Tribal Culture and Economic Prosperity

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I. Introduction

Early contact with non-Indians caused American Indian cultures to flourish in some ways and to atrophy in others. Non-Indians supplied steel chisels and paint to the Northwestern tribes for totem pole art, the loom and colored threads to the Southwestern tribes for weaving, and the horse to the Great Plains tribes that transformed buffalo hunting. Non-Indians also brought new diseases, grinding warfare, and brutal subjugation that disrupted and weakened tribal life. After conquest and subjugation in the 18th and 19th centuries, flourishing and atrophying continued in the 20th century when many tribes acquired the English language, elected government, hunting rifles, schools, western medicine, Bibles, rock and roll, powwows, rodeos, drugs, jails, cut-rate stores, store-bought food and clothes, cars, tractors, better roads, big-screen televisions, computers, and desk jobs. However, many tribes in the 20th century also lost their original language, prayers, dances, ceremonies, herbal medicines, religious beliefs, arts, crafts, clans, traditional societies and offices, and older methods of farming and hunting. By force and allure, American culture crowded out many forms of traditional culture.

In the 21st century rapid cultural change will presumably continue, especially through economic development on Indian reservations. Will economic growth in the 21st century erode or augment tribal culture? Will tribal culture retard or promote economic development? This is the two-question of causation, which we ask about American Indian reservations. The paper has three parts. First, we discuss theories of causation relating culture and economy on Indian reservations. Second, for texture and detail, we tell the story of the Hopi language dictionary completed by Emory Sekaquaptewa in 1997. Third, we perform an econometric analysis to

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determine whether income growth and surging casino revenues promote or undermine the speaking of Indian languages, many of which are considered endangered (Crawford 1995).

This research contributes to debate about whether indigenous culture must be sacrificed for economic gain in modern times. A common view, exemplified in a popular book entitled *Ethnicity, Inc.,* is that capitalism, commodification, and economic growth are key threats to indigenous cultures (Comaroff and Comaroff 2009). In particular, some consider reservation gaming a route to cultural destruction (e.g., Mezey 1996), or at minimum a serious threat to cultural purity (e.g., Mika 1995, Cattelino 2013). These views fit within broader claims that trade and capitalism inevitably lead to cultural homogenization and assimilation (e.g., Friedman 2012). Other commentators espouse different views. Miller (2013), for example, predicts that further economic development on reservations, including that arising from casinos, will create time and money surpluses enabling cultural practices to thrive.[2]

The empirical literature on these issues is thin, at least in terms of econometric study. Kuhn and Sweetman (2002) report that indigenous people in Canada whose "mother tongue" is an indigenous language earn lower wages, even when controlling for mastery of French and English. Feir (2016) and Gregg (2018) find that forced assimilation of Native American children through 20th century boarding schools caused higher modern incomes and further economic assimilation, but at the cost of traditional cultural connections in Canada and the United States. Dockery (2010) uses individual-level data from Indigenous Australians to show that a composite measure of "cultural attachment" correlates positively with the probability of employment, educational attainment, and self-assessed health status.[3] Though the author is careful to emphasize the relationship may not be causal, the findings suggest that cultural attachment may not be a hindrance to economic well-being in modern times. This is consistent with Cornell and Kalt (1992), who conclude from case study analysis that it is probably not necessary to stop being tribal or traditional for American Indian reservations to develop economically.[4]

[2] Miller (2013, 160) notes that "I am well aware of the concerns that that economic activities might have negative impacts on Indian cultures and also of the crucial importance of preserving Indian cultures, traditions, ceremonies, and ways of life…My main point on whether economic development can possibly injure tribal cultures is that it raises a false conflict.

[3] The cultural attachment measure combines answers to survey questions about indigenous language use, participation in arts, dances, and ceremonies, and fishing and hunting in groups among other factors.

[4] Cornell and Kalt (1992, 227) discuss and rebut the notion that Native American culture is somehow antithetical to markets and wealth creation and conclude that "evidence suggests that indigenous culture, in and of itself, is not the obstacle to development that it is often portrayed to be."

II. Theory of Tribal Culture and Economic Development

Culture is often described as social rather than individual, local rather than universal, learned rather than instinctive, historical rather than biological, evolved rather than planned, distributed rather than centralized, symbolic rather than literal, significant rather than meaningless, and cultivated rather than coarse. Among scholars, "culture" is a subject in anthropology and sociology ("cultural anthropology" and "cultural sociology") and a model in economics ("corporate culture"[5], "separating equilibria"[6]). Scholars often distinguish between cultural expressions and their foundations. Expressions include such activities as praying, singing, dancing, dressing, dining, building, crafting, and artistry -- the usual media representations of Indians. The foundation includes marrying, child-rearing, socializing, worshipping, governing, and working.

"Culture" can be a word of praise. A "cultured person" is more refined than an uncultured person. In American Indian communities, culture often distinguishes insiders and outsiders. People vigorously debate what is really Hopi (the "Hopi way"), or what is "Indian" and what is "white". Besides affecting pride and human relationships, the debate can affect subsidies, grants, school curricula, and jobs.

"Culture", it seems, is an indispensible concept like "society", "norm", "institution", or "personality", but it is also vague, and contested. Loose criteria control the word in speech and the concept in thought. Any scholarly attempt to find culture's "essence" or "true meaning" is inevitably too narrow for ordinary speech.[7] Instead of trying to define "culture", we will explain some causes connecting tribal culture and economic development.

Many tribes describe themselves as "nations", and their governments mobilize the symbols of nationhood. "Does national distinctiveness promote wealth, or does wealth promote

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[5] Corporate Culture:Apple's corporate culture v. Enron
Cyert, R. M. and J. G. March (1963). A Behavioral Theory of the Firm. Englewood Cliffs, New Jersey, Pretice-Hall.
Djankov's survey results from Russia
These findings support widespread feelings among theorists and practitioners that corporate governance is influenced by national culture. The implications of these finding range from the study of diversity and convergence in corporate governance systems to general analysis of the interface between law and culture—perhaps the two most important elements of social order.
Customs in trade: Elllickson.

[6] Economists frequently study separating equilibria. Cooter shows why separating equilibria are common for social norms. In conversation, Michael Adams suggested to Cooter that separating equilibria are the analytical foundations of cultural differences among people.

[7] We don't think that "culture" has an essence, although some analysis of culture is more fundamental than others. We also don't think that "culture" a "true meaning", although some definitions are better than others.

national distinctiveness? Is assimilation the price that Indian nations must pay for wealth, or is distinctiveness one of the rewards for obtaining wealth? This paper tries to answer this two-way question about the causal connection between culture and economy on Indian reservations.

Only tribal members can vote in tribal elections, and many jobs in tribal government are reserved for tribal members by law or practice. Membership in Indian tribes is defined by descent from original tribal roles. Consequently, kinship determines membership in the tribes. Besides this legal formality, the politics of reservation government and administration usually turns on kinship. People are expected to support their kin who seek political power on reservations, and people who obtain political power are expected to reward their kin for supporting them. Thus the legal definition of Indian nations and the practice of government on reservations involve kinship. When we address the question of whether assimilation is the price that Indians must pay for wealth, we will focus on whether Indians must loosen their ties of kinship in order to prosper.

II.1 Idealism, Materialism, and Entrepreneurs

We begin by reviewing two classical approaches to culture and economy, idealism and materialism. For our purposes, "idealism" is the claim that a culture's ideas determine its economy. Thus according to Hegel, ideas are the base of society and materiality is the superstructure. From this perspective, different nations have different foundational ideas, whose contradictions produce history, including economic development. Marx famously stood the logic of idealism on its head. For him, materiality is the base and ideas are the superstructure. In this perspective, different nations have different forms of property, whose contradictions produce history, including culture.

This paper combines idealism and materialism in an account of innovation. Innovations combine novel ideas and scarce resources (money, time, and effort). The resources develop the ideas. Since innovations combine ideas and resources, a theory of innovation combines idealism and materialism. Business and social entrepreneurs make many innovations. Business entrepreneurs find new ways to make money, and social entrepreneurs find new ways to make non-market goods, including culture. As an example, we will discuss later a remarkable social entrepreneur who spent years creating a Hopi dictionary that subsequently changed cultural on the Hopi reservation.

A theory of entrepreneurship of special concern holds that tribal people must become more individualistic in order to prosper. According to this theory, tribal people live their lives among kin, which affects their thoughts and behavior. Economic development requires them to change their thoughts and behavior, according to this view. To make the change, they must live less among kin. Thus the "folk Catholicism" of the O'Odam in Arizona (formerly called the Papagos) involves intensive participation in the ceremonial cycle of the saints. The ceremonies are costly and they redistribute wealth among relatives. Some ambitious Indians convert to Protestantism, stop participating in the ceremonies, and share less with their relatives. They become more individualist, which helps them to accumulate wealth. In the language of Max Weber, they renounce Catholicism and accept the "Protestant ethic", which causes them to work and save more systematically.[8]

This theory suggests that kinship holds American Indians back from innovating for two reasons. First, kin groups are naturally conservative. Relatives find change disorienting, and their resistance discourages innovation. Second, relatives feel entitled to share a kinsman's wealth. The need to share profits with relatives discourages wealth seeking, especially taking business risks. Trimming back kinship produces smaller, more compact families that are better situated for entrepreneurship. The logical extension of this belief implies that economic growth will dissolve kinship everywhere and reduce people to collections of individuals.

II.2 Kinship and Innovation

While partly true, this line of thought obscures the larger truth that entrepreneurship often involves relatives and friends. Extended families grow so many of the world's most successful businesses, like the Pritzkers in Chicago (Hyatt Hotels), the Koch brothers in New York (Koch Industries), the Mittals in India (AncelorMittal steel), the Liang Wengen family in China (Sany Group), or the Slim family in Mexico (Grupo Carso, Telmex, etc.). Family firms dominate the economy in rich places like northern Italy. Successful Japanese families sometimes adopt their firm's future CEO (usually a son-in-law), who takes the family name and ancestors as

[8] Weber explained the Europe's industrial revolution in terms of the Protestant ethic, whereas we apply the term to contemporary individuals. Note that Weber's theory of history being made by charismatic religious leaders who change the dominant ideas in a culture was a form of idealism –it explains economic development by cultural change.

his own.[9] Many new firms start from army friendships in Switzerland or Israeli, or college friendships in the U.S. Since kinship figures in so much business success, its presence as such cannot explain business failure.

Entrepreneurship often involves relative and friends because it requires trust. Kinship provides a basis for trust that is older and more certain than markets, courts, governments, or administrators. Whether in Silicon Valley, or the Hopi reservation, kinship plays an important role in business, and we suspect that it always will. To explain why we first discuss business ventures.

Innovation especially occurs through business ventures. A bold ship's captain in seventeenth-century England proposes to investors that they finance a voyage to Asia for spices.[10] The voyage is costly and risky, but if it succeeds, the spices will be worth a fortune. Similarly, an engineer in Silicon Valley in 1985 has an idea for a new computer chip. Development is costly and risky, but if it succeeds, it will be worth a fortune. Seventeenth-century spice voyages and twentieth-century technological innovations involve up-front investment, high risk, and high return.

A profitable business venture often has a life cycle like Figure 1. The venture begins with the development of a new idea in period 1, which costs 8. When the product is developed, the innovator has a valuable secret or patent, or perhaps a cluster of secrets or a portfolio of patents. After development, the innovation is launched and marketed to buyers. When launched in period 2, the innovation has no competitors, so the innovator is a monopolist who receives a payoff of 7. In period 3, imitators develop competing products that substitute for the innovation, which reduces the innovator's payoff to 4. In period 4, imitations improve and competition intensifies. Taking competition to its logical extreme, the imitations become perfect in period 4, so the market is perfectly competitive and the innovator's payoff is zero.[11] Summing over the life cycle in Figure 1, the venture's net payoff equals +3.

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[9] Mehrotra Vikas et al., *Adoptive Expectations: Rising Sons in Japanese Family Firms*, *in* BERKELEY LAW FACULTY WORKSHOP (2012).

[10] This characterization of the spice trade is based on Ron Harris, "Law, Finance and the First Corporations", in James J. Heckman, Robert L. Nelson & Lee Cabatingan, eds., Global Perspectives on the Rule of Law ((2009, Routledge).

[11] Perfect competition drives the prices of all goods to their cost of production. Profits are zero after including the cost of capital in the other costs of production. The cost of capital equals the ordinary rate of profit in alternative uses.

Figure 1
Life Cycle of a Profitable Venture

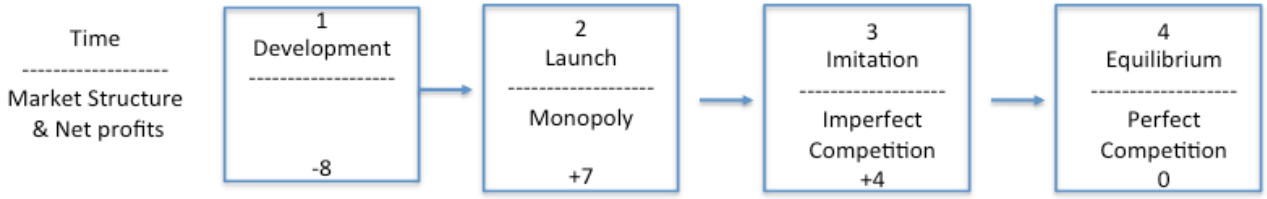


Figure 1 depicts a profitable venture, but most ventures fail and lose money. Recent U.S. data suggests that 40% of new businesses survive and 60% disappear within four years.[12] Some unsuccessful ventures involve unprofitable ideas that the innovator abandons before or after launch, and other unsuccessful ventures involve profitable ideas that never make money for the innovator because imitators steal them first.

From its beginning, a business venture requires trust among its members. Capital is required to develop a novel idea. If one person has the money and someone else has the capital, then the investor must trust the innovator not to steal the money. Sometimes the value of a new idea depends on keeping it secret. Dissemination of the innovative idea, especially before its launch, will dissipate the profits by attracting imitators. When success requires secrecy, the person with the ideas has to entrust his secrets to the investor. In a business venture, the relationship between the innovator and the investor poses a "double trust" problem. The innovator must entrust his ideas to the investor, and the investor must entrust his money to the innovator. Even after the venture succeeds, its continuing success often depends on continuing trust. The patriarch of a successful California business family instructed his son: "At the end of the day, a member of the family must count the money."

Loyalty within families is partly irrational when measured against their narrow self-interest. Relatives are bound by ties of affection and obligation, which make them more responsive and altruistic toward each other than with outsiders. Besides self-interest, relatives and friends also have a rational basis of trust, due to the fact that kinship is ascribed, not chosen. Your mother's brother is your uncle, and you are his nephew or niece until his death. Ascription

[12]44% of U.S. businesses started in the 1990s still existed 4 years afterwards. See Knap, A. E. (2005). "Survival and longevity in the Business Employment Dynamics data." Bureau of Labor Statistics of the U.S. Department of Labor. The number given by Dun and Bradstreet is 37% as cited in "Some of the Reasons Why Business Fail and How to Avoid Them," Entrepreneur Weekly, Issue 36, 3-10-96.

provides a framework for repeat dealing. Kinship and friendship supplies a basis for repeat dealings, thus supplementing the irrational basis of trust with a rational basis. If you are untrustworthy with your relatives, they will find out and treat you accordingly. Relatives come to know whom to trust in the family and whom to distrust.

Game theory explains how repeat dealings create trust. Imagine a game in which an investor decides whether or not to invest 1 in a business managed by someone else. If the investor invests and the manager cooperates, the capital of 1 will double in value yielding 2. The investor and manager can split the profit, with each one receiving .5, and the investor can get back his initial investment of 1. Alternatively, instead of cooperating, the manager can appropriate the investor's money, in which case the manager gains 1 and the investor loses 1. Appropriation is twice as profitable for the manager as cooperation. Consequently, if the manager is narrowly self-interested, he will appropriate instead of cooperating. Foreseeing this fact, the investor will refuse to invest. For lack of trust, the business venture never launches.

This problem disappears if the parties play the game over and again. With indefinitely many repetitions, the manager who cooperates receives .5 indefinitely many times. Alternatively, if the manager appropriates 1, which causes the investor to lose 1, the investor will stop investing. The manager will receive 1 when he appropriate and 0 thereafter. Thus a continuing relationship between the investor and the manager provides a rational basis for trust. In business dealing as in families, repetition builds reputation – for good or ill – which spreads trust more broadly.

Much the same is true for social entrepreneurs as for business ventures. As we will describe later, Emory Sekaquaptewa invested years of his life to create a Hopi language dictionary. Creating and launching it in schools, courts, cultural programs, and households required time and money. Emory especially drew on family and friends for support, including countering others who condemned his project as disclosing Hopi secrets to non-Hopis.

Over millennia, more people have moved from the country where kinship is pervasive to the city where they interact less through relationships and more through occupational roles (accountant, sweeper, salesman, consumer, client, etc.). In social theory, classical writers like Adam Smith, Karl Marx, and Emile Durkheim asked, "What holds society together when labor is finely divided and mostly people interact with non-kin?" Contracts, regulations, laws, and bureaucratic authority are part of the answer. Some people imagine that this tilt will eventually

crowd out family and friends in the economy and the state. However, this view fails to appreciate that contracts, regulations, laws, and bureaucratic authority, all of which are essential a modern economy, supply insufficient trust for many innovative ventures. Consequently, business and social entrepreneurship will continue to draw on kinship and friendship.

Indian reservations where relatives rely on each other in business and government are not necessarily anachronisms headed for extinction. Families and friends on Indian reservations provide networks for relational transactions that overcome some problems of trust. Kinship makes Chinese trading families, Indian hoteliers, and Israeli technology startups more creative, productive, and competitive. However, people accustomed to dealing with their kin may have difficulty trusting anyone else, as international experiments in trust games have shown.[13] Kinship also contributes to nepotism, unfair competition, and illegal favors. Indian reservations must build on the strengths of kinship and counter-act its weaknesses in economy and state.

II.3 Whirled Peas: Assimilation and Language

We began by asking the dual question of whether economic growth contributes to Indian culture and whether Indian culture contributes to economic growth. We discussed the culture foundations of life in Indian communities, notably kinship. We briefly explained that kinship can contribute to economic growth by increasing the trust and cooperation needed by business and social entrepreneurs. We raised the question without attempting to answer it, "How can that kinship play a creative role on Indian reservations, rather than suppressing competition and spreading corruption?" Answering this question requires a broad discussion of law and policy that we cannot attempt here.

Instead, will focus on a particular culture expression – Indian languages. We will develop a theory of language retention to use in the subsequent parts of this article. The first of our dual questions is whether economic development increases or decreases competency in Indian languages. Consider the value of an Indian language to individuals who speak it. Language is a means of expression and an instrument of communication. Expression is intrinsically valuable and enjoyable. People will pay in money, time, or effort to express

[13] Psychologists have played trust games in various societies and found that experience with markets increase the confidence that people place in others who are not identified as relatives. For an ethnographic study of this problem and related issues, see JEAN ENSMINGER, MAKING A MARKET: THE INSTITUTIONAL TRANSFORMATION OF AN AFRICAN SOCIETY (1992).

themselves in ways that they enjoy. Consequently, as Indians get richer, they should spend more money, time, and effort on cultivating Indian languages. In economic terminology, we predict that Indian languages are "normal goods" – demand increases with income.

One way to cultivate Indian languages is to spend more on activities using them such as ceremonies, prayers, story-telling, classes, and media. Sometimes individuals spend their money, time, and effort on these activities, and sometimes organizations make collective expenditures, including societies and reservation government. If Indian languages are normal goods, Indians will want their organizations to spend more on Indian languages as the reservation's wealth increases.

Besides expression, language is an instrument for doing business. For most Indian people, work necessarily occurs in English, and mastery of English is important to business success. However, some work activities may occur in Indian languages. Some tribes assure that this is so by holding debates in the tribal counsel in an Indian language, or rewarding tribal officials for conducting business in an Indian language.

However, economic development can also lower the instrumental value of native languages by drawing Indians into more business activities that require the use of English. In so far as economic development imbeds Indian business activity more deeply in the larger society, economic development lowers the instrumental value of speaking an Indian language relative to a native language.

Besides the intrinsic and instrumental benefits of speaking an Indian language, learning a language requires years of practice. Practice is low-cost for children raised in a household that speaks a native language, and learning is high-cost for anyone else. Outside the home, the availability of language classes can encourage language retention, although few non-speakers are likely to learn as adults.

These considerations suggest a simple model of language retention. The intrinsic benefit of speaking an Indian language is an increasing function of its expressive value and its instrumental value. Increases in income should result in more speaking of Indian languages for intrinsic reasons. Increases in income should result in more instrumental speaking of Indian languages due to preferences for it in conducting business with the reservation government. However, increases in income that imbed Indians more deeply in the business activities of the larger society should result in less instrumental speaking of Indian languages. Finally, the cost

of learning a native language decreases with the number of household already speaking it. Population growth among households that speak an Indian language should increase its use. To a lesser extent, the availability of classes in a native language may increase its use.

In this model, the probability that a person can speak an Indian language is a function of variables including income. Reversing causation, we ask whether income is a function of the ability to speak an Indian language. Since language ability starts at home, the ability to speak an Indian language should strengthen Indian kinship systems, such as clans. We have already explained that family provides a basis of trust that contributes to business ventures and social entrepreneurship. So language that strengthens Indian kinship should contribute to innovation in economy and society by increasing trust. However, family also provides a reason for nepotism and unfair advantage. Language that strengthens Indian kinship should undermine innovation by increasing nepotism and reducing competition.

III. The Hopi Dictionary *[a first-person narrative by Justin Richland]*

In the summer of 1998, I was sitting in the Tucson, Arizona office of Emory Sekaquaptewa, getting lessons on Hopi grammar and syntax. At the time, and up until his death in 2008, Sekuaptewa served as Research Professor in the Bureau of Applied Research in Anthropology at the University of Arizona, and Chief Justice of the Hopi Appellate Court, the highest court of the Hopi Nation. And while I had first met Emory in 1995 while still a law student doing legal research for the Hopi Appellate Court, I had long known that his real passion lay in Hopi language and culture. Indeed, despite having no formal training as a linguist (Emory was the first Native American JD to graduate from the University of Arizona), Emory had long turned many of our conversations– whether those of official court business or more informal dinners – to lectures on the significance of language to the vitality of contemporary Hopi jurisprudence and culture more generally.

Time and again he had told me of his efforts to document the Hopi language, and how starting with note cards and his own intuition, he would write down important words and phrases that he thought would better capture important concepts in Hopi that didn't have adequate translation in English, and alternatively, concepts and phrases in English that could, with some reflection on the agglutinative capacities of Hopi language (i.e. the ability to join phonemes to create novel words, much like in German) could and should be translated. This would eventually

result in the mid 1980s with the creation of the Hopi Dictionary Project, started when Emory brought in linguists and librarians and other Hopi language speakers to collaborate on his vision. That project, which enjoyed substantial funding from a number of private donors and public foundations from all over the world, including especially the National Endowment of Humanities, the Arizona Humanities Foundation, and the Wenner-Gren Foudnation for Anthropological Research, would eventually result in the publication in 1998 of the *Hopi Dictionary/Hopìikwa Lavàytutveni: A Hopi Dictionary of the Third Mesa Dialect*, (Hill, Malotki, Black, eds. University of Arizona Press), a 30,000 word volume that today stands as the single-most comprehensive dictionary not only of the Hopi language, but of any of the languages of the Uto-Aztecan family, one of the largest indigenous language groups in North and Central America.

Thus it was somewhat surprising that on that typical triple-digit day in Tucson, on the eve of the official release of the dictionary, that Emory's mood seemed less than ebullient at the achievement of what, on other occasions, he and others had considered as his life work (indeed, his obituary in more than one outlet would describe him as the "Noah Webster of the Hopi Nation"). Only later would I discover that objections had been made to the publication of the dictionary by certain members of the Hopi Tribe, including especially Leigh Kuwanwisiwma, Director of the Hopi Cultural Preservation Office, the arm of the tribal government charged with policing the (mis)representation of Hopi cultural property, including intellectual property, by those it determines are not sanctioned to make such representations. Among the concerns raised by Kuwanwisma and his affiliates, was that the publication and wide distribution of the dictionary would result in making the Hopi language and the cultural meanings that it conveys accessible to non-Hopis that, under certain views of Hopi ceremonial secrecy and ritual significance, they were not authorized to know.

Thus in those weeks that I was sitting with Emory as he was giving me personal lessons in the language relying on pre-published galley pages of the soon-to-appear volume, I had little appreciation that I was unwittingly enacting with him the very kind of engagement with the language and the dicitionary that was, in the view of some, the reason it shouldn't ever come to print. And it is instructive I think of Emory's views on these issues that in those early days, he never let on that this was at stake in our meetings. Instead, what Emory would say was the unfinished business of the Hopi Dictionary Project was not seeing it appear in print, but rather of

getting it distributed to the Hopi families and children who he believed needed to learn how to write the language as it was only by expanding Hopi literacy that the larger problems of Hopi language and cultural loss could be reversed. For Emory, the goal was to get Hopi people to realize that their language and culture could be the stuff of a standardized, national culture, a literate language by which they could and should accomplish all aspects of contemporary Hopi life – both quotidian and official – that today were being largely accomplished through English. This was the ultimate goal for Emory, the goal not only of Hopi cultural preservation but of vitality, and it was through a dictionary that could provide the basis for a Hopi literacy, taught to all Hopi children in Hopi primary and secondary schools, and required for the conducting of all official Hopi nation business (Emory often spoke of his dream not only to conduct all court hearings in Hopi, which already took place, but to author an opinion of the Court entirely in the Hopi language, which could be read and relied upon by those working in and with the court).

Thus I would witness how, in the months and years that would follow the publication of the dictionary, right up until his death, Emory would play an instrumental role in developing a variety of materials and programming designed to foster Hopi literacy and language learning, including teaching a summer language course to Hopi educators living on the reservation, supervising the drafting of novel Hopi literacy materials and lesson plans for use during the school year, even participating in the launching of a Hopi tribal radio station that would broadcast Hopi language programming to all of northern Arizona (and now streams live on the internet).

Importantly, it was the efforts –launched by the Hopi dictionary project but going much further than that -- that would gain the near universal support of the Hopi tribal membership, and which are now not only a mainstay of the contemporary Hopi tribe, and a key element in their sense of cultural pride and vitality. This is no more evident than in the fact that where the dictionary was largely funded by monies raised from contributions by non-Hopi agencies and individual donors, the language and literacy programming based on it are largely supported by tribal funds such as the Hopi Educational Endowment Fund, which was started in 2000 pursuant to Hopi tribal legislation that set aside $10 million dollars to be held for the purpose of supporting Hopi educational programming and individuals. This includes major and on-going support for the Hopi Lavayi Project -- the Hopi language and literacy program which, perhaps ironically, is run through the Hopi Cultural Preservation Office, still under the direction of Leigh

Kuwanwisiwma, the very same office that objected most strenuously to the publication of the Hopi Dictionary back in 1998. If Emory were alive today, I think he would allow himself a knowing and grateful smile at this positive turn of cultural events, and the role that his efforts at preserving and promoting Hopi language played in it.

IV. Econometrics of Language Retention

In this section we examine empirical relationships between the self-reported use of tribal languages at home and income growth on reservations from 1980 to 2010. As we will see, the use of tribal languages plummeted from 1980-1990, casting doubt on their future viability (see Crawford 1995). Tribal language use stabilized over 1990 -2010, however, as incomes on many reservations expanded. We probe this positive association in detail here, attempting to uncover causal relationships.

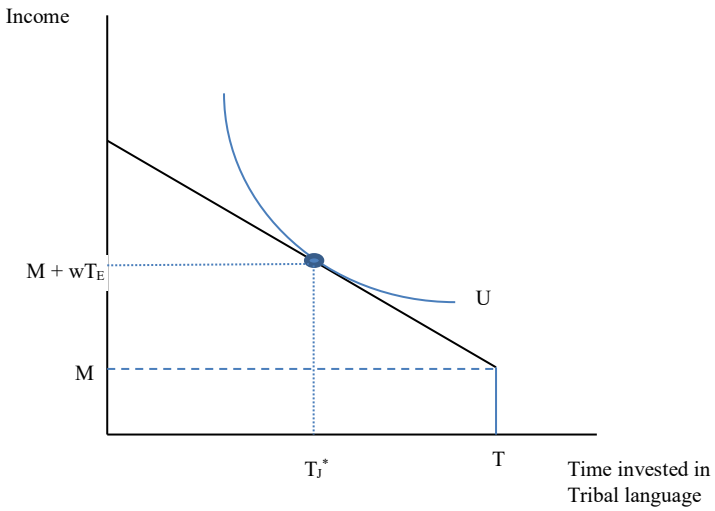
IV.1 Theoretical Context for Empirical Tests

Building from the broader theory described in section I above, we present here a narrower framework to guide our empirical tests. We assume an individual Native American gets utility from speaking his native language (and the enhanced access to reservation activities that indigenous language use provides) but also from standard consumption goods (e.g., movies, coffee). The individual is constrained by time, T, (e.g., hours of the day, months in a year) and his exogenous endowment of non-wage income (M). Sources of non-wage endowments may include lease payments to individual or tribal assets, transfer payments from the federal government, and per capita distributions of casino profits.

The individual's choice is how to allocate his time between activities related to tribal language use and activities related to using English. English-related activities generate utility indirectly, because these activities are a vehicle for earning wages, w_E, in the non-Indian economy. Activities related to tribal language use yield utility directly because we assume that tribal language use is a form of consumption. Tribal language use can also yield utility indirectly, if the speaker can market and bundle his knowledge of the language with other cultural services and sell those services to non-Indians. We denote the wage earned by selling culture (e.g., cultural tourism) w_J where subscript "J" denotes language J.

Figure 2 illustrates the tradeoffs of English and tribal language activities in a standard utility maximizing framework. The x-axis shows how much time the individual invests in tribal language use and the y-axis shows income. The slope of the line connecting the axes is the wage earned from English activities divided by the wage earned from tribal language activities (w_E/w_J). As a starting-point benchmark, we assume that $w_J \cong 0$ meaning there is no monetary market for tribal language products. Hence, the individual's income is equal to M if all of his time is allocated towards tribal language activities. He maximizes his utility by spending T_J^* time engaged in tribal language related activities and $T_E = T - T_J^*$ on English-related activities.

Figure 2
Utility Maximizing Choice of Individual



What happens if the non-wage income, M, rises and relative wages are held constant? As long as tribal language is a *normal*, rather than inferior, good we expect tribal language use to rise along with total income. Figure 3 illustrates.

Figure 3
An Exogenous Increase in the non-wage Endowment

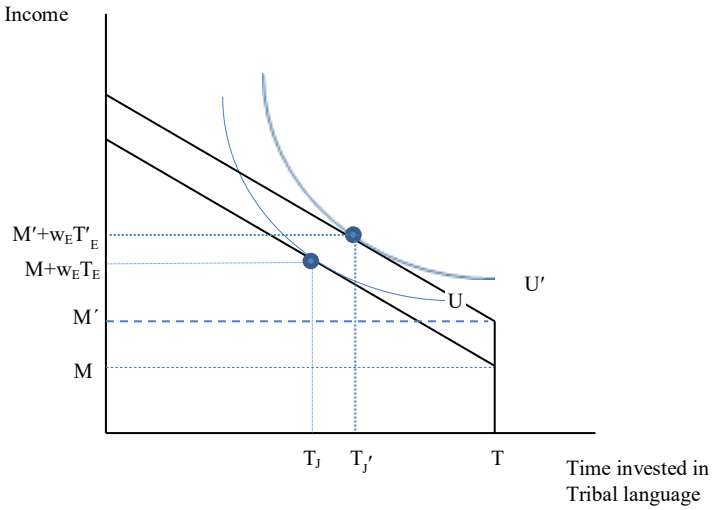
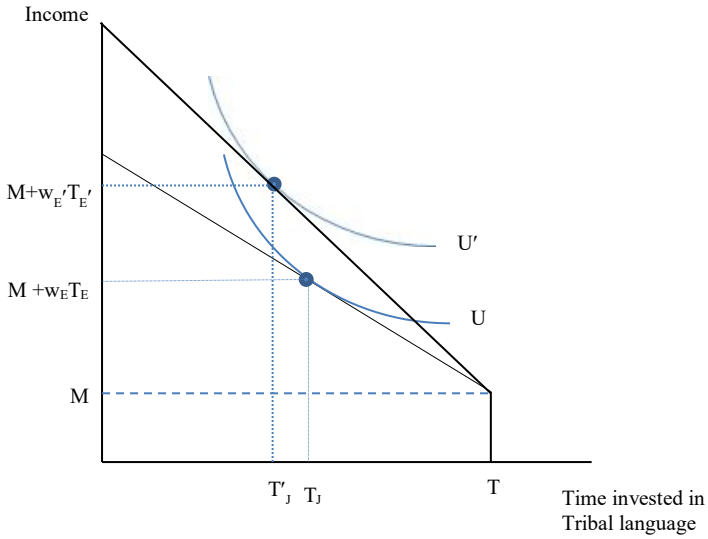


Figure 4 illustrates what could happen if the wage earned in the non-Indian economy, w_E, increases. This could happen, for example, if new employers in English-driven industries locate near a reservation, raising demand for Indian labor. The effect is shown in figure 4 as an increase in the steepness of the relative wage line. As long as the substitution effect (i.e., the incentive to work more at the higher wage) dominates the income effect, the individual will respond by working more. The effect will be less time devoted to tribal languages and higher

individual income. Alternatively, if the income effect dominates the substitution effect, the individual will work less and invest more in tribal language use.

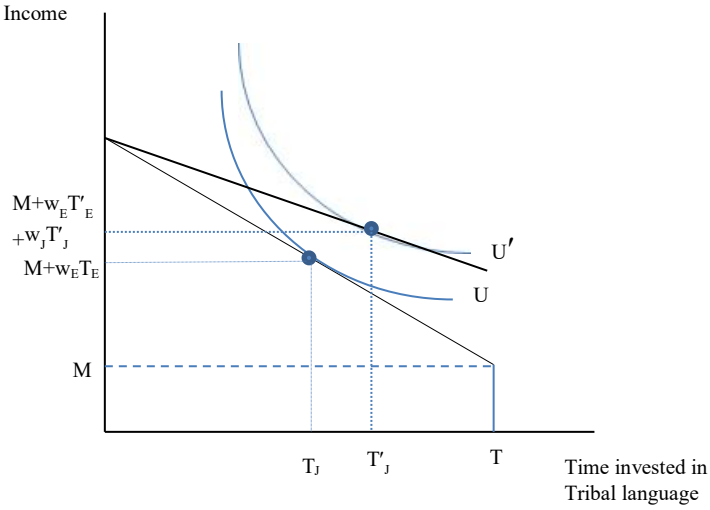
Finally, figure 5 illustrates what could happen if the economic return to tribal language use, w_J, increases relative to the wage earned in standard English-driven occupations. The wage w_J could rise, for example, if there is increased demand for cultural tourism on a reservation. As long as tribal language is a normal good, the individual's use of it will increase as illustrated in figure 5.

Figure 4
Increase in Wage offered in Nearby non-Indian Economy
(assuming substitution effect > income effect)



There are other factors not illustrated in figures 2-5 that could impact the individual's decision of how much time to invest in tribal language use activities. First, an increase in the non-monetary, local returns of speaking the tribal language will tend to increase time devoted to tribal language use and decrease total individual income. Second, a decrease in the individual's time cost of learning the tribal language will increase his allocation of time towards tribal language use and have an ambiguous effect on his total individual income. Time costs will fall, for example, if the tribal government provides resources for language learning (e.g., dictionaries, libraries, schools) or if a greater percentage of the population speaks the language.

Figure 5
Increase in Wage Earned with Use of Tribal Language



Note that our simple discussion of figures 2-5 assumes the individual starts at an interior solution engaging in both English and tribal language related activities but in fact, some individuals may be at corner solutions. We plan to examine this issue as our project moves forward.

IV.2 Data and Correlations

The theoretical ideas outlined above pertain to individual decision-making but the data we have collected thus far are reservation-level aggregates from the U.S. Census Bureau. Ideally, we would like to have objective measures of the fluency and frequency of tribal language use. Instead, the Census has simply asked respondents (through a written questionnaire) to self-report whether or not they speak a non-English language at home. For 1980 and 1990, the Census reports the percentage of the American Indian population age 5 and older who self-identified themselves (and their family members) as speaking a tribal language at home. For 2000 and 2010, the Census reports the percentage of the Indian population age 5 and older who self-identified themselves as speaking a language other than English, Spanish, all other Indo-European languages, and Asian Pacific Island languages.

Some shortcomings of the language data are worth noting from the onset. As Crawford (1995) points out, self-reports of language use can be less reliable than objective measures. Self-reported measures may be biased by feelings of ethnic pride, obligation to one's tribe, or even embarrassment about the true use of language. Also, because the Census language-at-home question enables only a binary yes-or-no response, it may elicit affirmative responses from individuals who only occasionally use non-English languages.

Fortunately for our purposes, the Census language questions were asked consistently from 1980 to 2010 so our empirical strategy of focusing on decadal *changes* in language use within reservations should mitigate some concerns about the effects of measurement error on our main empirical tests.[14] Broad tendencies among respondents to overstate or understate actual language use are not problematic from our perspective unless those tendencies systematically correlate with income growth on reservations. We discuss this possibility later, in the context of our empirical findings.

Table 1 summarizes the data on language use. First, note there is substantial variation in the use of tribal languages across reservations during all years of the sample. In 2010, for example, the use of tribal languages ranged from zero to 99.7 percent. For illustrative purposes,

[14] The one exception is the change from 1990 to 2000, when the Census stopped reporting the use of specific American Indian languages at home and instead started reporting the at-home use of languages other than English, Spanish, all other Indo-European languages, and Asian Pacific Island languages. This change in reporting biases upwards our proxy for the change in American Indian language use from 1990 to 2000 to the extent that that Native Americans on reservations speak a non-tribal, non-English language that is omitted from the options listed above.

we note the percentage of people speaking a tribal language on some of the largest reservations including the Navajo (73.4%), Pine Ridge (24.9%), Fort Apache (60.6%), Blackfeet (11.8%), and Hopi (62.8%).

Table 1 also reveals a sharp decrease in the mean use of tribal languages from 1980 to 1990, with language use stabilizing since 1990. Since 1990, the percentage of individuals speaking tribal languages increased on 46 of the 81 large reservations in the sample.[15] Table 1 also gives statistics on the percentage of individuals who do not speak English well, as reported by the Census. This percentage is decreasing on average across reservations, ranging from a low of zero percent to a high of 20 percent (on the Hopi reservation) in 2010.[16]

Table 1
Summary Statistics of Reservation Level Data on Language Use

Reservations with American Indian Pop. >1,000 in 2010				
	Min	*Mean*	*Max*	*N*
% Speaking tribal language at home				
In 1980	0.25	36.82	99.68	81
In 1990	0.12	22.78	91.11	81
In 2000	1.26	26.53	97.04	81
In 2010	0.70	25.08	95.24	81
Percentage point change, 1990-2010				
All Reservations	-32.65	2.30	55.26	81
Reservations with declining language use	-32.65	-8.24	-0.03	35
Reservations with rising language use	0.14	10.24	55.25	46
% Not speaking English well				
In 1990	0.00	11.49	58.00	81
In 2000	0.00	7.35	45.40	81
In 2010	0.00	2.97	20.00	81

Note: The source is the authors' compilations from U.S. Census reports.

We measure the per capita income of Native Americans on reservations using U.S. Census data from 1980, 1990, 2000 and 2010. The income data are self-reported and include money received on a regular basis from transfer payments but exclude the monetized value of

[15] We follow precedent is other econometric studies of reservation outcomes by focusing on reservations having American Indian populations exceeding 1,000 (see Cornell and Kalt 2000, Anderson and Parker 2008, Akee et al. 2013).

[16] The pearson correlation between the percentage speaking a tribal language and the percentage who do not speak English well was 0.78 in 1990 and 0.63 in 2010. The positive but declining correlations suggest that tribal languages were historically a substitute for English but are less so today.

noncash benefits such as food stamps, health benefits, subsidized housing, and goods produced and consumed on farms. Table 2 shows summary statistics for reservation incomes from the decadal Census reports. For this sample of the largest 81 reservations, real per capita income (in 2010 dollars) has ranged from $3,849 to $34,669. To give perspective, we also show incomes on reservations as a percentage of incomes on the counties adjacent to the reservation. This percentage ranges from 21.28 (Mille Lacs in 1989) to 162.2 (Isabella in 2010).

Table 2
Summary Statistics of Reservation Level Income and Related Data

Reservations with American Indian Pop. >1,000 in 2010				
	Min	***Mean***	***Max***	***N***
AI Per Capita Income (2010 $s)				
In 1980	4,127	9,665	17,438	81
In 1990	3,849	9,082	19,172	81
In 2000	5,292	11,732	22,821	81
In 2010	7,210	13,026	34,669	81
Adj. County Per Capita Inc. (2010 $s)				
In 1980	12,705	18,454	25,246	77
In 1990	11,321	19,778	28,345	78
In 2000	13,282	23,040	33,159	79
In 2010	13,259	23,341	33,550	79
AI Per Capita Income as % of Adj. County				
In 1980	22.48	52.88	93.21	77
In 1990	21.28	46.36	74.90	78
In 2000	23.07	51.74	94.72	79
In 2010	31.38	56.55	162.22	79
Number of Casino Gaming Machines				
In 1980 (0 reservations with slots)	0.00	0.00	0.00	81
In 1990 (4 reservations with slots)	0.00	77.29	4700	81
In 2000 (44 reservations with slots)	0.00	473.9	4700	81
In 2010 (70 reservations with slots)	0.00	1119.5	5350	81
Number of Casino Machines per capita				
In 1980	0.00	0.000	0.00	81
In 1990	0.00	0.082	5.911	81
In 2000	0.00	0.258	3.698	81
In 2010	0.00	0.463	2.890	81

Notes: The income data come from U.S. Census Reports. The 2010 data come from the American Community Survey (ACS) which differs from the earlier decennial reservation census reports in certain ways. For geographic areas with populations less than 20,000, the ACS reports 5-year estimates (i.e. 2006-2010 averages). Because of this, the only data available for most reservations are the 5-year estimates which are what were use in our analysis. The data on slot machines for 1990 and 2000 were compiled by Anderson and Parker (2008) and also used in Cookson (2010). The data on slot machines in 2010 were compiled by the authors from http://www.500nations.com/Indian_Casinos.asp. This site provides the number of slots/gaming machines for all American Indian casinos in the U.S. Each casino can be tied to a reservation by looking at which tribe owns the casino and where the casino is located. We downloaded information from the site in 2013, so our measure may include casinos built after 2010.

Before proceeding with more fundamental analysis of the theoretical ideas illustrated in figures 2-5, we first highlight stark changes in the correlation between income growth and language use over time. As column 1 in table 3 shows, American Indian per capita incomes

were strongly and negatively related to the concentration of tribal language use in the 1980 cross section. The -0.0055 coefficient means that an increase of $1,000 in incomes per capita was associated with a 5.5 percentage point decrease in tribal language use.

Table 3
OLS Correlations between Income and Language Use

	Y = % Speaking tribal language in 1980	Y = Δ% Speaking tribal language, 1980-1990		Y = Δ% Speaking tribal language, 1990-2010	
			Log of Y		*Log of Y*
	(1)	(2)	(3)	(4)	(5)
1980 AI Per Capita Income (in 2010 $s)	-0.0055*** (0.000)				
Δ AI PCI income, 1980-1990 (in 2010 $s)		-0.0011 (0.269)			
Log Δ AI PCI income, 1980-1990			-0.856* (0.060)		
Δ AI PCI income, 1990-2010 (in 2010 $s)				0.0007* (0.072)	
Log Δ AI PCI income, 1990-2010					1.103* (0.099)
% Speaking tribal language, 1980			0.0032 (0.393)		
% Speaking tribal language, 1990					-0.017*** (0.000)
Constant	89.90*** (0.000)	-14.58*** (0.000)	-0.928*** (0.000)	-0.586 (0.728)	0.376 (0.157)
Observations	80	80	80	81	81
Adjusted R^2	0.21	0.03	0.05	0.03	0.23

Notes: p values in parentheses, * statistically significant at p<0.1, ** p<0.05, *** p<0.01. The standard errors are robust to heteroskedasticity. The dependent variable in column 3 is the ln(1990 % Speaking tribal language) - ln(1980 % Speaking tribal language). The dependent variable in column 5 is the ln(2010 % Speaking tribal language) - ln(1990 % Speaking tribal language).

The coefficients in column 2 and 3 show the relationship between changes in per capita incomes over 1980-1990 and in the concentration of tribal language users over the same time period. In column 3, the variables are logged, so the coefficient has a different interpretation. The coefficient of -0.856, for example, means that a 10 percent increase in income over 1980 to 1990 was associated with a 8.6 percent (not percentage point) decrease in the concentration of language use. The regression in column 3 controls for the concentration of tribal language use in 1980. Including this control allows language use growth (or erosion) to depend on the initial

stock concentration of tribal language users. The coefficient on the stock of initial users, however, is statistically insignificant.

Turning to column 4, there was a positive relationship between income growth over 1990 to 2010 and the change in the concentration of tribal language speakers over the same time period. The 0.0007 coefficient means that an increase of $1,000 in per capita income was associated an increase of 0.7 percentage points in tribal language use. For perspective, consider that the mean change in Indian incomes per capita was $3,944 from 1990 to 2010. For the average reservation, therefore, the column 4 coefficient predicts a 2.76 percentage point increase in the concentration of language use.

In column 5, the coefficient of 1.103 means that a 10 percent increase in income over 1990 to 2010 was associated with an 11.03 percent (not percentage point) increase in the concentration of language use. The negative coefficient on the 1990 stock concentration of language users is interesting because it suggests that higher growth in language use over 1990 to 2010 was more often obtained on reservations having lower initial concentrations of tribal language users. One interpretation of this result is that more effort was applied to language recovery on reservations where tribal languages were closer to the brink of extinction.

Overall, the results in table 3 leave the impression that economic development eroded tribal culture, or vice versa, up until 1990. Since 1990, economic development appears to have been an impetus for tribal language recovery, or vice versa.

IV.3 Determinants of Language Use and Income Levels

We next investigate the determinants of tribal language use and per capita incomes in the 1990 cross-section of reservations, and in the 1990 to 2010 panel. We start with the 1990 cross-section because 1990 marks the eve of the casino era. Recalling our theoretical ideas described in section II and in figures 2-5 above, we hypothesize that the percentage of Native Americans speaking a tribal language on reservation J, is determined by the factors in (1).

(1) $P = \alpha M + \lambda q_E w_E + \delta q_J w_J + \eta b + \gamma c + \varepsilon$

P = proportion of the reservation speaking tribal language
M = non-wage income endowment
q_E = probability of finding English-related employment in the non-Indian economy
w_E = wage that can be earned doing English-related work in the non-Indian economy

q_J = probability of being able to sell tribal-language related goods and services
w_J = wage earnings from selling tribal-language related goods and services
b = probability of encountering speakers of tribal language on day-to-day basis
c = time cost of learning and maintaining tribal language
ε = a random (or unobservable) component of language use

Table 4 shows empirical proxies for the variables in (1) and their predicted relationship to tribal language use. In the 1990 cross-section, we attempt to measure non-wage income endowments (M) on reservations with a binary (yes or no) variable indicating whether or not the tribe had significant energy resources as described by Ambler (1990). This variable should be related to higher per capita incomes on reservations and higher tribal language use if tribal language is a normal good (see figure 3).

Table 4
Empirical Proxies for Costs and Benefits of Tribal Language Related Activities

	Main theory counterpart	Likely relationship with tribal language use	Likely relationship with income per capita	Mean	N
Variables for 1990 x-section analysis					
Energy resources tribe	M	+ (if normal)	+	0.36	81
Road miles to nearest city	q_E	-	-	157	79
Population density in adjacent counties	q_E	-	+	42.09	79
Per capita income in adjacent counties	w_E, w_J	?	+	19,778	79
Size of American Indian population	b, c	+	?	4,721	81
Percent literate in English in 1915	c	-	?	37.64	59
Percent full blood in 1940	c	+	?	59.39	71
Percent fee-simple land on reservation	q_E	-	?	27.95	81
Time variant variables for 1990-2010 panel analysis					
Slot machines per American Indian	M, w_J	+ (if normal)	+	0.267	243
Population density in adjacent counties	q_E	-	+	49.86	237
Per capita income in adjacent counties	w_E, w_J	?	+	22,066	237

We include two variables to proxy for q_E, which is the probability of finding English-related employment in a nearby non-Indian economy. Our proxies are 1) the number of road miles from a reservation to the nearest large city, and 2) the population density of counties

adjacent to the reservation. We expect both measures to negatively correlate with tribal language use and positively correlate with Indian per capita incomes (see figure 4).

We measure w_E, the wage that can be earned doing English-related work in the non-Indian economy, with the per capita income of non-Indians living in counties adjacent to the reservation. Higher adjacent county income, however, could also increase $q_J w_J$ (demand for tribal-language related goods and services) if the higher incomes translate into higher demand for Indian cultural goods and reservation tourism. We predict that higher adjacent county incomes will positively correlate with Indian per capita incomes on reservations. The relationship between adjacent county income and tribal language use is ambiguous, however, because higher adjacent county incomes raise both w_E and w_J (see figure 4 and 5).

The raw size of the American Indian population is one measure of the probability of encountering another individual who speaks the tribal language. We predict the size of Indian populations to positively relate to tribal language use.

To proxy for the time costs of learning a tribal language we include two variables that we have in hand as a crude attempt to measure variation in the historical density of tribal language use across reservations. Our first variable indicates the percentage of 1915 reservation Indians who were not literate in English at that time, which is the closest time period to 1980 for which we have reservation-level language data. Our second variable measures the percentage of reservation Indian populations considered to be "full-blooded" in 1940.[17] We include these variables because a) they plausibly measures the density of a tribal member's relatives and recent ancestors who spoke the indigenous language prior to 1990, and b) the time costs of learning a tribal language should be inversely related to ancestral use of the language.

Finally, we include a variable measuring the percentage of reservation land that was privatized during the allotment era and that is now held in fee simple. The fee simple variable should negatively correlate with American Indian language use if it validly measures some of the expected benefits of spending time in English related activities.[18]

[17] We obtained this variable from the National Archives in Washington D.C. and it was collected by the Bureau of Indian Affairs in their annual tribal census rolls. 1940 is the latest year for which systematic information on blood mix was available for a large number of reservations. We recognize that this variable may be constructed with error (See Frye et al. 2019).

[18] We assume the probability of encountering a speaker of English rises with the density of fee simple land because non-Indians own much of the privatized land on reservations (cite). Moreover, the benefits of interacting in English

Table 5 shows OLS cross-section regression correlations between the variables just described and the percentage of tribal language speakers in 1990. The dependent variable in columns 1-3 is the percentage of Native Americans speaking a tribal language. The dependent variable in columns 4-6 is Indian per capita income. In columns 1 and 4, we employ the 1915 literacy variable but this allows us to use only 58 observations. In columns 2 and 5, we employ the full-blood variable and this allows us to employ 71 observations. In columns 3 and 6, we include ten BIA regional indicator variables to control for region-specific relationships that may be correlated with our other right-hand side variables.

To summarize the results in table 5, many of the cross-sectional correlations are consistent with the theory about language use summarized in figures 2-5. Moreover, many of the statistically significant relationships persist with the inclusion of BIA administrative area controls, which soak up the predictive power of variables that vary across regions but not within regions.

Two specific findings deserve mention here. First, the insignificant relationship between the energy resources variable and language use may indicate that tribal language related activities were not normal goods prior to 1990. Based on the column 2 and column 4 coefficients, being endowed with energy resources was associated with $756 higher per capita income, but had no significant relationship with the concentration of tribal language use. Second, the strong negative relationships between adjacent county income and language use suggests the assimilation draws of having wealthy neighbors outweighed any compensating incentive to sell language-related tribal culture to neighboring non-Indians, at least prior to 1990. Based on the column 2 and column 4 coefficients, an increase of $1,000 in adjacent county per capita income was associated with a $233 increase in American Indian per capita incomes and a 2.3 percentage point decrease in tribal language use.

The sign of the other relationships in table 5 are not surprising, but some of the magnitudes are larger than one might expect. The coefficient of -0.463 on the percent literate in English variable means that a 10 percentage point increase in the percentage of a reservation's Indian population that were English speakers in 1915 is correlated with a decrease of -4.63 percentage points in tribal language use in 1990. The negative relationships between the percent

should also rise with the density of fee simple land because the rules governing property rights over privatized lands are primarily articulated in English.

fee simple variable and tribal language use suggest that privatization has had a destructive effect on tribal language use, at least through 1990.

Table 5
OLS Estimates of Tribal Language Use and Per Capita Income in 1990

	Y = % Speaking tribal language, 1990			*Y = Am. Indian per capita income, 1990*		
Independent Variables (1990 unless otherwise specified)	(1)	(2)	(3)	(4)	(5)	(6)
Energy endowed tribe	-3.22	4.27	3.62	886.7*	756.7*	82.56
	(0.483)	(0.432)	(0.585)	(0.055)	(0.051)	(0.875)
Miles to nearest city	-0.017	-0.045**	-0.071**	-2.509	-1.154	3.111
	(0.408)	(0.021)	(0.018)	(0.188)	(0.462)	(0.309)
Pop density in adj. counties	0.058	0.043	0.039	-4.288	9.166**	8.348***
	(0.190)	(0.216)	(0.344)	(0.655)	(0.028)	(0.008)
Income in adjacent counties	-0.0023**	-0.0027***	-0.0022**	0.278***	0.233***	0.131**
	(0.025)	(0.009)	(0.031)	(0.000)	(0.000)	(0.041)
Am. Indian population	-0.0003***	-0.0002***	-0.0020*	-0.012**	-0.0079	-0.077
	(0.000)	(0.000)	(0.053)	(0.041)	(0.122)	(0.431)
% Literate in English, 1915	-0.463***			16.06		
	(0.000)			(0.257)		
% Full blood, 1940		0.417***	0.427***		-11.33	-24.05
		(0.001)	(0.002)		(0.230)	(0.131)
Percent fee simple	-0.239***	-0.294***	-0.266***	-4.682	0.119	13.74
	(0.000)	(0.000)	(0.001)	(0.542)	(0.989)	(0.130)
BIA Region Fixed Effects	No	No	Yes	No	No	Yes
Constant	88.94***	63.27***	49.97**	3178.9**	4438.9	4519.9*
	(0.001)	(0.001)	(0.024)	(0.024)	(0.007)	(0.050)
Observations	58	71	71	58	71	71
Adjusted R^2	0.63	0.61	0.70	0.32	0.39	0.63

Notes: p values in parentheses, * statistically significant at p<0.1, ** p<0.05, *** p<0.01. The standard errors are robust to heteroskedasticity but are not clustered. The ten BIA regions are Southern Plains, Eastern Oklahoma, Western, Great Plains, Eastern, Pacific, Midwest, Northwest, Navajo, Southwest and Rocky Mountain. These regions are described at http://www.bia.gov/.

To more directly shed light on the theoretical ideas in figures 2-5, we now focus on the determinants of changes in tribal language use within reservations during 1990 to 2010. Focusing on changes allows us to hold constant much of the time-invariant noise that causes unobservable

cross-sectional differences in both language use and per capita incomes across reservations. Our panel analysis necessarily focuses on the subset of language and income determinants that were time-variant over 1990 to 2010. The time variant determinants include the emergence of casinos and changes in adjacent county populations and adjacent county per capita incomes.

We estimate standard panel regression models of the form in (2) and (3)

$$(2)\quad \begin{aligned}&\%\text{tribal language speakers}_{jt} = \alpha_j + \mu_t + \beta_1 slotspc_{jt} + \beta_2 slotspc_{jt}^2 + \beta_3 adjctypd_{jt} \\ &+\beta_4 adjctypci_{jt} + \beta_5 \%triballang_{jt-1} + \varepsilon_{jt}\end{aligned}$$

$$(3)\quad \begin{aligned}&\text{AI PCI}_{jt} = \alpha_j + \mu_t + \beta_1 slotspc_{jt} + \beta_2 slotspc_{jt}^2 + \beta_3 adjctypd_{jt} \\ &+\beta_4 adjctypci_{jt} + \beta_5 aipci_{jt-1} + \varepsilon_{jt}\end{aligned}$$

where j = 79 reservations (with complete data for each year) and t = 3 time periods (1990, 2000, and 2010). The variables α_j denoted the 79 fixed effects for each reservation. Including these fixed effects implies that we are identifying the coefficients from within reservation changes in income over 1990-2000 and 2000-2010. Thus, our strategy here is to hold constant factors that differ across reservations but that do not vary much over time (e.g., geographical isolation, historical language use concentration, land ownership). We estimate time effects, μ_t, for 1990, 2000 and 2010 to control for any trend in reported language use that is common across all tribes.

Table 6 shows our panel regression estimates. In columns 1-4, the dependent variable is the concentration of tribal language speakers. In columns 5-8, the dependent variable is American Indian per capita income. In columns 3, 4, 7, and 8, the dependent variables are logged allowing us to focus on percentage changes in the dependent variables. In columns 2, 4, 6, and 8 we include a lagged dependent variable on the right hand side ($\%triballang_{it-1}$ and $aipci_{it-1}$) to allow changes in language use and per capita incomes to be influenced by the starting-point stocks of each variable.

Focusing first on our measures of casino activity, note that we include the variable Slots per Am. Indian ($slotspc_{it}$) and its squared term ($slotspc_{it}^2$). Throughout the specifications, the slot machine variable is positively related to both per capita income and tribal language use. The squared term is always negatively related. These findings mean that the positive effect of having more casino gambling machines declines with the number of machines. Focusing on column 1, the coefficients of 3.474 and -1.103 mean that adding more slot machines had a positive effect on

tribal language use unless the decadal change in slot machines per capita exceeded 3.474/(2 x 1.103) = 1.57. In column 5, the coefficients of 3220 and -977 mean that adding more slot machines had a positive effect on tribal incomes unless the decadal change in slot machines per capita for a reservation exceeded 3220/(2 x 977) = 1.64.

Table 6
Panel Regression Estimates of Income Changes on Language Retention
For 1990, 2000, and 2010

	Y = % Speaking tribal language				*Y = Am. Indian per capita income*			
	Dependent Variable is not Logged		Dependent Variable is Logged		Dependent Variable is not Logged		Dependent Variable is Logged	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Slots per Am. Indian	3.474*	3.316	0.871***	0.793***	3220.6***	3180.1***	0.193**	0.200**
	(0.10)	(0.181)	(0.000)	(0.000)	(0.000)	(0.001)	(0.035)	(0.02)
Slots per Am. Indian^2	-1.103***	-1.091***	-0.238***	-0.215***	-977.6***	-962.8***	-0.048***	-0.053***
	(0.002)	(0.006)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Pop density in adj. counties	-0.0236	-0.0187			0.557	0.134		
	(0.467)	(0.620)			(0.951)	(0.989)		
Log of Pop density in adj. counties			0.141	0.239			-0.005	-0.005
			(0.348)	(0.195)			(0.911)	(0.911)
Income in adjacent counties	0.0014**	0.0014**			0.377***	0.382***		
	(0.014)	(0.013)			(0.003)	(0.003)		
Log of Income in adjacent counties			1.301*	1.212			0.854***	0.834***
			(0.098)	(0.136)			(0.000)	(0.000)
Lagged dependent variable		-0.194**		-0.241***		0.031		-0.167**
		(0.013)		(0.000)		(0.828)		(0.022)
Year 2000	-0.615	-3.678*	0.182	0.007	934.7**	957.4**	0.096**	0.087**
	(0.735)	(0.097)	(0.268)	(0.966)	(0.019)	(0.034)	(0.012)	(0.026)
Year 2010	-2.813	-5.098**	-0.124	-0.169	1608.6***	1556.8***	0.154***	0.185***
	(0.214)	(0.040)	(0.569)	(0.448)	(0.006)	(0.003)	(0.006)	(0.001)
Reservation fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time period effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations (N=79, T=3)	237	237	237	237	237	237	237	237

Notes: p values in parentheses, * statistically significant at p<0.1, ** p<0.05, *** p<0.01. The standard errors are clustered at the reservation level, with N=79 reservations.

To understand the effects of additional slot machines, consider the average change in slot machines per capita over 2000 to 2010, which was an increase of 0.205. The column 1

coefficients imply that this change increased tribal language use by 3.474 *x* 0.205 – (1.103 *x* 0.205^2) = 0.66 percentage points. The column 5 coefficients imply the change increased per capita income by 3220 *x* 0.205 – (977 *x* 0.205^2) = $619. The column 3 coefficients imply the increase of 0.205 in slot machines per capita led to an increase of 0.871 *x* 0.205 – (238 *x* 0.205^2) = 0.168 in the dependent variable, which is a 16.8 percentage (not percentage point) increase. The column 7 coefficients imply the increase of 0.205 led to an increase of 0.193 *x* 0.205 – (0.048 *x* 0.205^2) = 0.038 in the dependent variable, which is a 3.8 percentage increase in income.

Changes in adjacent county income were also positively related to changes in both dependent variables. In column 3, the coefficient of 1.301 means that a 10 percent increase in adjacent county income led to an increase of 13.01 percent (not percentage points) increase in the concentration of tribal language use. The corresponding column 7 coefficient of 0.834 means that a 10 percent increase in adjacent county income led to an 8.34 percent increase in Indian per capita incomes. These findings mean the percentage response of language retention to shocks in adjacent county income was larger for tribal language use than it was for per capita income.

Finally, note the negative signs on the lagged dependent variables in columns 2 and 4. These negative coefficients indicate that higher growth in language use over 1990 to 2010 was more often obtained on reservations having lower initial concentrations of tribal language users. One interpretation of this result is that more effort was applied to language recovery on reservations where tribal languages were closer to the brink of extinction.

To summarize the empirical findings, economic development and tribal language use were at odds with one another up until 1990, prior to the casino era. After 1990, however, the relationship flip-flopped. The weight of the empirical evidence indicates that recent income gains on reservations - emanating from casinos and adjacent county wealth - have perhaps enabled tribal language retention.

V. Future Directions

This analysis complements other research finding positive effects of casinos on incomes and health outcomes (Akee et al. 2010, Wolfe et al. 2012, Akee et al. 2013). Although many observers assume the benefits of casinos necessarily came at the expense of tribal culture, our empirics suggest the opposite effect. The emergence of casinos may have been a catalyst for language revival. Although we cannot precisely identify all of the mechanisms through which

casinos have enhanced language investments, our theory hypothesizes that pure income effects and increased demand for cultural tourism have played roles.

Our ability to improve on the empirical work presented here depends on the extent to which we can track down additional data and identify causal channels. Although our theory centers on an individual's decision to invest in language use, all of our empirical tests employ data aggregated up to the reservation level. Moving forward, we may attempt to obtain disaggregated individual household level data from 1980 – 2010 Census reports. Disaggregated data would allow us to examine language decisions at a deeper micro level. We also hope to obtain more detailed data on the sources of individual incomes. Our theory predicts that wage earnings, self-employment earnings, transfer payments, and payments to tribal assets will relate differently to language use decisions, but we are presently unable to precisely test for relationships by income source.

We focus here on gaming income but there are other plausibly exogenous shocks to tribal income that may also be utilized to study the effects of income and wealth on language use. In the U.S. and globally, there has been a recent wave of treaty settlement payments to tribal groups. It may be possible to track the extent to which these funds have been invested in cultural assets.

VI. References *[many more in text]*

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