



The transformation of labor supply in the pre-industrial world

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ABSTRACT

In pre-industrial economies labor supply curves bent backwards at very low levels of income. This changed in England before the industrial revolution (de Vries, 1994, 2008; Voth, 1998). Using a model of labor supply where consumption takes time, this paper shows that both an increase in the cost of subsistence and a fall in the price of time-intensive consumption could have generated an increase in hours worked but that only the latter would lead to an increase in the elasticity of labor supply. This model clarifies the role played by consumption in the behavior of labor on the eve of the onset of modern economic growth, distinguishing between an increase in hours worked caused by changing patterns of demand [the case of England] and an increase in hours worked caused by involution [the case of Italy and possibly Japan].

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1. Introduction

In 1930, John Maynard Keynes predicted that sustained economic growth would lead to the rise of an ever larger leisured class. Once this occurred work would be 'as widely shared as possible . . . three hours a day is quite enough to satisfy the old Adam in most of us!' (Keynes, 1963, 369). Implicit in his reasoning was an assumption that free time was a superior good. Keynes's suppositions about the prospects for sustained economic growth were broadly accurate; his predictions about the future of work were not.¹

Observers in pre-industrial Europe shared Keynes's view that leisure was a superior good. 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 labor of themselves' (Hagthorpe, 1625, 24). Thomas Mun held that English workers enjoyed the 'fruits of idleness' and drew unfavorable an comparison with the 'endeavours of the industrious Dutch' (Mun, 1664, 72). Ricardo (1950, 1817) writing a century and a half later, however, took the industriousness of the English worker for granted. He wrote '[g]ive to an Irish laborer a taste for the comforts and enjoyments which habit has made essential to the English laborer, and he would be then content to devote a further proportion of his time to industry, that he might be enabled to obtain them' (Ricardo, 1950, 1817, 100). What had changed? Recent work in economic history suggests that an 'industrious revolution' took place between 1600 and 1800 and that this transformation played a crucial role in enabling western Europe to achieve sustained economic growth after 1800 (de Vries, 1994, 2008).

This paper addresses this transformation in workers' labor supply by using a model built on Becker's (1965) theory of time use. The contribution of the paper is threefold. First, it demonstrates that the insights of de Vries (1994, 2008) and Voth

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¹ See the discussions contained in Pecchi and Piga (2008).

(2001b) into the character of the industrious revolution can be micro-founded in a model of labor supply. Second, this model clarifies the historical debate over the concept of an industrious revolution by distinguishing between an optimistic account advanced by de Vries (1994) of an industrious revolution driven by changing patterns of demand, and a pessimistic account as suggested by Van Zanden (1999). Finally, this enables us to assess whether or not other parts of the world, in addition to England, underwent similar industrious revolutions during the period before the industrial revolution.

This paper also sheds light on two other issues: the role played by consumer demand in the industrial revolution; and the role played by trade. Gilboy (1936) and Eversley (1966) argued that consumer demand played a central role in stimulating the British industrial revolution. Moykr (1977) demonstrated that simple general equilibrium considerations precluded an increase in demand from being a causal factor in growth. However, Moykr noted that 'it can indeed be maintained that demand factors mattered insofar as the supply of labor, the demand for leisure, and the demand for goods are simultaneously determined. If there was an increase in the "demand for income," economic growth would occur, but only at the expense of leisure' (Moykr, 1977, 985). By formalizing the insights of de Vries (1994) and Voth (1998, 2001b), this paper revisits this question.

The role trade played in the onset of modern economic growth is the subject of considerable dispute amongst economic historians ([as surveyed in Harley, 2004]. O'Brien (1982) showed that overseas trade and particularly trade with the periphery played a quantitatively small role in the eighteenth century English economy. However, the relatively small sector based on colonial trade could have had a disproportionately indirect large effect as Findlay and O'Rourke (2007) argue.² By analyzing how labor supply decisions depend on the relative prices of consumer goods, the analysis contained in this paper suggests how the arrival of new consumption opportunities in the form of colonial goods such as tea and sugar could have changed the labor/leisure calculus faced by workers, thereby playing a key role in laying the foundations for subsequent economic growth.

This article is organized as follows. Section 2 introduces the concept of an industrious revolution and explains its significance within the recent historical debate on the origins of modern economic growth and the great divergence. Section 3 presents a model of time-use and labor supply. In the model a distinction is made between leisurely consumption activities and intense consumption activities. Section 4 applies the predictions of this model to the historical evidence assessing the extent to which different processes could have driven labor intensification in England, Italy and Japan. Section 5 concludes.

2. The industrious revolution

2.1. Idleness in the pre-industrial world

In the seventeenth century, economic writers thought the labor supply schedule bent backwards at very low levels of income.³ This view is reflected in the following quotation from Bishop Pilkington in the early sixteenth century:

'The laboring man will take his rest long in the morning; a good piece of the day 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 spendeth 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).

It was not merely that workers displayed a taste for leisure; labor supply was also seen as highly inelastic. Bernard Mandeville observed of the mass of workers, that 'if by Fours Days labor in a Week they can maintain themselves, will hardly be persuaded to work the fifth' (Mandeville, 1924, 1723, 509). 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). Higher wages did not induce workers to work harder or longer.

While Keynes speculated about how our future selves would enjoy our leisure hours, writers during the seventeenth and early eighteenth century were seriously concerned. The industriousness of workers was seen as a source of wealth and national power. In his *Observations upon the United Provinces of the Netherlands*, written in 1668, Sir William Temple lauded the virtues of the Netherlands where 'the Multitude of the People' 'has planted and habituated industry among them'. However, he noted that 'men naturally prefer ease before labor, and will not take pains if they can live idle' (Temple, 1740, 61–64).

Low wages were held to be the solution to the problem of idleness.⁴ The anonymous author of *The Trade of England Revived; and the Abuses of Thereof Rectified* (1681) went so far as to argue in favor of regressive taxation on food and drink in

² There are several possible channels. Acemoglu et al. (2005) argues that Atlantic trade shaped institutional developments in England and the Netherlands. In more recent work, O'Brien (2001) emphasizes the role played by British control of Atlantic trade in the growth of the British state. Allen (2009) argues that the growth of British overseas trade during the seventeenth and eighteenth centuries was a pre-condition for the industrial revolution. This paper sheds light on one mechanism through which this might have been the case.

³ Surveys of this view are provided by Coleman (1956); Hill (1964); Appleby (1976); Blanchard (1978); Rule (1981); Himmelfarb (1984); Hatcher (1998).

⁴ This view is summarized by Weber (1930) who commented that '[f]or centuries it was an article of faith, that low wages were productive, i.e. that they increased the material results of labor' (Weber, 1930, 24). According to Walter Raleigh '[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).

order to encourage the poor to work more (Appleby, 1976, 513). According to this view the high wages, identified by Allen (2009) as characteristic of the English economy, were a source of economic weakness, not strength.

These views appeared consistent with available evidence which indicate a strong preference for leisure. 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 more hours each day. Hatcher (1998) found that the labor 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 and 6 hours a day; workers who earned the most, worked the least.

This attitude towards work changed in the century prior to the industrial revolution. The problem of idleness receded from view; commentators ceased to worry about labor supply curves bending backwards. For Adam Smith, low wages were not required to stimulate labor because '[t]he wages of labor are the encouragement of industry, which, like every other human quality, improves in proportion to [the encouragement it receives]' (Smith, 1776, I, vii). By the nineteenth century David Ricardo, as we have seen, could observe that the remedy to idleness in Irish workers was 'to stimulate exertion, to create new wants, and to implant new tastes' (Ricardo, 1950, 1817, 100). And Nassau Senior noted that '[t]o complain of our high wages is to complain that our labor is productive – to complain that our workpeople are diligent and skillful' (quoted in Coats, 1966, 114).⁵

2.2. The industrious revolution in England

De Vries (1994) labeled this transformation the 'industrious revolution' and this concept has proven influential because it coheres closely with both recent reassessments of the industrial revolution and the evidence of an increasingly sophisticated 'world of goods' emerging during the early modern period. Harley (1982) and Crafts (1985) reevaluated economic growth during the industrial revolution and established that growth was slower than had previously been thought on the basis of earlier estimates made by Deane and Cole (1969). This has led to a renewed focus on the period prior to the industrial revolution which De Vries and others have characterized as one of Smithian growth based on the expansion of the market and the division of labor.⁶

McKendrick et al. (1982) and Brewer and Porter (1993) had previously argued that a consumption revolution took place in eighteenth century England. Weatherill (1988) documented the rise in the number of households owning saucepans, cutlery, clocks, china, pewter and earthenware, and utensils for hot drinks recorded in probate inventories between 1675 and 1725. However, this seemed to contradict data which indicated that real wages did not rise during this period (Deane and Cole, 1967; Allen, 2001; Clark, 2005). Fig. 1 plots Weatherill's findings against real wages, which were more or less stationary in this period.⁷

De Vries (1994) resolved this by observing that consumer demand could increase despite relatively stagnant real wages because households were able to reallocate resources to the market.⁸ Increased participation in the commercial economy expanded the size of the market and fed into overall economic development through a 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 labor was diverted from self-provision of crafts to market provision of food' (De Vries, 1976, 181). In this account, the industrious revolution paved the way for the onset of modern economic growth. By changing the behavior of workers it helped to shape 'the human raw material for a modern capitalist economy' (De Vries, 1994, 258).⁹

⁵ Economic historians have confirmed the view that the supply of labor to have been highly elastic during the industrial revolution. Phyllis Deane described a reserve army consisting of 'an almost inexhaustible low-priced labor-supply' (Deane, 1968, 100). More recent research shows that this was half-right. Labor 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 (Allen, 2009).

⁶ See Grantham (1999). The attention devoted to Smithian growth has also focused more attention on the Netherlands as the 'first modern economy' see De Vries and van der Woude (1997).

⁷ The increase in durable goods left in probate inventories was particularly marked in the inventories from London. Utensils for hot drinks were almost completely absent from seventeenth century inventories but they were found in 96 percent of London inventories by 1725 (Weatherill, 1988, 27. Between 1550 and 1800 the composition of the population who left probate inventories changed but this change was not significant between 1675 and 1725.

⁸ The apparent inconsistency of the real wage data and estimates of per capita income growth during the early modern period have been investigated in further detail by Angeles (2008).

⁹ According to De Vries (1993, 2008) this increase in hours worked was not driven by exploitation by bosses as Marxians had contended nor by the introduction of the factories. Marx argued that industrialists increased working hours in order to extract as much of the value of labor as possible. Bienefeld (1972) followed Marx in arguing that 'industrialization of the economy produced pressures to lengthen hours' which were met by extending hours in particular industries. Thompson described this intensification of working hours as part of 'the political counter-revolution, from 1792 to 1832 . . . working



Fig. 1. Inventory data is from sample probate inventories taken from Kent, Hampshire, Cambridgeshire, the north-east, the north-west, Staffordshire, Cumbria, and London (Weatherill, 1988). The real wage series is from Clark (2005) and is normalized so that 100 = 1770–1779. Allen's (2001) London real wage series does show some increase in this period: (from 107 in 1665 to 114 in 1725).

Table 1

Estimated hours of work in London and the North from time-use data obtained from court records and subsequent estimates of average annual hours worked. Sources Voth (2001a, 1074) and Maddison (2003).

	Annual working hours		
	Estimate	Upper bound	Lower bound
1760	2576	2868	2284
1800	3328	3596	3060
1830	3356	3956	2784
England 1870	2755		
England 2000	1653		

What evidence is there for the industrious revolution? Hours worked were not recorded in any country in the pre-industrial period so we have no direct evidence of the industrious revolution. There is, however, a considerable amount of indirect evidence for working hours in England. 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 or how widespread it was. Voth (1998, 2001b) 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 extraordinarily hard during the industrial revolution, and that working hours peaked around 1830.¹⁰

Voth's estimates are reported in Table 1. 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.¹¹ Some studies do suggest that in some industries at least 'idleness' continued to be perceived as a problem by employers and that the phenomenon of working less on Mondays (St. Monday) continued into the middle of the nineteenth century, but Voth's data is the most systematic that we have (Kirby, 2009).¹²

people were forced into political and social *apartheid* during the Wars . . . We can now see something of the truly catastrophic nature of the Industrial Revolution; as well as some of the reasons why the English working class took form in these years. The people were subjected simultaneously to an intensification of two intolerable forms of relationship: those of economic exploitation and of political oppression' (Thompson, 1963, 216–217).

¹⁰ Child labor is an important part of this story. However, information on child labor is difficult to assess for the period before 1830, and it is understated in the censuses conducted in 1851 and 1871. It is not clear whether the total amount of child labor increased during the first part of the nineteenth century, or whether child labor merely became more visible as it became concentrated in factories (Horrell and Humphries, 1995, 487). If child labor declined during the first decades of the industrial revolution then an increase in male working hours may have been required to compensate for lost earnings. Therefore household labor may not have increased as much as this between 1800 and 1830. However, some accounts suggest that child labor increased during this period, in which case the converse conclusion applies.

¹¹ 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.

¹² Interpretations of the decline of St. Monday vary. According to Reid (1976, 1996) Monday served as an additional day of rest to Sunday, much as Saturday does today. The origins of this practice are unknown but it seems to have arisen in the eighteenth century. Thompson argued that the decline of this practice in the nineteenth century indicates that work intensified with the coming of the factory. But this does not mean that an industrious revolution could not

2.3. Industrious revolutions elsewhere?

De Vries (1994, 2008) argued that the increase in hours supplied to the market and in market participation in north-western Europe set the stage for the onset of sustained or ‘modern’ economic growth in the nineteenth century. Others, however, have argued that multiple industrious revolutions took place across Eurasia and since De Vries’s (1994) article the significance of the industrious revolution and its importance in explaining the Great Divergence has been contested.

Evidence on working hours in other parts of the world during the eighteenth century is lacking, so a direct comparison between England on the eve of the industrial revolution and Southern Europe, China, or India is not possible. Nevertheless, there is considerable indirect evidence that labor inputs were high in those regions too. The question is whether this meant that other parts of Europe such as Italy or parts of Asia such as the Yangzi delta in China or the Kanto plain in Japan were also undergoing industrious revolutions of the sort described by De Vries?

The main problem with this debate is that the meaning of the term ‘industrious revolution’ is not always made clear. The term was in fact coined by Akira Hayami in reference to Tokugawa Japan. However, in its original context the industrious revolution was viewed as an alternative, rather than as a necessary prelude, to industrialization (Hayami, 1977). We return to the case of Japan in Section 4. More recently Bin Wong (1997) and Pomeranz (2000) have argued that eighteenth century China had an industrious revolution similar to that which took place in England. They marshal a considerable amount of evidence to indicate that consumption levels of at least some goods were comparable to European levels. The alleged commonness of such industrious revolutions reflects the broader revisionist position that the economies of western Europe and China displayed many ‘surprising resemblances’ until late into the eighteenth century; and that both economies remained within the confines of a Malthusian world until the nineteenth century.

Bin Wong and Pomeranz argue that such processes of Smithian growth were distinct from, and not necessarily related to, sustained or modern economic growth. The concept of an East Asian industrious revolution as presented by Bin Wong and Pomeranz is thus compatible both with the optimistic assessment they offer of the Yangzi delta in 1750 and with more pessimistic interpretations of the same evidence. In the optimistic view ‘an intensification of labor’ in the most advanced parts of China was accompanied by ‘slight increases in consumption (at least before 1750)’ (Pomeranz, 2002, 558). In the opinion of the pessimists this intensification was part of a process of ‘involution’. Huang (1990, 2002) argues that population growth in the Yangzi delta meant that peasant holdings became smaller and more subdivided. As the returns to labor were diminishing, households had to continuously increase labor inputs in order to maintain their income, a process that if continued could force the marginal product of labor to zero. This process of involution led peasants to use their remaining time to produce for the market in the handicraft sector, a process that Huang terms ‘involuntary commercialization’ (Huang, 1990, 13–14). The fact that interpretation of an increase in labor inputs in the early modern Chinese economy can be contested in this way suggests that the concept of an industrious revolution needs to be refined.

2.4. Disputed implications

Van Zanden (1999) suggests that a more pessimistic reading of the European evidence is also tenable. The industrious revolution may have been a response to relative price changes, and falling real wages in at least some European economies. Van Zanden shows that the price of wheat rose across western Europe during the early modern period – causing the grain wage to fall in southern Europe between the sixteenth and the eighteenth centuries (Van Zanden, 1999, 185). Hoffman et al. (2002) similarly found that between 1500 and 1800 staple goods became more expensive while items associated with luxury consumption became cheaper. The ratio between money wages and the price of grain fell in southern European cities like Florence, Milan and Valencia during the eighteenth century. Fig. 2 uses data from Allen (2001) to trace the decline in southern European real wages during the early modern period. If increases 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 can be associated with a fall in living standards.

In the next section, a model is introduced that distinguishes between leisurely consumption activities and intense consumption activities. Late medieval workers consumed consumption bundles that were *leisurely*, costly in terms of time rather than money, as for the majority of the population ‘the things money could buy were few in kind and limited in quantity’ (Davis, 1966, 3). A household worked long enough to purchase necessities that it could not efficiently produce at home. As *income intensive* consumption experiences were not available or were very expensive, the household had no incentive to supply additional labor to the market beyond a point determined by the price of the basket of commodities it purchased from the market. This is the world described by Van Zanden (1999) and Huang (1990).

However, in a society where alternative, *income intensive*, consumption opportunities were available, a fall in the price of income intensive, time-cheap consumption opportunities increased the relative cost of leisure time, and, as result, the household now had an incentive to supply more labor time to the market. This is the world described by De Vries (1994, 2008).

have occurred prior to the industrial revolution. It seems that the practice of St. Monday may have emerged as a response to the demise of other holidays so it is difficult to know what the prevalence of St. Monday means for working hours overall (see Reid, 1976, 1996).

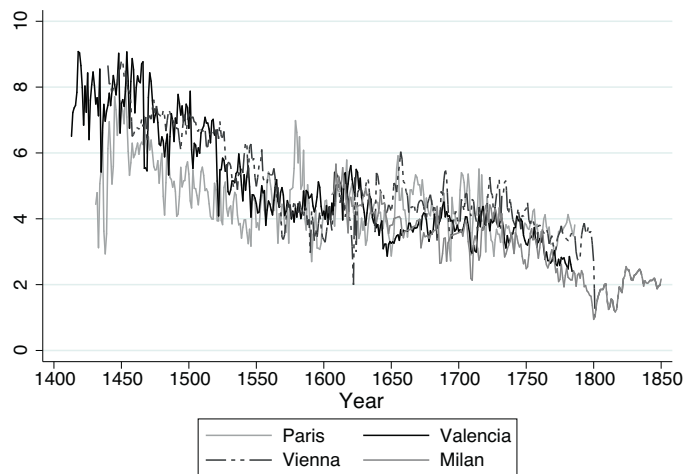


Fig. 2. Real wages for laborers in Paris, Milan, Valencia and Vienna in the early modern period. Data from Allen (2001). The real wage is obtained by dividing by the daily silver wage by a consumer price index.

The model enables a comparison between the predictions associated with each viewpoint. It clarifies the debate over the welfare implications of the rise in working hours associated with the industrial revolution and can be used to assess both Van Zanden's concern that an industrious revolution could lower living standards even if it maintained measured levels of consumption because it involved less 'consumption of leisure' (Van Zanden, 1999, 176) and the more optimistic consumption driven industrious revolution that De Vries (1994) outlined.

3. A model of labor supply

The model is a specific variant of the generalization of Becker's (1965) time-use model developed by Atkinson and Stern (1979, 1980, 1981). Individuals derive utility from the characteristics of goods rather than the goods *per se* (Lancaster, 1966). In Atkinson and Stern (1979, 1980, 1981) consumption \mathbf{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 . 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. The price of work is the negative of the wage rate $-w$ and labor does not enter the utility function. The maximization problem facing a representative worker is therefore: $\max u(c_1, \dots, c_m)$, subject to a budget constraint $\sum_{j=1}^m p_j c_j \leq M + wl$ and a time constraint $\sum_{j=1}^m t_j c_j \leq T - l$, where M is non-labor income and where $l, c_1, \dots, c_m \geq 0$.

3.1. Labor supply

Stern (1986) outlines many of the different shapes that the labor supply schedule can take when consumption takes time. For the purposes of the paper we look at the case where there are three consumption activities ($m = 3$). Activities 1 and 2 are consumption activities while activity 3 involves the consumption of basic necessities where γ represents the minimum level of food, clothing and shelter that all individuals need to consume in order to survive.¹³ This basic consumption requirement need not be biologically determined as we can also think of it as being influenced by social variables. We employ the following log utility function:

$$u(c) = \log \beta_1 c_1 + \log \beta_2 c_2 + \log \beta_3 (c_3 - \gamma)_-, \quad (1)$$

¹³ There is a conceptual issue with the distinction between time and income intensive consumption that the reader should bear in mind. To some extent the time spent consuming a good may be endogenous i.e. consumers can linger over a cup of tea or coffee or they can consume it quickly.

where the general argument $(x)_- = \min \{0, x\}$ 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 $p_1c_1 + p_2c_2 + p_3c_3 \leq M + wl$ can be combined with the time constraint to form:

$$q_1c_1 + q_2c_2 + q_3c_3 = M + wT,$$

where $q_i = p_i + wt_i$ for $i \in \{1, 2, 3\}$. Using the fact that at the optimum the subsistence requirement will always be satisfied, the effective amounts of non-labor income and time an individual has left over are $M' = M - p_3 \cdot \gamma$ and $T' = T - t_3 \cdot \gamma > 0$, respectively. Therefore the combined constraint after subsistence needs have been met is:

$$q_1c_1 + q_2c_2 = M' + wT'. \tag{2}$$

By maximizing $u(c)$ with respect to the budget constraint (Eq. (2)) we obtain the following condition for labor supply:¹⁴

$$l = T' - (M' + wT') \left(\frac{t_1\beta_1}{q_1} + \frac{t_2\beta_2}{q_1} \right). \tag{3}$$

Labor supply is increasing in the monetary price of consumption activities p_1 and p_2 , in the minimum consumption requirement γ , and in the price of basic commodities p_3 . Labor supply is decreasing in the temporal price of consumption activities t_1 and t_2 , and in non-labor income M .¹⁵

3.2. The shape of the labor supply schedule

We are interested in how the shape of the labor supply schedule varies according to the matrix of monetary and time prices of the available consumption activities. In order to examine the shape of the labor supply schedule further let us turn to look at the effect of the wage rate on labor supply. The labor supply curve can be differentiated with respect to the wage w to obtain:¹⁶

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

The sign of both these terms and therefore the direction of the effect of wages on labor supply depends on the sign of $t_i(M' t_i - p_i T')$. To examine this suppose that one consumption activity can be defined as *leisurely* or time consuming while the other is labeled *intense* or time cheap.

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

In order to ensure that there is a single point at which the labor supply curve turns we impose the following assumption on the second order conditions.¹⁷

Assumption 2.

$$\left| \frac{2\beta_2 t_2^2 (M' t_2 - T' p_2)}{(p_2 + wt_2)^3} \right| > \left| \frac{2\beta_1 t_1^2 (M' t_1 - T' p_1)}{(p_1 + wt_1)^3} \right|.$$

One interpretation of this condition is that it requires activity 2 to be more 'income intensive' than activity 1 is 'leisurely' i.e. $|t_2 M' - p_2 T'| \gg |t_1 M' - p_1 T'|$.

¹⁴ Details of the maximization are confined to the appendix.

¹⁵ To see this note

$$\begin{aligned} \frac{\partial l}{\partial p_1} &= \frac{t_1 \beta_1 (M' + wT')}{(p_1 + wt_1)^2} > 0, & \frac{\partial l}{\partial p_2} &= \frac{t_2 \beta_2 (M' + wT')}{(p_2 + wt_2)^2} > 0, \\ \frac{\partial l}{\partial t_1} &= -\frac{p_1 \beta_1 (M' + wT')}{(p_1 + wt_1)^2} < 0, & \frac{\partial l}{\partial t_2} &= -\frac{p_2 \beta_2 (M' + wT')}{(p_2 + wt_2)^2} < 0. \end{aligned}$$

¹⁶ As $\frac{\partial l}{\partial w} = -(M' + T'w) \left(-\frac{\beta_1 t_1^2}{(p_1 + wt_1)^2} - \frac{\beta_2 t_2^2}{(p_2 + wt_2)^2} \right) - T' \left(\frac{\beta_1 t_1}{p_1 + wt_1} + \frac{\beta_2 t_2}{p_2 + wt_2} \right)$.

¹⁷ We thereby rule out the interesting case of an s-shaped labor supply schedule in favor of a curve that bends just once. This is justifiable because we are interested in a representative worker. An s-shaped labor 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 labor force as a whole. Considering more esoteric specifications for labor supply would make the comparative statics intractable.

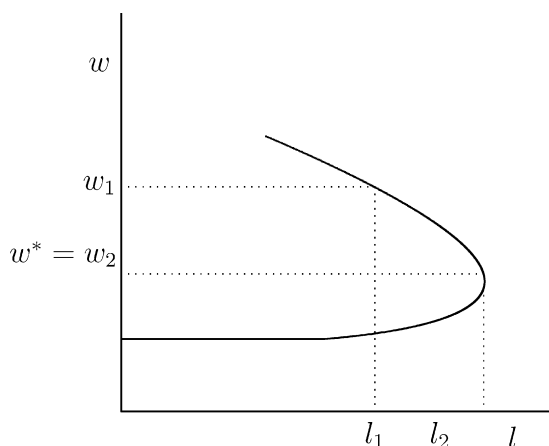


Fig. 3. Movements along a given labor supply curve.

3.3. w^* and the elasticity of labor supply

The standard expression for the point elasticity of labor supply ϵ is: $\epsilon = \partial L / \partial w \cdot w / L$. A labor supply curve bends backwards where $\epsilon = 0$, at the point at which the wage $w = w^*$ solves the following first order condition:

$$\frac{\beta_2 t_2 (M' t_2 - T' p_2)}{(p_2 + w^* t_2)^2} = - \frac{\beta_1 t_1 (M' t_1 - T' p_1)}{(p_1 + w^* t_1)^2}. \quad (4)$$

Under [Assumption 2](#) this gives a unique maximum for the quantity of labor supplied thereby defining w^* as shown in [Fig. 3](#). Using this, a labor supply curve can be described as becoming more elastic if w^* increases.

3.4. Movements along the labor supply curve

This model can distinguish between different types of industrious revolutions. It keeps separate (i) movements along a given labor supply schedule; (ii) shifts in the labor schedule; (iii) changes in the shape of the labor supply schedule.

An immiserating industrious revolution can be explained in terms of movements *along* the labor supply schedule. A fall the wage rate w has different effects depending on where one is on the labor supply curve.

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 $w < w^*$.

Evidence for a movement *along* the labor supply curve can be found for late medieval England. [Blanchard \(1994\)](#) documents that 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 labor 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, after the Black Death ‘they worked only some 80–100 days, reducing their total work-load to 200–210 days a year’ ([Blanchard, 1994, 18](#)).¹⁸ In terms of [Fig. 3](#), workers during the late Middle Ages were earning wages w_1 and supplying labor equal to l_1 . Increases in the wage rate w led to them supplying less labor. This inverse relationship between real wages and the 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 (see [Karakacili, 2004](#)).

The gains made by workers in the post-Black Death period were eroded over the course of the subsequent centuries. In [Fig. 3](#), a fall in the real wage rate from w_1 to $w_2 = w^*$ induces workers to increase the amount of labor 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.¹⁹

¹⁸ 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, 25](#)).

¹⁹ The only types of miners who did not do this as prices rose in the early modern period were those independent miners who sold their output. When lead prices began to increase after 1580 independent miner could ‘steadily decrease the level of his labor intensity. Accordingly, by 1600 whilst he earned a higher cash income than in 1520, he actually performed slightly less work than earlier’ ([Blanchard, 1978, 10](#)). Miners who were dependent on wage payments did not benefit as much from the rise in lead prices and had to increase the hours that they worked.

In general after 1500, rising wheat prices obliged workers to either cut back on consumption, consume lower quality produce, or increase labor 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), '[m]en's diet between the fifteenth and the eighteenth centuries essentially consisted of vegetable foods'.²⁰

The kind of economy in which labor hours are rising because real wages are falling cannot have been a conducive environment for economic growth. If growth did occur then, as real wages rose, workers would cut back hours and consume more leisure, and labor supply constraints would act as a brake on the expansion of industry. This resembles the English economy as it was viewed by mercantilist writers in the seventeenth century who saw no way of stimulating industriousness except poverty because 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).²¹

During the eighteenth century the English economy was not immune from the problems caused by rising grain prices as Van Zanden (1999) points out, especially during the 'high price years of the French wars' (Thompson, 1963, 241). However, the evidence presented by Voth (1998, 2001b,a) suggests that neither the timing nor the extent of the increase in working hours that occurred in England between 1750 and 1830 is explicable in terms of rising wheat prices.²² Hence the industrious revolution that took place in eighteenth century England cannot be understood in terms movements along a given labor supply curve, but should, rather, be thought of in terms of either shifts in, or changes of, the shape of the labor supply schedule.

3.5. Shifts in the labor supply curve

We can examine the effects of a change in non-subsistence, non-labor income $M' = M - p_3\gamma$, on the shape of the labor supply curve. The first order 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 Eq. (4) holds. This equation can be totally differentiated with respect to M' to obtain:

$$\frac{dg}{dM'} = \frac{\partial g}{\partial M'} + \frac{\partial g}{\partial w^*} \frac{dw^*}{dM'} = 0.$$

Rearranging, we have:

$$\frac{dw^*}{dM'} = -\frac{\partial g / \partial M'}{\partial g / \partial w^*}. \quad (5)$$

The numerator of the RHS is equal to

$$\frac{\partial g}{\partial M'} = \frac{2t_1\beta_1}{(p_1 + t_1w^*)^2} + \frac{2t_2\beta_2}{(p_2 + t_2w^*)^2} > 0. \quad (6)$$

The denominator is

$$\frac{\partial g}{\partial w^*} = \frac{\beta_1 t_1^2 (t_1 M' - pT)}{(p_1 + t_1 w^*)^2} - \frac{\beta_2 t_2^2 (t_2 M' - pT)}{(p_2 + t_2 w^*)^2}. \quad (7)$$

The sign of this equation is positive under Assumption 2. Therefore we have the following proposition.

Proposition 1. *The turning point in the labor supply curve w^* is increasing in non-subsistence income M' .*

Conversely, a fall in the amount of subsistence income lowers w^* . A fall in non-labor, non-subsistence income M' elicits an increase in labor hours supplied to the market but also causes the labor supply curve to bend backwards at a still lower level of income. This is illustrated in Fig. 4. This phenomenon can be characterized as an industrious revolution, but its predictions are qualitatively distinct from those associated with De Vries's argument. It is an involuted industrious revolution.

²⁰ The process of substituting in favor of ever cheaper sources of calories inevitably reached 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 the energy to work for more than three hours a day (Fogel, 1994, 373). This interaction between wages and ability to supply labor is not in the model.

²¹ 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 labor.

²² According to Voth (2001a) hours worked peaked in 1830 whereas the relative price of wheat – obtained by dividing the silver price of wheat by the price of a weighted basket of consumer goods (from Allen (2003)) – peaked in the 1790s and had declined considerably by 1830.

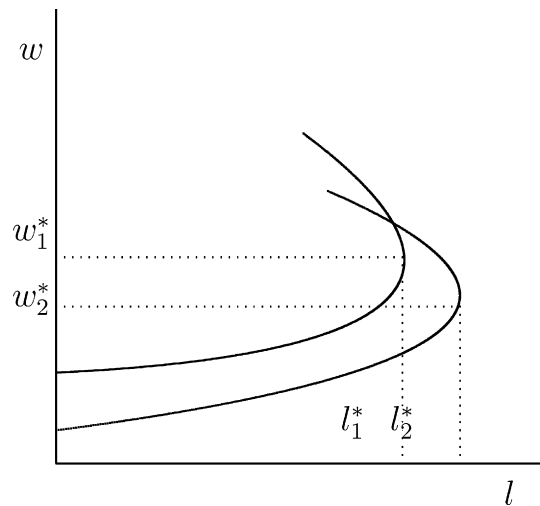


Fig. 4. A fall in non-subsistence income M' causes an increase in l and a fall in w^* .

3.6. Straightening out the backwards bending labor supply curve

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

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

The numerator on the right-hand-side can be obtained by differentiating Eq. (4) with respect to p_2 to obtain:

$$\frac{\partial g}{\partial p_2} = -\frac{2t_2(-T'p_2 + M't_2)\beta_1}{(p_2 + wt_2)^3} - \frac{T't_2\beta_1}{(p_1 + wt_2)^2}. \quad (8)$$

This is unambiguously negative. By Assumption 2, $\partial g / \partial w^*$ is also negative. Therefore $dw^* / dp_2 < 0$. Thus we have the following result.

Proposition 2. *The turning point in the labor supply curve w^* increases as p_2 falls.*

An exogenous fall in the price of activity 2 will lead to an increase in the elasticity of labor supply. This corresponds to the industrious revolution described by De Vries (2003, 2008): an increased willingness to supply more labor in response to higher wages. Falling prices for certain goods changed the trade-off workers faced between labor and leisure (consumption time). Workers now wanted to work for longer in order to purchase these goods and they were prepared to sacrifice leisure time in order to do so, in part because these new consumption activities were less time consuming. A 'modern' budget constraint containing reasonably priced income intensive consumption activities was steeper in wage-hour space, generating a straightening out of the labor supply curve as illustrated in Fig. 5.

4. Applying the model to history

The model predicts:

1. An increase in the price of the basic commodities causes l to rise and w^* to fall.
2. A decrease in the price of the income intensive consumption activity p_2 causes l and w^* to rise.

England appears to confirm to the second prediction. Contemporaries certainly attributed the new industrious habits of workers to their desire to obtain consumption goods and affordable luxuries.²³ The next section outlines the historical evidence supporting the claim that changing patterns of consumption drove changes in the behavior of labor supply.

²³ 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' produced poverty and misery: the remedy was 'to stimulate exertion, to create new wants, and to implant new tastes' (Ricardo, 1950, 1817, 100). John Stuart Mill similarly emphasized the importance of 'making men alive to new objects of desire' (Mill, 1848, 189).

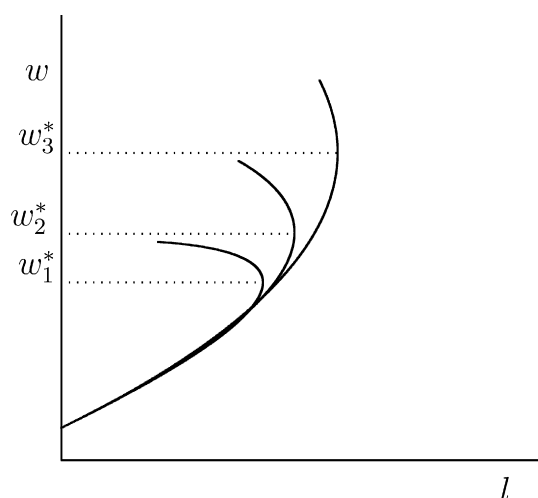


Fig. 5. A fall in p_2 causes an increase in l and an increase in w^* .

A consumer revolution in England

The growth of small retail shops facilitated a new consumption culture, enabling customers to purchase goods immediately, on a whim, as opposed to putting in bulk orders to merchants (Mui and Mui, 1989). 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).²⁴ 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). The rise of shops reduced the time involved in many consumption activities and reduced the effective price of time-intensive activities.

The fall in p_2 can be seen in the shift from buying textiles from wholesalers and making one’s own clothes to buying ready-made clothes from shops. Styles (2007) documents the increased popularity of cotton garments and other ‘luxurious’ goods amongst ordinary people in the eighteenth century. This is demonstrated by the increase in the number of court cases involving stolen items of either printed cottons or linens or watches shown in Fig. 6. Significantly, many of the owners of stolen watches were plebeian. In 55 cases from the Northern Circuit Assize in the second half of the eighteenth century men whose occupations were listed as laborers, husbandmen and servants reported watches stolen from them (Styles, 2007, 344).

Falling prices drove this phenomenon. Shammass (1990) details how the price of woollens and linens fell dramatically in real terms between the late sixteenth century and the early eighteenth century.²⁵ 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 meant perhaps one week’s wages or less’ (Lemire, 1991, 97).²⁶ Foreign observers now described ordinary Englishmen and women as well-dressed and fashion conscious.²⁷

It is difficult to quantify this fall in the price for cotton and linen textiles, partly because as clothes became less valuable they were less likely to be left in probate inventories, and partly because the nature of the phenomenon driving the fall in prices – an expanding and increasingly diverse market – meant that there was a greater variety of products and a greater range of prices for very similar types of apparel.²⁸ Moreover, the significance of the emergence of a new market for printed cottons and ready-to-wear clothes for ordinary people is likely understated in existing consumer price indices precisely because real wage indices have well-known problems coping with the emergence of new goods.

²⁴ In order to provide a comparative perspective it should be noted that in 1950 there was one shop per 92 people (Flanders, 2006, 44).

²⁵ 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. There were 240 *d* or 20 *s* to the £. Male winter farm wages in the eighteenth century were around 10–15 *d* per day. Women earned around a third or a half as much.

²⁶ McKendrick (1974) argued that women’s tastes drove the consumption trends of eighteenth century. Berg (2004, 380–383) 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’.

²⁷ A German visitor, Friedrich August Wendeborn noted that ‘[a]ll do their best to wear fine clothes, and those who cannot purchase them new buy the old at second-hand, that they may at least have the appearance of finery’ (quoted in Styles, 2007, 10).

²⁸ The records of fire in Brandon in Suffolk in 1789 cast light on the number and value of the clothing owned by both the master and mistress of the house and of their servants. Two things are striking: (1) how much cheaper the clothes of the working class were. The mistress had three cotton gown each worth 15s whereas one servant has a gown that is only valued at 4s 6d; (2) even the servants have several changes of clothing and reported between 16 and 69 items lost as a result of the fire.

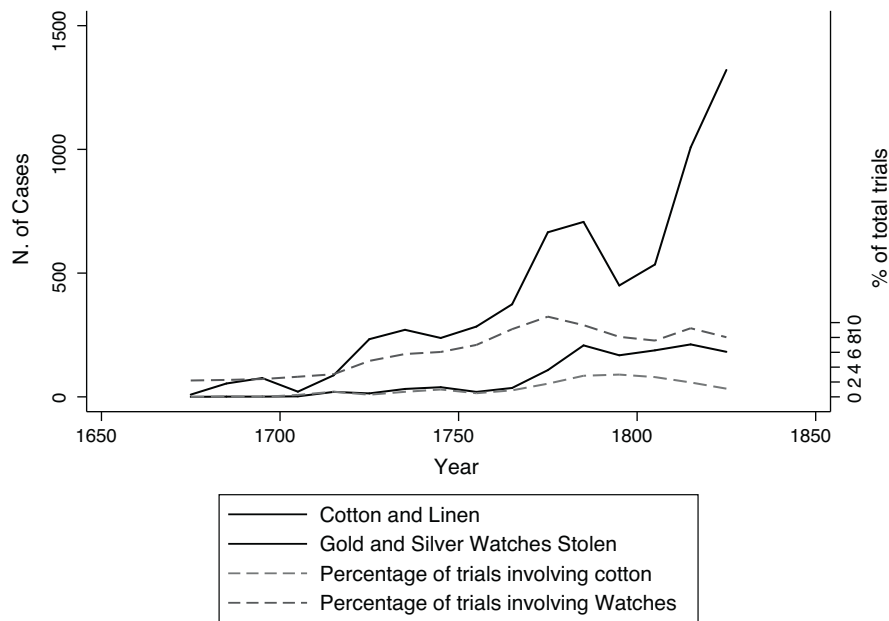


Fig. 6. The frequency of trials involving stolen items of printed cotton or linen clothing or watches increased between 1670 and 1830. The data, taken from Old Bailey proceedings, is from (Styles, 2007, 343–345).

A still more dramatic example of the way in which consumption opportunities were transformed in this period was the rise in tea and sugar consumption. In the late seventeenth century tea was drunk by wealthy households. Over the course of the eighteenth century, as its price fell, it gained popularity with the middle classes, and then from the 1730s and 1740s onwards, it became 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).²⁹ 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.

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, 71). 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. However, it seems that perhaps average per capita consumption was as high as 2 pounds per person by the end of the eighteenth century (Shammas, 1983, 1990).³⁰ This meant that the median individual could have at least two cups of tea a day. The scale of the 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).³¹

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.³² 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 increasing demand was

²⁹ 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 neighbors, or even stimulated its colour by pouring boiling water over a burnt crust' (Thompson, 1963, 351).

³⁰ 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.

³¹ A similar process occurred 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.

³² In France, according to Braudel, in 1788 'sugar was still a luxury item despite public favor and the relative fall in price' (Braudel, 1973, 157). He reports an estimate that average consumption per year could have been around 1 kg 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).

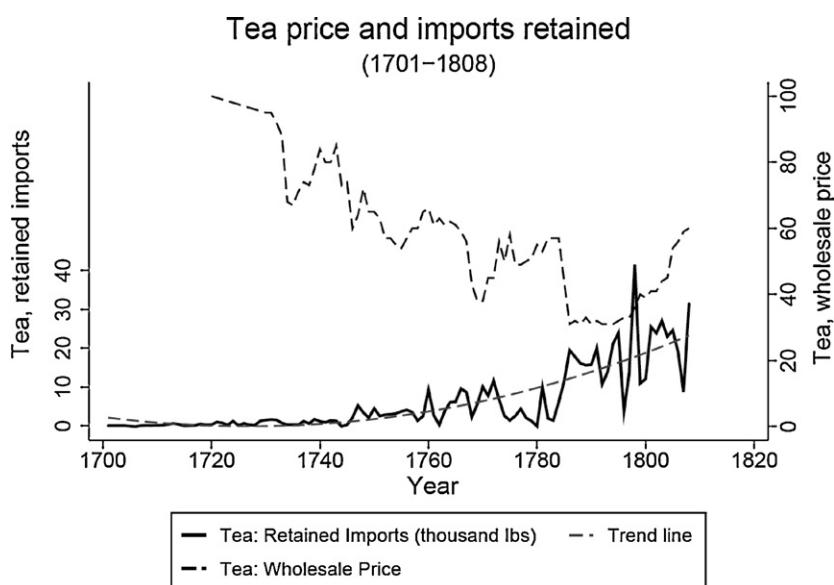


Fig. 7. Tea prices and retained imports: average real tea prices from Cole (1958); the number of retained imports from Schumpeter (1960). The volume of smuggled tea was significantly higher.

Table 2

The price of a cup of tea. Source: Beveridge, 1939; Davis, 1966.

		Price of a cup of tea (in pence)				
		1686	1708	1784		
Sugar	No. cups	30s per lb	24s per lb	Black tea 5s per lb	Green tea 8s per lb	Hyson tea 12.33s per lb
		0 sp.	196	1.84	1.47	0.3
	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	0.65
3 sp.	196	2	1.73	0.54	0.73	1
	300	1.39	1.22	0.44	0.56	0.72

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 labor 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.

According to the price index constructed by Cole (1958), the real price of tea fell by seventy-five percent between 1720 and 1800. The inverse relationship between prices and consumption in the eighteenth century is illustrated in Fig. 7.³³ 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 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 increase in sugar imports is depicted in Fig. 8.

Table 2 summarizes a number of different estimates of the cost of a cup of tea 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

³³ 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 Fig. 7 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. Hersh and Voth (2009) estimate how much tea was really imported into Britain, correcting for smuggling. They show that the affect of the tariffs imposed during the eighteenth century was to understate tea consumption during the first three quarters of the eighteenth century and to overstate the acceleration of growth of tea consumption in the last quarter of the eighteenth century.

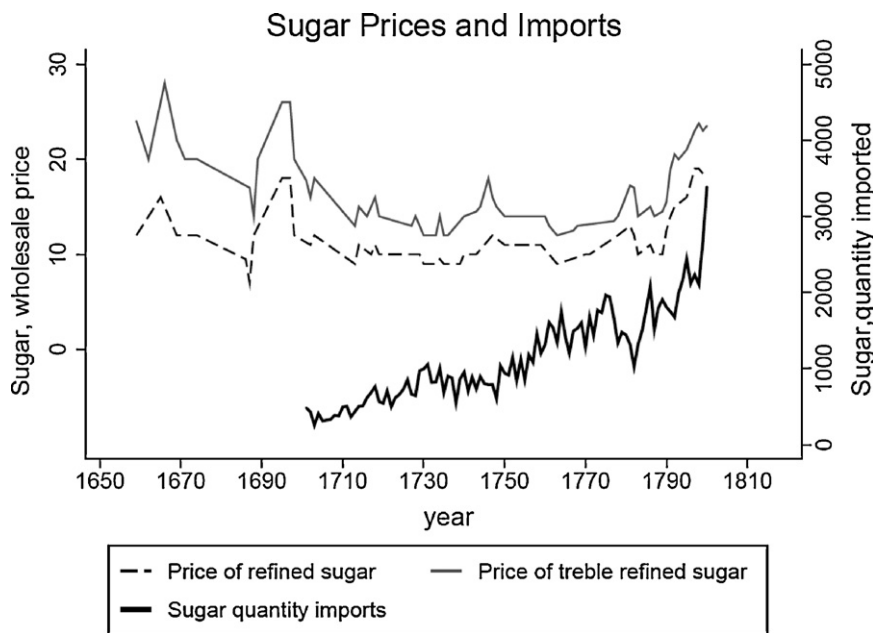


Fig. 8. Sugar imports and prices: price data from Beveridge (1939); import data from Schumpeter (1960) and Mitchell and Deane (1962). The sugar price series in Clark (2005) similarly shows little decline during the eighteenth century. Clark's series declines from 271.9 in the 1650s to 125.3 in the 1710s where the price in 1869 is normalized to 100 but then stabilizes during the eighteenth century. It then rises to between 190 and 200 during the Napoleonic wars before falling sharply in the 1840s and 1850s (see Clark, 2005, 1331).

1708 and 1784.³⁴ The rise of tea represents a shift in the consumption patterns of the middle and working classes.³⁵ It represents exactly the kind of shift in relative prices that, echoed elsewhere could have generated a straightening out of the labor supply curve in the model. The historical evidence is consistent with a fall in the price of time-intensive consumption p_2 increasing the elasticity of labor supply.

In fact the change in relative prices alone does not seem large enough to have occasioned 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: addiction. 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).³⁶

The consumer revolution was predominantly an urban phenomenon.³⁷ So too, it seems, was the industrious revolution. Clark and van der Werf (1998) found little evidence of an industrious revolution amongst agricultural workers during the period. Allen and Weisdorf (2011) 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. This estimate can approximate independent estimates of labor hours for the rural workers, but cannot explain the observed hours worked by urban workers based in London, indicating that urban workers must have purchasing goods outside of basic consumption basket. This is in accordance with the second prediction of the model, since cities like London and Amsterdam were the main centers of fashion and consumption. The next question is whether similar phenomenon characterized other parts of the world during the early modern period.

³⁴ 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 g of tea leaf (Cole, 1958, 403). 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 leaves, to suggest that this larger figure is probably more plausible.

³⁵ 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 laborer'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 lb 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 each through the week.

³⁶ An extension of the model in which individuals form consumption habits can be considered. In the Becker and Murphy (1988) framework consumers

4.1. Italy

Real wage series from southern European cities indicate that the real cost of meeting basic subsistence needs was rising in the eighteenth century (Allen, 2001). Fig. 2 plots the real wages of laborers several Southern European cities including Milan.³⁸ Since real wages here are defined in terms of a “pre-modern” consumer price index that excludes many of the new consumption goods, this is a suitable approximation for the inverse price of subsistence. Whereas real wages in northern Europe either rose or were roughly stationary during the early modern period, urban wages in Italy fell from late medieval levels and reached their nadir between 1800 and 1870. Wages in Florence were the highest in Europe in the fourteenth century but by the nineteenth century they were amongst the lowest (Malanima, 2003, 2007). Real wages in Madrid and Valencia experienced a similar decline (Allen, 2001).

Population growth from the eighteenth century onwards was accompanied by falling levels of labor productivity (Malanima, 2007, 141–142). Malanima (2003) constructs a basket of subsistence goods capable of providing 2100–2200 calories per day, basic clothing and accommodation. He calculated the number of hours a year an average urban worker would have to labor in order to obtain this basket and found that this increased from between 500 and 1000 hours in the late middle ages to 1500 in the nineteenth century. This corresponds directly to a fall M' in the model.

Did this result in an actual increase in hours worked? Estimated per capita GDP fell in early modern Italy but it did not fall as much as real wages did – reaching a plateau in the eighteenth century. This suggests that longer working hours and an increase in non-wage incomes partly compensated for adverse real wage trends. Specifically, the arrival of maize in the sixteenth and seventeenth centuries and the growth of proto-industry made it possible for workers to increase total output, albeit at the expense of declining labor productivity (see Malanima, 2007, 147).

As the model predicts, rising costs of subsistence lead to the intensification of labor inputs into production. Using estimates of per capita income, average wage rates and the ratio between labor incomes and total output, Malanima estimates that the average working year increased from around 2000 hours a year in the fourteenth century to between 2500 and 3000 hours a year in the second half of the eighteenth century (Malanima, 2007, 144).³⁹ This intensification of work was not associated with either urbanization or the rise of a consumer economy as in England. The level of urbanization in northern and central Italy fell during this period (Malanima, 2005). Malanima concludes that in Italy the industrious revolution ‘did not aim to raise the standard of living and introduce the population to the modern world of consumer goods, but it aimed to offset the worsening in the standard of living under rising demographic pressure’ (Malanima, 2007, 145). The experience of Italy appears to fit the first case identified by the model, that of involution – labor intensification driven by falling real wages.

4.2. Tokugawa Japan

The example of Italy corresponds to the first prediction identified by the model. The case of England bears out the second prediction of the model. What about East Asia? A detailed examination of work and consumption patterns in the Yangzi delta and Tokugawa Japan is beyond the scope of this paper. However, it is possible to briefly comment on the case of Tokugawa Japan.

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:

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

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: $p_1 c_1 + p_2 c_2 = M$ 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 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.

³⁷ Styles notes that ‘[p]lebeian Londoners enjoyed much more direct engagement with the world of high fashion than cottagers in remote Pennine townships where there were few shops and fewer resident gentry’ (Styles, 2007, 7).

³⁸ The Allen (2001) wage series is comparable to Malanima’s wage series for Florence and Milan (Malanima, 2007, 156–157). The Allen series is preferred here because it is more convenient for comparative purposes.

³⁹ These estimates are consistent with the grain wages found by Van Zanden (1999). Malanima (2007) finds the highest estimates for hours worked for the sixteenth century when Van Zanden finds particularly high grain prices.

Economic historians of Tokugawa see the industrious revolution as part of a process of Smithian growth based on the expansion of markets during the seventeenth and early eighteenth centuries (Sugihara, 2004; Saito, 2005, 2009b). There is no systematic evidence of hours worked in Tokugawa Japan so in a Japanese context the concept of an industrious revolution refers to an overall increase in labor inputs into production rather than a measured increase in hours worked per day or per year. Pressure on scarce land led to an intensification of labor inputs in agriculture that is evident in the widespread practice of double-cropping (Saito, 2005). This increase in labor inputs was accompanied by the growth of proto-industry. By the late eighteenth century onwards peasants were participating actively in rural industry and in handicrafts production. As in Europe, the expansion of rural industries enabled workers to utilize available 'spare time' left over after the agricultural work had been completed (Sugihara, 2007). One noticeable difference between Japan and Europe is that in Japan the industrious revolution was based in the countryside: economic growth was 'rural centered' (Smith, 1973).

Did Japan experience a consumption-driven industrious revolution driven by falling values of p_2 ? Or was the increase in labor inputs a sign of involution as M' fell? Making comparisons between Europe and Japan in the Tokugawa period is, however, fraught with difficulty. This is particularly so because the concept of an industrious revolution in Japan is contested by pessimistic and optimistic accounts of economic growth during the early modern period.

De Vries (2008) argues that the East Asian industrious revolution should be distinguished from developments in England and the Netherlands because it was not driven by consumption. In Japan and China, he argues that the industrious revolution was a 'supply-side phenomenon. Industrious activity trained people to become more productive workers, but it did not make them more active or innovative consumers' (De Vries, 2008, 80). This assessment is at odds with Hanley (1997) who argued that a transformation in the types of material goods ordinary peasants possessed occurred during the Tokugawa period. If established this contention would imply that Japan resembled the case of early modern England, thereby strengthening the case against the uniqueness of the western Europe economic experience made by Bin Wong (1997) and Pomeranz (2000).

However, comparing the level of material welfare as revealed by the kinds of goods found in probate inventories across societies is fraught with difficulty and most historians do not accept the strong claims Hanley makes on behalf of this data (see Saito, 1998). Real wages in Kyoto and Tokyo in the later Tokugawa period were comparable to those in Southern Europe and about a third of wages in London, and they did not rise until the Meiji period (Bassino and Ma, 2005). On the other hand, real wages did not fall as they did in Italy. The real wage data consequently has ambiguous implications for any interpretation of the Japanese industrious revolution.

The industrious revolution described by Hayami was of an adaptable peasantry able to adopt values of diligence, thrift and industriousness in order to maintain its living standards. He conjectures that 'much of the careful planning and the long workdays of disciplined labor substituted for the absence of markets' (De Vries, 2008, 80).⁴⁰ According to Smith (1986) peasant households had internalized a concept of time discipline during the early modern period as the combination of land scarcity, strong competition between small holders, and the nature of rice-based agriculture inculcated values of diligence and forward planning. Time was held to belong to the family and the village rather than to the individual because the provision of public goods at a village level depended on the industriousness of each member of the village (Smith, 1986, 181–182).

Additional evidence on consumption patterns provided by Francks (2007) similarly suggests that the 'modernization' of Japanese consumption did not occur until the last third of nineteenth century and casts doubts on the idea of a consumption driven Tokugawa industrious revolution. Francks (2007) observes that 'growth and change in the consumption of rice, tea, soy sauce, and *sake* in nineteenth and early twentieth-century Japan parallel those of white bread, tea, coffee and sugar in eighteenth and nineteenth-century England and France' (Francks, 2007, 149). This Meiji period consumption revolution occurred alongside urbanization and industrialization and Francks argues that it was these developments that 'forged the link between a rice-based diet and a 'proper,' 'civilized,' Japanese existence (Francks, 2007, 162). Saito also suggests that it was in the later period that both consumption and hours worked increased noting that from the 1890s onwards the 'cash income of the farming population increased, enabling the construction of larger, more comfortable houses but production for export also led to developments that made farming even more labor intensive' (Saito, 1998, 261). Taken together the evidence of real wages and consumption patterns suggests that the Tokugawa industrious revolution was not comparable to the industrious revolution occurring in north-western Europe. Japan was an intermediate case sharing elements of both the English and the Italian experience.

5. Conclusions

This paper has shown that the insights of De Vries (1994, 2008) and Voth (2001b) can be generated in a micro-founded model in which consumption takes time. The model shows that this consumption-driven industrious revolution can be

⁴⁰ Underlying this view is the suggestion that since markets for land and labor were either absent or severely curtailed the *only* way peasants in Japan and China could increase or maintain output per capita was by increasing labor inputs. Saito (2009a) critiques this characterization, in part because it downplays the important role played by rural industry and agricultural by-employment in the later Tokugawa period and because recent research shows that some factor markets did play an important role in the Japanese industrious revolution. Saito goes on to develop Chayanov's model of a peasant household economy in order to show that the emergence of alternative employment outside farming could have induced households to supply more total labor to both farm and non-farm work.

conceptually distinguished from other ‘industrious revolutions’ taking place elsewhere in the early modern world. Both a consumption-driven industrious revolution and an increase in the cost of subsistence could have led to an increase in hours work but only the former was capable of changing the shape of the labor supply curve. The concept of an industrious revolution advanced by De Vries as a description of England and the Netherlands in the early modern period can thus be distinguished from other episodes of labor intensification.

Developments on the consumption side of the economy could have driven this transformation in the behavior of labor in the period prior to the industrial revolution. An economy with an inelastic supply of labor was an inhospitable environment for investment in new technologies [even labor-saving technologies] because increases in labor demand led to rapidly increasing labor costs. Conversely, an elastic labor supply curve was 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’. The fall in the price of intensive consumption activities meant labor was supplied elastically at relatively high wage rates; and these two factors together may have been particularly conducive to economic growth as they encouraged investment as well as the innovation in labor-saving technologies that Allen (2009) has emphasized.

Finally, this paper provides a theoretical basis for the new appreciation for the importance of imports found in the work of De Vries (2008) and it supports McCant’s (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). Max Weber thought that a transformation in the attitude of workers was a necessary pre-requisite for an industrial revolution. This view 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).⁴¹ We have shown that these insights can be rediscovered and fruitfully applied using standard microeconomics.

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Appendix A. Obtaining an expression for labor supply

To obtain an expression for labor supply equation maximize 1 with respect to 2. The first order conditions are:

$$c_1 = 1/\lambda\beta_1/q_1, \quad (\text{A.1})$$

$$c_2 = 1/\lambda\beta_2/q_2. \quad (\text{A.2})$$

The equation for labor supply, given by $l = T' - t_1c_1 - t_2c_2$, can now be rewritten as follows:

$$l = T' - \frac{1}{\lambda} \left(\frac{t_1\beta_1}{q_1} + \frac{t_2\beta_2}{q_1} \right). \quad (\text{A.3})$$

where λ is the Lagrangian multiplier associated with the combined budget constraint. Since this constraint binds at the optimum, $1/\lambda$ is equal to $M' + wT'$. This means that labor supply is equal to:

$$l = T' - (M' + wT') \left(\frac{t_1\beta_1}{q_1} + \frac{t_2\beta_2}{q_1} \right). \quad (\text{A.4})$$

It follows that the relationship between labor supply and non-labor income is given by:

$$\frac{\partial l}{\partial M'} = -\frac{\beta_1 t_1}{p_1 + wt_1} - \frac{\beta_2 t_2}{p_2 + wt_2}, \quad (\text{A.5})$$

where the full price of consumption q_i has been written out in full for each good. The effect of effective non-labor, non-subsistence, income M' on labor 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 labor supply.

⁴¹ Factory discipline played a crucial role 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 (1994) reinterpretation of the coercive elements of factory discipline.

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