BILINGUALISM RECONSIDERED

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ABSTRACT

This paper argues that some of the key results of Church and King (1993) are not robust to a generalization of language-learning costs, and that contrary to their findings, the network externality associated with minority language learning justifies its subsidization.

1. INTRODUCTION

Church and Ian King (1993) examine bilingualism in a model of communication technology adoption in the presence of network externalities. Their stated purpose is "to stimulate discussion among economists about the welfare effects of language policies". (p.342). This is a commendable goal. Church and King point out that there are important network externalities associated with second language acquisition and that policy intervention may be necessary to ensure efficiency. Intervention may also be needed to correct a potential coordination failure that can lead to equilibrium learning of the "wrong" second language. They also correctly emphasize that second language acquisition is costly and that the formulation of any policy that encourages bilingualism should explicitly recognize those costs. These are important contributions to the language debate.

Church and King also draw some strong conclusions regarding the efficiency of second language acquisition and appropriate language policy. In particular, they claim that minority language learning is potentially efficient only in the extreme case where "the curvature of the utility function is very pronounced, making the network externality argument for learning more important than the private benefit argument". (p.342). They also draw the explicit policy conclusions that "it is never optimal to subsidize the learning of the minority language [based on the externality argument alone]" (p,342), and that other factors (such as a preference for cultural diversity) are necessary for any argument for minority language subsidies. (p.343, emphasis added).

These are very strong results that could potentially have important implications for language policy in Canada. Moreover, it is likely that certain groups in both French and English Canada will embrace these results and use them in support of their anti-bilingualism stances. It is therefore imperative that the robustness of the Church and King results be carefully examined. This is the purpose of my paper.

I focus on Church and King's assumption of identical second language learning costs across individuals. I relax this assumption and assume instead that learning costs are uniformly distributed across the populations in both native language groups. My main finding is that the Church and King conclusions that I have highlighted in the preceding paragraph are not robust to this generalization.

The rest of my paper is organized as follows. Section 2 outlines my modification to the Church and King model. Section 3 derives necessary and sufficient conditions for efficient minority language learning, and shows that there exists a role for subsidization based on the externality argument alone. Section 4 concludes. An appendix contains all proofs.

2. THE MODEL

The new assumption on learning costs is the only modification I make to the Church and King model. There are two native language groups, E and F. In each group there are a continuum of agents uniformly distributed on the interval $[\underline{c}, \bar{c}]$ according to second language learning cost c. It is assumed, without loss of generality, that $\bar{c} - \underline{c} = 1$. Letting $\underline{c} = \bar{c}$ yields the identical learning cost case examined by Church and King. The mass of native E speakers is e_0 and the mass of native F speakers is $f_0 < e_0$. Thus, F is the minority language. The total population size is $N = e_0 + f_0$. Let s_i be the fraction of native speakers of language *i* who learn a second language. An agent derives utility $v(e_0 + s_F f_0)$ if he knows only E, $v(f_0 + s_E e_0)$ if he knows only F, and $v(N)$ if both languages are known. It is assumed that $v'(.) > 0$ and $v''(.) < 0$.[1]

3. EFFICIENT MINORITY LANGUAGE LEARNING

Church and King consider two notions of efficiency. In the first, which they call "constrained efficiency", the policy-maker cannot restrict second language subsidization to a subset of a native language group. If any agent within a particular group is induced to learn a second language then all agents in that group must learn. The relevance of this notion of efficiency hinges on the assumption of identical learning costs. The idea is that if the policy-maker reduces the private cost of learning then it must be reduced for all agents because agents are identical. This is of course no longer true when agents are heterogeneous with respect to learning costs. The policy-maker can offer subsidized learning to all agents and still only induce learning among the subset of agents whose subsidized cost of learning is low enough to make learning privately worthwhile. There is no reason why the policy-maker cannot induce partial learning within a native language group. This has important implications for the robustness of one of Church and King's strongest results. In particular, they claim that there is no place at all for minority language learning in the constrained efficient solution (regardless of the curvature of the utility function). This result retains no relevance when learning costs are uniformly distributed across agents because in such circumstances "constrained efficiency" is not an appropriate welfare criterion.

The second notion of efficiency that Church and King consider, which they call "first-best", allows the policy-maker "to dictate which individuals within a language group should learn the other language". (p.340). This is clearly the most appropriate notion of efficiency when learning costs are uniformly distributed across agents, and it is this notion of efficiency that I use here. Church and King claim that minority language learning is potentially efficient only in an extreme case where the curvature of the utility function is sufficiently pronounced as to make the network externality effect of learning more important than the private benefit effect. I will show that utility does not have to exhibit pronounced curvature in order for minority language learning to be efficient. In fact, when learning costs are uniformly distributed, minority language learning can be efficient even if utility is linear.

The welfare maximization problem for the policy-maker is:

$$(1) \quad \max_{s_E, s_F} W(s_E, s_F) \equiv s_E e_0 v(N) + (1-s_E) e_0 v(e_0 + s_F f_0) + s_F f_0 v(N) + (1-s_F) f_0 v(f_0 + s_E e_0) - e_0 \int_{\underline{c}}^{c_E} c\,dc - f_0 \int_{\underline{c}}^{c_F} c\,dc$$

$$\text{subject to } s_E \in [0,1] \text{ and } s_F \in [0,1]$$

where c_i, is the learning cost for the marginal agent in the subset of language group i who learn a second language. Since $\bar{c} - \underline{c} = 1$, it follows that $c_i = \underline{c} + s_i$. The above expression for welfare has the following interpretation. The first two terms represent the utility to native E speakers. A fraction s_E of them become bilingual and can therefore communicate with the entire population. The remaining fraction remain unilingual and

[1] These restrictions are needed for the existence of the Nash equilibrium.

can communicate only with E speakers (both native E speakers and bilingual native F speakers). The third and fourth terms are analogous expressions for native F speakers. The last two terms represent the aggregate learning costs to the fraction of native E and F speakers respectively who become bilingual. The maximization problem is to partition the sets of native E speakers and native F speakers according to who should, and who should not learn a second language.

Implicit in the formulation of the problem in (1) is the solution property that if anybody in a language group learns it should be the least cost learners. This is the key to why efficient minority language learning does not require extreme curvature of the utility function. When learning costs are identical across agents, the social cost of second language learning by one more native F speaker is the same as that for a native E speaker, regardless of how many F speakers learn. It is therefore efficient for an E speaker to learn F only if the associated social benefit exceeds that from having one more F speaker learn E. But the private benefit from an E speaker learning F must always be lower (because F is the minority language), and so the social benefit from an E speaker learning F can be greater than that from an F speaker learning E only if the external benefit is significantly greater. This requires extreme concavity of the utility function. In contrast, when the populations are uniformly distributed between low- and high-cost learners, the social cost of second language learning by one more F speaker rises as increasingly higher-cost learners learn. The marginal F speaker who learns E will have a higher learning cost than the lowest-cost E speakers. It can therefore be efficient for some E speakers to learn F even if the marginal social benefit from an E speaker learning F is lower than that from an F speaker learning E, because the net social benefit will be higher. This means that minority language learning can be efficient even without strongly concave utility. I show this by first deriving necessary and sufficient conditions for efficient minority language learning, and then presenting a simple linear example that satisfies these conditions.

In appendix A I show that $s_E^* > 0$ if and only if the following conditions are met:

(2) $$\underline{c} < v(N) - v(f_0) + e_0 v'(e_0)$$

(3) $$v(N) - v(f_0) + e_0 v'(N) < \overline{c}$$

(4) $v(N) - v(e_0 + s_F f_0) + (1 - s_F) f_0 v'(f_0) > \underline{c}$ for s_F such that

$$v(N) - v(f_0) + v'(e_0 + s_F f_0) - \underline{c} - s_F = 0$$

Condition (2) ensures that it is efficient for at least some F speakers to learn E, and condition (3) ensures that it is not efficient for all F speakers to learn E. Thus, conditions (2) and (3) ensure that $s_F^* \in (0,1)$. This is a necessary condition for $s_E^* > 0$. To see this, note that it is pointless (in the context of the model) for any E speakers to learn F if all F speakers are bilingual, and also, that if it is not worthwhile for at least some F speakers to learn the majority language then it cannot be worthwhile for any E speakers to learn the minority language. Condition (4) states that there is a positive net social return from the lowest-cost E speaker learning F at the interior optimum.

To see that these three conditions can be mutually satisfied when v(.) is not strictly concave, consider a linear example. Let $v(x) \equiv x$. Then conditions (2) and (3) become $\underline{c} < 2e_0 < \bar{c}$, and condition (4) becomes $f_0 > \underline{c} / 2(\bar{c} - 2e_0)$. These conditions are mutually consistent in a wide range of circumstances. For example, suppose $2e_0 = \underline{c} + 1/3$. Then a sufficient condition for efficient minority language learning is $f_0 > 3\underline{c}/4$, which is certainly feasible.

Concavity of the utility function is clearly not necessary for efficient minority language learning. However, it turns out that Church and King's notion of "pronounced curvature" of the utility function continues to distinguish an interesting extreme possibility in the case of uniformly distributed learning costs. If v(.) exhibits enough concave curvature then it is possible that the fraction of E speakers who should learn F is greater than the fraction of F speakers who should learn E. (See appendix B). That is, there should be more minority language learning than majority language learning. This is an efficient possibility only when e_0 is not much greater than f_0, and then only when v is sufficiently concave for the external benefit effect to dominate the private benefit effect. However, it cannot be ruled out.[2]

[2] The necessary condition is $-(1-s)Nv''(.)/(2v'(.) > 1$. This is analogous to C&K's $\rho > 1$ condition.

4. THE ROLE FOR SUBSIDIZATION

I have shown that minority language learning can be efficient even when the private benefit of learning the majority language clearly dominates the external benefit of learning the minority language, such as when utility is linear. My remaining task is to demonstrate that there exist circumstances under which the externality associated with minority language learning justifies its subsidization. Consider the pure strategy Nash equilibrium. The best-response functions are:

(5) an E speaker learns F if and only if $v(N) - v(e_0 + \hat{s}_F f_0) > c$

(6) an F speaker learns E if and only if $v(N) - v(f_0 + \hat{s}_E e_0) > c$

where $\hat{s}_i \equiv \hat{c}_i - \underline{c}$ is the equilibrium fraction of language group i who learn a second language, and $\hat{c}_E$ and $\hat{c}_F$ are the values of $c \in [\underline{c}, \overline{c}]$ for which (5) and (6) respectively hold with strict equality where possible. The Nash equilibrium is then given by the solution to the following equations:

(7) $\hat{s}_E = \min[1, \max[v(N) - v(e_0 + \hat{s}_F f_0) - \underline{c}, 0]]$

(8) $\hat{s}_F = \min[1, \max[v(N) - v(f_0 + \hat{s}_E e_0) - \underline{c}, 0]]$

It is not my intention to completely characterize this equilibrium.[3] It is sufficient for my purposes to show that there exist parameter combinations for which minority language learning is efficient but does not occur in equilibrium. Suppose $v(N) - v(e_0) \le \underline{c}$. Then the Nash equilibrium is unique, and in that equilibrium $s_E = 0$. (See appendix C). This parameter case can feasibly coincide with conditions (2) to (4) for efficient minority language learning. This is most easily seen for the case of linear utility, in which case the supposed parameter case is $f_0 \le \underline{c}$. In comparison, recall the earlier linear example in which minority language learning is efficient if $f_0 > 3\underline{c}/4$, which is clearly consistent with $f_0 \le \underline{c}$. There is a clear argument for subsidized minority language learning in such circumstances.

It is important to point out that although I have highlighted the potential for too little minority language learning, the potential for too much minority language learning still exists in my modified model. There are some parameter combinations for which there exist multiple equilibria, and without appropriate coordination policy, the economy can potentially be at the "wrong" equilibrium. I have no argument with Church and King's important insight on this issue.

5. CONCLUSION

In this paper I have argued that subsidized minority language learning can be justified purely on efficiency grounds. This conclusion contrasts sharply with Church and King's claim, derived under a more restrictive assumption on learning costs, that it is never optimal to subsidize minority language learning based on the externality argument alone. I will leave it for the reader to decide which assumption on learning costs is more realistic. The important point to note is that the extreme policy claims made by Church and King are not robust to a highly plausible generalization of their model, and may therefore be seriously misleading.

[3] There are eight different parameter-dependent cases to consider.

APPENDIX

A. Efficient Minority Language Learning

The Kuhn-Tucker conditions for (1) are:

(A1) $\frac{\partial W}{\partial s_i} - \lambda_i \le 0$, $s_i \ge 0$ and $s_i\left[\frac{\partial W}{\partial s_i} - \lambda_i\right] = 0$ for $i = E, F$

and

(A2) $1 - s_i \ge 0$, $\lambda_i \ge 0$ and $\lambda_i(1 - s_i) = 0$ for $i = E, F$

where λ_i is the multiplier on the $s_i \le 1$ constraint, and

(A3) $\frac{\partial W}{\partial s_E} = e_0[v(N) - v(e_0 + s_F f_0) + (1 - s_F) f_0 v'(f_0 + s_E e_0) - \underline{c} - s_E]$

and

(A4) $\frac{\partial W}{\partial s_F} = f_0[v(N) - v(f_0 + s_E e_0) + (1 - s_E) e_0 v'(e_0 + s_F f_0) - \underline{c} - s_F]$

It follows from (A1) and (A2) that $s_F^* \in (0,1)$ is necessary for $s_E^* > 0$. The necessity of the second inequality is obvious. To see that the first inequality is also necessary, note that if $s_E^* > 0$ and $s_F^* = 0$, then $\partial W(0,0)/\partial s_E > 0$ and $\partial W(0,0)/\partial s_F \le 0$. But this implies that $v(N) - v(e_0) + f_0 v'(f_0) > \underline{c}$ and $v(N) - v(f_0) + e_0 v'(e_0) \le \underline{c}$, which cannot be mutually satisfied when $e_0 > f_0$. Thus, $s_F^* \in (0,1)$ is necessary for $s_E^* > 0$. This in turn requires that $\partial W(0,0)/\partial s_F > 0$ and that $\partial W(0,1)/\partial s_F < 0$.[4] The first condition implies $v(N) - v(f_0) + e_0 v'(e_0) > \underline{c}$ and the second condition implies $v(N) - v(f_0) + e_0 v'(N) < \overline{c}$. These are conditions (2) and (3) in the text.

It is then sufficient for $s_E^* > 0$ that $\partial W / \partial s_E > 0$ at a candidate optimum in which $s_F \in (0,1)$ and $s_E = 0$. This is condition (3) in the text.

[4] Note that since $\partial^2 W / \partial s_E \partial s_F < 0$, $\partial W(0,0)/\partial s_F > 0$ is necessary for $\partial W(s_E, 0)/\partial s_F > 0$ for any $s_E > 0$.

B. Efficient Minority Language Learning With Concave Utility

Consider a strictly interior optimum, in which $\partial W / \partial s_E = 0$ and $\partial W / \partial s_F = 0$. Noting that $f_0 = N - e_0$, totally differentiate the first-order conditions to yield:

(B1) $$(1-s_F)\left[v'(N-e_0+s_E e_0)+v'(e_0+s_F(N-e_0))+(1-s_E)(N-e_0)v''(N-e_0+s_E e_0)\right]de_0$$
$$+\left[1-(1-s_F)(N-e_0)v''(N-e_0+s_E e_0)e_0\right]ds_E$$
$$+(N-e_0)\left[v'(N-e_0+s_E e_0)+v'(e_0+s_F(N-e_0))\right]ds_F = 0$$

(B2)
$$(1-s_E)\left[v'(e_0+s_F(N-e_0))+v'(N-e_0+s_E e_0))+(1-s_F)(N-e_0)v''(e_0+s_F(N-e_0))\right]de_0$$
$$-e_0\left[v'(N-e_0+s_E e_0)+v'(e_0+s_F(N-e_0))\right]ds_E$$
$$-\left[1-(1-s_E)(N-e_0)v''(e_0+s_F(N-e_0))\right]ds_F = 0$$

Solving by Cramer's rule and evaluating at $e_0 = N/2$ (where $s_E = s_F = s$) yields:

(B3) $$\left[\frac{ds_E}{de_0}-\frac{ds_F}{de_0}\right]\Bigg|_{e_0 = N/2}$$

$$= \frac{Nv'(((1+s)N/2)(1-s)[2v'((1+s)N/2)+(1-s)v''((1+s)N/2)N]}{H}$$

where H is the determinant of the system, and is negative by the second-order conditions for a maximum. It follows that:

(B4) $$\left[\frac{ds_E}{de_0}-\frac{ds_F}{de_0}\right]\Bigg|_{e_0 = N/2} > 0 \text{ if } -(1-s)Nv''(.)/2v'(.) > 1$$

Thus, if $v(.)$ exhibits sufficient concave curvature then it is possible that $s_E > s_F$ for $e_0 > f_0$.

C. Nash Equilibrium

If $v(N) - v(e_0) \le \underline{c}$ then $\max[0, v(N) - v(e_0 + s_F f_0) - \underline{c}] = 0 \ \forall s_F \ge 0$. It follows from equation (7) that $\hat{s}_E = 0$.

REFERENCES

Church, Jeffrey and Ian King (1993), Bilingualism and Network Externalities, *Canadian Journal of Economics*, 26(2), 336-344.