Culture as Organizational Capital in Economic Growth

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December 7, 2003

Abstract

Recent economic growth theory has suggested that wealth differences across nations must be due, at least in part, to the failure in many places to adopt existing production techniques. There are many potential reasons for the failure to adopt existing technology, including the political clout of those currently using or earning rents from inferior technologies. There are other reasons as well, and we explore one of them here that is based on a concept that we call *basic culture*. Basic culture is defined to be a learnable skill, just like other skills, but has value to its holder only if participating with a group of individuals who have acquired the same culture. Once this concept is formalized, we explore a number of implications including: (1) the possibility that individuals might choose to join a group (or firm) that uses an inferior technology because the members of that group have a more similar culture, (2) old members of a society might wish to impose cultural training on their young, training which is contrary to the long-term interests of the young, (3) a large group may choose to divide itself into distinct groups, even if the division requires the use of an inferior technology, and (4) technology adopted from a foreign firm can cause a cultural switch that harms the country.

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> Without an understanding of the political economy of technological change, then, the historical development of economic growth will remain a mystery. (Joel Mokyr, 2002, p. 221)

> Culture can be a brake, but cars with their handbrakes on can move, if at a slower speed, and doing so for a prolonged time does wear the brake down. Perhaps that is as much as we will ever be able to say about the deeper cultural roots of economic growth. (Joel Mokyr, 2002, pp. 251–2)

1 Introduction

According to recent arguments by Parente and Prescott (1994, 1999, 2000), a substantial portion of the differences in wealth levels across the world can be attributed to the failure of some countries or groups within countries to adopt existing technologies. This proposition has profound implications for global poverty alleviation and development, since it points to policies that are both tractable and economically feasible. It also suggests that the economic consequences of the political power of interest groups may be more severe than is traditionally believed.

The Parente-Prescott argument has two essential components. The first is to quantify the magnitude of adoption barriers that must exist in order to explain existing income differences. The second is to explain why such barriers exist in the first place. For the second component, they suggest a mechanism that is based on the monopoly position of some workers. In essence, when the monopoly rents at stake are sufficiently high, a group of workers may choose to not adopt a new technology, and may be inclined instead to erect barriers to technology adoption through the legal or regulatory apparatus.

In this paper we develop an explanation for the second component of the Parente-Prescott thesis that is based on a concept that we call *basic culture*, rather than on monopoly rents. We provide a tractable definition of basic culture and then explore some of its implications. Our specific goal is to demonstrate various ways in which conflict over cultural differences can motivate the desire to prevent technology from being adopted.

The suggestion that culture and economic development can conflict with each other is by no means new. Producing a formal model of this conflict, however, is not trivial. Defining culture is not easy either. The anthropologists Kroeber and Kluckhohn (1952) provide six distinct categories of definitions and multiple definitions within each category.

The properties that we attempt to capture in our notion of basic culture are the following:

1. It is learnable with time, effort and resources. It is behavior that is not purely instinctive.

2. More is better. A broad vocabulary (of words or art) is better than a narrow one.

3. There can be more than one. While each may be equally valuable in its own right, they may be incompatible with each other, like two distinct languages.

4. It is a social skill. It is of value to a group when all members possess the same one. Like language, its value derives from interaction with other people who have acquired the same skill.

5. It is distinct from technology. Technology is a means of transforming a given mass of labor and quantity of materials into some quantity of outputs. Basic culture is a vehicle for transforming a group of people into a quantity of labor.

The last item, which might be disputed by anthropologists, requires emphasis and clarification. It is common to refer to methods of food preparation and related tasks as a mark of a culture. We believe that such methods are better thought of as technology, since they involve a productive process.

Basic culture and technology are conceptually distinct, but not functionally divorced. The statement that culture facilitates the ability of people to work together implicitly assumes the desirability of people working together. Two merged groups of people must be able to accomplish more together than the sum of each group acting alone; there must be value in size. A recurring theme in the examples below is that a larger group of individuals may have access to a superior technology than a smaller group does. In so far as cultural compatibility contributes to the formation of larger groups, culture can contribute to the adoption of superior technology. Conversely, cultural incompatibility can reduce the access to better technologies and adversely affect the income status of a person or group.

The expression *basic culture* is used because we do not treat such issues that might be called *high culture*, such as drama, painting and music, or *cultural institutions* such as political or educational systems, or *cultural traditions* such as marriage. In our usage, *basic culture* is fundamentally about the capacity of individuals to interact constructively. (We abbreviate *basic culture* to *culture* below for ease of exposition.)

The formal definition of a basic culture is a vector in an N_a–dimensional Euclidean space. Each component of the vector is a distinct culture. A person can learn one or more of these in the same way that other skills are learned, through time and effort and perhaps with the support of schools. Also, learning multiple cultures will reduce the time and resources available for expanding the knowledge of the primary culture, if there is one. The culture of each individual, after cultural learning is an N_a–vector. This vector multiplied by a skill-hour term gives a labor unit for an individual. The labor vector for a group (or firm) is the sum of these labor units for all of its members. The quantity of labor is the norm of this labor vector.

For a given set of skill-hour contributions, the labor quantity is greatest when the culture vectors are parallel. Cultural compatibility is reflected by the extent of the alignment of the culture vectors. Incompatibility is reflected by orthogonal vectors. If an atomless individual has learned nothing but the first culture (putting zeroes in all but the first entry of his N_a–vector) joins a group whose members have learned nothing but the second culture (putting zeroes in all but the second entry of their N_a–vector), then the marginal contribution of that individual to the group is zero.

The remainder of the paper is organized as follows. The next section expands on the concept of culture and reviews some of the related literature. Section 3 provides a formal description of the model. Section 4 analyzes a two-group two-culture version in which individuals indirectly support an inferior technology by choosing to join a group that uses this technology. The key factor is that cultural compatibility trumps technological inferiority. Section 5 extends section 4 and studies what effect culture learning that is imposed on the young has on later behavior of those individuals regarding further cultural adoption and choice of skills and work groups. Section 6 shows that inferior technology might be used because one large group finds its desirable to split into two smaller groups, and each smaller group must use an inferior technology due to the smaller size. Section 7 adds a government sector, which all of society participates in, and an employment offer from a large foreign firm. Working for the foreign firm requires adoption of some of the foreign culture. The diversion of some learning toward the foreign culture reduces the cultural uniformity and that reduces the productive capacity of the government sector and harms all of society. Section 8 concludes. The appendix considers some of the properties of the definition of basic culture.

2 Literature

Not too long ago, to mention economics and culture in the same sentence required, if not an apology, then an explanation. A good example is Haskell and Teichgraeber (1996), where, on the first page of a collection of essays entitled *The Culture of the Market,* the editors point out that

> There is one intellectual tradition, unfashionable today among academics but possessed of greater staying power than meets the eye, that understands true culture to embrace only the priceless, only that which is (or ought to be) immune from the tawdry calculations of least cost and maximum utility that notoriously prevail in the marketplace. [...] To anyone firmly wedded to that conception of culture, our title can only be puzzling, for it would seem unnaturally to couple domains of human existence that are mutually exclusive.

There are many ways in which culture and the economy interact. One is in the means by which the economy sustains culture. This subject is reviewed in Heilbrun and Gray (2001), Throsby (2001), Caves (2000), and Cowen (1998, 2002). Social structures are often transformed by technological evolution, as reflected by Mokyr (2002, p. 237) who writes

> [In addition to altering rents going to specific skills,] technological change altered the non-pecuniary characteristics of labor. It created and destroyed labor hierarchies, it changed the physical work environment, and it increased and decreased the advantages of domestic production where workers were in control of their own schedule.

Recent attempts to study culture as an economic choice variable include Fryer (2002) and Fryer and Jackson (2003), who treat cultural behavior as a signalling device, and Kuran and Sandholm (2003) who consider competing motives to hold to or switch cultures and investigate whether convergence to a given culture will occur. Their model may have some bearing on the question posed by Mokyr (2002, p. 250) as to whether "Eric Jones (1995) who argues that culture is largely endogenous and adjusts itself to circumstances" is correct or "David Landes (1998) for whom culture is destiny" is right (or some middle ground is valid). In the model of Kuran and Sandholm (2003), like ours, an incentive can arise for some groups to thwart the natural evolution of culture. Our paper is different from theirs because of our emphasis on the adoption of technology rather than just of culture, and in our definition of culture.

Lazear (1999) equates culture with language, which allows him to study the adoption of culture through the choices made by recent immigrants in the U.S. on the decision to learn English. He finds that a low concentration of compatriots is associated with a higher likelihood of learning English, and this evidence suggests that economic forces can guide the choice of culture adoption.

Krusell and Ríos-Rull (1996) and others study the manner in which economic incentives to block technological adoption might be translated into political forces that implement those forces. This is an important aspect of the story that we do not explore.

Other authors have investigated detailed models of social interactions in which individuals choose social/cultural characteristics. Examples include Cole, Mailath, and Postlewaite (1992, 1998), Greif (1993, 1994), Mailath and Postlewaite (2002, 2003), Fang (2001), and Okuno-Fujiwara (2002), among others. In this literature the notion of social capital receives attention; for a critique of social capital see Sobel (2002). We do not follow this literature in order to keep our model focused on the culture/technology question.

In the model that we consider the next section the main emphasis is on the definition of basic culture and the relationship of the adoption of culture and the adoption of technology. In the analysis, the compatibility of the culture within a group is central. This suggests the need for a general theory of group formation and group entry. Ellickson, Grodal, Scotchmer and Zame (2003) provide a framework in which some of these issues are made explicit. Quite possibly, our model can be treated as a special case or an extension of theirs; this is a question for further research.

3 A model of basic culture

Our concept of basic culture requires individuals, who acquire the culture, and firms or groups whose transformation of labor into output depends on the culture of its members. Physical capital and all types of assets are excluded for simplicity. Consumption of any individual i is the current wage of that individual.

Basic culture is a learnable skill. There are N_a cultures that any individual can learn. An individual can learn some or none of each of these. Basic culture for individual i is an N_a-dimensional real vector denoted by a^i. An individual can also acquire skill s^i, which is a real number. The initial levels of basic culture and the skill will often be zero, but sometimes positive.

Individual i will supply labor time h^i_γ to group γ. A group is a productive entity, that is formally organized, like a firm, or informally organized, like Silicon Valley. The labor time supplied to group γ by individual i is the product of culture, a^i, skill, s^i and labor time h^i_γ. This product is an element of $\mathbb{R}^{N_a}$.

The labor quantity for group γ is the norm of the sum of the labor contributions of all members in the group. The set of members for group γ is denoted by S_γ. The labor vector for group γ is

$$\tilde{L}_\gamma = \sum_{i \in S_\gamma} a^i s^i h^i_\gamma \in \mathbb{R}^{N_a}_+. \tag{1}$$

The labor quantity is the norm of the labor vector, or

$$L_\gamma = \|\tilde{L}_\gamma\|, \tag{2}$$

where

$$\|\tilde{L}_\gamma\| = \left[\sum_{n=1}^{N_a} \tilde{L}^2_{\gamma,n}\right]^{1/2}. \tag{3}$$

3.1 Production and wages

Output is a function f_j of labor input L_γ and the technology utilized, the value for which is denoted by θ_γ. Output of the consumption good, y_j, is

$$y_j = f_j(L_\gamma, \theta_\gamma) = \theta_\gamma L_\gamma. \tag{4}$$

The wage income of individual i with culture vector $a^i \in \mathbb{R}^{N_a}$ and with skill-hour $x^i = s^i h^i_\gamma$ arbitrarily close to zero is

$$w^i_\gamma = \frac{\partial f_j}{\partial x^i} = \theta_\gamma \frac{\partial \|\tilde{L}_\gamma + x a^i\|}{\partial x}. \tag{5}$$

Since

$$\frac{\partial \|\tilde{L}_\gamma + x a^i\|}{\partial x} = \lim_{x \to 0} \frac{1}{2} (\sum_{n=1}^{N_a} (\tilde{L}_{\gamma,n} + x a^i_n)^2)^{-1/2} (2) \sum_{n=1}^{N_a} (\tilde{L}_{\gamma,n} + x a^i_n) a^i_n = \frac{\tilde{L}_\gamma \cdot a^i}{\|\tilde{L}_\gamma\|},$$

where the last equation uses the standard dot product, the per skill-hour wage rate is

$$w^i_\gamma = \theta_\gamma \frac{\tilde{L}_\gamma \cdot a^i}{\|\tilde{L}_\gamma\|}. \tag{6}$$

Equation (6) states that the wage that individual i obtains depends on both the technology used by the group γ and on the extent of correlation between the culture of individual i and the group γ. An individual might choose to join a group that uses an inferior technology if the culture of the group using the inferior technology is sufficiently more similar to that of the individual than that of a group using a superior technology. This fact is demonstrated momentarily.

3.2 The individual's optimization problem

Individual i is born at date t_i and has lifespan equal to T, which is a finite number. Individuals value consumption and leisure. For convenience, discounting of the future is ruled out. Time is allocated among leisure, l_t^i, learning time for the various cultures, skill acquisition and work hours. Learning time of i for culture n is $\lambda_{n,t}^i$, for $n = 1, 2, \ldots, N_a$. Learning time for the skill is Λ_t^i. The time endowment at each moment is 1. G is the set of groups that are available to work for. It is possible (and likely) that any given individual will choose to work with only one such group. The $A_{n,t}$ are parameters indicating the level of academic facilities that are available for each culture. $A_{0,t}$ is an indicator of facilities for learning the skill. The $A_{n,t}$ could be choice variables for society, reflecting school subsidies, although that possibility is not pursued here.

Individual i maximizes

$$U^i = \int_{t_i}^{t_i+T} u(c_t^i, l_t^i)dt \tag{7}$$

subject to the income and spending constraint,

$$c_t^i = \sum_{\gamma \in G} w_{\gamma,t}^i s_t^i h_{\gamma,t}^i, \tag{8}$$

the time constraint,

$$1 = l_t^i + \sum_{n=1}^{N_a} \lambda_{n,t}^i + \Lambda_t^i + \sum_{\gamma \in G} h_{\gamma,t}^i, \tag{9}$$

cultural learning for each $n = 1, 2, \ldots, N_a$,

$$\dot{a}_{n,t}^i = \lambda_{n,t}^i A_{n,t}, \tag{10}$$

skill learning

$$\dot{s}_t^i = \Lambda_t^i A_{0,t}, \tag{11}$$

and initial levels for a^i and s^i.

3.3 Interpretations

In the framework described in this section, culture has several of the desired features. First, it is something that can be learned. Secondly, more of it is better than less; increasing a^i will raise the contribution of i to potential group γ and hence the earnable wage. Thirdly, the culture is of value only if other members of the same group γ have adopted it. For example, if a group γ has adopted culture $n = 1$ exclusively, and individual i has adopted culture $n = 2$ exclusively, then $\tilde{L}_\gamma = (x, 0, \ldots, 0)$ for some $x > 0$, and $a^i = (0, y, 0, \ldots, 0)$ for some $y > 0$. This implies that $\tilde{L}_\gamma \cdot a^i = 0$, and the wage income is zero for i with the group γ.

Some further implications are explored in Appendix 1.

3.4 Technology-specific skill

The above analysis can be extended so that skill is technology specific. Let M_τ denote a set of technologies. Each of these has a technology level θ_τ. Individual i spends time Λ^i_τ learning technology τ and acquires skill level s^i_τ in τ. A group can use only one technology.

The labor vector for group γ is then

$$\tilde{L}_{\gamma,\tau} = \sum_{i \in S_\gamma} a^i s^i_\tau h^i_\gamma \in \mathbb{R}^{N_a}_+, \tag{12}$$

and the labor quantity is again the norm of the labor vector, or

$$L_{\gamma,\tau} = \|\tilde{L}_{\gamma,\tau}\|. \tag{13}$$

Output for group γ is

$$y_j = f_j(L_{\gamma,\tau}, \theta_\tau(\gamma)) = \theta_\tau(\gamma) L_{\gamma,\tau}. \tag{14}$$

The wage is

$$w^i_\gamma = \theta_\tau(\gamma) \frac{\tilde{L}_{\gamma,\tau} \cdot a^i}{\|\tilde{L}_{\gamma,\tau}\|}. \tag{15}$$

The budget constraint conditions for individual i become, for spending,

$$c^i_t = \sum_{\gamma \in G} w^i_{\gamma,t} s^i_t h^i_{\gamma,t}, \tag{16}$$

for time,

$$1 = l_t^i + \sum_{n=1}^{N_a} \lambda_{n,t}^i + \sum_{\tau \in M_\tau} \Lambda_{\tau,t}^i + \sum_{\gamma \in G} h_{\gamma,t}^i, \tag{17}$$

and for skill learning,

$$\dot{s}_{\tau,t}^i = \Lambda_{\tau,t}^i A_{\tau,t}. \tag{18}$$

4 Joining a group

Technology adoption may be divided into two parts. First, a group has to adopt a technology, and secondly some people have to join the group that adopts it. One way to end the use of an inferior technology is to terminate the group that uses it. If the group resists termination, use of an inferior technology can continue. This section explores how culture considerations can enter this decision process and affect which technology is chosen and whether a group using an inferior technology can be sustained.

4.1 Two groups, static case

There are two groups, γ_1 and γ_2. Technology used by γ_1 is τ_1 and has level θ_1, while γ_2 uses τ_2 which has level θ_2. Technology 2 is better: $\theta_2 > \theta_1$.

There are two cultures, so $N_a = 2$. Initially, the members of γ_1 have a preponderance of culture 1. Their initial labor vector is $\tilde{L}_1 = (10, 1)$. The members of γ_2, on the other hand, have a preponderance of culture 2. Their initial labor vector is $\tilde{L}_2 = (1, 10)$. Each group has a unit mass of individuals.

The static decision regards the choice of an atomless individual to select a skill and group to join. (Later, the choice of culture will be explored.)

Individuals live for $T = 3$ time periods, each of length 1. During the first period, culture is learned. During the second, skill is learned, and during the third, the individual works. Individual 1 is born into γ_1 and is forced to learn culture 1 exclusively, the culture that predominates in γ_1. Individual 2 is born into γ_2 and is similarly forced to learn the predominant culture of γ_2, which is culture 2. The learning parameters, $A_{n,t}$ and $A_{\tau,t}$ are all assumed to equal 1. The culture acquired for individual 1 is $a^1 = (1, 0)$ and for individual 2 is $a^2 = (0, 1)$.

The decision for individuals 1 and 2 is which skill to acquire during period 2 of life and which group to join during period 3 of life. Thus, these two individuals have no freedom of choice in their first period of life, but perfect freedom in their remaining two periods of life. In other words, $\lambda_{n,t}$ can only be positive in the first period, $\Lambda_{\tau,t}$ can only be positive in the second period, and $h_{\gamma,t}$ can only be positive in the third period.

These constraints imply that that each individual $i = 1,2$ faces the constraints:

$$s_1^i + s_2^i = 1,$$

and

$$h_{1,t}^i + h_{2,t}^i = 1.$$

If i intends to spend any time working with one group, then any skill learned for the other group is wasted. Hence, each individual will choose to acquire only one skill and will work for exactly one group. The question becomes which one skill to acquire and which group to join.

For individual 1, the wage for learning skill 1 and joining group 1 is

$$w_1^1 = \theta_1 \frac{a^1 \cdot \tilde{L}_1}{\|\tilde{L}_1\|} = \theta_1 \frac{(1,0)\cdot(10,1)}{\|(10,1)\|} = \theta_1 \frac{10}{\sqrt{101}}$$

and for learning skill 2 and joining group 2 is

$$w_2^1 = \theta_2 \frac{a^1 \cdot \tilde{L}_2}{\|\tilde{L}_2\|} = \theta_2 \frac{(1,0)\cdot(1,10)}{\|(1,10)\|} = \theta_2 \frac{1}{\sqrt{101}}.$$

It follows that so long as θ_2 does not exceed θ_1 by a factor of 10, individual 1 will choose to learn skill 1 and join group 1. That is, individual 1 chooses to learn the inferior technology and to join the group that uses it. A similar computation shows that individual 2 will choose technology 2 and will join group 2 that uses it, which is the less paradoxical behavior.

4.2 Two groups, dynamic case

Consider a dynamic variation of the above economy. There are two groups, γ_1 and γ_2, each with mass M. Members of both groups live for $T = 3$ periods. Birth rates and death rates are constant for both groups and the population for each is one. At each instant t a new member is born into each group and will spend the time interval $[t, t+1)$ learning the culture of the group born into, time $[t+1, t+2)$

learning a skill of the individual's choosing, and time $[t+2,t+3]$ working for the group of the individual's choosing.

The members of γ_1 acquire culture $a^1 = (1,0)$. Since one third of the population is working, and they all have culture vector $a^1 = (1,0)$, the labor vector for γ_1 is $L_1 = \frac{M}{3}(1,0)$. For members of γ_2 culture acquired by each young member is $a^2 = (0,1)$, and the labor vector is $L_2 = \frac{M}{3}(0,1)$.

The expected wage for a young individual of γ_1 who intends to learn skill 1 and join γ_1 is

$$w_1^1 = \theta_1 \frac{a^1 \cdot \tilde{L}_1}{\|\tilde{L}_1\|} = \theta_1 \frac{(1,0)\cdot(\frac{M}{3},0)}{\|(\frac{M}{3},0)\|} = \theta_1,$$

and for a young individual of γ_1 who intends to learn skill 2 and join γ_2 the expected wage is

$$w_2^1 = \theta_2 \frac{a^1 \cdot \tilde{L}_2}{\|\tilde{L}_2\|} = \theta_2 \frac{(1,0)\cdot(0,\frac{M}{3})}{\|(0,\frac{M}{3})\|} = 0.$$

For the young member of γ_2, the wage earned after having learned skill 1 and joined γ_1 is

$$w_1^2 = \theta_1 \frac{a^2 \cdot \tilde{L}_1}{\|\tilde{L}_1\|} = \theta_1 \frac{(0,1)\cdot(\frac{M}{3},0)}{\|(\frac{M}{3},0)\|} = 0,$$

and for joining γ_2 the wage is

$$w_2^2 = \theta_2 \frac{a^2 \cdot \tilde{L}_2}{\|\tilde{L}_2\|} = \theta_2 \frac{(0,1)\cdot(0,\frac{M}{3})}{\|(0,\frac{M}{3})\|} = \theta_2.$$

The result is an extreme dichotomy. All young members of γ_1 learn culture 1 (by fiat), learn skill 1 (by choice) and join γ_1 (by choice) and earn wage θ_1. Similarly, all young members of γ_2 learn culture 2, acquire skill 2 and join γ_2 and earn the wage θ_2. This extreme result holds whenever θ_1 and θ_2 are both positive.

4.3 The desire to change the technology

The main point of this example is to illustrate that an inferior technology might be willingly used indefinitely. The key factor is that the young are forced to learn the culture of the home group, and that indoctrination is sufficient to cause them to be inclined later in life to choose the skill type of their home group and to join the home production group and use its inferior technology.

The desire to switch from one technology to a superior one depends on the age of the individual. All individuals of ages 0 to 1 will prefer that γ_1 switches from technology 1 to technology 2, so that a better wage will await them in their later life. Of those between the ages of 1 and 2, some will wish to abandon their learning of skill 1 and switch to skill 2. If γ_2 switches to technology 2 when a member of γ_2 is at age m, then that member will have time $s_2 = 2 - m$ to acquire skill 2, and will earn a wage of $(2-m)\theta_2$, while a non-switch will cause skill 1 to be $s_1 = 1$, and the final wage to be θ_1. A switch is desirable so long as $(2-m)\theta_2 > \theta_1$. That is, so long as the individual is sufficiently young, the switch will be desirable.

For all working individuals, those between the ages of 2 and 3, the switch is not desirable, for it will render all of their skill worthless, and they will henceforth earn zero wage.

In sum, the switch from one technology to a better one will be desirable for the youngest third of the population, none of the oldest third and some of the middle third. The greater the ratio of θ_2 to θ_1, that is, the greater the gain to switching, the more of the middle group that will want to switch.

5 Forced schooling of the young

> Skills and experience are acquired over a lifetime, but the ability to learn new skills declines over the life cycle. Workers beyond the student or apprentice stage can be expected to resist new techniques insofar as innovation makes their skills obsolete and thus irreversibly reduces their expected lifetime earnings. [...] It is of little consolation to an older generation that their children may have no difficulty adjusting to the new regime, mastering the new technique, and thus improving their material standard of living.
>
> Mokyr (2002), 257–258.

5.1 Overview

In the economy of the previous section, people choose a skill to learn and group to join. They may choose to acquire the skill for an inferior technology and join a group that uses it if their own culture is sufficiently similar to that of the group using the inferior technology. This section extends the argument to the case in which the choice of culture is partly endogenous.

Individuals live for $T = 3$ periods. In the first period, they acquire culture. In the second period they acquire a technology-specific skill. In the third period they work.

The first time period for the young is divided between two segments. The first T_a units of time are controlled by the elders. The remaining $T_b = 1 - T_a$ units of time are chosen by the individual. Once individuals reach age T_a, they are free to learn whatever culture they see fit, but not before that.

The world is again divided into two groups, γ_1 and γ_2. There are two cultures, so $N_a = 2$, and there are two technologies whose levels are θ_1 and θ_2. As before, technology 2 is better, so $\theta_2 > \theta_1$.

The two groups have a constant birth rate, death rate and constant population equal to 3 (one unit acquiring basic culture, one unit acquiring skill and one unit working).

Initially all members of γ_1 have culture 1 exclusively, acquire skill for technology 1 and work in γ_1, while all members of γ_2 acquire culture 2 exclusively, skill for technology 2 and work for γ_2. There is nothing particularly interesting about the members of γ_2 who use the best technology available. We focus on the decision making of members of γ_1 to see if they would continue to acquire skill for and work with the group that uses the inferior technology, or if they would switch culture and group.

Recall that culture n for individual i grows at rate

$$\dot{a}^i_{n,t} = A_{n,t}\lambda^i_n,$$

where $A_{n,t}$ is the schooling parameter. Here these parameters are set as constants, A_1 and A_2.

Skill grows at rate

$$\dot{s}^i_{\tau,t} = A_{\tau,t}\Lambda^i_{\tau,t},$$

The schooling parameters are set to one: $A_{\tau,t} = 1$.

It follows that a member i of γ_1 that spends all time in the first period learning culture 1, and all time in the second period learning skill for technology 1, will have culture vector $a^i = (A_1, 0)$, and skill $s^i_1 = 1$ and $s^i_2 = 0$. If all members of γ_1 have done this in the past, the labor vector for γ_1 will be $\tilde{L}_{\gamma_1} = (A_1, 0)$. The wage for this individual is

$$w^i_1(\gamma_1) = \theta_1 \frac{a^i \cdot \tilde{L}_{\gamma_1}}{\|\tilde{L}_{\gamma_1}\|} = \theta_1 \frac{(A_1, 0) \cdot (A_1, 0)}{\|(A_1, 0)\|} = \theta_1 A_1. \tag{19}$$

If individual i spends the first T_a units of time learning culture 1, but then switches and commits the remaining T_b units of the first period to culture 2, and all of the second period learning the skill for technology 2, then the resulting culture vector will be $a^i = (A_1 T_a, A_2 T_b)$. The labor vector for γ_2 is $\tilde{L}_{\gamma_2} = (0, A_2)$. The wage for the individual that switches from γ_1 to γ_2 at age T_a is therefore

$$w_1^i(\gamma_2) = \theta_2 \frac{a^i \cdot \tilde{L}_{\gamma_2}}{\|\tilde{L}_{\gamma_2}\|} = \theta_2 \frac{(A_1 T_a, A_2 T_b) \cdot (0, A_2)}{\|(0, A_2)\|} = \theta_2 A_2 T_b = \theta_2 A_2 (1 - T_a). \quad (20)$$

The following proposition follows immediately.

Proposition 5.1 *If $1 - T_a < \frac{\theta_1 A_1}{\theta_2 A_2}$, then individuals in γ_1 will choose to continue to acquire the skill for technology 1 and work in γ_1. The groups γ_1 and γ_2 will both be sustainable, with each using their respective technology and with no member of either group who is old enough to be able to switch wanting to switch.*

This proposition has several implications. A group can preserve itself by:

1. Forcing its young to learn the domestic culture up until a fixed age. This age will rise as the alternative technology becomes relatively better.

2. Improving the schooling of the domestic culture; raising A_1.

3. Undermining the schooling of the foreign culture; reducing A_2.

These results are related to those of Kuran and Sandholm (2003), who study culture as choice variable and consider when convergence might occur or not. Since their model is very different from ours, a direct comparison is difficult.

It should be noted that the above model needs to be modified in some way to ensure that someone would want to preserve group 1. One such alteration is to assume that the use of the technology 1 requires a minimum labor force. When sufficiently many of the young switch away, the old suffer as result.

6 Merging versus trading

A common theme in the study of culture is the capacity of people to work together; having a common culture allows people to work effectively together, while having different cultures can make it difficult to work together. Implicit in such a discussion is the assumption that there is value in having people work together, that a large group of people acting collectively is more potent than many smaller groups acting independently are, even if the total number of individuals is the same for both cases.

In this section, we examine a situation in which it is assumed that larger groups are better than smaller ones because they have access to better technologies. A group can access a superior technology only when the quantity of its labor input exceeds a given threshold level.

A large group composed of two subgroups with incompatible cultures faces a dilemma. If it works as a whole, then cultural frictions can affect it adversely. If it works as two separate units, then it will not have access to the best technology. In effect, when the large group chooses to operate as two separate subgroups, it is choosing to not use the best technology available. This section demonstrates how this phenomenon can happen. It also suggests a new motive for trade: the exchange of productive inputs allows culturally different people to not have to work together, even though they are engaged effectively in joint production.

6.1 The production process

There are three intermediate goods, x_0, x_1, and x_2, and one final consumption good, y. Intermediate goods x_1 and x_2 are needed to produce the consumption good y. The goods x_1 and x_2 can be produced directly or from good x_0. Specifically,

$$y = \min\{x_1, x_2\}, \quad x_0 = f_0(L_0), \quad x_1 = f_1(L_1), \quad \text{and} \quad x_2 = f_2(L_2).$$

Production of x_1 and x_2 when x_0 is used satisfies:

$$x_1 + x_2 \leq x_0. \tag{21}$$

The functions f_j all satisfy

$$f_j(L_j) = \begin{cases} \theta_1 L_j & \text{if } 0 \leq L_j < \bar{L}, \\ \theta_2 L_j & \text{if } \bar{L} \leq L_j, \end{cases}$$

where $\theta_2 > \theta_1$.

The intermediate good x_1 might be thought of as motors, x_2 as chassis, and y as cars. Firms that produce motors use production function f_1, those that produce chassis use f_2, and those that produce motors, chassis and cars simultaneously use f_0.

The threshold effect implies that in the absence of culture effects it is always best to use f_0. To see this, let $\theta(L) = \theta_1$ if $0 \leq L < \bar{L}$ and θ_2 if $\bar{L} \leq L$ so that $f_j(L_j) = \theta(L_j)L_j$. If there is one culture, then an initial labor quantity L_0 can be divided equally between L_1 and L_2, so that $L_0 = 2L_1 = 2L_2$. Total output of y using f_0 is $y_0 = \frac{1}{2} f_0(L_0) = \frac{1}{2}\theta(L_0)L_0 = \frac{1}{2}\theta(L_0)2L_1 = \theta(L_0)L_1$. Using the functions f_1 and f_2 gives output $y_1 = x_1 = x_2 = \theta(L_1)L_1$. Since $\theta(L_0) \geq \theta(L_1)$, $y_0 \geq y_1$.

When cultural differences are not an issue, joint production is best because it gives access to the best possible technology. When culture is a factor, the large group may choose to subdivide and thereby forego the best possible technology. It may choose a substandard technology.

The following proposition gives a case in which a large group of L_0 individuals could use a superior technology but chooses to subdivide into two equal groups that each use the inferior technology. In this economy skill and culture are fixed *a priori*. Skill is equal to one for all individuals. The only choice is whether to work as a large group using a superior technology or separately using an inferior one.

A group with L_0 individuals has $L_1 = \frac{1}{2}L_0$ members that have culture $a^1 = (1,0)$ and $L_2 = \frac{1}{2}L_0$ members that have culture $a^2 = (0,1)$. The threshold labor level is $\bar{L} = 100$, and $1 = \theta_1 < \theta_2 < \sqrt{2} \approx 1.41$.

Proposition 6.1 (a) *The group will partition itself two separate production units, with one unit producing x_1 and the other producing x_2. This is true regardless of the size of L_0.* (b) *If* $100\sqrt{2} < L_0 < 200$, *then the partition will occur despite the unified group having access to* θ_2 *and the divided units only having access to* θ_1.

Proof. If $L_0 < 200$, then $L_1 = L_2 < 100 = \bar{L}$, so the divided subgroups must use the inferior technology. Joint production uses the labor vector $\tilde{L}_u = L_1a^1 + L_2a^2 = (\frac{L_0}{2}, \frac{L_0}{2})$, giving labor quantity $L_u = \|\tilde{L}_u\| = \|(\frac{L_0}{2}, \frac{L_0}{2})\| = \frac{\sqrt{2}}{2}L_0$. This implies that $L_u = \frac{\sqrt{2}}{2}L_0 > \frac{\sqrt{2}\sqrt{2}}{2}100 = \bar{L}$, so the unified group will be able to use θ_2. Output for the unified group is $y_u = \frac{x_0}{2} = \frac{\theta_2 L_u}{2} = \frac{\theta_2\sqrt{2}L_0}{4} < \frac{\sqrt{2}\sqrt{2}L_0}{4} = \frac{L_0}{2}$. The divided groups will use $\theta(\gamma_1)$, which will equal either θ_1 or θ_2. Total output for the group when it is divided into two groups is $y_D = x_1 = x_2 = \theta(\gamma_1)L_1 = \theta(\gamma_1)\frac{L_0}{2} \geq \frac{L_0}{2}$, that is, $y_u < y_D$. Thus, total output is higher when the group is divided into two than when the group is unified. ■

In this economy trade serves a distinct purpose: it allows the world economy to partition itself into groups of individuals that have a similar culture. Rather than working together, it is better in this economy to work separately and exchange intermediate goods. This seems to correspond to the behavior of the Korean company Hyundai, that did not join with firms in neighboring Japan, but rather formed its unified car production and purchased motors (and motor licenses) from Japanese companies.

7 Harmful foreign cultural influence

> Furthermore, technologically backward societies are at times reluctant to import superior technology. The foreign technology is resented because of fears — often not unfounded — that it will be accompanied by foreign political domination or cultural influence.
>
> (Joel Mokyr, 2002, p. 241)

The above quote from Joel Mokyr suggests that nations may resist new technologies because of possible accompanying cultural changes. This section develops one mechanism by which this can happen. Technology is introduced via a foreign firm with a foreign culture, the domestic culture is altered and the domestic economy suffers as a result.

The production function of the previous sections is modified to include a government sector. Government output contributes to private production. We interpret the government sector as providing trading facilities, contract enforcement and social stability, all of which contribute to the production of the private goods.

The production of the government good has the same dependence on cultural compatibility as private production. For a given number of workers and skill, government output is higher when culture is more similar among those workers. If some workers alter the culture they acquire in order to accommodate a foreign firm, they will reduce the overall productivity of the government.

The key factor in the mechanism here is that everyone works in two groups, during the day for a goods producer, and at night for the government. Working for the government might be thought of as the one hour that each person spends each night reading the newspaper and following public affairs. The public is a grand monitoring agency. Government production also requires tax revenue, which might be thought of as covering the government staffing cost.

7.1 A small country model

A small country with N individuals operates in large world with a large number of individuals. In the small country, three sectors may operate: a domestic private goods sector, a foreign private goods sector, and a government sector. The output in the domestic private sector is denoted by y_D, in the foreign private sector by y_F, and in the government by g. The per capita amount of government output is a positive externality in private production in all sectors.

The world has two cultures, 1 and 2. The learning parameters are $A_n = 1$ for all n. Individuals live for $T = 3$ periods. All N individuals in the country learn culture 1 during the first period of their life. In the second period of life, a subset of N_1 individuals, who are called *talented*, are able to learn the second culture. By the end of the second period of their life, their culture level is $a^i = (2,0)$ if they continue to learn their domestic culture and $a^i = (1,1)$ if they devote the second half of their learning to the foreign culture. The remaining $N_2 = N - N_1$ individuals, called *non-talented,* are unable to learn the foreign culture and end up with $a^i = (2,0)$.

In the third period of life, each individual supplies 1 unit of labor during the day and 1 unit of labor during the night. Skill levels are equal to one in all cases.

The set of individuals working in the domestic sector is denoted by S_D, in the foreign sector by S_F and in the government sector by $S_D \cup S_F$ because all workers also work for the government.

The labor vectors are for the domestic sector,

$$\tilde{L}_D = \sum_{i \in S_D} a^i = (N_D, 0), \tag{22}$$

for the foreign sector,

$$\tilde{L}_F = \sum_{i \in S_F} a^i = (N_F, N_F), \tag{23}$$

and for the government sector

$$\tilde{L}_G = \sum_{i \in S_F \cup S_F} a^i = (N_D + N_F, N_F). \tag{24}$$

The labor quantity in the domestic sector is the norm of L_D, or

$$L_D = \|\tilde{L}_D\| = \|N_D(2,0)\| = 2N_D. \tag{25}$$

Output in the domestic sector is

$$y_D = \theta_D L_D \frac{g}{N} = 2\theta_D N_D \frac{g}{N}. \tag{26}$$

Output in the foreign sector depends on the culture of the foreign firm, $L_A = (0, M)$. Specifically,

$$y_F = \theta_F \frac{\tilde{L}_F \cdot L_A}{\|L_A\|} \frac{g}{N} = \theta_F \frac{N_F(1,1)\cdot(0,M)}{\|(0,M)\|} \frac{g}{N} = \theta_F N_F \frac{g}{N}. \tag{27}$$

The government raises tax revenue T. Government labor quantity is

$$L_G = \|\tilde{L}_G\| = \|(N_D + N_F, N_F)\|, \tag{28}$$

and government output is

$$g = G(L_G, T, \theta_G) = \theta_G L_G^{\alpha} T^{1-\alpha}. \tag{29}$$

The government can raise tax revenue only through a proportional tax on output, where the tax rate is τ. Tax revenue is therefore,

$$T = \tau(y_D + y_F). \tag{30}$$

The after-tax wage rate in the domestic sector is

$$w_D^{\tau} = (1-\tau)\frac{y_D}{N_D} = 2(1-\tau)\theta_D \frac{g}{N}, \tag{31}$$

and in the foreign sector,

$$w_F^{\tau} = (1-\tau)\frac{y_F}{N_F} = (1-\tau)\theta_F \frac{g}{N}. \tag{32}$$

There is no wage in the government sector. People do not get paid for doing their civic duty of monitoring the government.

It follows immediately from (31) and (32) that if technology is not at least twice as productive in the foreign sector relative to the domestic sector, then no one would work in the foreign sector. But if θ_F is at least twice as high as for the domestic sector, then all talented people will work for the foreign sector.

We assume that the tax rate is set so that the after tax wage rate is as high as possible. The following lemma states what this tax rate is.

Lemma 7.1 *The tax rate that maximizes*

$$W_{Tot}^{\tau} = (1-\tau)(w_D^{\tau} + w_F^{\tau}) \tag{33}$$

is $\tau = 1 - \alpha$.

Proof. Government output equals:

$$g = \theta_G L_G^{\alpha} T^{1-\alpha} = \theta_G L_G^{\alpha}(\tau(y_D + y_F))^{1-\alpha} = \theta_G L_G^{\alpha}(\tau(2\theta_D N_D \frac{g}{N} + \theta_F N_F \frac{g}{N}))^{1-\alpha},$$

from which follows that

$$g = [\theta_G L_G^{\alpha}((2\theta_D \frac{N_D}{N} + \theta_F \frac{N_F}{N}))^{1-\alpha}]^{1/\alpha} \tau^{\frac{1-\alpha}{\alpha}} = M\tau^{\frac{1-\alpha}{\alpha}}, \tag{34}$$

where M is the constant inside the brackets (and exponentiated) in the previous term. The after tax wage is therefore

$$W_{Tot}^{\tau} = (1-\tau)(w_D^{\tau} + w_F^{\tau}) = (1-\tau)(\frac{2\theta_D}{N} + \frac{\theta_F}{N})g = (1-\tau)(\frac{2\theta_D}{N} + \frac{\theta_F}{N})M\tau^{\frac{1-\alpha}{\alpha}}$$

If we take the derivative and set to zero we obtain $\tau = 1-\alpha$. ■

7.2 A numerical specification

To see the impact of government, consider the following specification. Let the number of talented and non-talented individuals be $N_1 = N_2 = 100$. Let $\alpha = 0.9$, so that the optimal tax rate is $\tau = 0.1$. Let $\theta_D = \theta_G = 1$ and consider variations in θ_F according to the chart below. For each foreign technology level, θ_F, the value of g can be computed from (34), and all of the other variables from the above equations.

The following chart gives the steady state values for the output and wage of the three sectors for different (permanent) values of the foreign sector technology.

θ_F	L_G	g	y_D	w_D	y_F	w_F	$y_T = y_D + y_F$
1	400	334.5	669.0	3.345	0	0	669.0
2.01	316	264.4	264.5	2.64	264.5	2.64	528.9
3	316	271.1	271.1	2.71	406.63	4.067	677.7
4	316	276.6	276.6	2.77	555.03	5.55	829.9
10	316	298.8	298.8	2.98	1493.9	14.94	1,792.6

Note that:

1. When θ_F is less than 2 (less than twice the domestic sector), there is no operation in the foreign sector.

2. As soon as the foreign sector technology rises slightly above twice the domestic sector technology, all of the talented people to the foreign sector. The government labor quantity falls as a result, and this hurts the domestic workers. This is the domestic discord caused by the infiltration of the foreign culture.

3. As foreign technology rises, the tax revenue from the foreign sector workers rises to the benefit of the domestic sector workers.

4. Non-talented domestic sector workers here have a strong incentive to resist the opportunity to use the foreign technology offered by the foreign firm.

An extension of this version of the model might ask whether the non-talented in this economy would eventually switch to the foreign sector as well. If there were a complete switch, cultural harmony would again be restored in the government sector, and technology would be used optimally.

8 Conclusion

This paper has developed a notion of basic culture and has applied it in a variety of situations. We have shown that a number of the statements that have been made in casual discourse can given some formal support. In particular, culture and cultural class can be a strong impediment in the evolution of technological progress. Finally, this paper extends and refines the arguments of Parente and Prescott (2000) and others who suggest that technological adoption is an important aspect of economic growth and development. A primary contribution is the demonstration of a wider set of motives that citizens might have for blocking the useful adoption of technology.

Extensions of the paper could involve making the school parameters (the A_n) endogenous. Issues of conflict, in which members of one culture might wish to inflict harm on members of another culture could also be explored.

Appendix

This appendix explores some of the mechanics of the notion of basic culture.

The first point to explore is that of crowding out. In our group setting, it is often the case new entrants make old incumbents worse off. In our setting, resources are not finite, so we do not have that type of problem (although we could of course add it). We do not have an entry price or barrier to entry in a group, even though entry might affect current members. One reason we do not is that we do not want the assumptions that would be required to create such barriers to interfere with the interpretation of the other results. We could add barriers as well.

Nonetheless, new entrants affect current incumbents and it is worth seeing how this effect operates. In Figure 1, the initial group has labor vector $\tilde{L}_\gamma$ (from 0 to x_0). The labor quantity is the distance from the origin to point x, a quantity designated by $\|x_0\|$. The entrants add the vector L^1 to the original. The new total labor quantity is the distance from 0 to point M. The value of labor of the original incumbents is the projection of the old ray onto the new one, which gives the value $\|x_1\|$ as the new labor quantity.

The new quantity, $\|x_1\|$, is lower than the old one, $\|x_0\|$. This is the sense in which the new entrants have crowded out the old.

It might be noted that the effect is rather small $\|x_1\|$ is not that much less than $\|x_0\|$ In Figure 2, we see the effect of a greater number of entrants. The new labor quantity of the original members is $\|x_2\|$. This change is more noticeable than the one from Figure 1.

Generally speaking, people prefer entrants that are similar to themselves. This is not always the case, however. A current member i who is not well aligned with the aggregate may wish for entrants who have a culture vector different from i's. This is shown in Figure 3. The aggregate labor vector is L_γ and an incumbent has labor vector L^i (which is drawn longer than might be appropriate). If new entrants are just like i, then the new labor vector would be the ray OB. However, if people with quite different culture from i, such as those of L^d entered, the new labor vector would be the ray OG. The result is much more favorable to L^i.

Thus, some people might wish to have new entrants who are quite different from themselves. This desire will only arise, however, among people that positive amounts of more than one culture. Monoculturalists will always prefer entrants who are just like themselves.

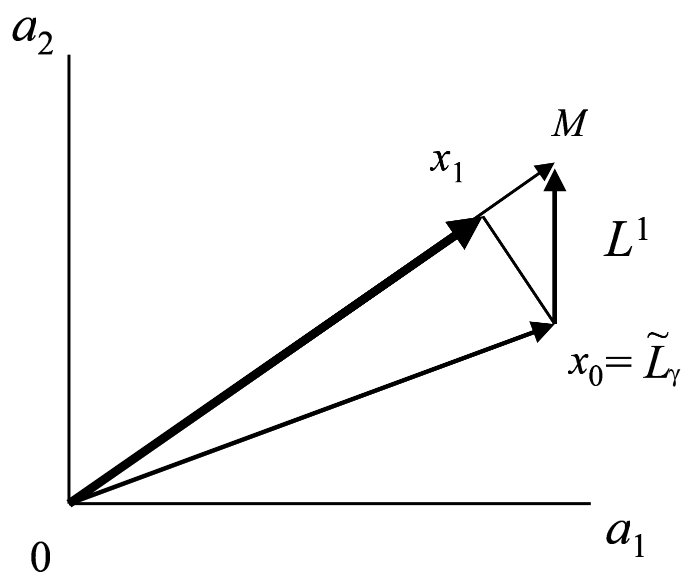

Figure 1: Crowding out. A group begins with labor vector $\tilde{L}_\gamma$, and all members of the group have the same culture. The labor quantity for this group is $\|x_0\|$. A new set of members enters with total labor vector L^1. The new group labor vector is the ray OM. The new labor quantity for members of the original group is $\|x_1\|$, which is slightly less than $\|x_0\|$. The original members suffer a slight diminution of their labor upon the entry of the newcomers, since the newcomers have a different culture.

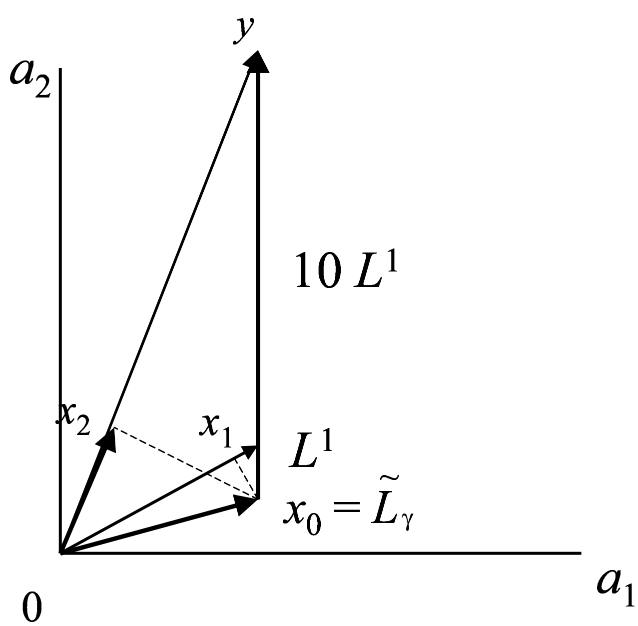

Figure 2: More severe crowding. This continues the story of Figure 1. When a small number of people join the original group, the labor quantity for the original group falls to $\|x_1\|$, which is a mild decrease. When there is a 10-fold increase in the number of entrants with culture vector L^1, the labor quantity for the original group falls to $\|x_2\|$, which is a sharper decrease. The point is that a small number of newcomers with a different culture does not matter, but a large number can impose a more severe reduction on incumbents.

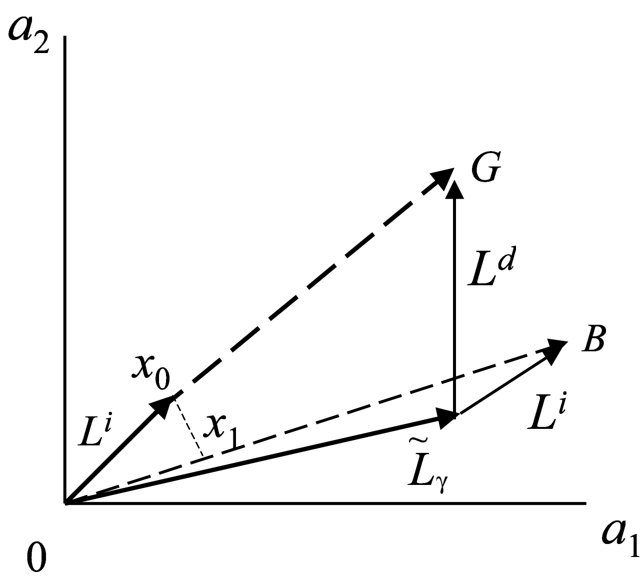

Figure 3: Individual *i* begins with a culture vector L^i. The current group has vector $\tilde{L}_\gamma$. The group can add either a number of people that are similar to *i*, or a group of people with a different culture. Adding the similar people gets the group to point *B*. The labor contribution of *i* is the projection of Li onto ray *OB*, giving labor quantity $0,x_1\|$. Adding the group with labor vector L^d, whose culture is different from *i*, moves the group to point *G*. Labor quantity for *i* in this case is $\|x_0\|$, which is greater than $\|x_1\|$. The point is that multicultural individuals, such as *i*, will often welcome the induction of individuals with a culture vector very different from their own. The same cannot be said of monoculturalists.

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