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Culture and Market : A Macroeconomic Tale of Two Institutions

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Abstract

In this paper we model endogenous evolution of cultural traits which is mediated through market, and examine its impact on long run economic growth. Historically culture has played an important role in the process of economic development. Yet, economic development itself impacts upon the pre-existing cultural values and beliefs. We interact culture with market and show that such interaction may generate multiple growth trajectories depending on the initial distribution of cultural traits in the economy. In particular, an economy may end up in a culture-induced low growth trap in the long run. We also show that over time, with economic development, culture takes a back seat but its initial influence continues to impact long run outcomes.

Keywords: Culture, Market, Intrinsic Motivation, Growth
JEL Classification : Z130, O110, D90

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1 Introduction

> "If generation and continuous improvement of new 'useful knowledge' - both scientific and technological- is at the core of modern economic growth, the riddle is one of motivation or incentives."
>
> - Joel Mokyr (2016)

The significance of culture in the process of economic development is now well established. Max Weber in his seminal thesis (Weber (1930)) argued that rise of Protestanism played a crucial role in ushering in forces of industrial revolution in the Western Europe in the late 18th and early 19th century. More recently, culture and other social institutions have been identified as key factors in explaining the observed growth patterns across different societies.[1]

Yet, culture does not operate in a vacuum. It often interacts with market forces to chart out certain path of economic development for a country. In this paper we model a mechanism of endogenous evolution of cultural traits which is mediated through market. We then explore its long run implications for economic growth and development.

Culture is a concept that has many different dimensions and its definition varies from one context to the other. Here we follow Mokyr (2016) to identify culture as a set of beliefs, values and preferences that are shared by some subset of the society at any given point of time and is transmitted over time through social interactions. Culture, as defined above, is likely to have a bearing on the aggregate economy through its influence on optimal decisions of agents regarding various economic activities like occupational choice, labour force participation, savings behaviour, educational investment, entrepreneurial initiative, technology adoption and so on. Culture, however, is different from ability or skill in that it works through nonpecuniary channels (such as utility) rather than income or wealth.[2]

In this paper we focus on a specific cultural trait called public spirit. There are certain occupations which have a strong public spirit component attached to them. These are occupations which, in addition to generating private gains for individuals directly engaged in these occupations, also generate some social benefits that accrue to all. Examples of such professions include doctors who cure individual patients and thereby prevent spread of

[1] There is a growing volume of literature that links various cultural factors to long run economic development, starting with Greif (1994). Other important works in this arena include Putnam, Leonardi, and Nanetti (1994);Guiso, Sapienza, and Zingales (2006); Doepke and Zilibotti (2008);Tabellini (2010); Gorodnichenko and Roland (2011) and Gorodnichenko and Roland (2017).

[2] To be sure, some cultural traits may also impact the potential earning capacity of an agent indirectly. But the primary impact of culture is on preferences, which distinguishes it from skills.

the disease and improve the overall health capital of the country; teachers who promote learning at the individual level but at the same time add to the overall dissemination of knowledge; scientists who, in the process of making individual discoveries, add to the existing stock of scientific knowledge that can be used for greater well being of the society. Agents who choose to work in these occupations are more often than not ‘intrinsically motivated’ towards these social causes by virtue of their cultural attributes.

There exists an independent literature which explores the designing of optimal incentive structure for engaging such ‘intrinsically motivated’ agents.[3]. Borrowing from this literature (in particular from Besley and Ghatak (2005)), we define intrinsically motivated agents as those who, apart from getting tangible or monetary return, also derive some non-pecuniary benefit or utility from engaging in occupations that they are motivated towards. We however differ from this literature in that in our model, the intrinsic motivation towards public spirited occupations is not exogenous. It is culturally acquired and is passed on from one generation to another through a cultural transmission mechanism.

There are various mechanisms of cultural transmission outlined in the literature. Transmission of cultural traits can happen vertically (from parent to child), horizontally (among individuals of the same generation) and in an oblique manner (from one generation to another but not directly through parents). In this paper we consider a process of vertical and oblique transmission of cultural traits which is similar to Bisin and Verdier (2000). We develop an overlapping generations framework where the parental generation and their children coexist for one period. In line with Bisin and Verdier (2000), we assume that parents wish to maintain allegiance to specific cultural traits in their family and derive a warm glow utility if their children acquire the same cultural disposition as themselves. To this end, they spend time/effort in socializing with the children to inculcate their own cultural values in them. But spending time/effort in socialization is economically costly as it requires taking time off work. The opportunity cost of such direct socialization effort is therefore measured by the market wages foregone. Apart from her parent, a child also mingles with other members of the parental generation and may indirectly pick up the parental trait by being randomly matched with someone in the parental generation who share the same cultural trait. Thus parental socialization effort and the proportion of parental type in the adult population jointly determine the probability that a specific cultural trait will picked up by an agent during her childhood. In the context of our model, this process of direct and indirect socialization determines the proportion of ‘intrinsically motivated’ agents in the next generation, who, upon adulthood, decide whether to opt for a public spirited

[3]See, for example, Francois (2000), Besley and Ghatak (2005) and Benabou and Tirole (2006)

occupation or not.

Culture and market interact in our paper through three distinct channels. First, market determines the opportunity cost of socialization, thereby influencing the cultural transmission mechanism. Secondly, conditional on the cultural trait acquired during childhood, an agent compares the market returns from various occupations in determining her optimal occupational choice. Thirdly, in a competitive general equilibrium framework, the market returns themselves are endogenously determined by agents' occupational choice decisions, which in turn depend on the composition of different cultural types in the working population. The first of these three links is intertemporal in nature, while the latter two work contemporaneously. These interfaces between culture and market create a dynamic feedback loop in our model whereby culture impacts market and market in turn impacts culture. In this set up, we then seek to answer the following question: does this two way feedback mechanism lead to long run convergence (economic and/or cultural) or does it open up possibilities of divergence and culture-induced poverty traps? We show that it is indeed possible to have a scenario where an economy in the long run gets stuck in a low growth trap due on its initial cultural composition. We further show that the dynamic interaction between culture and market neither generates complete cultural assimilation nor ensures economic equality across households in the long run. In fact, there may exist a long run trade off between inequality and economic growth such that higher growth is accompanied by persistent wage inequality.

Our work broadly fits into the emerging literature on joint evolution of culture and institutions (see for example Bisin and Verdier (2017); Besley and Ghatak (2017) and Iyigun, Rubin, and Seror (2018).[4] These papers focus on the interaction between culture and the set of formal institutions (political, legal and organizational frameworks that define the rules of the game) and the causal effect one has on the other. We, in contrast, focus exclusively on the interaction between culture and a hands-off, laissez faire market institution, whereby the latter operates under minimal rules and regulations.

Close to our work, Besley and Ghatak (2016) also study the evolution process of motivation and its interaction with the market forces. Besley and Ghatak consider endogeneous motivation of economic agents in a team production set up, wherein the firms and workers enogenously match with each other on the basis of the reward structure offered by the firms and the matching outcome determines both the output as well the culture of the organisation in the next generation. Unlike us, they focus on a socialisation process channeled through co workers who act as cultural parents (horizontal transmission of culture). In an evolutionary game theoretic set up, they show that over time, organisations where there are few motivated workers, tend to

[4]Alesina and Giuliano (2015) provides an excellent summary of this literature.

push down further the proportion of motivated agents, whereas those that start with a proportion above a certain threshold level continue to thrive on motivation with fewer market incentives. Our paper connects to this idea but we approach the problem from a macroeconomic general equilibrium perspective with atomistic agents and with a cultural transmission process different from that of Besley and Ghatak (2016).

The rest of the paper is organized as follows. Section 2 describes the basic set up of the model. Section 3 derives the optimal socialization effort by parents. The occupational choice of the child in equilibrium is discussed in section 4. Section 5 and section 6 describe the population dynamics and the growth dynamics respectively. The conclusion is provided in section 7.

2 The Model

We consider a closed economy producing a single final commodity, and is populated by a finite measure of overlapping generations of dynasties. Time is discrete, measured by $t = 0, 1, 2....$ Each individual lives exactly for two time periods - first period as a child, and second period as an adult. Each adult agent has exactly one offspring. Thus population size of each cohort is constant, normalized to unity.

Every agent is endowed with one unit of time in both periods of his life. In the first period, as a child, the agent consumes nothing. He also does not take part in any economic activity and spends his entire time interacting and socializing with the adult population of the parental generation, acquiring certain cultural traits in the process. The precise socialization mechanism through which these cultural traits are acquired is described in section 2.4 below.

The cultural traits acquired during childhood predisposes an agent towards certain occupations. In the second period of his life, an adult agent chooses an occupation depending on his acquired cultural traits and the market returns associated with various occupations. He also decides on the optimal allocation of his adulthood time between working and interacting with his child, the latter enabling him to influence the cultural traits picked up by his child. Finally, he consumes his entire second period income and dies at the end of the period.

2.1 Mapping Culture to Occupations

There are various occupations available in the economy - each making positive and symmetric contribution towards the production of current output. What differentiates these occupations is that some of them, in addition, also contribute towards augmenting overall future productivity. 1 betterment of the society in future as well.have a public good component attached to them in the sense that they also contribute to the future productivity betterment of the society in future as well. These societal benefits however are not rewarded by the market. Hence these latter occupations have special appeal (beyond their market returns) only to the people who are public spirited or 'motivated'.

For simplicity, we consider two occupations - one is public-spirited, the other one is non public-spirited. For want of a better term, we call the first profession 'scientist' (denoted by S) while the second one is called 'manager' (denoted by M).[5]

Adult agents on the other hand are of two types - public-spirited/motivated (type s) and market-oriented/non-motivated (type m). These traits are culturally acquired during childhood through social interactions.

An individual of either type can potentially choose any occupation. However, if a motivated agent (type s) joins the public spirited occupation (profession S), then apart from receiving the corresponding monetary returns, he also derives some utility by serving the society at large (a la Besley and Ghatak (2005)). We model this extra utility by attaching a multiplier to the indirect utility of income derived by joining a particular occupation. To be more precise, if an agent of type s (who is motivated) joins the public spirited occupation (i.e., if he becomes a scientist (S)), then his utility valuation of the corresponding income gets scaled up by a factor q, where $q > 1$.

2.2 Preference

An adult agent's utility function has various components. He derives utility from consumption. The associated utility is captured by the following CRRA utility function:

$$u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma} \tag{1}$$

where $0 < \sigma < 1$. For analytic convenience, we assume that $\sigma = \frac{1}{2}$.

Apart from consumption, an agent also gets utility if his child acquires the same cultural trait as his own. For instance, for an agent of type s who is highly motivated and public spirited, if his child also becomes public-spirited, then he gets a constant utility $\bar{V}$. Likewise, an agent of type m who is market oriented derives a constant utility $\bar{V}$ if his child is also market-oriented. Agent of either type derives zero utility if his child turns out to be of a different type.[6] The combined utility from own consumption and acquired child-trait (in expected terms) for an adult agent of either type is therefore given by:

[5]This is just a matter of nomenclature. It is not our intention to imply that managers do not contribute to the society.

[6]This is a normalization for the sake of simplification. We can assume a positive utility lower than $\bar{V}$ in case the child becomes a different type.

$$
\begin{aligned}
EU_t &= P_t^{ik}\bar{V} + 2\sqrt{c_t} \text{ if } k = i \\
&= 2\sqrt{c_t} \text{ if } k \neq i
\end{aligned} \tag{2}
$$

where i denotes the type of the adult individual and P^{ik} denote the probability that an individual of type i has a child of type k where $i, k \in \{s, m\}$. Note that an individual gets the utility $\bar{V}$ if and only if $i = k$.

In addition to these, an agent of type s derives extra utility should he join occupation S, knowing that his contribution to this profession will bring in future benefits to the society. As we have postulated above, this additional utility shows up in his utility valuation of the income associated with occupation S, whereby the latter is scaled up by a factor $q > 1$. The precise expression of his subjective (indirect) utility from joining either occupation is shown in section 4 below.

2.3 Production Structure

There is a single final good in the economy which can be produced using managerial inputs and inputs from scientists. The technology for producing final good is Cobb Douglas, given as

$$
Y_t = 2A_t S_t^{\alpha} M_t^{1-\alpha} \tag{3}
$$

where S_t is the aggregate amount of scientific input (measured in terms of labour time or efficiency units), M_t is the aggregate amount of managerial input (measured in terms of labour time or efficiency units) and A_t represents a time dependent technology index (or total factor productivity index) that captures the state of the technology at time t. For expositional simplicity, we assume that $\alpha = \frac{1}{2}$. This assumption also implies that the contribution of scientific inputs and managerial inputs in current production is *exactly symmetric*: their share in the total output is the same.

Given the above technology, the per unit market return for each factor is given by their respective marginal products, as specified below:

$$
w_t^S = A_t \left(\frac{M_t}{S_t}\right)^{\frac{1}{2}}
$$

$$
w_t^M = A_t \left(\frac{S_t}{M_t}\right)^{\frac{1}{2}}
$$

where w_t^S denotes the market return (per unit of time) from being a scientist and w_t^M denotes the market return (per unit of time) from being a manager. Both w_t^S and w_t^M are endogenously determined in every period by the occupational choice decisions of agents of various types. The occupational choice decisions in turn depends on the (expected) market returns and the type of an agent. We now specify the exact socialization mechanism that determines the type of an adult agent at any time period t.

2.4 Socialization Mechanism

The socialization mechanism we adopt here is similar to Bisin and Verdier (2000). A child is born naive - without any specific cultural attribute. During childhood, he picks up a specific cultural type by interacting with the adult population belonging to his parental generation, as well as due to conscious time and effort spent by his parent to indoctrinate him to the parent's own cultural values. The outcome of this socialization process determines his cultural type upon adulthood, which in turn may make him predisposed towards certain occupations.

Recall that a parent gets a constant utility $\bar{V}$ from his child being of his own type. He therefore has an incentive to spend time with his child in order to pass on his own cultural trait to him. [7] More time a parent spends in socializing his child, higher is the probability that the child will be of the same type as that of the parent. However, there is a cost associated with this transmission process and the nature of that cost is purely economic. Given the fixed time endowment of the parent (of one unit), if he spends any time with his child, then for that duration he cannot participate in the labour market and therefore has to forego that part of his wage income. Since wages are market determined, market forces and the prevalent economic conditions will indirectly affect the cultural transmission process through the opportunity cost of foregone wage income. A forward-looking parent optimally decides how much time to spend in socializing his child by doing an appropriate cost-benefit analysis.

Let τ_t^i denote the fraction of time chosen by a parent of type $i \in \{s, m\}$ in socializiling his child. The probability that the child will acquire the same cultural trait as the parent depends positively on τ_t^i. Hence, without much loss of generality, we use τ_t^i also to denote the probability of successful socialization by the parent. However, if the parental socialization mechanism fails with a probability of $1 - \tau_t^i$, the child then picks up a cultural trait from someone else in the rest of the adult population whom he is matched with randomly. The adult agent that the child randomly interacts with may belong to either type s or type m. However, since the matching is random, the likelihood of the child interacting with an adult of either type would depend upon the proportion of each type in the total adult population. These two factors together would determine the overall probability of a child

[7] We should emphasize here that the utility that the parent derives if his child acquires his own type is purely egoistic; it does not depend on the subsequent occupational choice of the child. There is enough evidence in evolutionary biology that indicate that people have a natural tendency to replicate their own types quite independent of the associated economic or social benefits.

being of the same or a different type as his parent.

Let p_t be the proportion of people of type s in the population at time t. Then the probability that a parent of type s has a child of the same type is given as follows

$$P_t^{ss} = \tau_t^s + (1 - \tau_t^s)\, p_t \tag{PI}$$

For a parent who is of type m, this probability is given by:

$$P_t^{mm} = \tau_t^m + (1 - \tau_t^m)\,(1 - p_t) \tag{PII}$$

Finally, the probabilities that parent of type i has a child of a type different from his own are given respectively as follows:

$$P_t^{sm} = (1 - \tau_t^s)\,(1 - p_t) \text{ - for a parent of type } s \tag{PIII}$$

and

$$P_t^{ms} = (1 - \tau_t^m)\, p_t \text{ - for a parent of type } m. \tag{PIV}$$

Given these probabilities, the parent optimally chooses his socialization effort so as to maximize his expected utility.

3 Optimal Socialization Time

Recall that the utility from consumption is given by the CRRA utility function as specified in (1). In the absence of any savings or bequest motive, each adult agent consumes his entire income. However income of the adult agent depends on how much time he spends in the labour market. Out of his total unit time endowment, if he spends τ_t^i fraction in socializing his child, then the labour supply of the individual is given by $\left(1 - \tau_t^i\right)$. This allows him to earn a net wage income of $\hat{w}_t^{iJ} = \left(1 - \tau_t^i\right) w_t^J$, where w_t^J denotes the market wage rate associated with occupation $J \in \{S, M\}$. Substituting $c_t = \hat{w}_t^{iJ}$ into (1) gives us the following indirect utility from consumption for agent i: $\hat{u}\left(\hat{w}_t^{iJ}\right) = 2\left(\sqrt{\hat{w}_t^{iJ}}\right)$.

Hence the combined consumption and child-trait utility (in expected terms) of an agent of type i who spends time τ_t^i in socializing his child and spends $(\left(1 - \tau_t^i\right))$ working in occupation J is given by (from equation 2)

$$EU_t^{iJ} = P_t^{ii}\bar{V} + 2\left(\sqrt{\left(1 - \tau_t^i\right) w_t^J}\right) \tag{4}$$

where the relevant probabilities for either type are given by (PI) and (PII) respectively.

For any arbitrary choice of occupation J (which will eventually be determined optimally), an agent maximizes the above expected utility function with respect to τ_t^i and chooses the optimal socialization time. Given p_t, for an agent of type s, the optimal socilaization time spent with the child is

$$\tau_t^{sJ} = 1 - \frac{w_t^J}{\left[(1-p_t)\left(\bar{V}\right)\right]^2} \tag{5}$$

Likewise, for an agent of type m, the optimal socialization time spent with the child is

$$\tau_t^{mJ} = 1 - \frac{w_t^J}{\left[p_t\left(\bar{V}\right)\right]^2} \tag{6}$$

where $J \in \{S, M\}$.

From (5) and (6), notice that optimal socialization effort chosen by an agent of type s (or m) depends on two things: the wage rate in the chosen occupation (w_t^J) and the proportion s -type (or m -type) in the total population, denoted by p_t (or $(1-p_t)$). In particular, for any given value of p_t (or $(1-p_t)$), higher wage rate in the chosen profession is associated with a lower optimal value of τ_t^i . Alternatively, for a given w_t^J, higher proportion of own type in the total population is associated with lower optimal value of τ_t^i . This makes intuitive sense. For a given p_t (or $(1-p_t)$), higher wage rate implies higher opportunity cost of socialization; hence agents cut down on their optimal socialization effort. On the other hand, higher representation of own type in the population means the child is very likely to pick the parental trait by interacting with the larger population anyway. Socialization being costly, this induces the parent to reduce his optimal socialization effort. Indeed, for every p_t (or $(1-p_t)$), there exists a threshold wage rate for either type of agents such if the wage rate in the chosen profession lies above this threshold level, then optimal socialization effort falls to zero. Figure 1 below plots this threshold wage rate for either type for different values of p_t. The downward sloping line drawn in blue (which is to be traced from left to right) represents all the combinations of (w_t^J, p_t) such that the optimal socialization time by the s-type is just zero. Likewise the upward sloping line drawn in red (which is to be traced from right to left) represents all the combinations of $(w_t^J, (1-p_t))$ such that the optimal socialization time by the m-type is just zero. In the region below these two lines, both sets of parents spend time in socializing, and therefore the distribution of types in the next generation (p_{t+1}) might change. On the other hand, in the region above these two lines, neither sets of parents spend time in socializing, and the distribution of types in the subsequent generation remains constant. In any region lying in between the two lines, only one type of parents spend time socializing and therefore the representation of that type in the next generation increases.

Factoring in these time choices, we next examine how adult agent of either type optimally choose their occupations.

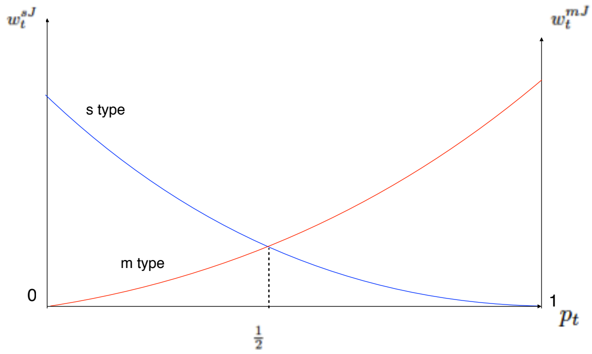

Figure 1: Optimal Socialization Time: Interaction between Income and Population Size

4 Optimal Occupational Choice

In section 3 above, we have treated the occupational choice of agents as exogenous (given arbitrarily). The occupational choice decisions of the adult agents in period t are however determined endogenously, which in turn determine the wage rates in either occupation (w_t^S and w_t^M). In the general equilibrium set up, the occupational choices of agents and the concommitant wage rates will be simultaneously determined in a way such that they are mutually consistent. In this section, we first characterise the optimal occupational choice decisions of agents for given values of w_t^S and w_t^M. We then go on to characterize the general equilibrium solution path (or the temporary/static equilibrium in each time period t) when the economy starts with a given distribution of the types (p_t and $1 - p_t$).

Each adult agent in period t decides on his optimal occupational choice so as to maximise his overall utility. Recall that at the beginning of period t, the type of the adult agent is already decided, but his occupation is not yet decided. Also note that in our model there is no market imperfection or fixed investment requirement associated with any occupation: anybody can choose any occupation and all are equally productive in terms of current production irrespective of their types. Hence in choosing one's occupation, one only compares the utility from being a scientist vis-a-vis utility from being a manager. Agents however differ in terms of their perceived utilities from joining either occupation. In particular, an agent of type s derives some extra utility if he joins occupation S. Hence for the same w_t^S and w_t^M, the optimal occupational choice may differ across the two types of agents.

4.1 Optimal Occupation Choice: *s type*

Let us first carry out the utility comparison for an agent of type s. In the previous section we have seen that for any arbitrary choice of occupation $J \in \{S, M\}$, the combined utility from own consumption and from acquired child-trait for an agent of type s is given by (from equation 2)

$$\begin{aligned} EU_t^{sJ} &= P_t^{ss}\bar{V} + 2\left(\sqrt{\left(1-\tau_t^{sJ}\right) w_t^J}\right) \\ &= \left[\tau_t^{sJ} + \left(1-\tau_t^{sJ}\right) p_t\right]\bar{V} + 2\left(\sqrt{\left(1-\tau_t^{sJ}\right) w_t^J}\right) \end{aligned}$$

Substituting for the optimal socialization time choice τ_t^{sJ} from (5) and simplifying, we can re-write the above expression as

$$EU_t^{sJ} = \bar{V} + \frac{w_t^J}{\bar{V}\left(1-p_t\right)}$$

where the 2nd term on the RHS represents the utility valuation of the wage rate in occupation J. Recall however for an agent of type s, the utility valuation of income associated with occupation S is scaled up by a factor $q > 1$. Thus for an agent of type s, the indirect utility of joining occupation S is given by:

$$EU_t^{sS} = \bar{V} + q\left(\frac{w_t^S}{\bar{V}\left(1-p_t\right)}\right); \; q > 1,$$

while the indirect utility of joining occupation M is given by:

$$EU_t^{sM} = \bar{V} + \frac{w_t^M}{\bar{V}\left(1-p_t\right)}.$$

An agent of type s will choose occupation S (i.e., choose to be a scientist) if and only if

$$\begin{aligned} & EU_t^{sS} \geqslant EU_t^{sM} \\ & \Rightarrow q w_t^S \geq w_t^M. \end{aligned} \tag{7}$$

4.2 Optimal Occupation Choice: *m type*

Next we carry out the utility comparison for an agent of type m. As before, for any arbitrary choice of occupation $J \in \{S, M\}$, the combined utility from own consumption and from acquired child-trait for an agent of type m is given by (from equation 2)

$$
\begin{aligned}
EU_t^{mJ} &= P_t^{mm}\bar{V} + 2\left(\sqrt{\left(1-\tau_t^{mJ}\right)w_t^J}\right) \\
&= \left[\tau_t^{mJ} + \left(1-\tau_t^{mJ}\right)(1-p_t)\right]\bar{V} + 2\left(\sqrt{\left(1-\tau_t^{mJ}\right)w_t^J}\right)
\end{aligned}
$$

Substituting for the optimal socialization time choice τ_t^{mJ} from (6) and simplifying, we can re-write the above expression as

$$
EU_t^{sJ} = \bar{V} + \frac{w_t^J}{\bar{V}p_t}
$$

where, as before, the 2nd term on the RHS represents the utility valuation of the wage rate in occupation J. For agents of type m, there is no extra utility associated with any occupation beyond their monetary returns. Thus for an agent of type m, the indirect utility of joining occupation S is given by:

$$
EU_t^{mS} = \bar{V} + q\frac{w_t^S}{\bar{V}p_t},
$$

while the indirect utility of joining occupation M is given by:

$$
EU_t^{mM} = \bar{V} + \frac{w_t^M}{\bar{V}p_t}.
$$

An agent of type m will choose occupation S (i.e., choose to be an scientist) if and only if

$$
\begin{aligned}
&EU_t^{mS} \geqslant EU_t^{mM} \\
&\Rightarrow w_t^S \geq w_t^M. \qquad (8)
\end{aligned}
$$

4.3 General Equilibrium

In general equilibrium, the market wage rates w_t^S and w_t^M are endogenously determined by the corresponding marginal products, which in turn depend on the labour time supplied by the people (of either type) who join the scientist profession (S_t) vis-a-vis the managerial job (M_t). In particular,

$$
w_t^S = A_t\left(\frac{M_t}{S_t}\right)^{\frac{1}{2}} \qquad (9)
$$

$$
w_t^M = A_t\left(\frac{S_t}{M_t}\right)^{\frac{1}{2}} \qquad (10)
$$

These values of w_t^S and w_t^M again will have to be consistent with the optimal occupation choice decisions of all agents such that for every s-type agent who chooses to be a scientist, condition (7) holds, and for every m-type agent who chooses to be a scientist, condition (8) holds. Thus in period t, the general equilibrium (or temporary equilibrium) solution for the economy is characterized by a pair (M_t, S_t) which simultaneously satisfies conditions (7), (8), (9) and (10).

Consider an economy which start with some historically given values of A_t and p_t. We now proceed to identify the general equlibrium solution for this economy at period t. Let λ_t^s denote the proportion of s-type agents who choose to become scientists and let λ_t^m denote the proportion of m-type agents who choose to be scientists, when the equilibrium values of λ_t^s and λ_t^m are yet to be determined. Recall that each of the agents spends $(1-\tau^{iJ})$ units of time working in their respective occupations. Accordingly, for any λ_t^s and λ_t^m, the aggregate volume of scientific input S_t (in efficiency units) is given by

$$S_t = \lambda_t^s p_t \left(1-\tau_t^{sS}\right) + \lambda_t^m \left(1-p_t\right)\left(1-\tau_t^{mS}\right) \tag{11}$$

and the aggregate volume of manegerial input M_t (in efficiency units) is given by

$$M_t = \left(1-\lambda_t^s\right) p_t \left(1-\tau_t^{sM}\right) + \left(1-\lambda_t^m\right)\left(1-p_t\right)\left(1-\tau_t^{mM}\right) \tag{12}$$

Also from section 3, we know that the optimal choice of socilization time for agent $i \in \{s, m\}$ who is engaged in occupation $J \in \{S, M\}$ would be as follows:

$$\tau_t^{sS} = 1 - \frac{w_t^S}{\left[\left(1-p_t\right)\left(\bar{V}\right)\right]^2}; \tag{13}$$

$$\tau_t^{sM} = 1 - \frac{w_t^M}{\left[\left(1-p_t\right)\left(\bar{V}\right)\right]^2}; \tag{14}$$

$$\tau_t^{mS} = 1 - \frac{w_t^S}{\left[p_t\left(\bar{V}\right)\right]^2}; \tag{15}$$

$$\tau_t^{mM} = 1 - \frac{w_t^M}{\left[p_t\left(\bar{V}\right)\right]^2}. \tag{16}$$

From (9), (10), (11), (12) and from the τ^{iJ} solutions given above, we can write the equilibrium wage ratio in terms of λ_t^s and λ_t^m as follows:

$$\frac{w_t^S}{w_t^M} = \frac{M_t}{S_t} = \frac{\left(1-\lambda_t^s\right) p_t \left\{\frac{w_t^M}{\left[\left(1-p_t\right)\left(\bar{V}\right)\right]^2}\right\} + \left(1-\lambda_t^m\right)\left(1-p_t\right)\left\{\frac{w_t^M}{\left[p_t\left(\bar{V}\right)\right]^2}\right\}}{\lambda_t^s p_t \left\{\frac{w_t^S}{\left[\left(1-p_t\right)\left(\bar{V}\right)\right]^2}\right\} + \lambda_t^m \left(1-p_t\right)\left\{\frac{w_t^S}{\left[p_t\left(\bar{V}\right)\right]^2}\right\}}$$

Simplifying,

$$\frac{w_t^S}{w_t^M} = \left[\frac{(1-\lambda_t^s)\left\{\frac{p_t}{(1-p_t)^2}\right\} + (1-\lambda_t^m)\left\{\frac{(1-p_t)}{p_t^2}\right\}}{\lambda_t^s\left\{\frac{p_t}{(1-p_t)^2}\right\} + \lambda_t^m\left\{\frac{(1-p_t)}{p_t^2}\right\}}\right]^{\frac{1}{2}} \tag{17}$$

Using this expression of $\left(\frac{w_t^S}{w_t^M}\right)$ in (7) and (8) respectively, we get the following two inequalities in terms of λ_t^s and λ_t^m that define the occupational choices of the s-type and m-type agents in equilibrium:

An agent of type s chooses to be a scientist in equilibrium if and only if the following holds:

$$qw_t^S \geq w_t^M$$

$$\Rightarrow \lambda_t^s \leq \frac{q^2}{q+q^2} + \frac{q^2}{q+q^2}\left(\frac{1-p_t}{p_t}\right)^3 - \lambda_t^m\left(\frac{1-p_t}{p_t}\right)^3\left(\frac{q^2+1}{q^2+q}\right) \tag{QTRbfS-M Frontier I}$$

Similarly, an agent of type m chooses to be a scientist in equilibrium if and only if the following holds:

$$w_t^S \geq w_t^M$$

$$\Rightarrow \lambda_t^s \leq \frac{1}{1+q} + \frac{1}{1+q}\left(\frac{1-p_t}{p_t}\right)^3 - \lambda_t^m\left(\frac{1-p_t}{p_t}\right)^3\left(\frac{2}{1+q}\right) \tag{QTRbfS-M Frontier II}$$

Our objective here is to identify the equilibrium values of $\lambda_t^m, \lambda_t^s \in [0,1]$, such that the above two inequalities are simultaneously satisfied and, moreover at those $\lambda_t^m, \lambda_t^s \in [0,1]$, all the s-type and the m-type agents are happy with in respective occupation so that nobody switches from one occupation to the other.

In order to identify the equilibrium, we plot the equality counterparts of the inequality conditions represented by S-M Frontier I and S-M Frontier II respectively in the $(\lambda_t^m, \lambda_t^s)$ plane. These equality conditions are represented by two downward sloping lines in the $(\lambda_t^m, \lambda_t^s)$ plane, each with positive intercepts. Moreover, since $q > 1$, the boundary line representing S-M Frontier I always lies above the boundary line representing S-M Frontier II (as shown in figures 2, 3 and 4 below).

Notice that any $(\lambda_t^m, \lambda_t^s)$ which lies below both these boundary lines cannot be an equilibrium. At all such points, the utility from being a scientist is still greater than the utility from being a manager for both types of agents.

Agents of either type would therefore switch from occupation M to occupation S; therefore λ_t^m and λ_t^s would both increase. Likewise, any $(\lambda_t^m, \lambda_t^s)$ which lies above both the boundary lines cannot be an equilibrium. At all such points, the utility from being a scientist is lower than the utility from being a manager for both types of agents. Agents of either type would therefore switch from occupation S to occupation M; therefore λ_t^m and λ_t^s would both decrease. Finally, at any point $(\lambda_t^m, \lambda_t^s)$ that lies in between the two boundary lines, for s-type agents, the utility from being a scientist is still greater than the utility from being a manager; hence λ_t^s would rise. However, for m-type agents, the utility from being a scientist is now lower then the utility from being a manager; hence λ_t^m would fall. Thus depending of the positions of the two boundary line representing S-M Frontier I and S-M Frontier II, equilibrium $(\lambda_t^m, \lambda_t^s)$ will be attained at the furthest North-West point that lies between these two boundary lines.

The exact positions of these two boundary lines of course depend on the value of p_t. Accordingly, we discuss three alternative ranges of p_t values (which are mutually exclusive and exhaustive) and characterise the corresponding equilbrium $(\lambda_t^m, \lambda_t^s)$ for each of these cases.

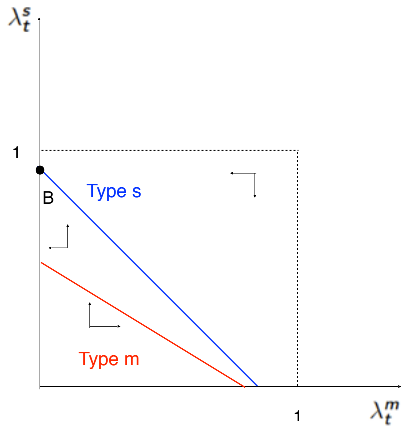

Figure 2: Static Equilibrium for high values of p_t

4.3.1 High p values: $p_t \geq \frac{q^{1/3}}{1+q^{1/3}}$

For relative high values p_t such that $\frac{q^{1/3}}{1+q^{1/3}} \leqslant p_t \leqslant 1$, we have an equilibrium where all the market-oriented m-type agents choose to be managers and a proportion $\hat{\lambda}_t^s \equiv \frac{q^2}{q+q^2}\left(1+(\frac{1-p_t}{p_t})^3\right)$ of the motivated s-type agents choose to be scientists and the rest become managers. This equilibrium configuration has been depicted in figure 2. In this temporary equilibrium, the wage rate for the scientists is $w_t^S = q^{-1/2}A_t$ and that for the managers is $w_t^M = q^{1/2}A_t$. The equilibrium wage ratio is given by $\frac{w_t^S}{w_t^M} = \frac{M_t}{S_t} = \frac{1}{q}$. Notice that in this case the managers earn a higher wage than the scientists. This happens because there are too many s-type in the population who are willing to become scientists even at a lower wage (compared to the managerial wage), which pushes the equulibrium wage rate for the scientists down.

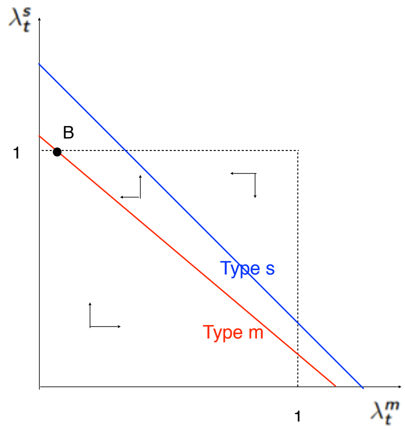

Figure 3: Static Equilibrium for low values of p_t

4.3.2 Low p values: $p_t \leq \frac{1}{1+q^{1/3}}$

For relatively low values of p_t such that $0 \leqslant p_t \leq \frac{1}{1+q^{1/3}}$, all the motivated s type choose to be scientists and a proportion $\tilde{\lambda}_t^m \equiv \frac{1}{2} + \frac{1}{2}\left(\frac{p_t}{1-p_t}\right)^3$ of the non motivated m-type also choose to be scientists. This equilibrium has been depicted in figure 3. For these values p_t, the wage rate for scientists is equal to the wage rate of the managers: $w_t^S = A_t = w_t^M$. The corresponding the wage ratio is given by $\frac{w_t^S}{w_t^M} = \frac{M_t}{S_t} = 1$. Note that in this case we have compete wage equality. This happens because now there are two few s-type in the population. Hence even when all of the s-type agents are engaged in occupation S, the resulting wage rate in S sector is still high enough to attract the m-types to join the job of scientists. Hence equilibrium is attained when the m-types are just indifferent bewteen the two occupations, which happens when the two wage rates are exactly equal.

4.3.3 Intermediate p values: $\frac{1}{1+q^{1/3}} \leq p_t \leq \frac{q^{1/3}}{1+q^{1/3}}$

For the intermediate range of values of p such that $\frac{1}{1+q^{1/3}} \leq p_t \leq \frac{q^{1/3}}{1+q^{1/3}}$, in equilibrium all the motivated s type choose to be scientists and all the non-motivated m type choose to be managers (depicted in figure 4). The wage rates for scientists and managers are given respectively by $w_t^S = A_t \left(\frac{1-p_t}{p_t}\right)^{3/4} \frac{1}{q^{1/4}}$ and $w_t^M = A_t \left(\frac{p_t}{1-p_t}\right)^{3/4} q^{1/4}$. In this case the wage ratio is given by $\frac{w_t^S}{w_t^M} = \frac{M_t}{S_t} = \left(\frac{1-p_t}{p_t}\right)^{3/2} \frac{1}{q^{1/2}}$. Once again the managers earn a higher wage than the scientists.

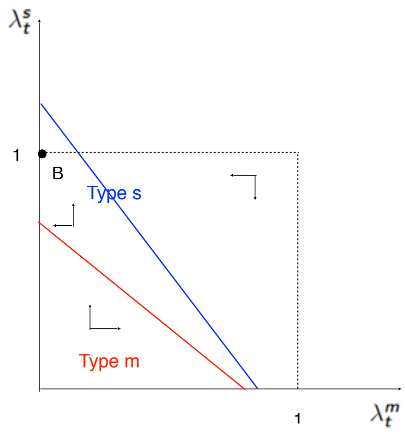

Figure 4: Static Equilibrium for intermediate values of p_t

Summarizing all these cases, we can now completely characterize the general equilibrium solution for this economy at time t starting with any given value p_t and A_t. We present below the equilibrium values of the relevant variables for difference ranges of p_t in a concise manner:

(i) $0 \leqslant p_t \leq \dfrac{1}{1+q^{1/3}}$:

$$\left.\begin{array}{c} \lambda_t^s = 1;\ \lambda_t^m = \frac{1}{2} + \frac{1}{2}\left(\frac{p_t}{1-p_t}\right)^3 \\ w_t^S = w_t^M = A_t \\ \frac{M_t}{S_t} = 1 \\ \tau_t^{sS} = 1 - \frac{A_t}{\left[(1-p_t)(\bar{V})\right]^2} \\ \tau_t^{mS} = \tau_t^{mM} = 1 - \frac{A_t}{\left[p_t(\bar{V})\right]^2} \end{array}\right\}$$

(ii) $\dfrac{1}{1+q^{1/3}} \leqslant p_t \leq \dfrac{q^{1/3}}{1+q^{1/3}}$:

$$\left.\begin{array}{c} \lambda_t^s = 1;\ \lambda_t^m = 0 \\ w_t^S = A_t\left(\frac{1-p_t}{p_t}\right)^{3/4}\frac{1}{q^{1/4}};\ w_t^M = A_t\left(\frac{p_t}{1-p_t}\right)^{3/4} q^{1/4} \\ \frac{M_t}{S_t} = \left(\frac{1-p_t}{p_t}\right)^{3/2}\frac{1}{q^{1/2}} \\ \tau_t^{sS} = 1 - \frac{A_t\left(\frac{1-p_t}{p_t}\right)^{3/4}\frac{1}{q^{1/4}}}{\left[(1-p_t)(\bar{V})\right]^2} \\ \tau_t^{mM} = 1 - \frac{A_t\left(\frac{p_t}{1-p_t}\right)^{3/4} q^{1/4}}{\left[p_t(\bar{V})\right]^2} \end{array}\right\}$$

(iii) $\dfrac{q^{1/3}}{1+q^{1/3}} \leqslant p_t \leq 1$:

$$\left.\begin{array}{c} \lambda_t^s = \frac{q^2}{q+q^2}\left(1 + (\frac{1-p_t}{p_t})^3\right);\ \lambda_t^m = 0 \\ w_t^S = A_t q^{-1/2};\ w_t^M = A_t q^{1/2} \\ \frac{M_t}{S_t} = \frac{1}{q} \\ \tau_t^{sS} = 1 - \frac{A_t q^{-1/2}}{\left[(1-p_t)(\bar{V})\right]^2};\ \tau_t^{sM} = 1 - \frac{A_t q^{1/2}}{\left[(1-p_t)(\bar{V})\right]^2} \\ \tau_t^{mM} = 1 - \frac{A_t q^{1/2}}{\left[p_t(\bar{V})\right]^2} \end{array}\right\}$$

We have now derived the equilibrium wages in occupation S and occupation M for different values of p_t (and a given A_t). These equilibrium wages are shown in figure 5 below. We further know that in equilibrium the m-type agents mostly work as managers (except for low p values when some of them opt to be scientists but earn the same wage as the other m-types who have become managers). On the other hand, in equilibrium the s-type agents mostly work as scientists (except for high p values when some of them opt to be managers and earn higher wages than the other s-types who have become scientists). As is obvious from figure 5, for all values of

p_t, the managers always earn at least as much as (and often more than) the scientists . Moreover, while the wage earnings of all m-type agents are always identical irrespective of the occupation that they are engaged in, there could be *intra-group wage inequality* among the s-type people (with some s-type earning a higher income than others, although utility-wise they all are equivalent). In particular, for moderate to high p_t values, wage inequality appears endogenously in our model even though there is no market imperfection or technological indivisibilities.

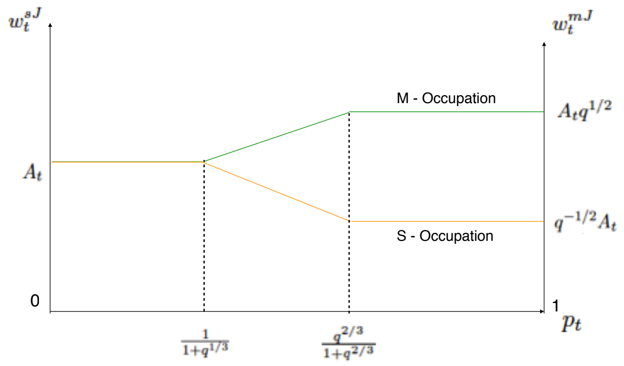

Figure 5: Actual Incomes

In characterizing the general equilibrium solution in this section, we have of course taken p_t (and A_t) as given. It is conceivable that as p_t changes over time, these wage rates also change and in the long run they converge. Alternatively, p_t might tend to 0 or 1, such that in the long run the entire population become homogenous in terms of culture. Whether such economic or cultural convergence happens or not depends crucially on the p_t dynamics which we turn to next.

5 Population Dynamics

The proportion of the motivated agents in the total population (p_t) changes over time depending on the time and effort spent by parents of either type in socializing their respective children. Note that the type s population in period $t+1$ would consist three sets of people: (a) children of the s type who have picked up their parental trait either to the direct socialization effort made by their parents; (b) children of the s type who have picked up their parental trait indirectly by interacting with the larger population; and (c) children of the m type who have picked up a trait different from their parents indirectly by interacting with the larger population. The optimal socialization effort however varies depending on the type and the chosen occupation of the parent. In particular, a parent of type $i \in \{s, m\}$ who is engaged in occupation $J \in \{S, M\}$ would optimally spend τ_t^{iJ} amount of time in socializing, where these optimal values are given by (13), (14), (15) and (16) respectively. Moreover, since the equilibrium wage earnings of all m-types are always identical irrespective of their occupational choice, it implies that $\tau_t^{mS} = \tau_t^{mM}$.

Suppose in equilibrium there are λ_t^s proportion of s-type agents and λ_t^m proportion of m-type agents engaged in the S sector, then the proportion of the s type people in the next time period will be given by

$$p_{t+1} = \overbrace{\left[\tau_t^{sS}\lambda_t^s p_t + \tau_t^{sM}(1-\lambda_t^s)p_t\right]}^{\text{Direct socialization } (s \text{ type})} + \overbrace{\left[(1-\tau_t^{sS})\lambda_t^s p_t + (1-\tau_t^{sM})(1-\lambda_t^s)p_t\right] p_t}^{\text{Indirect socialization } (s \text{ type})}$$
$$+ \underbrace{\left(1-\tau_t^{mJ}\right)(1-p_t)\, p_t}_{\text{Indirect socialization } (m \text{ type})}$$

Substituting for the equilibrium values of τ_t^{iJ}s and λ_t^s for different ranges of p_t, we get the following dynamic equation in p_t :

$$p_{t+1} - p_t = \begin{cases} \frac{A_t}{[\bar{V}]^2} \frac{(1-p_t)^2 - (p_t)^2}{p_t(1-p_t)} & \text{for } 0 \leqslant p_t \leq \frac{1}{1+q^{1/3}} \\ (1-p_t)\, p_t \left[\frac{A_t}{(\bar{V})^2}\right] \left[\frac{\left(\frac{p_t}{1-p_t}\right)^3 q^{1/4}}{p_t^2} - \frac{\left(\frac{1-p_t}{p_t}\right)^3 (1/q)^{1/4}}{(1-p_t)^2}\right] & \text{for } \frac{1}{1+q^{1/3}} \leqslant p_t \leq \frac{q^{1/3}}{1+q^{1/3}} \\ (1-p_t)\, p_t \left[\frac{A_t}{(\bar{V})^2}\right] q^{1/2} \left[\frac{1}{p_t^2} - \frac{1}{(1-p_t)^2} + \frac{q-1}{q(1+q)} \frac{1}{(1-p_t)^2} \left(1 + \left(\frac{1-p_t}{p_t}\right)^3\right)\right] & \text{for } \frac{q^{1/3}}{1+q^{1/3}} \leqslant p_t \leq 1 \end{cases} \quad (18)$$

Equation (18) is obviously a non-linear equation and multiple steady states are possible. Needless to say, this dynamic equation is valid only as long as the productivity level A_t is low enough such that at least one set of parents are exerting positive effort in socializing their children. Instead of characterizing the entire dynamic path associated with equation (18) for various parameter configurations, we simply construct an example below which exhibits the possibility of multiple steady states and long run divergence.

We have already seen how optimal socialization effort depends on the income of the parent and size of the parental type in the total population

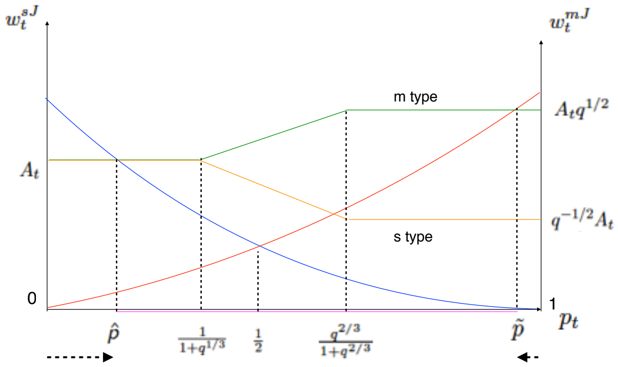

Figure 6: Dynamics

(refer to figure 1). Recall that if the wage rate rises beyond a certain threshold, agents stop socialising their children. Since we have now determined the equilibrium occupation choice of each type and the corresponding equilibrium wage rates, we can compare these values to the threshold wages obtained in section 3, which would immediately tell us which set of parents will exert time and effort to socialize their children and which set of parents will not. To see this we superimpose figure 5 (showing the actual earning in equilibrium) on figure 1 (showing the boundary lines above which parents do not spend time socializing). One such superimposed picture is presented here (figure 6). The actual earnings of course depend on the productivity ratio A_t (although the relative wage ratio, and therefore the optimal occupation choices, do not), which will affect the position of the actual earnings lines. In drawing figure 6 , we have assumed that the parametric conditions are such that (i) $1 < q < 4^{4/3}$ and (ii) $q < \frac{(\bar{V})^2}{A_t} < 4q^{1/2}$.

From figure 6 we can see that as long as A_t remains within the above bounds, an economy which starts with a $p_t < \hat{p}$ converges to $\hat{p}$ while an economy which starts with a $p_t > \tilde{p}$ converges to $\tilde{p}$.[8] In addition to $\hat{p}$ and $\tilde{p}$ (which obviously are steady states), all other p-values lying between

[8]This is because, for any $p_t < \hat{p}$, the actual wage earning of the s-type (the orange line) lies below the relevant threshold (the blue line), while the actual wage earning of the m-type (the green line) lies above the relevant threshold (the red line). Hence only the s-type will exert effort in socialization and p_t will increase until $\hat{p}$ is reached. Similarly, for any $p_t > \tilde{p}$, only the m-type will exert effort in socialization and p_t will decrease until $\tilde{p}$ is reached.

$\hat{p}$ and $\tilde{p}$ also represent steady state points in the sense that if an economy starts at any p_t lying in between, no parent exerts effort in socializing his child and a child simply picks up a trait randomly from the total population, which means the initial p_t value will perpetuate forever. These steady states may however be associated with different wage ratios $(\frac{w_t^S}{w_t^M})$ and therefore different composition of managerial vis-a-vis scientific inputs $(\frac{M_t}{S_t})$.

Also notice that for sufficiently high value of A_t, the actual earning lines for all types will lie above their respective thresholds, which implies that nobody would actively spend time and effort in socializing his child and the cultural composition of the society would remain constant. This allows us to write the following proposition.

Proposition 1. *Active participation in the cultural transmission process takes place only in economies which are relatively poor and characterized by low productivity. In economies with high productivity, there is no concious attempt at socializing one's child towards any specific cultural trait, which ensues a stable cultural composition of the population.*

6 Productivity Dynamics and Growth

In our analysis so far, we have treated the productivity index A_t as given. However we started with the premise that scientists are the ones who contribute to existing stock of knowledge, which add to the future productivity and augments economic growth. Indeed it was this feature that motivated the s-type agents to become scientists. This would indicate that agents' occupational choice, in particular whether one becomes a scientist or a manager, should influence the future productivity of the economy. In this section we add a simple mechanism whereby the productivity index changes endogenously over time responding to the occupational choice of agents. In particular, we postulate that the growth rate of the productivity index is a positive function of the ratio of scientific inputs vis-a-vis managerial inputs employed in period t. In other words,

$$\frac{A_{t+1} - A_t}{A_t} = g\left(\frac{S_t}{M_t}\right), \; g(0) = 0; \; g' > 0. \tag{19}$$

This equation captures a knowledge spillover mechanism ala Romer (1986). Since the $\frac{S_t}{M_t}$ ratio is always positive in this economy [9], this mechanism generates a process of endogenous growth whereby the productivity index will rise perpetually over time. However, the *rate* at which it rises would depend on the exact $\frac{S_t}{M_t}$ ratio, which in turn depends on p_t.

[9]The production function being Cobb-Douglas, zero employment of any input is necessarily ruled out.

From the general equilibrium solution derived earlier, we know that for the high values of p_t, $\frac{S_t}{M_t} = q$. For intermediate values of p_t, $\frac{S_t}{M_t} = \left(\frac{p_t}{1-p_t}\right)^{3/2} q^{1/2}$. And for low values of p_t, the ratio of $\frac{S_t}{M_t} = 1$, where $q > \left(\frac{p_t}{1-p_t}\right)^{3/2} q^{1/2} > 1$. Hence economies with high p_t will attain higher rate of growth of productivity and therefore higher levels of income. However p_t itself changes over time due to the socialization efforts of parents, and the socialization efforts in turn depend on their income levels. How do these twin process of cultural evolution (p_t-dynamics) and economic growth (A_t-dynamics) interact with each other and what is its long run implication? This is the question that we attempt to address now.

From our analysis of the population dynamics in the previous section, recall that when A_t rises over time, the actual earnings of *all* agents increase, which makes the actual earnings lines in figure 5 shift up. Thus eventually the actual earnings of all agents will rise above their respective thresholds and active socialization would stop. However, in the process, different economies may reach different steady state p values, which may spell out different long run growth rates for these economies.

In this context the specific example discussed in the previous section is again illustrative. The population dynamics in figure 6 point to an interesting scenario where there exists a continuum of steady state p-values lying between $\hat{p}$ and $\tilde{p}$. Now, as A_t rises and the actual income lines shift up, $\hat{p}$ shifts to the left while $\tilde{p}$ shifts to the right. In other words, the continuum of steady state p-values for this economy expands on both sides. Thus the cultural composition of the economy reaches a steady state sooner and the process of socialization stops. However, economies which started with a low initial p reaches a steady state with lower p, while economies which started with a high initial p reaches a steady state with higher p. Since growth rate of the economy depends positively on p, latter countries will exhibit higher steady state growth. To put it differently, economies which start with very few motivated agents (low p) would end up in a steady state where the rate of growth of output is perpetually low (culture-driven low growth trap).

The possibility of a low growth trap arises in our model because of the following reason. When there are very few public spirited agents in the population to begin with, the relative wage rate for the scientists is initially high. This draws in people of the other type into the profession. Since the other type (being non-motivated towards being a scientist) require a higher wage, the relative earning from being a scientist continues to remain high. Higher wage income discourages the s-type parents to exert effort towrads active socialization and the low population of s-type agents perpetuates, resulting in a trap characterized by few motivated agents and a low rate of economic growth. It is also worth noting that at these steady states with low p, all agents (irrespective of their type) earn exactly the same wage income and there is no wage inequality.

At the same time, the possibility of a high p- high growth virtuous cycle is created by the fact that in the presence of too many public spirited agents, the relative income from being a scientist remains so low that only the motivated ones stay in the profession. (Since they are already motivated to be scientists, they continue to be in the profession despite the wage being low.) At the same time, their wage rate being lower compared to the other type, the s-type agents who work as scientists also spend more time socializing their children, which means the high population of s-type agents perpetuates, resulting in high growth. Notice however that at these steady states with high p, agents who work as scientists earn lower wages than agents who work as managers and the wage inequality persists.

Given the above observations, we may conclude that high levels of growth are associated with high income inequality in the long run and vice versa. In other words, there exists a trade off between economic growth and income inequality.

The findings of this section are summarized in the propositions below.

Proposition

Proposition 2. *There exists parametric cases*[10] *such that a poor (low productivity) economy which starts with a population of few motivated agents in the long run end up in a culture-driven low growth trap. On the other hand, poor economies which begin with a large population of motivated agents in the long run move to a high growth path.*

Notice that in rich (highly productive) economies, cultural transmission mechanism is muted and there is no transitional dynamics. Yet the initial cultural composition matters even in these economies. The rich countries experience perpetual high or low steady state growth depending on the initial size of motivated agents in the total population.

Proposition 3. *There exists a long run trade off between the income inequality and economic growth such that higher economic growth is associated with greater wage inequality.*

Finally, note that since the rate of growth of the productivity is always positive, the income level of agents of either type would keep on increasing in all economies -including the initially poor ones. As the income level rises, at some point it becomes high enough such that parents no longer spend time socializing their children, thereby making the cultural transmission process dormant. Cultural values no longer influence parental decision making process in a tangible way; yet the initial cultural history continues to influence the long run outcome of the economy.

[10] In particular, $q < \frac{(\bar{V})^2}{A} < 4q^{1/2}$ and $1 < q < 4^{4/3}$

Proposition 4. *Cultural transmission ceases to play a significant role in any economy in the long run; yet culture matters in the long run.*

7 Conclusion

The bidirectional relation between culture and the economy has been well documented in the literature. Earlier studies had assumed culture to be exogenously determined. More recently some studies have looked at endogenous evolution of cultural traits through various cultural transmission mechanisms. In our paper we consider one of such mechanisms and interact this process of culture with the market forces. We have shown that in the long run, there exists a possibility of culture-driven low growth trap, whereby an economy may experience lower long run growth purely due to its initial cultural composition. We also show the high growth is associated with higher inequality, thereby pointing towards a trade off between inequality and growth.

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