increase their own consumption (Humphries, 1999). Children typically contributed their earnings to the family pot, and parents may have sent their children to work in order to increase their own consumption opportunities—a suggestion which, if taken seriously, singes the wings of any overly optimistic interpretations of the industrious revolution.[48] In the case of orphans or pauper apprentices, where child labour was effectively forced labour, this exploitation story is clearly the appropriate one but whether that is true or not for ordinary families is a more contentious issue that cannot be addressed here.

How did the industrious revolution affect economic growth? The analysis presented here has focused on one particular channel: the elasticity of labour supply. Lewis argued that an infinitely elastic labour supply was an important pre-condition for economic growth because it meant

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the consumer to purchase more of good 1 until the extra utility he derives from an additional unit of consumption is low enough to equate the two ratios again. A fall in the price of good 2 in period τ has an additional effect. By raising consumption in period τ, it also raises the marginal utility obtainable from consumption of good 2 in period $\tau + 1$. In other words a temporary change in prices can have a permanent effect on consumption.

[47]Information on child labour is difficult to assess for the period before 1830, and it is understated in the censuses conducted in 1851 and 1871. As a result of this, it is not clear whether the total amount of child labour increased during the first part of the nineteenth century, or whether child labour merely became more visible as it became concentrated in factories (Horrell and Humphries, 1995, 487).

[48]Parents may have limited or bounded altruism, which they traded-off against their own consumption, when deciding whether or not to send their children to work; an increase in the attractiveness of particular consumption opportunity, in this framework, may 'tip' parent's decision to force their children to work i.e. increased consumption opportunities can led to increased exploitation within the family. The adverse consequences of this exploitation could have been magnified if child labour crowded out human capital accumulation.

that industry and manufacturing could expand without increasing rapidly rising costs, or hitting bottlenecks in labour supply. Workers could be drawn out of employment or more strictly under-employment in agriculture or domestic service and into high productivity sectors. In a society where labour supply is limited, this required an increase in the wage rate, which in turn reduced the rate of profit for entrepreneurs. An unlimited labour supply however, meant that entrepreneurs could continue to invest without the rate of profit falling: 'profits will grow continuously relatively to the national income, and capital formation will also grow relatively to the national income' (Lewis, 1954, 158).

What conditions are required for labour supply to be elastic? Lewis argued that 'an unlimited supply of labour may be said to exist in those countries where population is so large relatively to capital and natural resources, that there are large sectors of the economy where the marginal productivity of labour is negligible or even negative' (Lewis, 1954, 141).[49] The problem with Lewis's analysis was that he identified the fact of labour surplus with large populations when this is clearly an incorrect measure of labour supply. A large population of peasants, accustomed to traditional consumer patterns, will provide a less elastic and responsive source of labour than will an equal population of urban workers, used to consuming more recognizably 'modern' consumption bundles. If individual labour supply curves bend backwards at very low wage rates, the elasticity of the aggregate labour supply relation will be less than infinite, and as wages increase, it will eventually turn negative. In the absence of an 'industrious revolution' of sorts, the habits of pre-industrial workers constitute an impediment to sustained economic growth.

Perhaps an industrious revolution was a necessary pre-requisite for an industrial revolution? This was the view of Weber and of E.P. Thompson, and is neatly expressed by Gary Cross as follows: 'Industrialization was impossible without a radical change in thinking about time ... time discipline (or the work ethic) and the temporal segmentation of work and leisure were cultural prerequisites of industrial capitalism' (Cross, 1988, 3).[50] Support for this proposition can be found in the findings that the early stages of growth in Europe and in America in the late nineteenth century also appear to have accompanied by miniature industrious revolutions.[51]

[49]Lewis justifies employment when marginal productivity is zero or negative on the grounds that in poor countries the line between dependent and employee is thin and that social norms encourage firms to 'over hire' workers.

[50]Factory discipline played a crucial in this, although the imposition of the factory discipline largely postdates the industrious revolution highlighted by de Vries. The focus in this paper on the importance of consumption opportunities is complementary to Clark's Clark94 reinterpretation of the coercive elements of factory discipline.

[51]Huberman (2004) finds that working hours in 1870 were longest in countries like Belgium and Germany which were rapidly industrializing at the time. Working hours in Russia at the end of the nineteenth century were so long as to allow no time for leisure (Kir'ianov, 1994, 147).

Formalizing this generates insights into the development process in contemporary economies. An increase in labour inputs was crucial for East Asian growth. Crafts (2003) calculates per capita GDP per hour worked for East Asian and European countries. Incomes in Japan, Korea and Taiwan are equal or higher than in many European countries. But this is partly the result of longer working hours. This general stylized fact raises exactly the questions that this paper has attempted to answer: What drove these industrious revolutions? Why did worker's labour supply curves cease to bend backwards at low incomes? In the case of East Asia in the late twentieth century it was surely, in part, a desire to purchase consumer goods, and to buy into affluent Western lifestyles that drove this process. Analogously, in Europe in the late nineteenth century, workers were prepared to work harder in order to buy the goods produced and exported by industrialized Britain. What about Britain in the eighteenth century? The analysis here provides a theoretical basis for the new appreciation for the importance of imports found in the work of de Vries (2008). It supports McCants (2007) supposition that 'the consumer revolution itself would have been inconceivable without the stimulus provided by "luxuries" first trickling and then steaming into Europe from Asia broadly defined' (McCants, 2007, 438).

Finally it is worth reflecting on the implications the argument presented here has for the more general debate on living standards before and during the industrial revolution. Crafts (1985) argued that if working hours did increase during the industrial revolution, this increase could account for a lot of what has previously been ascribed to TFP growth. Similarly for Voth (2001), the industrious revolution meant a fall in the amount of leisure workers could consume, a view that goes back at least as far as Marx. Conceived in terms of changing consumption opportunities, this is no longer necessarily the case. One implication raised by this paper, and neglected by many commentators, is that measurements of wellbeing such as stature, morbidity or literacy may not accurately measure preference satisfaction. It is well known that many of these measures either declined or stagnated between 1770 and 1830. One reason for this was what Shammas (1990, 293) has described as 'a very deleterious change in the content of the human diet'. But declining health outcome do not suggest a worsening of living standards, as measured by those individual's own subjective preferences, if this decline was the product of choice.[52]

[52] We know from the late twentieth century that economic growth and worsening health outcomes can accompany each other.

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