STATUS EFFECTS AND NEGATIVE UTILITY GROWTH

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We have benefited from the comments of Tony Atkinson, Rafael Di Tella, Andrew Oswald, and seminar participants at Oxford and QREQAM.

ABSTRACT. This paper explains the observed stagnation of 'happiness' measures in the post-war period through a growth model in which agents care about conspicuous consumption. There are two goods: a 'normal good' and a 'status good'. Normal goods confer direct utility, while status goods confer utility only at the expense of someone who consumes less of the good. Firms can improve the quality of both goods through R&D. We show that the Nash equilibrium of the game in which consumers compete for status results in the share of expenditure on status goods increasing with the number of times the status good has been improved. As the economy grows, resources for innovation are transferred entirely to status-good R&D and the rate of improvement of normal goods drops to zero. Improvements in status goods have only a negative effect on utility, consequently the long-run rate of utility growth is negative.

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> And I saw that all labour and all achievement spring from man's envy of his neighbour. This too is meaningless, a chasing after the wind.[1]
>
> *Ecclesiastes* 4:4

1. Introduction

It is easy to agree with both Oswald (1997) and Ng (1997) that since most people cite happiness as their most important life-objective, then reported levels of happiness should also be an important measure of economic performance. Of course, there remains considerable doubt among economists trained in the aftermath of the ordinal revolution in utility theory that it is *possible* to measure "happiness" in any meaningful way. Nevertheless, there is now a considerable body of data on happiness in the form of responses to simple survey questions. There is a question in the United States General Social Survey, for example, which asks: "Would you say that you are very happy, pretty happy, or not too happy?". If we can take such data seriously, then the picture it paints of economic performance over the last thirty years is not a rosy one. In his pioneering study, Easterlin (1974) found that over the period 1946 to 1970 there is no upwards trend in measures of happiness in the US. Using data up to 1990, Oswald (1997) concludes that happiness *has* increased in the U.S., but only very slightly, while Myers and Diener (1996) reach more pessimistic conclusions[2]. A recent paper by Di Tella, MacCulloch and Oswald (1997) examines the evolution of happiness in 13 industrialized countries since the early 70s. One of their more striking findings is the diversity in the experiences of different countries. For example, they find no trend in the US, a decline in Italy and Germany, and an increase in Belgium.

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[1] Quoted from the New International Version of the Bible, published by Hodder and Stoughton.

[2] Certainly, any claim to increasing happiness over this period has to contend with the fact that, in the U.S., the proportion of respondents who said they were "very happy" reached a peak in 1957.

Meanwhile, real incomes have more than tripled over the period for which we have happiness data. If happiness corresponds to cardinal utility, comparable across both agents and time, then happiness stagnation in the face of such increasing affluence simply cannot be explained by conventional models of growth. These models can neither give a reason for the absence of an upwards trend in happiness which mimics that observed in the GDP data, nor do they help us understand the different evolution of happiness in countries with similar growth performances. This paper seeks to provide a possible answer to these questions.

There are, of course, many potential explanations of happiness stagnation. Scitovsky (1976), for example, suggests that we respond dynamically to consumption. He argues that there is a distinction to be made between comfort and pleasure. Roughly speaking, comfort is related to the level of stimulation provided by consumption, and (positive) pleasure is related to increases in stimulation. Comfort, he argues, is satiated at quite low levels of consumption. Hence, in affluent economies with a constant growth rate, consumers experience constant levels of comfort and pleasure.

An alternative explanation, which we explore in this paper, is that happiness stagnation is caused by the widespread pursuit of enviable social status. This is, of course, an explanation that has always been current in popular discussion and remains so today. In the United States, for example, a recent PBS television program has popularised the term "affluenza" to describe the disappointments of consumerism[3]. It has also not been completely neglected in the economics literature. A century ago, Veblen (1899) coined the term "conspicuous consumption" to describe consumption intended to indicate social class—an idea that has found its way

[3]The program defined "affluenza" to be: "1. The bloated, sluggish and unfulfilled feeling that results from efforts to keep up with the Joneses. 2. An epidemic of stress, overwork, waste and indebtedness caused by dogged pursuit of the American dream. 3. An unsustainable addiction to economic growth. 4. A television program that could change your life." The irony of the fourth item, of course, is that even anti-consumerism progams have to sell themselves.

into some recent signalling models such as Bagwell and Bernheim (1996), Bernheim (1994) or Corneo and Jeanne(1998). The question then arises, whether this class of preferences has implications for aggregate economic behaviour. One of the first to ask this type of questions was Duesenberry (1952). In the post-war debate on the consumption function, Duesenberry maintained that observed savings behaviour could only be explained if consumers cared about *relative* rather than absolute consumption expenditure.

More relevant to our discussion, some models have explored the implications of status-seeking behaviour for economic growth. Cole, Mailath and Postlewaite (1992) attempt to explain the status conferred by wealth as a consequence of equilibrium social rules when there is an underlying preference for certain types of social matching (membership of exclusive clubs, marriage to "desirable" partners *etc.*). Different social-rule equilibria can result in different saving rates, hence affecting the growth rates of output and utility[4]. Fershtman, Murphy and Weiss (1996) show that when status is ascribed to occupations that enhance growth, these may be filled by workers with high wealth but low ability. However, while these models may be able to explain suboptimal levels of utility growth, they are stretched to explain the stagnation (or decline) we observe in the happiness data.

Perhaps closest to the present paper is the approach of Hirsch (1977). Hirsch distinguishes between material goods and goods that confer status, which he calls "positional goods". In Hirsch's formulation, material goods are reproducible, but positional goods—such as works of art, access to the countryside or employment in leadership roles—are not. The result is consumer frustration as people compete for this *fixed supply* of positional goods. Hirsch never fully develops these ideas, but they have been picked up by a number of authors, including Frank (1985).

[4]Similar models are Basu (1989), Corneo and Jeanne(1998) and Cole, Mailath and Postlewaite (1998). See also the comments by Landsburg (1995) and, in the same edition, the reponse by Cole *et al*.

Our explanation is based precisely on the observation that goods that confer status have *not* been in fixed supply in capitalist economies.[5] Indeed a key feature of capitalist economies seems to be their ability to invent new products able to confer status—or re-package existing products to do the same. Many quite mundane products have been developed into status items this way. The fact that clothes designed for manual labour, sports footwear and two-way radios (for which you can now read designer jeans, hi-tech trainers and mobile phones) could become status items is remarkable. Moreover, there seem to be some products that are continually subject to status improvements. Given traffic congestion and national speed limits there is little to choose in practice between two types of car of a similar class. Yet manufacturers have become adept at generating quite disproportionate differences in desire for different brands, or between this year's model and that of the year before.

We get some important clues about the plasticity of peoples' preferences with regard to status from the way that products are marketed and advertised. One cannot fail to notice, reading through a modern text-book on marketing such as Chisnall (1994), how often status is cited as a basic motivation for consumer behaviour in affluent societies. Of course, advertisers use a variety of methods of persuasion, but forming an association between a product and some sort of status remains very effective if an advertiser can pull it off with conviction. Sometimes this is done overtly (the advertising slogan for a recently launched car in the U.K. is "Envy comes as standard"), but more often it is done almost subliminally. For example, a product is shown being used by people from a certain social class or with an affluent life-style—as if buying a certain brand of coffee gains its consumer automatic entry to the professional middle-classes.

In what follows we explore the implications of conspicuous consumption for the evolution of individuals' utility over time. Our suggestion is that the stagnation, or decline, we observe in average utility levels is caused, in part at least, by the presence and innovation of status goods

[5]One can, of course, think of some exceptions, such as art or (maybe) access to certain educational stablishments.

in the economy. Like Hirsch's positional goods, status goods confer utility only at the expense of someone who consumes less of the good. The difference here is that we consider the relative consumption of status goods in an endogenous growth model where firms are able to influence the degree of importance consumers attach to their position within the status-good consumption hierarchy, through changes in the (real or perceived) quality of status goods. These changes can be due to innovations that change the physical quality of products, or to marketing and advertising that changes how existing products are perceived. The results we obtain are quite striking. In the long-run we find plenty of innovative activity in the economy. However, this activity is increasingly directed at the innovation of status goods rather than goods that have intrinsic utility. Such activity cannot increase total utility. Indeed, as status goods become more and more prestigious, more and more of a consumer's budget is diverted away from goods with intrinsic utility, resulting in a *decrease* in total utility.

The paper is organised as follows. Section 2 presents the model. Section 3 solves for both the consumers' demand function and for firms optimal research employment. Both are shown to depend on the current quality of the status good. We then examine the evolution of individual utility over time. We find that although output remains constant, utility may increase or decrease in the short run, but it will eventually reach a negative rate of growth. Section 5 considers possible corrective polices. Section 6 concludes.

2. THE MODEL

The basic structure of the economy is shown in Figure 1. There are two final goods sectors: a normal-good sector and a status-good sector. The current period is denoted by $t = 0, 1, 2, \ldots$ The current quality of the normal good is denoted by q_t, and its current price by p_t^n. Quality depends on the number of normal-good innovations that have occurred up to time t, denoted by ν_t. Activity in the normal-good R&D sector ensures that quality moves step by step up a "quality ladder", such that $q_t = (\gamma_n)^{\nu_t}$, where $\gamma_n > 1$.

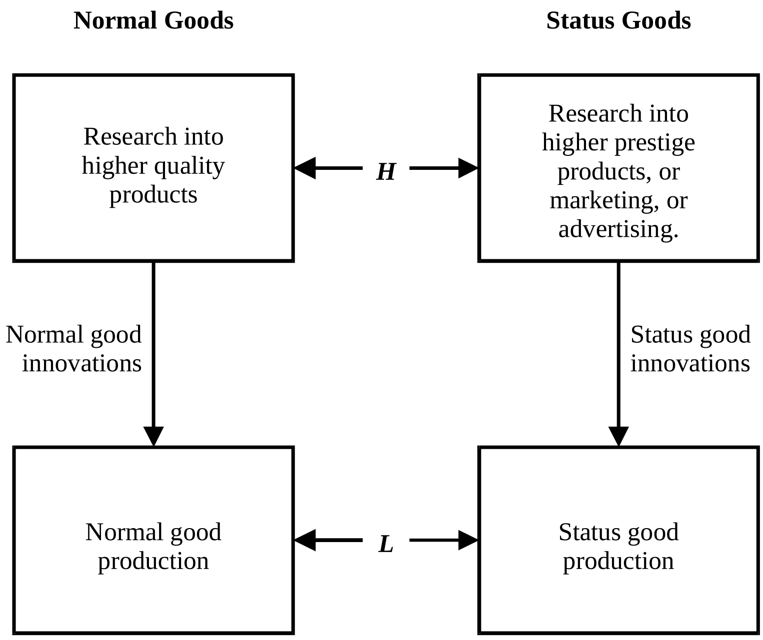

FIGURE 1. The Basic Structure of the Model

The current "prestige" of the status good is given by α_t, and its current price by p_t^s. The prestige conferred by the status good depends on the number of status-good innovations that have occurred up to time t, denoted by σ_t. Activity in the status-good R&D sector ensures that prestige moves step by step up a "prestige ladder", such that the current value of α_t is given by $(\gamma_S)^{\sigma_t}$, where $\gamma_S > 1$.

There is a fixed stock of skilled labour, H, that can be used in either of the two R&D sectors, and a fixed stock of unskilled labour, L, that can be used in any of the two production sectors[6].

2.1. **Consumers.** The utility function in a typical neoclassical model is often just a increasing, concave function of consumption; although it may also include the quality of the good. For example, Grossman and Helpman (1991b) develop a growth model with quality ladders in

[6]The main implications are exactly the same when there is only one type of labour. However, having two types of labour makes it easier to see exactly what is driving the results. A model with one type of labour is solved in Appendix B.

which an individual's utility is assume to take the form $v_t^i = \ln\left(q_t y_t^i\right)$, where y_t denotes consumption by consumer i and q_t is quality.

We consider a more sophisticated utility form, which is also a function of the quality of goods, and which is able to accommodate the consumption of status goods. Suppose the $L + H$ consumers in this economy are arranged into non-overlapping peer groups. Label the consumers in peer group k by $1, 2, \ldots, N^k$, where N^k is the number of people in the group. The utility of consumer i from peer group k in period t is given by

$$u_t^{i,k} = \ln\left(q_t y_t^{i,k}\right) + (\ln \alpha_t) \sum_{j=1}^{N^k} R\left(x_t^{i,k}, x_t^{j,k}\right) \tag{2.1}$$

where $y_t^{i,k}$ denotes consumption of the normal good, $x_t^{i,k}$ denotes consumption of the status good, and

$$R(x_t^{i,k}, x_t^{j,k}) = \begin{cases} 1 & \text{if } x_t^{i,k} > x_t^{j,k} \\ 0 & \text{if } x_t^{i,k} = x_t^{j,k} \\ -1 & \text{if } x_t^{i,k} < x_t^{j,k} \end{cases} \tag{2.2}$$

There are thus two aspects to the consumption of status goods in this model. First, as in Frank (1985), the utility a consumer derives from the status good depends on where she fits in the ranking of status-good consumption across the peer group. For everyone below her in the ranking, she derives utility $\ln \alpha$; for everyone above her in the ranking she loses $\ln \alpha$. Thus inter-personal comparisons of status-good consumption, inducing either feelings of pride or envy, determine a consumer's overall utility from consuming the product. When the consumer is making these comparisons, we need not think of x as only a measure of numbers of units consumed. High x could denote "more of" the status good in other senses. For example, a luxury car is "more of" a car than a city run-around, even though it is still just one car.

Secondly, we assume that the weight a consumer places on her position within the status-good consumption hierarchy is affected by changes in the "prestige" of the status good, α. We can interpret the effect of an increase in α through the $\ln \alpha$ term in (2.1) in a number of ways. It could be the effect of a *new* status good. For example, a consumer might not be especially bothered if a friend bought themselves a new pair of running shoes; but green with envy if they happened to be the latest branded product with plenty of obvious "special features". Alternatively, it could be the effect of a successful advertising campaign making the consumer more aware of—or more sensitive to—her position within the hierarchy.

The flow of spending by consumer i from peer group k at time t is given by $m_t^{i,k} = p_t^n y_t^{i,k} + p_t^s x_t^{i,k}$. We assume that consumers arrange themselves socially such that peer groups consist of consumers with identical incomes, so that $m_t^{i,k} = m_t^k$ for all $i = 1, \ldots, N^k$. (This means that skilled labour never interacts socially with unskilled labour.) Let aggregate expenditure be $M_t = \sum_k N^k \cdot m_t^k$. Following Grossman and Helpman (1991a), we find it convenient to normalise prices so that nominal aggregate spending is constant each period, that is $M_t = 1$ for all t. Now m_t^k represents the share in total spending of an agent in peer group k.

2.2. **Final Goods Producers.** Final goods are produced with a single input, which is unskilled labour. One unit of unskilled labour produces one unit of final good, regardless of quality or prestige. The cost of a unit of unskilled labour at time t is given by w_t^u. There are many firms in each sector. Hence all those qualities for which the patent has expired will be produced under perfect competition. At each point in time, the unskilled labour market clears. That is,

$$L = D_t^s + D_t^n \tag{2.3}$$

2.3. **Research and Development.** Firms can engage in R&D in order to obtain a patent for a higher quality good. R&D for normal goods can be interpreted as a search for a higher quality product. However, R&D for status goods can be given a broader interpretation. While it could be a search for goods with higher prestige, it could also be advertising or marketing activity that, if successful, increases the prestige of an already existing product.

The aggregate quantity of skilled labour devoted to normal-good R&D at time t is denoted by H_t^n, while that devoted to status-good R&D at time t is denoted by H_t^s, where $H_t^n + H_t^s = H$. We assume that innovations in a sector are governed by the quantity of skilled labour devoted to R&D in that sector in the following way. The level of research employment in a sector at time t determines the probability of an innovation occurring during that period, which becomes usable at time $t+1$. If the quantity of skilled labour devoted to R&D in sector $l = n, s$ is H_t^l at time t, the probability of an innovation occurring in that sector during the period is given by

$$\phi\left(H_t^l\right) = Q\left(H_t^l\right) H_t^l \tag{2.4}$$

As in Jones (1995), $Q\left(H_t^l\right)$ is a term capturing the externalities occurring because of duplication in the R&D process. Here we take $Q\left(H_t^l\right) = 1/\left(H_t^l + \lambda\right)$, where $\lambda > 0$, so that

$$\phi(0) = 0; \qquad \lim_{H_t^l \to \infty} \phi\left(H_t^l\right) = 1. \tag{2.5}$$

An individual firm devoting ε units of skilled labour to R&D in sector l has a probability of success of $\phi(\varepsilon) = Q \cdot \varepsilon$. If the number of firms in the sector is large, an individual firm makes such a small contribution to H_t^l that it takes Q as given.

We consider the case where a product patent lasts for just one period[7]. After that, the state-of-the-art quality can be produced by any firm and there is perfect competition in the final good sector. We assume free entry into the two R&D sectors.

[7]This is just a simplifying assumption. All our results would hold if patents were infinitely-lived as in Grossman and Helpman (1991b). However, the model would become much more cumbersome, as the incentives to do R&D at any point in time would depend on the interval over which the firm expects to be a monopolist—*i.e.* on expectations of future research employment.

3. Solving the Model

3.1. **The Demand Functions.** As they decide how to allocate their budgets between the two types of good, the consumers in each peer group play a *status game* against each other in every period. The timing of the game is as follows. At the start of a period, consumers know the available quality and price of the two goods. Each agent chooses simultaneously how much of the two goods to consume. Moreover, all agents decide their consumption simultaneously to each other. The ranking in status consumption is then observed.

We solve for the symmetric mixed-strategy Nash equilibrium of the model. In Appendix A we shoe that the equilibrium strategy in a peer group where the individual's budget is m_t^k has each member choosing a level of status-good consumption from the cumulative distribution

$$F^k(x_t) = \frac{1}{2(N^k - 1)\ln \alpha_t} \ln \left(\frac{m_t^k}{m_t^k - p_t^s x_t} \right) \tag{3.1}$$

with support $[0, \bar{x}_t^k]$, where $p_t^s \bar{x}_t^k = m_t^k (1 - \alpha_t^{-2(N^k - 1)})$. This gives an expected level of status-good consumption by a member of peer group k of

$$E\left(x_t^{i,k}\right) = \frac{m_t^k}{p_t^s} \left(1 - \theta^k\left(\alpha_t\right)\right) \tag{3.2}$$

where $\theta^k(\alpha_t) = \dfrac{(1 - \alpha_t^{-2(N^k - 1)})}{2(N - 1)\ln \alpha_t}$. That is, the individual spends a fraction $\left(1 - \theta^k\left(\alpha_t\right)\right)$ of her budget on the status good, and a fraction $\theta^k\left(\alpha_t\right)$ on the normal good. Note that $\partial\theta^k/\partial\alpha < 0$ and $\partial\theta^k/\partial N^k < 0$.

Let D_t^s be the aggregate demand for the status good and D_t^n that for the normal good. If $L + H$ is large, and given the above peer group Nash equilibria, we may write the demand functions for the two goods as

$$D_t^s = \sum\nolimits_k \sum\nolimits_i E(x_t^{i,k}) = \frac{1 - \Theta(\alpha_t)}{p_t^s} \tag{3.3}$$

$$D_t^n = \frac{1 - p_t^s D_t^s}{p_t^n} = \frac{\Theta(\alpha_t)}{p_t^n} \tag{3.4}$$

where the aggregate spending share is defined as $\Theta(\alpha_t) = \sum_k N^k m_t^k \theta^k(\alpha_t)$.

The crucial feature of these demand functions is that they are affected by the quality of the status good, but not by that of the normal good. The unit elasticity of substitution implies that, at any point in time, a constant share of income is spent on each good, with the shares being determined by α_t. A higher quality of the status good implies that the good is perceived as being better, hence more utility is obtained from wining the status competition. Consequently, a greater fraction of income will, on average, be devoted to that good (i.e. $\partial\Theta/\partial\alpha < 0$).

3.2. **Monopoly Profits.** Firms engage in R&D in order to obtain a patent for a higher quality good and hence obtain monopoly profits . If a firm innovates in a sector at time $t-1$, it becomes the only producer in that sector for one period. The profits accruing to sector leaders are given by

$$\begin{aligned} \pi_t^n &= D_t^n \left(p_t^n - w_t^u\right) \\ \pi_t^s &= D_t^s \left(p_t^s - w_t^u\right) \end{aligned}$$

Prices depend on the current market state. There are, then, two possibilities in each sector. Either all firms have access to the current best product, in which case price competition forces the price down to w_t^u. Alternatively, R&D activity in the past results in *one* firm holding the patent for the current best product, with all other firms exactly one step behind. Consumers always choose the normal good with the lowest quality-adjusted price, and the status good with the lowest prestige-adjusted price. This means that in a price-setting equilibrium, a normal-good sector leader (if one exists) can charge a "limit" price just below $w_t^u \cdot \gamma_n$ and win the entire market for normal goods. Similarly, a status-good sector leader (if one exists) can charge a price just below $w_t^u \cdot \gamma_s$. So:

$$p_t^n = z_t^n \cdot w_t^u, \text{ where } z_t^n = \begin{cases} 1 & \text{if no quality innovation at } t-1 \\ \gamma_n & \text{if quality innovation at } t-1 \end{cases} \tag{3.5}$$

$$p_t^s = z_t^s \cdot w_t^u, \text{ where } z_t^s = \begin{cases} 1 & \text{if no prestige innovation at } t-1 \\ \gamma_s & \text{if prestige innovation at } t-1 \end{cases} \tag{3.6}$$

Thus the profits to any patent holders are determined by the current market state:

$$\pi_t^n\left(z_t^n, \alpha_t\right) = \left(\frac{z_t^n - 1}{z_t^n}\right)\Theta\left(\alpha_t\right) \tag{3.7}$$

$$\pi_t^s\left(z_t^s, \alpha_t\right) = \left(\frac{z_t^s - 1}{z_t^s}\right)\left(1 - \Theta\left(\alpha_t\right)\right) \tag{3.8}$$

There are four possible states, depending on whether an innovation has occurred in each of the two sectors. For example, if only the status good sector has innovated, we would have $z_t^n = 1$, $z_t^s = \gamma_s$, $\alpha_t = \gamma_s \alpha_{t-1}$, and $q_t = q_{t-1}$. The four possibilities are tabulated in Table 1.

Since a higher α_t implies a greater share of expenditure is devoted to the status good, we have $\partial \pi_t^s / \partial \alpha_{t-1} > 0$ and $\partial \pi_t^n / \partial \alpha_{t-1} < 0$.

3.3. **Research Intensities.** R&D firms maximize expected profits. From equation (2.4) the probability of the firm becoming the sole patent holder, conditional on an innovation occurring, is ε / H_t^l. Thus firms maximize

$$Q H_t^l \left(\frac{\varepsilon}{H_t^l}\right) V_t^l - w_t^h \varepsilon \tag{3.9}$$

where V_t^l is the value of becoming the sole patent holder of an innovation at time $t+1$, discounted to time t, and w_t^h is the current cost of *skilled* labour.

State		Patent-holder Profits	
z_t^n	z_t^s	$\pi_t^n\left(z_t^n, z_t^s, \alpha_{t-1}\right)$	$\pi_t^s\left(z_t^s, \alpha_{t-1}\right)$
1	1	-	-
1	γ_s	-	$\left(\frac{\gamma_s-1}{\gamma_s}\right)(1-\Theta(\gamma_s\alpha_{t-1}))$
γ_n	1	$\left(\frac{\gamma_n-1}{\gamma_n}\right)\Theta(\alpha_{t-1})$	-
γ_n	γ_s	$\left(\frac{\gamma_n-1}{\gamma_n}\right)\Theta(\gamma_s\alpha_{t-1})$	$\left(\frac{\gamma_s-1}{\gamma_s}\right)(1-\Theta(\gamma_s\alpha_{t-1}))$

TABLE 1. Profits as a function of market state and α_t

Under free entry, the expression in (3.9) is forced down to zero, which is true when

$$QV_t^l = w_t^h \tag{3.10}$$

Since product patents last for just one period, the value of becoming the sole patent holder of an innovation at time $t+1$ is simply the discounted expected profits,

$$V_t^l = \frac{1}{(1+r)}E\left(\pi_{t+1}^l\right) \tag{3.11}$$

where r is the given discount rate.

Combining (3.10), (3.11) and the fact that $Q\left(H_t^l\right) = 1/\left(H_t^l+\lambda\right)$, we get

$$w_t^h(1+r) = \frac{E\left(\pi_{t+1}^n\right)}{H_t^n+\lambda} = \frac{E\left(\pi_{t+1}^s\right)}{H_t^s+\lambda} \tag{3.12}$$

We can now calculate the expected profit to a firm engaged in R&D at time t if they succeed in becoming sole patent-holder at time $t+1$. Re-writing equation (3.12) gives:

$$\frac{\phi\left(H_t^s\right)\pi_{t+1}^n(\gamma_n,\gamma_s\alpha_t)+\left(1-\phi\left(H_t^s\right)\right)\pi_{t+1}^n(\gamma_n,\alpha_t)}{H_t^n+\lambda} = \frac{\pi_{t+1}^s(\gamma_s,\gamma_s\alpha_t)}{H_t^s+\lambda} \tag{3.13}$$

Using Table 1 and the skilled labour market clearing condition, $H_t^n + H_t^s = H$, to substitute into equation (3.13) we can calculate the equilibrium allocation of skilled labour to the two sectors for a given value of α_t, $H^{*n}(\alpha_t)$ and $H^{*s}(\alpha_t)$. That is, $H^{*s}(\alpha_t) = \max\{\min\{H^s(\alpha_t), H\}, 0\}$, where

$$H^s(\alpha_t) = \frac{\Gamma(1-\Theta(\gamma_s\alpha_t))(\lambda+H) - \lambda\Theta(\alpha_t)}{\Gamma(1-\Theta(\gamma_s\alpha_t)) + \Theta(\gamma_s\alpha_t)}, \tag{3.14}$$

and where $\Gamma = \left(\frac{\gamma_s - 1}{\gamma_s}\right)\left(\frac{\gamma_n}{1-\gamma_n}\right)$.

The allocation of skilled labour to normal good R&D is simply $H^{*n}(\alpha_t) = H - H^{*s}(\alpha_t)$.

Differentiating (3.14) we have $\partial H^{*s}/\partial\alpha_t > 0$.

To understand why the allocation of researchers varies with α_t, look again at the demand functions. The demand functions given by (3.3) and (3.4) are affected by the quality of the status good. As α_t grows, the demand for the status goods, and hence the profits obtained by the monopolist producing the latest vintage, increase, while the profits accruing to the producer of the normal good fall. As a result, research in the status good sector becomes more profitable relative to R&D in the normal good sector, and the resources devoted to the former, H_t^{*s}, increase at the expense of H_t^{*n}. That is, as long as $H_0^{*s} > 0$, α_t is growing and the fraction of skilled labour allocated to the status good sector increases over time. Consequently, the rate of technological change in that sector increases over time. Clearly, this means that technical change in the normal good sector becomes slower.

4. UTILITY GROWTH

In this economy, research affects utility but not output. R&D improves the quality of final goods and therefore the satisfaction derived from them. However, the level of output is fixed by the supply of unskilled labour. Recall that, for all q_t and α_t, one unit of each of the goods is produced with one unit of labour, implying that the level of output is given by L at all times.

Individual utility is affected by technological change. In deriving the peer-group consumption Nash equilibria in Appendix A, we show that the equilibrium level utility for a consumer peer group k at time t is given by

$$u_t^{*k} = \ln\left(\frac{m_t^k}{p_t^n}\right) + \ln q_t - (N^k - 1)\ln \alpha_t \tag{4.1}$$

What is striking about this indirect utility function is that although improvements in the quality of normal goods increase utility, a better quality of the status good *reduces* the level of utility. To understand this note that engaging in the status competition has a resource cost, since consuming less of the normal good means forgoing utility. A higher α_t makes conspicuous consumption more desirable and thus individuals purchase, on average, more of the status good (see equation (3.2)). This means that a higher quality of the status good has two effects. On the one hand, whenever an individual ranks above somebody else, she obtains more utility. On the other, a greater expenditure on the status good is required in order to attain the same ranking, as all individuals are consuming more of the good. That is, more normal good consumption—and hence more utility—is foregone in order to attain the same ranking. The second effect always dominates, implying that a higher α_t results in lower equilibrium utility levels.

Utility also depends on the size of the individual's peer group. The larger the social group of an agent, the lower her level of utility is for a given α_t. Note that for utility to be defined, the size of the peer groups has to be finite. To understand this effect, recall that individuals care about their ranking in the status competition. If N^k is infinite, there will always be an infinite number of agents with consumption above that of individual i, and hence his utility is not defined.

Two things affect the evolution of utility over time: technical change in the two sectors and changes to the price of the normal good. Technological advances have permanent effects on the utility function, determining its average rate of growth. Changes in prices are only temporary,

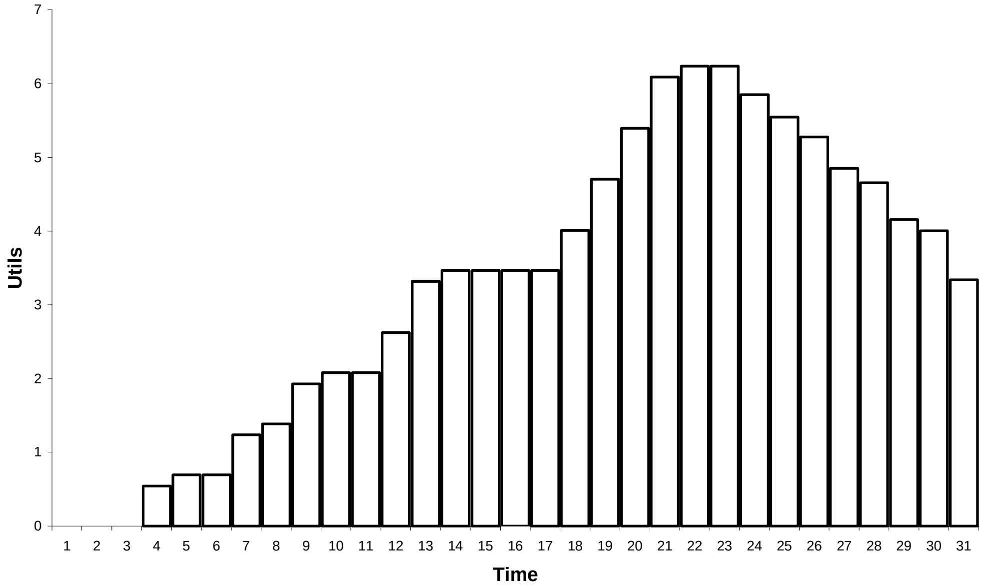

FIGURE 2. A typical utility path. Note the small change in utility one period after an innovation—a consequence of normal good price reverting back to its "no innovation" value.

and result in fluctuations along the trend. To see this, recall that $p_t^n = z_t^n \cdot w_t^u$. From the unskilled labour market clearing condition, $D_t^n + D_t^s = L$, we can calculate the equilibrium unskilled wage for a given market state and prestige level,

$$w_t^u = \frac{1}{L}\left(\frac{\Theta(\alpha_t)}{z_t^n} + \frac{1-\Theta(\alpha_t)}{z_t^s}\right) \tag{4.2}$$

Thus innovations in either sector will result one-period changes in the price of the normal good. One period later, there is an equal and opposite change in utility due to price reverting to its "no innovation" value of $1/L$. Figure 2 depicts a typical utility path.

Let us concentrate in the trend described by the rate of growth—that is, we ignore the shocks to p_t^n resulting from an innovation. We can then define the underlying growth in utility to be the expected change in utility due only to product improvements. For an agent in peer group k

this is given by

$$\begin{aligned} g_t^k &= E\left(\Delta \ln q_t\right) - \left(N^k - 1\right) E\left(\Delta \ln \alpha_t\right) \\ &= \phi\left(H_t^{*n}\left(\alpha_t\right)\right) \ln \gamma_n - \left(N^k - 1\right) \phi\left(H_t^{*s}\left(\alpha_t\right)\right) \ln \gamma_s \end{aligned} \tag{4.3}$$

At any point in time, utility grows whenever a new quality of the normal good is invented, and falls when there is an improvement in the status good sector. The relative strength of these two effects will vary over time, which implies that the rate of growth is not constant[8]. Figure 3 depicts the distribution of possible utility time paths. Initially innovations in the normal good sector occur frequently enough for the rate of growth to be positive (H_t^{*n} is high enough). However, quality improvements in the status good imply that demand, and therefore research employment, shift from the normal to the status good sector. At some point, the effect of increases in α_t becomes strong enough, and utility starts to fall.

The long-run rate of growth will always be negative, as the reallocation of researchers to the status good sector will continue until all researchers are employed in it. Thus the long-run rate of growth of utility for an agent in peer group k is given by

$$g_\infty^k = -\left(N^k - 1\right) \frac{H}{\lambda + H} \ln \gamma_s. \tag{4.4}$$

That is, it falls at a constant rate which is higher the greater the individual's peer group is.

Let $\bar{N}$ be the mean peer group size. Then, the average rate of growth of utility is simply

$$g_\infty = -\left(\bar{N} - 1\right) \frac{H}{\lambda + H} \ln \gamma_s. \tag{4.5}$$

The economy will exhibit a constant level of output and a negative rate of growth of utility. Our conclusion that the long-run rate of utility growth is always negative is extreme given that

[8]The rate of growth will be constant only if initial R&D employment in one of the sectors is zero. If $H^{*s}(\alpha_0) = 0$, then $H_t^{*n} = H$ for ever and the rate of growth of utility will be positive and constant, $g_t^k = \phi(H) \ln \gamma_n$. If $H^{*n}(\alpha_0) = 0$, then $g_t^k = -(N-1)\phi(H) \ln \gamma_s$, which is negative and constant.

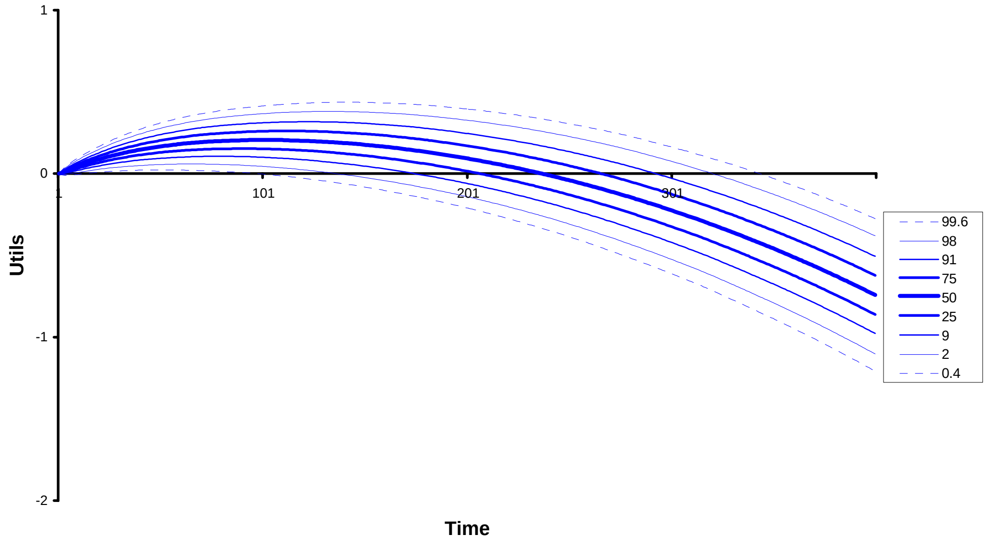

FIGURE 3. Numerical results for the distribution of utility to a consumer in a representative peer group across different possible innovation paths. The figure shows results for $\gamma_s = \gamma_n = 1.01$.

our choice of utility function in (2.1) means that expenditure share depends on α_t but not on q_t. Different utility functions (*e.g.* one in which the marginal utility to normal-good consumption was increasing in q_t) would result in expenditure share depending on both α_t and q_t[9]. In this case, long-run utility growth would depend on the relative sizes of γ_n and γ_s. So we would get positive, zero or negative growth, depending on these parameter values—although the level of utility growth would always be sub-optimal.

5. Corrective Policies

5.1. **Policies When the Status Good is Identifiable.** When individuals care about status consumption, their expenditure choices generate an externality which affects the utility of other individuals in their peer group. There are two types of inefficiency that may be addressed by

[9]See (1998) for a more detailed discussion of other utility functions with status effects.

policy: *static* inefficiency caused by excessive spending on status goods, and *dynamic* inefficiency caused by status good R&D which induces higher spending on these goods in the future. Suppose that the policy-maker can correctly identify which is the status good. With the simple, clear-cut distinction between normal and status goods that we have in the model above, an outright ban on status goods is optimal. However, such a clear-cut distinction may not be true in practice. Goods that confer status may also produce direct utility, or may be a status symbol within some peer groups but not within others. Hence we consider the less drastic alternatives of a tax on status good consumption and a tax on status good R&D.

Both types of taxes have dynamic effects on individual utility. By reducing profits to status-good patent holders, they reduce the incentives to innovate in this sector, which implies that, in the long-run, utility declines at a slower rate. However, through the general equilibrium structure of the model, a tax on status good consumption also has a static effect on utility. This is despite the fact that p_t^s does not appear in equation (4.1). A tax that increases p_t^s means that fewer units of the status good are bought, reducing the demand for unskilled labour. The price of the normal good falls, increasing utility. To put it another way, the reduction in total status good consumption, while it has no direct effect on utility (since it is the *ranking* in the status good consumption hierarchy that bothers people), frees labour for normal good consumption. This increase in normal good consumption raises current utility.

Overall, when the two types of goods can be identified, a tax on status goods is preferable to a tax on research for status innovations as the former increases both the level and the rate of growth of utility, while the latter only has a dynamic effect.

5.2. **Policies When the Status Good is not Identifiable.** The design of optimal policies becomes more complex when the government cannot identify which is the good that confers direct utility and which is the one that generates a competition for status. In this case, taxes and subsidies will have no effect on utility. Since the status good cannot be identified, any tax on prices has to be imposed on both goods. The relative price of the two goods, does not change and hence relative demands are unaffected. Moreover, total consumption of each good is also unaffected as total output is fixed by the supply of unskilled labour. The tax will reduce the profitability of research, but since profits fall by the same proportion in both sectors[10], the "relative profitability" of doing R&D in one or the other sector will be unaffected. Consequently, the allocation of skilled labour between the two remains the same as before the tax was introduced. Utility, as expressed in equation (4.1) is unchanged. Similarly, a tax on R&D expenditures would not affect the relative incentives to engage in research in the two sectors and hence would have no effect on the relative rates of growth of the qualities of the two goods.

This policy ineffectiveness depends crucially on our assumption of two types of labour, one of which is used for production and the other for research. As we will see in the next subsection, a small modification of the model can restore the capacity of the social planner to use taxes in order to affect consumption even when the status good cannot be identified.

5.2.1. *Slowing-down the rate of innovation.* In our basic model both total output and total R&D expenditures are fixed by, respectively, the stock of unskilled and the stock of skilled labour. Since one type of workers is employed to produce current consumption and the other to produce future consumption there is no substitutability between the two. Consider now an alternative version of the model. Suppose that there is only one type of labour, and that there are L efficiency units in the economy. Labour has four possible employments: in the production of the normal good, in the production of the status good, in R&D for the normal good, and in

[10]It is straight forward to check that a proportional tax on prices, τ, that increases the price of goods to $p_t^s = (1+\tau)z_t^s w_t^u$ and $p_t^n = (1+\tau)z_t^n w_t^u$, will results in profit functions of the form

$$\pi_t^s = \frac{\Theta(\alpha_{t+1})}{1+\tau}\frac{z_t^s - 1}{z_t^s} \quad \text{and} \quad \pi_t^n = \frac{1-\Theta(\alpha_{t+1})}{1+\tau}\frac{z_t^n - 1}{z_t^n}.$$

R&D for the status good. The labour market clearing condition is now given by

$$D^n(\alpha_t, w_t) + D^s(\alpha_t, w_t) + H^n(\alpha_t, w_t) + H^s(\alpha_t, w_t) = L. \tag{5.1}$$

where H_t^l is the number of worker employed in research in sector l at time t.

The possibility of substituting current production for R&D creates a new effect of α_t. Just as in our basic model, a higher quality of the status good raises profits from innovating in this sector and hence the demand for researchers in the status goods sector increases (this version of the model is solved in Appendix B). As a result the wage, and hence prices, are higher. This implies a reduction in the current demands for both types of goods. The amount of the normal good produced falls, which has a negative effect on current utility. The effect of a higher α_t on the amount of the status good consumed is ambiguous. On the one hand, it shifts expenditure towards this good; on the other, the increase in the wage implies that less of it will be produced for a given quality. Whether one effect or the other dominates is, however, irrelevant since the amount of the status good consumed has no impact on current utility. Overall, an increase in α_t now has two effects: it shifts researchers from R&D in the normal good to R&D in the status good, and it shifts labour from current production into research.

The introduction of substitutability between R&D and production allows for the use of taxes even if the two goods cannot be identified. There are two possible types of taxes that a social planner can use: a consumption tax and an R&D tax. Although neither of them would change relative demands between the two goods, they can change the demand for production labour relative to the demand for research labour in each sector.

It is straight forward to check that a consumption tax will have no impact whatsoever on either consumption or research. Suppose that consumption is taxed at a rate τ, so that an individual's expenditure is now $(1-\tau)m^k$. If the consumption tax is the same for all agents, the aggregate demands will simply be a fraction $(1-\tau)$ of what it was before the tax was introduced. The reduction in demand results in a proportional reduction of profits, and hence of the value of an innovation. The four demands for labour thus fall by the same proportion, leaving the equilibrium allocations to research and consumption unchanged.

Taxes on R&D expenditures, on the other hand, have a positive effect on both current and intertemporal utility. Suppose that innovators are taxed at a rate τ. Expected profits are now lower in both sectors. Once more, since both sectors are taxed at the same rate, the allocation of research between the two sectors is not affected. However, the demands for R&D are lower, which tend to depress the wage. The demands for goods are unchanged, however the lower wage will result in lower prices and greater consumption. The R&D tax thus has two effects. By shifting labour away from research and into production, it increases the amount of the normal good consumed thus raising current utility. At the same time it slows down the rate of innovation, implying that utility will fall at a slower rate.

Note that initially the reduction in R&D employment will reduce the rate of growth of both q_t and α_t. If the former effect dominates, this could reduce the rate of growth of utility. However, what is important is that because α_{t+1} is now lower than it would have been in the absence of the tax, the transfer of resources from normal-good research into status-good research is slower. That is, the tax will decrease the rate of negative utility growth.

5.2.2. *Distribution Effects.* An important issue is whether the evolution of utility over time is affected by the distribution of income in the economy. Recall that the aggregate share of income spent of the status good is given by

$$\Theta\left(\alpha_t\right) = \sum\nolimits_k N^k m_t^k \theta^k(\alpha_t)$$

It therefore depends on two things: the size of peer groups and the share in income of each group. Note first that if all peer groups have the same size, $N^k = N$ for all k, the distribution of income across groups is irrelevant. All individuals will spend on the normal good a fraction of income given by

$$\theta(\alpha_t) = \frac{(1 - \alpha_t^{-2(N-1)})}{2(N-1)\ln \alpha_t}$$

and the aggregate expenditure share will be simply equal to the individual share, $\Theta(\alpha_t) = \theta(\alpha_t)$.

However, when peer-group size varies, those individuals who are in large groups will spend a smaller share of their income on the normal good. Hence distribution matters. In particular, what is important is the correlation between peer group size and income share. For a given partition of individuals into peer groups, a positive correlation - that is, richer individuals have larger peer groups than poorer individuals- will results in a greater share of expenditure being devoted to the status good than if there is a negative correlation. This in turn will enhance the incentives to engage in status-good R&D, increase the rate of growth of the quality index α_t relative to q_t, and thus accelerate the rate of utility decline. Under this scenario, progressive income taxation, which transfers resources from richer to poorer agents, will have the effect of reducing the aggregate expenditure share devoted to the status good. That is, redistribution will reduce conspicuous consumption, hence reducing the incentives to do research for status innovations and slowing down the rate of negative utility growth.

6. Conclusion

The model we have outlined above can explain why the observed increase in per capita income levels has not been necessarily associated with an increase in happiness. It has also highlighted structural variables that may help understand cross-country variations in happiness, such as preferences for conspicuous consumption, peer group size, the relative rates of innovation of the two types of good, and the distribution of income.

We have identified two sources of inefficiency: static and dynamic. Policy implications depend crucially on whether the status good can be identified by the policy maker. As far as taxes are concerned, there are two possibilities: a tax on consumption and a tax on R&D. When the status good can be identified a selective consumption tax is preferable. The reason for this is that it increases both the level and the rate of growth of utility, while an R&D taxes affects only the latter. On the other hand, when it cannot be identified, taxes on R&D are the best option. The reason for this difference is that since ‘unchecked’ innovation eventually leads to a fall in utility, the only feasible policy if relative prices cannot be affected is to slow down innovative activity.

Another possible policy is income redistribution. Since being in a larger peer group increases the incentives to spend resources on the status game, a tax system that redistributes income towards those in smaller peer groups will reduce the aggregate demand for the status good. A particularly important issue then arises: whether there is any correlation between peer group size and income. In general one would expect that higher income individuals have larger peer groups, hence redistribution to the poorer would reduce the speed of negative utility growth.

Further work could be to investigate more explicitly the dynamics of peer group formation. Have peer groups sizes increased over time? This could be a further effect dampening the rate of growth of utility (*i.e.* happiness) even during periods in which q is growing faster than α. On this sense, we may have *underestimated* the potential for economic growth to depress happiness in the above. An important issue here may be the increase in women’s labour market participation. Consumption is usually decided within a household. If peer groups are basically (a) neighbourhood friends and (b) work colleagues, then as women start to work outside the home, the number of individuals in (b) will become much larger than if only men work.

Overall, we hope that the main point of the model as it stands is clear. That is, given a plausible specification of utility, status effects may result in technical change actually making people *less* happy. We believe that the incorporation of status goods into the above model captures some important features of change in capitalist economies that are missing in most treatments of growth. At the very least, it teaches us that a high rate of innovative activity in an economy is not necessarily a good thing.

APPENDIX A. DERIVATION OF SYMMETRIC MIXED-STRATEGY NASH EQUILIBRIUM IN A REPRESENTATIVE STATUS GAME.

First note that the highest value of status-good consumption over which consumer i is prepared to mix, denoted by $\bar{x}^{i,k}$, is the value at which she is indifferent between winning $\ln\alpha$ from the other $N^k - 1$ members of her peer group and her maxmin strategy—where she spends all her budget on the normal good, but loses $\ln\alpha$ to each of her peers. That is,

$$\ln q + \ln\left(\frac{m^k - p_s\bar{x}^{i,k}}{p_n}\right) + (N^k - 1)\ln\alpha = \ln\left(\frac{m^k}{p_n}\right) - (N^k - 1)\ln\alpha + \ln q$$

This gives:

$$p_s\bar{x}^{i,k} = p_s\bar{x}^k = m^k(1 - \alpha^{-2(N^k-1)})$$

In a mixed-strategy equilibrium, consumer i will be indifferent between all the pure strategies over which she is prepared to mix. Let $F^{j,k}(x^i)$ denote the probability that consumer $j \neq i$ chooses a level $x^j < x^i$. (We can ignore the possibility of ties, since it is easy to show that the distributions we shall derive have no atoms.) In the symmetric equilibrium $F^{j,k}(\cdot) = F^k(\cdot)$ for all j. The expected payoff to consumer i for all $x^{i,k} \in [0, \bar{x}^k]$ is:

$$\ln q + \ln\left(\frac{m^k - p_s x^{i,k}}{p_n}\right) + (N^k - 1)\left(F^k(x^{i,k})\ln\alpha + (1 - F^k(x^{i,k}))(-\ln\alpha)\right) = u^{*k}$$

Using the fact that $F^k(\bar{x}^k) = 1$ (or $F^k(0) = 0$) we can deduce that $u^{*k} = \ln\left(m^k/p_n\right) + \ln q - (N^k - 1)\ln\alpha$. Hence the symmetric mixed-strategy Nash equilibrium is characterised by the common distribution over status-goods consumption of

$$F^k(x) = \frac{1}{2(N^k - 1)\ln\alpha} \ln\left(\frac{m^k}{m^k - p_s x}\right)$$

It is now straightforward to derive the expected value of x for any individual:

$$E(x^{i,k}) = \int_0^{\bar{x}^k} x^{i,k} dF = \frac{m^k}{p_s}\left(1 - \frac{(1 - \alpha^{-2(N^k - 1)})}{2(N^k - 1)\ln\alpha}\right) \tag{A.1}$$

APPENDIX B. A MODEL WITH ONE TYPE OF LABOUR

Consider a model identical to that in section 2 except that now there is only one type of labour, denoted L, which can be used either for production or research. As before, free entry into research in each sector drives profits down to zero, implying

$$\frac{1}{\lambda + H_t^l} V_t^l = w_t, \tag{B.1}$$

where w_t is the wage rate. In equilibrium, the wage must be equal in both sectors, hence

$$\frac{1}{\lambda + H_t^s} V_t^s = w_t = \frac{1}{\lambda + H_t^n} V_t^n. \tag{B.2}$$

In order to determine the value of the innovation we use the expression for expected profits that can be obtained from table 1. For the status good sector, this is simply

$$V_t^s = \frac{\gamma_s - 1}{\gamma_s} \frac{\left(1 - \Theta(\gamma_s \alpha_t)\right)}{(1+r)}. \tag{B.3}$$

For the normal good sector the value of the innovation depends on whether or not there has been an innovation in the status good sector that period, hence expected profits are

$$V_t^n = \frac{\gamma_n - 1}{\gamma_n} \frac{1}{(1+r)} \left[\frac{H_t^s}{\lambda + H_t^s} \Theta(\gamma_s \alpha_t) + \frac{\lambda}{\lambda + H_t^s} \Theta(\alpha_t) \right]. \tag{B.4}$$

Substituting for equations (B.3) and (B.4) into (B.2) we can determine the demand for researchers in the normal good sector as a function of H_t^s,

$$H_t^n = \frac{H_t^s \Theta(\gamma_s \alpha_t) + \lambda \Theta(\alpha_t)}{\Gamma \left[1 - \Theta(\gamma_s \alpha_t)\right]} - \lambda. \tag{B.5}$$

From (B.2) and (B.3), the wage can also be expressed as a function of H_t^s,

$$w_t = \frac{\gamma_s - 1}{\gamma_s} \frac{\left(1 - \Theta(\gamma_s \alpha_t)\right)}{(1+r)} \frac{1}{\lambda + H_t^s}. \tag{B.6}$$

Recall that the demands for the two goods are given by $D_t^s = (1 - \Theta(\alpha_t))/z_t^s$ and $w_t D_t^n = \Theta(\alpha_t)/z_t^n w_t$, which given the wage in equation (B.6) imply

$$D_t^s(\alpha_t) = \frac{1-\Theta(\alpha_t)}{z_t^s}\frac{\gamma_s}{\gamma_s - 1}\frac{1+r}{1-\Theta(\gamma_s\alpha_t)}\left(\lambda + H_t^s\right) \tag{B.7}$$

$$D_t^n(\alpha_t) = \frac{\Theta(\alpha_t)}{z_t^n}\frac{\gamma_s}{\gamma_s - 1}\frac{1+r}{1-\Theta(\gamma_s\alpha_t)}\left(\lambda + H_t^s\right). \tag{B.8}$$

We can now express the labour market clearing condition as

$$H_t^s + H_t^n + D_t^n + D_t^s = L. \tag{B.9}$$

Substituting in for (B.5), (B.7), and (B.8), we can obtain the equilibrium level of research in the status good sector, H_t^{*s}. It is defined by the solution to the following equation:

$$\begin{aligned} L \;=\; & H_t^{*s} + \frac{H_t^{*s}\Theta(\gamma_s\alpha_t) + \lambda\Theta(\alpha_t)}{\Gamma\left[1-\Theta(\gamma_s\alpha_t)\right]} - \lambda + \\ & \frac{\gamma_s}{\gamma_s - 1}\frac{1+r}{1-\Theta(\gamma_s\alpha_t)}\left[\frac{1-\Theta(\alpha_t)}{z_t^s} + \frac{\Theta(\alpha_t)}{z_t^n}\right]\left(\lambda + H_t^{*s}\right). \end{aligned} \tag{B.10}$$

Lastly, we can express equilibrium utility as

$$u_t^{*k} = \ln\left(m_t^k\right) + \ln\left((1+r)\frac{\gamma_s}{\gamma_s - 1}\right) + \ln\left(\frac{\lambda + H_t^{*s}}{z_t^n(1-\Theta(\gamma_s\alpha_t))}\right) + \ln q_t - (N-1)\ln\alpha_t. \tag{B.11}$$

Two new effects have now appeared due to the possibility of substituting current production for R&D, which are captured by the third term in equation (B.11). As the quality of the status good α_t increases, the profits from innovating in this sector are raised and hence the demand for researchers in the status goods sector increases. As a result the wage is higher, implying a reduction in the level of output of both the status and the normal good. On the other hand, a higher H_t^{*s}, implies the marginal product of labour is lower in equilibrium, an thus the wage is lower. This would increase consumption of the normal good and thus current utility.

It is straight forward to check that a consumption tax will have no impact whatsoever on either consumption or research. Suppose that consumption is taxed at a rate τ, so that an individual's expenditure is now $(1-\tau)m^k$. If the consumption tax is the same for all agents, the demand for both goods will be

$$D_t^s = (1-\tau)\frac{1-\Theta(\alpha_t)}{z_t^s w_t}$$
$$D_t^n = (1-\tau)\frac{\Theta(\alpha_t)}{z_t^n w_t}.$$

Profits, and the value of an innovation, are therefore reduced by the same amount. Relative profits are not affected, hence H_t^n is still given by equation (B.5). However, the wage is now

$$w_t = (1-\tau)\frac{\gamma_s - 1}{\gamma_s}\frac{\left(1-\Theta(\gamma_s\alpha_t)\right)}{(1+r)}\frac{1}{\lambda + H_t^s}.$$

Substituting this expression into the demand functions, we obtain that D_t^s and D_t^n are also unchanged. Hence, the labour market clearing equation, (B.10), is unchanged and the equilibrium levels of research and consumption are unaffected by the consumption tax.

Consider now the effect of a tax on R&D. Suppose that research expenditures are taxed, so that the innovator receives $(1-\tau)V_t^l$. The zero-profit condition now implies

$$(1-\tau)\frac{1}{\lambda + H_t^s}V_t^s = w_t = (1-\tau)\frac{1}{\lambda + H_t^n}V_t^n. \tag{B.12}$$

Equilibrium in the labour market still requires that the marginal product of researchers be the same in the two sectors. Hence the demand for researchers in the normal good sector is still given by equation (B.5). However, the wage is now

$$w_t = (1-\tau)\frac{\gamma_s - 1}{\gamma_s}\frac{\left(1-\Theta(\gamma_s\alpha_t)\right)}{(1+r)}\frac{1}{\lambda + H_t^s}, \tag{B.13}$$

which is lower than in the absence of the tax. A lower wage implies a lower price of the two goods and hence higher demands,

$$D_t^s(\alpha_t) = \frac{1}{(1-\tau)} \frac{1-\Theta(\alpha_t)}{z_t^s} \frac{\gamma_s}{\gamma_s - 1} \frac{1+r}{1-\Theta(\gamma_s \alpha_t)} \left(\lambda + H_t^s\right) \tag{B.14}$$

$$D_t^n(\alpha_t) = \frac{1}{(1-\tau)} \frac{\Theta(\alpha_t)}{z_t^n} \frac{\gamma_s}{\gamma_s - 1} \frac{1+r}{1-\Theta(\gamma_s \alpha_t)} \left(\lambda + H_t^s\right). \tag{B.15}$$

The equilibrium level of research in the status good sector, $H_t^s(\alpha_t)$, is now defined by the solution to the following equation:

$$\begin{aligned} L &= H_t^s + \frac{H_t^s \Theta(\gamma_s \alpha_t) + \lambda \Theta(\alpha_t)}{\Gamma\left[1-\Theta(\gamma_s \alpha_t)\right]} - \lambda + \\ &\quad \frac{1}{(1-\tau)} \frac{\gamma_s}{\gamma_s - 1} \frac{1+r}{1-\Theta(\gamma_s \alpha_t)} \left[\frac{1-\Theta(\alpha_t)}{z_t^s} + \frac{\Theta(\alpha_t)}{z_t^n}\right] \left(\lambda + H_t^s\right). \end{aligned}$$

Simple algebraic manipulation shows that the resulting level of research employment in the status good sector (and, by equation (B.5), in the normal good sector) is lower than in the absence of a tax on research.

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