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Colonialism and Modern Income -- Islands as Natural Experiments

James Feyrer and Bruce Sacerdote[1]

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Using a new database of islands throughout the Atlantic, Pacific and Indian Oceans we find a robust positive relationship between the number of years spent as a European colony and current GDP per capita. We argue that the nature of discovery and colonization of islands provides random variation in the length and type of colonial experience. We instrument for length of colonization using variation in wind speed and direction. Wind patterns which mattered a great deal during the age of sail do not have a direct effect on GDP today, but do affect GDP via their historical impact on colonization. We explore whether the income-colonialism connection comes through institutions, human capital, trade, or religion. We find evidence consistent with the hypotheses that the quality of government institutions matters a great deal as does the human capital brought by colonial settlers. Post-enlightenment years as a colony are more beneficial than pre-enlightenment years. Higher settlement rates and more intensive government administration increase the impact of colonialism. Missionary activity is positively correlated with income and this is likely through the channel of formal schooling. Modern Christian religiosity, the introduction of trade products and historical reliance on slavery and sugar plantations are unrelated to current income per capita.

[1] Feyrer, Dartmouth College: james.feyrer@dartmouth.edu; Sacerdote, Dartmouth College and NBER: bruce.sacerdote@dartmouth.edu; We thank Lauren Burrows, Katie Jaxheimer, and Celia Carmen for superb research assistance and the National Science Foundation for generous support. Seminar participants at MIT, NBER, Brown, University of Houston, Texas A&M, and other universities provided very helpful comments.

I. Introduction

Understanding the variation in income across countries remains one of the most important research questions in economics. This paper examines one potentially major cause of long term income differences between countries – variation in the nature and length of colonization by Europeans. We use a new dataset of islands in the Pacific, Atlantic, and Indian oceans that were colonized during the Age of Discovery. The main advantage of our new dataset is random variation in the colonial experience. We argue that the finding and colonizing of the islands in our dataset has a large random component and that the colonial experiences of our islands constitute a natural experiment. We test this conjecture by using wind patterns as an instrument. Wind was crucial during the Age of Discovery, but is not relevant to modern travel and therefore provides an ideal instrument for the colonial experience.

The central finding in our paper is that the length of colonial period is strongly positively related to modern outcomes. In order to asses the randomness of the colonial experience (colonizers may settle the best places first and give them up last), we instrument for the year of European discovery and subsequent length of colonial period using data on wind patterns. The IV results are extremely similar to the OLS results, which is consistent with our assertion that much of the variation in the colonization of islands is random. Our finding is quite robust within our islands data set and we show it also holds within the Acemoglu Robinson Johnson [2002] set of continental countries.[2]

Having established this fact about colonialism and income, we then attempt to distinguish among four possible channels which connect income and colonialism – government institutions, human capital, trade, and culture in the form of religion.

Consistent with AJR, we find that the type of government institutions and the degree of settlement matter and in the same direction their work suggests. The historical record

[2] We define a colonial year as one in which Britain, France, the Netherlands, Germany, Spain, Portugal, or the US had political control of the island and had officially designated the island to be a colony, territory or protectorate. Later in the paper we will further divide colonial years into those with and without settlers and with and without a colonial administration present on the island itself.

suggests that the quality of colonial regime was influenced by the identity of the colonizer and the timing of colonialism. Pre-enlightenment colonization (i.e. in the 1500 and 1600s) and colonization by Spain and Portugal are found to be less beneficial than later colonization. More intensive colonial supervision (through having a colonial administration and governor on the island) increases the strength of the connection to modern outcomes.[3]

Our results also support the notion that colonialism raises income by raising human capital on the island (Glaeser et al. [2004]). For example formal schooling on these islands was largely a function of the presence of missionaries and we find a strong connection between missionaries per capita (measured at various time periods) and current income.[4] The amount of settlement (with or without a colonial administration) is also correlated with current income, and this fact is consistent with both the human capital (via importation of settlers) story and an institutional quality story.

In contrast to Engerman and Sokoloff [2003, 2005] we do not find evidence that colonialism effects income through inequality. In fact, the sugar-slave islands in our sample are no higher or lower income on average than the other islands. The current percentage of inhabitants that are black (which is one good marker for former plantation islands) is uncorrelated with current income per capita. For example, some of the richest Carribbean islands (St. Kitts, The Bahamas, Turks and Caicos, Sint Martin) are predominantly black as are some of the poorest (Haiti, Jamaica, and Dominica).

We also failed to find evidence that colonizers affect modern income by introducing exportable trade products. We certainly believe that these export products raised income

[3] One institutional feature that is often suggested as a cause of income is democracy. We look at the first date that each island has an elected legislature (including colonial legislatures). By this measure, there is substantial variation in when the various islands obtained democratic institutions. Former Spanish colonies were the slowest to have a democratically elected legislature and former British island colonies were the fastest. However, this measure of democratic institutions is not a significant predictor of modern output in our sample.

[4] The idea of collecting data on missionaries by country is from Woodberry [2004] who examines the connection between missionary presence and democratic government. As detailed below, we use several of his key data sources to build our missionary variables.

at the time they were introduced given for example the vast wealth amassed by plantation owners while growing these crops.

Finally, we do not find evidence that religious affiliation (eg percent Christian or percent Protestant) is correlated with income. Historical presence of missionaries has a strong connection with current levels of religious affiliation, but percent Protestant, Catholic or Christian is not correlated with income across islands.

II. Previous Literature

Many authors have explored the links between colonialism and modern day outcomes, though little consensus exists. Historians and political scientists have emphasized the long term negative consequences of colonial rule including the possible inability of former colonies to transition to a stable form of self government or the possible negative effects of resource extraction (see for example Rodney [1974]).

Recent economic work on the importance of institutions has emphasized the colonial legacy. La Porta, Lopez de Silanes, Shleifer and Vishny [1997, 1998] show that former colonies of English common law countries have more developed capital markets than former colonies with French civil law. Banerjee and Iyer [2005] look at the effect of differences in colonial property rights institutions in India. Acemoglu, Johnson and Robinson [2001, 2002] show that the form of colonization (extractive versus heavy settlement by Europeans) tended to determine the type of institutions created in the country and therefore strongly affected modern outcomes. Engerman and Sokoloff [2005] hypothesize that forms of colonialism which promoted severe inequality hampered the future growth prospects of a colony.

Obviously causality is problematic in considering the effect of institutions on income. Glaeser, La Porta, Lopez de Silanes, Shleifer and Vishny [2004] argue that human capital causes growth and rich countries then adopt good institutions. The literature has attempted to deal with this reverse causality through the use of instrumental variables, but finding appropriate instruments is difficult. Mauro [1995] uses ethnolinguistic fractionalization to instrument for corruption. Hall and Jones [1999] use the distance

from the equator as an instrument, arguing that this determines the degree of European influence. In neither case is it clear that the instrument does not have a direct effect on output. In a paper focusing on Indian states, Iyer [2005] uses the deaths of rulers lacking male heirs as an instrument for the degree of British colonial control. Acemoglu, Johnson, and Robinson [2001, 2002] argue that the death rates of settlers provide a useful instrument for modern institutions. This approach has not been without critics. McArthur and Sachs [2000] argue that settler mortality is related to the overall disease environment and has a direct effect on output.

We bring two innovations to this debate. First, we have created a new database of 81 islands which contains a large number of additional data points beyond the usual cross section of countries used by growth economists. Of the 136 countries in the Penn World Tables with GDP data for 1989 only 13 are in our database.[5] Islands provide an interesting experiment in that our sample has more homogenous initial conditions than the Penn World Tables group. Second we argue that variation in the colonial experience of islands was relatively random and therefore constitutes a natural experiment.

We propose and implement a new source of exogenous variation in colonial history – wind patterns. Wind speed and direction were crucial during the age of sail, and have useful variation within each ocean and within given latitudes. Islands located near routes in the prevailing winds made useful stopovers and were more easily revisited and colonized. However, since the beginning of the age of steam began over 100 years ago, the importance of wind patterns has disappeared. We argue that any effect of wind speed on current GDP works only through wind's effect on European settlement.

[5] Barbados, Comoros, Dominican Republic, Fiji, Haiti, Jamaica, St. Kitts and Nevis, Mauritius, Philippines, Seychelles, Trinidad and Tobago, Puerto Rico, Vanuatu

III. Islands as Natural Experiments and the Importance of Wind

The Random Component of Island Settlement

The exploration and settlement of islands in the Pacific, Atlantic and Indian Oceans entails hundreds of fascinating stories and historical accidents. At the broadest level, the pattern of island discovery by Europeans makes a great deal of economic sense. Most of the Caribbean islands were known to Europeans prior to most of the Pacific Islands. This was a matter of distance from Europe and the incredible vastness of the Pacific. For example, Columbus sighted the British Virgin Islands in 1493 and he had already sighted portions of the Bahamas, Hispaniola and Cuba a year before that. Of the 39 Atlantic islands in our database, 24 were first sighted by Columbus during one of his three voyages. By 1685 the Dutch were using St. Thomas (Virgin Islands) as a slave trading post and the island contained large sugar plantations by the mid 1700s.

Meanwhile, certain islands in the Pacific (in French Polynesia and the Cook Islands in particular) were not sighted by Europeans until the late 1700s. Patterns of settlement were determined in part by obvious economic factors like distance to the mainland. However, a fair amount of colonization was due to unique historical accidents and due to historical trade routes and wind patterns.

The Mutiny on the Bounty itself led to the discovery of several islands and the colonization of at least two. While fleeing Tahiti, the mutineers discovered Rarotonga in the Cook Islands. Captain Bligh discovered Kadavu in Fiji as he sailed his open boat 3,600 miles from the Friendly Islands to Java (without losing a single one of his 18 crewmembers). The mutineers settled on Pitcairn (with their Tahitian wives) precisely because no one lived there and it was not near any land mass of note. The mutineers' descendants became so numerous that the British government then moved some of them to Norfolk Island thereby creating a second new colony.

One island in our data set, Penrhyn in the Cook Islands was accidentally colonized in 1788 when Captain Sever smashed his ship (the Penryhn) into the shoreline on his way to deliver convicts to Botany Bay. Vanuatu acquired a small settlement in 1825 when one

sailor discovered that it contained sandalwood, which was at that time very valuable. Palmerston was colonized by the British mostly because it was empty when Captain Cook discovered it. The first group of settlers took to murdering each other. However the second settlement was more successful; William Marsters moved there in 1862 with his three Polynesian wives and his descendants are still there.

III.A. The Importance of Wind

Though random accident played a large role, we will also argue that wind speed and direction were important factors in the pattern of island colonization. Unlike powered boats, sailboats require steady wind to make headway. Islands located in areas where the wind is weak were less likely to be discovered, revisited, and colonized by Europeans. Wind direction is also important. The technology available at the time of the voyage of Columbus only allowed ships to sail about twenty degrees into the wind. This technology improved slowly over time, but sailing into the wind remained difficult until steamships became the norm in the twentieth century.[6]

Consistent downwind routes between useful destinations were therefore well traveled while much of the globe went virtually untouched. Much of the east to west traffic across the Pacific after Magellan's 1521 crossing closely followed his pioneering voyage because his path was the logical and efficient way to cross. Crossing in the opposite direction turned out to be much more difficult due to prevailing wind patterns.[7] At least four Spanish expeditions attempted and failed to establish a west to east route across the Pacific in the wake of Magellan's voyage. It was not until 1565 that a west to east path was found across the Pacific and this required sailing much farther north.

The net result of this history is that the pattern of colonization is related to the speed and direction of the prevailing winds. Islands like Fefan and Pohnpei in the Federated States

[6] Sailing ships were common for transoceanic voyages long after the introduction of steam powered ships because it was difficult for early steamships to carry enough fuel for long voyages. This was particularly true in the Pacific.

[7] At the middle latitudes where most of our sample is located the prevailing winds are to the west in both the Pacific and the Atlantic.

of Micronesia have calm winds, were not located near the Spanish trade route and were basically left alone, even after their discovery in the 1680s. At the other extreme, despite also being quite isolated, Guam was directly on the Spaniard's Manila Galleon route due to a favorable combination of wind and currents. Magellan found Guam in 1521 and by the end of the century it was settled as a watering hole for Spanish ships on the Mexico-Philippines route.

Once an island was discovered, the path to European settlement was made more difficult by the crude state of mapping technology. Before the mid eighteenth century the measurement of longitude at sea was extremely imprecise. Sailors had to rely on dead reckoning to measure which became less and less precise the further the ship strayed from known landmarks.[8] There are many cases of islands appearing multiple times on early maps because longitude was estimated differently by separate voyages. Revisiting an island charted by a previous voyage was problematic. The known map of the world at the dawn of the eighteenth century was therefore incomplete and inaccurate. Such was the state of ignorance that many still held out hope of a large undiscovered land mass in the Pacific. This changed during the latter half of the eighteenth century with the solution of the longitude problem by Harrison. James Cook and others made voyages which filled in the remaining map of the Pacific.

Latitude sailing was the most common form of navigation before the solution to the longitude problem. Suppose you were trying to sail from Europe to a particular island in the Pacific without an accurate measure of longitude. You would head north after rounding Cape Horn until the vessel was at the same latitude as the destination. This was easy and effective because the ship's latitude could be easily and accurately determined by measuring the height of the sun off the horizon at noon. Similarly, the latitude of your destination on charts was well measured even if the longitude was not. Once at the proper latitude, all that was needed to get to the destination was to sail due west until you arrived. In order for this strategy to work, it was important that you arrived at the target

[8] Magellan's voyage was predicated on the hope that the spice islands were on the Spanish side of the line described by the Treaty of Tordesillas. This uncertainty was made possible because the precise longitude of the islands was uncertain at the time.

latitude to the east of your destination, forcing ships to sail north more rapidly than would be sensible on a direct route. With this style of navigation, east-west corridors with steady winds become more frequently traveled.

We propose wind speed as an ideal instrument for colonization and settlement. Wind was incredibly important during the age of sail, but its importance came to an abrupt halt early in the twentieth century. Within our sample, wind speed should not have a direct effect on an island's current level of GDP, but could have an important effect via the island's history of colonization. The vast majority of our sample is in the westerly trade winds. In a first stage regression, the average speed and variability of the westerly winds are significant determinants of the number of years of colonization.

IV. The Nature of Island Colonization

In the Atlantic islands, colonization generally consisted of several hundred or a few thousand Europeans arriving and in some cases being granted large parcels of land for farming. Early Spanish colonialism was governed by the *encomienda* system which essentially introduced feudal institutions to the colonies. The *conquistadors* were given trusteeship over the native peoples. In practice, natives (mostly Arawaks or Caribs) were often enslaved to work on these plantations.

Initially the Spanish focused on extracting gold from rivers and showed reckless disregard for the natives enslaved to do the work. At its peak in 1510, Puerto Rico produced 100,000 pesos of gold, but gold production gave out completely by 1540 (Carrión [1973]). Sugar cane was introduced and soon became a chief export crop in the Caribbean islands. As early as 1550, Puerto Rico had 10 sugar mills producing 500,000 pounds of sugar a year. Coffee was introduced in Puerto Rico in 1736 and ginger and tobacco were also important crops (Carrión [1973]).

The English and French were more enterprising than the Spaniards in setting up the sugar-slave economy and by 1673 there were 57 plantations in English controlled

Barbados. Jamaica was at one point in the 17th century (after the British captured it from the Spaniards) the world's largest producer of sugar (Black [1881]). By 1700, the French had established many sugar plantations on virtually all of their islands, including Martinique, Guadeloupe, Grenada, St. Croix, and Saint-Domingue (present day Haiti).

In the late sixteenth and early seventeenth centuries the island-colonies in the Caribbean tended to have several hundred Europeans and, following the introduction of sugar were often outnumbered by African slaves by a factor of 10 to 1. In 1530 Puerto Rico had about 400 Spaniards and 2200 African slaves (Wagenheim [1973]). By 1789 Saint-Domingue was home to 40,000 whites and 455,000 black slaves.

Colonies in the Pacific Islands tended to involve fewer numbers of Europeans and far less reliance on imported slaves. Missionaries were often the first colonial residents. For example, Guam was first sighted by Magellan in 1521. In 1668 the Spanish installed a group of Jesuit missionaries, a single garrison of soldiers and a colonial governor. The Spanish mission totaled 50 people relative to the 12,000 Chamorros on Guam. (Douglas [1994], Rogers [1995]).

European contact with and colonization of Tahiti was relatively late in coming. Wallis landed there and traded with the natives in 1767. Cook did the same two years later and then Bligh visited several times and stayed for several months. British missionaries eventually showed up around 1797. The mission consisted initially of 18 men and 5 women and these Europeans settled on the Matavai Bay peninsula. British ships continued to stop in Tahiti with increasing frequency to take on water and food. By the census in 1848 there were about 500 white people in Tahiti (Newbury [1980]).

French missionaries arrived in New Caledonia in 1843. By 1878, the French had established a penal colony there with 6,000 white prisoners and several hundred free whites including soldiers (Lyons [1986]). Spain's colonization of the Caroline and Marshall Islands was extremely sparse. In 1710 two Jesuit missionaries were landed at Palau but were never seen or heard from again. The Spanish placed a handful of

Capuchin monks on Yap who opened a school and managed to convert a large number of natives.

In the late nineteenth century entrepreneurial traders and employees of trading companies were also responsible for a modest presence of Europeans and Americans on some Pacific Islands. O'Keefe was an Irish-American from Georgia who ran a series of trading outposts and stores on Yap and Palau (Hezel [1995]). James Paddon, a sandalwood merchant, was one of the first white settlers in New Caledonia. In 1851, he moved his trading and shipping business to the area that became the town of Noumea.

IV.A. The Immediate Impact of Colonization: Loss of Native Peoples to Disease and Slavery

One of the most striking and terrible facts about colonization by Europeans is the degree to which native populations on some islands were decimated either by brutal enslavement or by diseases carried by Europeans and their animals (See Diamond [1997]). This is most true in the Atlantic where certain islands lost their entire native population in a short amount of time. For example, the Spaniards began to colonize Puerto Rico in 1505 under the leadership of Ponce de Leon. The native Tainos were enslaved as part of the *encomienda* system in which land grants to Spaniards included the right to extract tribute or labor from the natives assigned to that land. The original population of Tainos was estimated to have been 60,000. By 1515 this had fallen to 14,400 and by 1530 to 1,500 (Wagenheim [1998]). Prior to the arrival of Europeans, Jamaica was heavily settled and was home to tens of thousands of Arawaks. Not a single one of the natives were alive by the time the British took over from the Spanish in 1655 (Black [1881]).

The Pacific islanders also faced shocking mortality due to smallpox and other diseases brought by the Europeans.[9] However, only a few of the islands saw a complete wiping out of the original inhabitants and several islands fared reasonably well. Perhaps the worst depopulation occurred in Guam and the Marianas. The number of pure blooded

[9] Venereal disease brought by the Spaniards often lead to sterilization.

Chamorros on Guam fell from 12,000 in 1668 to 1,576 in 1742[10]. By this point the Chamorros were well intermarried with Filipino and Spanish immigrant families.

The Tahitians saw a drop in their population as a result of the introduction of European disease, but this was followed by a partial recovery. One estimate puts the population of Tahiti at 24,000 around the time of Cook's visit but only 9,000-10,000 by 1800. The native population stabilized and remained around 9,500 at the time of the 1848 census. There was a discrete drop in the 1850s (an epidemic?) but population not only recovered to the 1848 level but grew modestly for the next 60 years (Newbury [1980]).

Any discussion of the effects of colonialism on economic output has to acknowledge the devastation of native populations and cultures. Our results show that islands with a longer colonial history (and more settlement by Europeans) have higher income per capita and lower infant mortality than other similar islands. Is it sensible to measure the positive effects on growth from European contact if in fact the original inhabitants are partially or entirely wiped out because of that contact? Is the possibility of no European contact a realistic counterfactual? Even without colonialism proper, any contact still may have wiped out entire populations.

We do not intend to address these questions in this paper. Our results are simply an examination of the standard of living of people currently alive on these islands relative to the colonial experience. We do, however, recognize that there are other measures of the outcomes from colonialism that may generate different conclusions. It is certainly plausible to argue that the accumulated utility of Pacific Islanders since first encountering Europeans is lower than in the counterfactual even if the current standard of living on these islands is significantly higher because of that contact.

[10] Douglas [1995] notes that the population decline probably started much earlier, i.e. in 1564 when Legazpi's expedition visited the Marianas and likely introduced European diseases.

V. A Framework for Understanding the Long Run Impact of Colonialism on Income

The central finding of our paper is that there is a robust positive relationship between colonial tenure and modern outcomes. The obvious question is why? We consider four possible theories: Institutions, Human Capital, Trade, and Culture.

To distinguish among competing theories of colonialism's impact on modern income, we introduce additional right hand side variables into our cross island growth regressions and ask which of these variables are significant predictors of current income and which of these variables reduce the estimated coefficient on "number of years as a colony." We then ask whether the results are consistent with each of the theories. Below we list the hypotheses and how the variables in our data set might be useful in distinguishing among the hypotheses.

Additionally, we ask whether there is any relationship between historical income inequality and income today. Some islands might have experienced a negative effect from colonialism if for example the main impact of the colonizers was to introduce very lopsided land holdings or the plantation system (Engerman and Sokoloff [2005]). Inequality could potentially be a mechanism which *reduces* the positive effect of colonialism on income if the plantation system is associated with longer colonial rule. The islands in our sample that had sugar plantations experienced 150 more years of colonialism than those without sugar plantations. But this is mostly an Atlantic Pacific difference that goes away when we control for ocean dummies.

V.A. Institutions

More intensive involvement with Europeans or longer colonial rule might have left islands with a more stable or better structured government. This theory is most associated with Acemoglu Robinson and Johnson [2001]. However it's not easy to identify which governmental institutions are the most critical, and measuring institutional quality is extremely difficult. Furthermore, even if we had a modern index of say,

expropriation risk or corruption for these islands, one might worry that good modern institutions were caused by high incomes rather than the other way around. We offer several partial (and admittedly imperfect) solutions to this conundrum.

In order to examine whether the quality of governmental institutions matters we look at variation in both who did the colonizing and when colonialism occurred. It is fairly well acknowledged that the Spanish and the Portuguese were particularly brutal in their treatment of the natives. If years as a Spanish and Portuguese colony produce less of a positive impact of colonialism on modern income, we take that as evidence that institutional quality is partially driving our result. The Spanish thought very little of enslaving hundreds of thousands of Arawaks on Puerto Rico to pan for gold, and worked the natives to extinction within a very short period of years. The Spanish were also happy to enslave and relocate entire island populations if the Crown thought the labor was needed on a different island (where the slaves had already all died.). The Bahamas and the Northern Marianas are two prime examples.

Leaving aside the shocking treatment of the natives, the Spanish also spent hundreds of years pursuing policies which were counter productive to growth and which were known to be so, even given the state of economic understanding in the 1500s. For example, for a long time the Spanish insisted that all trade from the West Indies be funneled through Seville. This made less and less sense as the population in British North America and the British West Indies grew and was eager to trade with Cuba, Puerto Rico, the Dominican Republic and the other Spanish islands. Spanish planters in Puerto Rico lost their productive advantage in sugar to the British held islands and they turned to ginger which was in high demand. The Spanish governor in Puerto Rico responded by banning the production of ginger explicitly because it was attracted trade that was not from Seville. The Spanish also handed out enormous tracts of island land to aristocrats who in some cases were absentee landlords and in other cases had weak incentives to maximize agricultural output.

The British and French colonizers had policies which killed fewer natives and killed fewer imported slaves and which achieved much higher levels of agricultural productivity than the Spanish had achieved with the same piece of land. Jamaica and Barbados are two examples of this phenomenon.

We also think that the timing of colonialism (holding colonizer constant) may be related to institutional quality with the later period representing both better governmental institutions and better intentions on the part of colonizers. There was a distinct change in the attitude of the explorers toward the world between the beginning of the period of exploration and the final filling in of the map of the world. A simple illustration of this point can be seen in the differences between the voyages of Ferdinand Magellan and James Cook.

When Magellan set sail on his famous circumnavigation in 1519 his goal was to find a Spanish route to the Spice Islands. The Treaty of Tordesillas in 1494 split the world between Spain and Portugal at 46°W longitude. The Spanish felt that a westward route would allow them to lay claims on the Spice Islands. The agreement between Spain and Portugal had the blessing of the Pope and along with their rights to these unfound lands came a responsibility to spread Christianity. Magellan's voyage was therefore explicitly commercial with religious overtones.

This stands in stark contrast to the voyages of James Cook between 1768 and 1779. Cook's missions had explicit scientific aims. On all three voyages, Cook brought artists and scientists to record and study all that he found. Unlike Magellan, who was driven to bring Christianity to the natives, Cook had a much more romantic view of the Pacific islanders.

> "We debauch their morals already too prone to vice and we introduce among them wants and perhaps diseases which they never before knew and which serves only to disturb that happy tranquility they and their forefathers have enjoyed … If anyone denies the truth of this assertion let him tell me what the natives of the whole extent of America have gained by the commerce they have had with Europeans."[11]

[11] Hough [1994].

There is evidence that the more enlightened attitude of the later explorers is correlated with a more enlightened approach to administering colonies. Some of the Pacific Islands were not colonized until the mid-19th Century (for example Tahiti and the Marquesas). No enslavement of the natives took place there and representative local governments were set up within 70 years of colonization.

More generally, many of the institutional features considered to be important for modern outcomes were not well developed in European countries in the earlier period and therefore not available for transfer. The primacy of parliaments, the importance of the rule of law, and the protection of property rights advanced significantly between the sixteenth and eighteenth centuries. To the extent that we find that later colonial years (for example those after 1700) are more beneficial than earlier colonial years (e.g. those before 1700), we take this as another indicator that institutional quality partly explains the colonialism-income connection.

Another source of variation is in the intensity of institutional transfer. To this end we examine differences in years with and without active administration on the ground. We also look at the effect of different levels of settlement. Many islands in our data set have both large administrations and many settlers, while other islands have many settlers but no administration and no governor physically present on the island. If the intensity of colonial government or intensity of settlement matter, we take this as supportive of both the institutional quality story and the human capital story. AJR argue that heavy settlement leads to better government, but the settlers themselves also represent the embodiment of human capital.

We also examine two specific types of institutional transfer that have been emphasized in the literature. Engerman and Sokoloff [2005] emphasize the negative effect of unequal land holdings. The most extreme examples are colonies relying on the plantation system and cultivation of sugar with slave labor. We will test to see whether there is a negative effect of sugar plantations or imported slave labor.

Finally, we ask whether the timing of democracy's arrival on an island is correlated with current income. This may be a useful test if democracy is a signal of longstanding high quality institutions. On the other hand, if democracy is simply an outcome from successful economic growth (Glaeser et al [2004]) then this test may be a red herring.

V.B. Human Capital

Colonialism may raise an island's income via an effect on human capital. The human capital that matters could be either formal schooling (e.g. literacy), or it could be the practical knowledge that craftsmen and other professionals transmit to their apprentices, coworkers and family members. For example, the Europeans had a much more advanced knowledge of navigation, sailing theory, and large ship building practices than did the natives whom they colonized. Furthermore, the Europeans may have introduced agricultural products or agricultural techniques which significantly raised total output on these islands.[12] Human capital of both types (formal schooling and practical knowledge) is both transmitted to natives and embodied in the colonial settlers themselves. And as noted in the previous section this makes it difficult to distinguish between a human capital and an institutional story if settlement promotes both human capital and good government.

Fortunately we are able to explore the degree to which schools and formal schooling brought by colonizers are correlated with income today and the degree to which this explains the colonialism income connection. Following Woodberry's [2004] methods and sources we collected data on the presence of missionaries, missionary schools, and numbers of students island by island. We believe that missionaries are a good proxy for historical levels of schooling on the island. Until the twentieth century, schools on our islands were almost exclusively the province of the Church.[13] Furthermore, there is no

[12] It's impossible to dispute that output went up following the European takeover of these islands and surely this is related to European technology and methods. What is at issue is whether or not this historical increase in human capital can explain variation in income today.

[13] We have found only one or two examples of non-church schools on the islands prior to 1900. And these were set up by wealthy planters as a bequest.

direct effect of religion on income in our sample. So we suspect that the effect of missionaries works primarily through their effects on schooling, but this is of course open to interpretation.

San Juan, Puerto Rico had one school built by the Franciscans in 1640 and a second shortly thereafter by the local Bishop. (Wagenheim [1998], p. 74). San Juan's first high school was established in 1832 by a group of clergymen. By 1897 Puerto Rico had 551 schools and 28,000 pupils. (Wagenheim, p. 234-235.) The first school on Guam was opened in 1873 by the missionary Father San Vitores (Rogers [1995], p. 50). Several schools on Tahiti were opened by missionaries in the late 1800s (Newbury [1980]).

Missionaries are not the only link between colonialism and schooling. By the twentieth century we do see colonial governments setting up schools and some of the islands get a universal education system in this manner. After Puerto Rico became a US commonwealth, the American administration rapidly expanded the number of rural schools. By 1920 there were 11 high schools and the University of Puerto Rico had been founded (Carrión [1983], p. 174). The French colonial government in Tahiti opened a school for teachers in 1901 (Newbury [1980], p. 150). For this reason we suspect that the effects we see from missionary schools on income significantly understate the total effects of colonial promotion of schooling on income.

V.C. Trade

Our third theory is that colonialism is linked to modern income via colonizers' promotion of international trade. To test this theory we created dummy variables for the introduction or development of various trade products during the colonial period. Settlers and colonial governments introduced agricultural products which like sugar, cotton, coffee, and tobacco which grew well in island climates and which were valued highly in Europe and North America. In some cases colonizers developed various islands' mineral and timber resources.

Colonial governments were obsessed with introducing and expanding the production of export commodities and with "making the colony profitable" or at least self sustaining. Home governments wanted to collect more tax revenue than they were pouring into the island as subsidies. Colonial governors wanted to generate cash flow from exports so that they could direct some of this cash into their pockets.

By 1510, Spain was closely monitoring production in Puerto Rico and the Crown appointed an accountant, a commissioner and a treasurer to measure production and exports and to collect the appropriate duties on the King's behalf. When opportunities for extracting gold and salt ran out in 1530, Puerto Rico's Governor, Franciso Manuel de Lando seized on the idea of growing sugar for export. He convinced the Crown to provide loans to build sugar mills and to finance the voyage of families from Spain and refugees from Brazil to provide labor. Prospective plantation owners were lured from Spain with the promise of the indefinite use of large (several hundred acre) tracts of land for growing sugar (Wagenheim, p 56-57).

The Spanish colonists in Jamaica experimented with a wide variety of export crops including tobacco, indigo, and cocoa before they hit upon sugar as the real cash crop. Once the British seized Jamaica, Governor Sir Thomas Modyford (1664) immediately set about both increasing the amount of land under sugar cultivation and encouraging large scale plantation agriculture (Black [1881], pp. 89-90).

European colonists in the Pacific Islands also focused on trade and exports. New Caledonia settlers in the 1860s initially tried growing coffee, sugar, tobacco and rice. But cattle proved the ideal product and there were more than 100,000 cattle there by 1890. However, the real export legacy of colonists in New Caledonia came in 1864 when Garnier discovered nickel (Lyons [1986], p. 49). New Caledonia is currently the world's fourth largest nickel producer and has about 25 percent of proven reserves.[14] Even very lightly settled islands of the Pacific were affected by international trade introduced by the

[14] CIA World Factbook, minerals.usgs.gov

Europeans. Copra (dried coconut) became a chief export of Yap by the 1880s and natives would haul baskets of coconuts to local trading stations. (Hezel [1995], p 19.).

V.D. Culture

The final hypothesis that we will examine is whether transmission of culture effects output. This hypothesis was examined at length by Landes (1998). Barro and McCleary (2003) more recently examine the link between religion and output. Our ability to identify cultural transmission is limited, but we do have some variables which provide hints. We examine whether the percentage Protestant or Catholic (which are related to missionary activity) affect modern GDP.

VI. Data Description

The data on island colonization, GDP, and infant mortality are assembled from a large number of sources. Our starting point was a database of islands maintained by the UN.[15] This dataset provided us with a comprehensive list of individual islands along with nation, population and area. We sorted the islands by size and investigated islands that satisfied two criteria. First, we only included islands that require open ocean sailing to reach them from Europe. Second, we limited the sample to relatively small landmasses, specifically those less than 150,000 square kilometers.

These selection criteria are intended to generate a sample of islands that fit our story of random variation in colonial experience. We are particularly interested in the randomness associated with the age of exploration. Islands that were unavoidably found as Europeans made their way down the coast of Africa clearly have a less random history than the islands of the Pacific.[16] The size criterion is intended to make the sample as homogeneous as possible. Large landmasses like Australia are fundamentally different

[15] http://islands.unep.ch/

[16] The islands that make up Indonesia and Papua New Guinea are excluded for this reason: they were found and settled quite early and there was nothing random about this process. Our results are however robust to including these two countries as an additional two data points.

than the islands in our sample. Within the group of islands fitting these criteria we researched islands in order of population using any islands for which data were available.

Islands that are part of a group are only included as independent data points if there is some independent information for the individual island. For example, the majority of the islands in the Maldives have an identical colonial history and we only have one GDP data point for the entire group. In this case, there is only one island in the Maldives included in our dataset. On the other hand, the islands of the Netherlands Antilles have heterogeneity of both colonial history and GDP, so the individual islands in the group are included separately. We do, however, recognize that these may not be completely independent data points so all the econometric analysis is clustered at the islands group level.

Where available, we obtained GDP per capita for the year 2000 from the United Nations. Per capita GDP figures were available for 39 island nations covering 61 of the islands in our dataset. Twenty islands are possessions of other countries, for example Guam is a US possession. In those cases we obtained island level income per capita and infant mortality numbers for the island from the statistical agency of the relevant country.[17] In the case of islands that are currently part of an island group (such as the Cook Islands), we disaggregated country level data into the component islands where possible. For example Yap and Pohnpei are both states in the Federated States of Micronesia, but the two islands have different histories, wind patterns, and economic output and are located more than 1,000 miles apart. In some of these cases we were able to obtain separate GDP breakdowns from a series of reports on Pacific island groups produced by the Asian Development Bank.[18]

[17] In these cases we will be using income per capita as a proxy for GDP per capita. We recognize that this is an imperfect measure. We report robustness checks where we limit ourselves to the GDP data.
[18] We used the breakdowns by island in the following way. The island group level data was used to establish relative income levels. For example, the disaggregated data tells us that Yap in the FSM has twice the per capita income of Moen in the same group. Using the relative income and population data we calculated the per capita income for each island so that the relative income levels were correct and that the population weighted group average was equal to the GDP per capita figure for the group from the UN.

The colonial and settlement histories for each island come from a myriad of sources. For the Pacific islands we relied heavily in the Pacific Island Yearbook. For Atlantic and Indian Ocean islands, we used Encyclopedia Britannica, Wikepedia, and supplemented these sources with the individual island histories listed below in the references section. We collected the entire history of each island, including the first European sightings, the first settlements, the extent of such settlements, and the political history of the island's colonization if any. The sources for each colonial history are noted in our publicly available dataset.

In our broadest definition, we define colonialism as those years during which an island is claimed politically by one of the European countries, the US, or Japan. This requires that the colonizing country has not only landed on the island and claimed it, but that the central government of the European power has ratified a law stating that the island is one of its possessions.[19] We take any of the words territory, possession, protectorate or colony to signify an islands status as a colony. Disputes of ownership were relatively short lived and in the case of a dispute we always code as the colonizing the country that power which maintained physical (eg military and administrative) control of the majority of the islands' people.

We then subdivide colonial years into those with and without a colonial administration on the island and with and without settlers on the ground. In other words we know for each island and for each colonizing country the years during which the island was held politically, years for which the island had an administration and years for which the island had settlers. Our sources for administrative presence on the islands are books devoted to individual island histories as our references section and the website Rulers.org. In our searching, we found this site to be the world's most comprehensive list of what nation controlled a given piece of territory or island in a given year along with the name of the governor or chief executive.

[19] We also coded New Zealand's ownership of Niue from 1904 to 1974 as colonial years. We did the same for Australia's ownership of Nauru during 1914-1968. We did this following a referee's suggestion, and it makes sense given that New Zealand and Australia were highly developed "neo-Europes" by the twentieth century.

We have several ways to capture the intensity of settlement. First, the islands that had a full colonial administration tended to be the more heavily settled ones. Second we created a dummy variable for 10 percent or more of the population being settlers or imported slaves. In the Atlantic this is measured as of 1750 and in the Pacific this is measured as of 1900. Third, we have the modern ethnic composition for each of our islands. This will be related to the number of white colonists and black slaves that arrived on the island during the colonial period.

Here is a brief example of a typical island history and our coding process: Columbus landed on the Bahamas in 1492 and claimed ownership of the islands for Spain. The Spanish did not put settlers or an administration there (though they did manage to enslave the entire native population and drag them off to work in gold mines in Hispaniola.). So Spain is coded as having political control but not administrators or settlers. The islands were claimed by the British government in 1656 which is about 10 years after British settlers began arriving from Bermuda. But the Bahamas did not get an actual colonial administration (and governor) until 1710. The Bahamas became independent in 1973. So years of British colonization are from 1656 to 1973 and years of British administration are from 1710 to 1973.

Our collection of data on missionaries follows closely the work done by Woodberry [2004] which examines the correlation between missionary presence and democracy. His and hence our key sources are the World Atlas of Christian Missionaries for 1911 and 1925 by Dennis, Beach and Fahs, and the Handbuch der Katholischen Missionen by Arens (1925). We also use the Church Missionary Atlas (1879) and the Missionary Herald (1819) and Streit's Atlas Hierarchicus (1929) which contains maps showing locations for Catholic missionary stations. From these sources we collected the date of the first mission and the number of Protestant and Catholic mission stations on each island in 1925. The latter come in large part from examining the detailed color maps available in the 1925 Atlas. These have a red dot denoting the location of each mission station. The World Atlas of Christian Missions is primarily about Protestant missions

(though it does have one (not very detailed) map for Catholic missions. For this reason we also use Streit to determine the number of Catholic missions stations on each island in 1929.

Given the number of missionary stations on each island, we calculate the number of missions per capita using historical population data for each island available at http://www.populstat.info/. This is a Dutch site maintained by Jan Lahmeyer and (analogous to Rulers.org) is the most comprehensive site on historical population statistics by country, island, and geographic division and city within countries and islands.

For the Protestant missions we also collected detailed data on total pupils and pupils at the elementary, middle, and high school level in 1925. We also have number of schools at each level. Unfortunately these numbers are only available for large groups of islands as opposed to the disaggregated (island by island) data in our other variables. So we report below results that use the number of missions per capita instead of mission schools or pupils per capita. However the good news is that there is a very high degree of correlation between the number of mission stations and the number of mission schools, which makes sense given that the missionaries were explicitly in the schooling business. For example, where we do have data (at the island group level) the correlation between the number of mission stations and the number of mission elementary schools is .96. The correlation between the number of mission stations and total pupils is .85.

Modern breakdowns of an island's population by race and religious affiliation are taken from the CIA World Factbook and supplemented with information from Wikepedia. Our publicly available islands data set includes notes as to the source for each set of variables, and any deviation from the standard sources above is noted.

Wind speeds measured in average knots are from satellite data taken from CERSTAT.[20] The satellites measure wind speeds over water for the entire globe, reported on a one degree longitude latitude grid. The data we utilize are reported monthly and consist of the average wind vector in knots in the north-south direction and the average wind vector in the east-west direction. For our instruments, we use the average and standard deviation of these data points over the year.

Table I contains summary statistics for the data. Forty of the eighty one islands are located in the Pacific. Thirty five are in the Atlantic and the remaining islands are in the Indian Ocean. The median population on our islands is about 14,000 people. This ranges from as few as 102 people on Palmerston Island (in the Cook Islands) to more than 11 million people in Cuba. Our results are robust to dropping islands with fewer than 10,000 people. The median land area for the islands is 130 square kilometers. The mean 2000 GDP per capita on the islands in the sample is $8,279 with a high of $53,735 for Bermuda.

The average number of centuries of colonization (using the broad political definition) is 2.24. But there are many islands with relatively limited colonial experience. Twenty two countries in the sample were a colony for one hundred years or less and eleven for less than fifteen years. In general the Atlantic islands were the first to be colonized by Europeans and some islands including Bonaire, Curacao, and Barbados have 400 years of colonial history. The average number of centuries of administration on the ground is 1.54 and 57 percent of the islands were heavily settled, meaning again that 10 percent or more of the population were either white or black by 1750 for the Atlantic and 1900 for the Pacific.

[20] The CERSAT (Centre ERS d'Archivage et de Traitement - French ERS Processing and Archiving Facility) is part of IFREMER (French Research Institute for Exploitation of the Sea. It was created in 1991 as a node of the ESA (European Space Agency) ground segment for the ERS-1 and ERS-2 Earth observation satellites. http://www.ifremer.fr/cersat/

The average number of mission stations per 1000 people is .25 as measured in 1925.[21] Twenty six of the islands have no missionaries at all, while 15 have exactly one mission station. We truncated this variable at 1 missionary per 1000 people for six of the islands: islands like Kosrae are reported as having 1 Protestant mission and 1 Catholic mission serving a population of 200 people, which would imply 10 missionaries per thousand people. Our results are robust to using the raw data and not top coding.[22]

One possible criticism of our approach is that islands tend to be small and have different natural resources than continental nations and are therefore not "real countries" of interest to macroeconomists. Since many successful islands focus on tourism, one could also make the case that this also makes them different from "real" countries. We have several responses to this. First, the islands in the sample have significant variation in levels of income and industry mix. Appendix Table IV shows that agriculture is a large fraction of the economy for islands like Dominica and some of the Federated States of Micronesia like Pohnpei. Bermuda and the Virgin Islands tend to focus on services, though this can mean banking and insurance in addition to tourism.[23] More importantly, even if all the islands in the South Pacific or the Atlantic had beautiful beaches, we still would need to ask why certain islands have a subsistence level of income while others have a standard of living that rivals Sweden and the US. Grand Cayman is a tourist paradise while Hispaniola (Haiti plus the Dominican Republic) is not, despite the fact that both islands have tropical breezes and the beauty of the Caribbean Sea.[24]

The fact that many of our islands have similar initial conditions also makes them an interesting group to study. For example, studying the effects of the plantation system

[21] We also refer to this variable more loosely as "missionaries per capita." This is an accurate characterization as most of the islands had exactly one ordained priest or minister per residence station.
[22] Using the log(missionaries per capita) could be sensible but then we would need an ad hoc way to handle the islands with 0 missionaries.
[23] If one goes down the road of rejecting various islands as being insufficiently diverse economically to be interesting, this then also implies tossing many African or Latin American countries out of a standard cross country growth regression.
[24] We are not claiming that the length of the colonial period explains the Grand Cayman Hispaniola income gap but rather that even within Caribbean islands, there is massive and interesting variation in economic performance.

may be best done in a sample that is more geographically homogenous than the Penn World Tables set of countries.

Table IX shows that the basic relationship between colonialism and GDP holds in the larger country sample and has a similar coefficient as in our islands sample. Certain truths about colonialism are likely to hold across both the islands sample and a larger sample. For instance if bad colonial institutions constructed four hundred years ago can still affect GDP per capita today, then this may well apply to island and non-island nations. If the presence of missionaries matters for islands, then missionaries may likely matter for other countries too.

VII.Results

Figure 1 shows a scatter plot of log GDP per capita versus number of centuries as a colony. The circles are for islands in the Atlantic. The triangles are for islands in the Pacific and the squares are for islands in the Indian Ocean. The regression line shows a positive relationship between length of colonial period and modern GDP. While there is a large amount of variation around the regression line (we certainly don't think colonial history explains everything), the t-statistic for the slope is 6.1. The coefficient is 0.42 meaning that every additional 100 years of colonial history is associated with a 42 percent increase in GDP. Remarkably the upward slope holds within each of the oceans. The relationship is not driven simply by the fact that Atlantic islands were discovered by Europeans earliest and are the richest.

Table II shows five different cross sectional regressions with our basic result. For columns (1) through (5) log GDP per capita is the dependent variable. Column (1) shows the basic correlation illustrated in Figure (1). A longer period under colonial rule is associated with higher per capita GDP. Each additional hundred years is associated with GDP per capita that is 42 percent higher.

Column (2) adds geographic controls. We include dummies for each ocean and we control for island land area and absolute value of latitude (distance from the Equator). As in Gallup, Sachs and Mellinger [1999] and Sachs [2003], the absolute value of latitude is strongly related to current levels of income. Every 10 degree increase in latitude (i.e. moving roughly 700 miles away from the equator) is associated with a 53 percent increase in GDP. Those authors find that latitude works through the efficiency of agriculture and disease prevalence. Acemoglu et al [2001] provide evidence that latitude's effects work through variation in the nature of European settlements and institutions that were established. Island area is also significant with larger islands doing more poorly than smaller islands. Interestingly, the Pacific and Atlantic Ocean dummies are not significantly different from each other, though the Pacific coefficient is significantly different from the Indian Ocean (the excluded category). Including the geographic controls does not substantially alter the results for colonial tenure.

One important possibility is that Europeans simply chose to settle the best islands first and hence the more successful islands have a longer colonial history. For example, being near a continent could be correlated both with heavy settlement and with current GDP. We are able to reject this explanation for our results by using wind direction and speed as instruments for settlement or length of colonial period. As discussed in a previous section, wind patterns make an appealing instrument because they were incredibly important during 1500-1890 (and determined discovery and settlement), but may have little direct effect on GDP today.

In column (3) we instrument for the number of years as a colony using data on wind speed. Given the direction of travel from Europe, the east-west component of the wind is particularly important for sailing voyages. We use the average value for the east-west component of the wind and its standard deviation.[25] Column (1) in Appendix I shows the first stage. The instruments are significant predictors of the length of colonial history

[25]Appendix II explores the use of other variations on wind speed and direction as instruments. The results are quite similar.

with a first stage F statistic of 6.0.[26] Column (3) of Table I shows the second stage of the two stage least squares regression. The results are statistically indistinguishable from the OLS results and the coefficient on years of colonization remains very significantly away from zero with a t-statistic of 2.8. Each additional hundred years of colonization is associated with 67 percent larger GDP per capita.

One objection to our IV strategy is that the instrument is well suited to describing the beginning of colonial rule, but is not a good instrument for the end of colonial rule. Given that the years of colonial rule is determined by both the beginning and end dates of the colonial period, it seems sensible to examine these separately. A final concern about late colonialism is that our data includes countries which currently have a colonial relationship with a developed country such as Puerto Rico, Guam, or the Netherlands Antilles. It is possible that current transfers from the colonizing country to these islands are important.[27]

Columns (4) and (5) present regressions which use the first and last year of colonialism instead of the total number of years of colonialism.[28] These regressions also include a dummy to indicate if the country was a colony after 2000. The results indicate that it is the start date of colonialism that is driving our results, not the end date. The coefficient on the beginning year of colonialism is identical in magnitude (but opposite in sign) to the coefficient on the number of years of colonialism in the previous regressions. Being colonized one hundred years earlier is associated with a 34% increase in income. The coefficient on the last year of colonialism is not statistically significant. Whether the island was still a colony in 2000, however, is significant and positive. Being a colony in 2000 is associated with 95% higher income. The inclusion of this dummy has no significant impact on the coefficient on the first or last year of colonialism, suggesting that our base result is not being driven by current transfers. In Column (5) the first year

[26] In the event that the instrument is weak, we ran the IV regression using LIML and Moreira's (2002) conditional test. The IV coefficient is significant at the 5% level.
[27] It is not clear that we should be excluding late transfers as part of the colonial legacy. If one aspect of having been a colony in 1800 is that you increase the probability of being a colony in 2000 this should be included as part of the effect of colonialism.
[28] These data are divided by 100 in order to have the coefficients consistent with centuries as a colony.

of colonialism is instrumented with wind direction and speed. The results are statistically identical to the OLS results.

As an additional outcome measure use infant mortality as the dependent variable in Columns (6) – (8). These results mirror the results for GDP per capita. The number of centuries that an island was a colony is a negative and significant predictor of infant mortality in all the specifications. One notable difference compared to the GDP columns is the importance of the ocean dummies. The Indian Ocean has significantly higher infant mortality than the Pacific. This result is also robust to our IV strategy.

The regressions in Table III examine whether our results are being driven by sample and data selection. Column (1) repeats our base result. Column (2) excludes islands for which there is no direct GDP data available from the UN. These excluded islands are generally territories of developed countries such Guam and the British Virgin Islands. This column does allow for adjustments to GDP within island groups as described in the data section. Column (3) does not include these adjustments. The results for these three columns are similar, suggesting that our particular sample choices are not driving the results.

Columns (4) through (7) show the results of running our base regression on sub samples of islands limited to the Atlantic and Pacific Oceans. Columns (4) and (5) are estimated with OLS. Columns (6) and (7) instrument the number of centuries of colonialism with wind data as described above. The results are fairly similar for each ocean as for the entire sample and in the Pacific where we have the most variation in years of colonization the coefficient on the number of years of colonialism is statistically significant.

VII.A. Mechanisms

The island data show a robust relationship between the length of colonization and modern day income. The next question is of course, why? [29] Section V provided a fair amount of detail on how we can conduct partial tests of our four theories of the colonialism income connection.

Table IV provides evidence that the intensity of the colonial experience matters. The intensity of settlement and the presence of a colonial government is strongly related to current income. We split the number of years as a colony into those that included a colonial government on the island, and all other years (which are mostly years in which there are some settlers but no appointed governor). The coefficient on centuries of administration is 0.64 which is 30 percent larger than the baseline coefficient on all centuries of colonialism. This is not to say that years as a colony without an administrator on the ground are unimportant. The coefficient on years without an administration has a coefficient of 0.32 and is highly significant.

Column (3) replaces the centuries as a colony variables with a dummy for heavy settlement, meaning that by a specified year (1750 for the Atlantic and 1900 for the Pacific) 10 percent or more of the population were nonnatives. Heavily settled places have income that is about twice that of the islands that were not heavily settled. More heavily settled places and places with a longer history of direct colonial administration have higher income today. These facts suggest that the intensity of European contact matters. This supports both an institutional transfer story and a human capital story.

In Table V we split out the effects of centuries of colonialism by the identity of the colonizer. The "omitted" category is years spent not as a colony. Our main purpose is our belief that institutional quality varied across the colonizers. Specifically we expect that years of Portuguese or Spanish rule will be less beneficial than years of US, British or French rule for the reasons given in Section V. This is precisely what we find.

[29] We can't fully answer this question, but we provide as much evidence as we can to distinguish among the competing theories.

The coefficients on centuries of British, French, and Dutch rule are all in the .5 to .6 range and are statistically indistinguishable. However, centuries of Spanish rule have a statistically significantly lower coefficient (at .20) and the Portuguese coefficient is significantly negative. We find this to be quite consistent with the hypothesis that colonialism's effects on income work through institutional quality. The Spanish and Portuguese seem to have made a series of mistakes which are still affecting GDP per capita today.

The positive coefficient on centuries of US rule is very large. This is not surprising given the direct benefits to Guam, Puerto Rico, the Northern Mariana, the US Virgin Islands and Hawaii of current US ownership and of the ability of these islanders to migrate to the mainland US. The US federal government has invested heavily in these places in infrastructure, schools, and health care systems.

In column (2) we ask whether we can detect any difference in incomes among islands that use the British versus French legal system and the answer is no. Incomes in the two types of islands look quite similar.

Table VI is also intended to explore possible differences in governmental or institutional quality, but this time we cut the data by the timing of the colonial experience. As discussed in Section V, early colonizers were much more likely to engage in wholesale enslavement and massacre of the natives while initial land holding and other property rights were less likely to be allocated based on a market system or with an eye towards maximizing productivity.

The differences in pre and post enlightenment colonialism are evident in our data. Column (1) splits the number of years of colonialism into years before 1700 and years after 1700.[30] The results suggest that only the years after 1700 are positively associated with modern outcomes. An additional 100 years of post-1700 colonialism is associated with much higher per capita income (though this includes the very rich places that are

[30]The results are robust to moving the cutoff to 1750.

still colonies). The coefficient is highly significant and significantly different than the coefficient on pre-1700 colonial years. This suggests that the colonial era of Cook was indeed different from that of Columbus and Magellan.

Column (2) breaks the years into three eras, pre-enlightenment, post-enlightenment, and post 1900. Once again, the pre and post enlightenment years are significantly different from each other. The 20th century years are not significantly different from either era. In column (3) we add a dummy for whether an island was a colony in 2000 in order to isolate the effect of transfers from other mechanisms. With this additional control, years of 20th century colonialism become statistically worse than years between 1700 and 1900. Being a colony at the end of the 20th century remains very positively associated with income.

Overall it seems that later colonialism and remaining a colony today are significantly better for income than are colonial years before 1700. We take this as a further piece of evidence in favor of the institutional quality story.

In Table VII we test the trade hypothesis and the inequality hypotheses by asking whether the colonizers introduction of specific trade products or of imported slaves has any relation to modern GDP. We also look at whether the modern ethnic composition matters for outcomes. This should capture the effect of embodied human capital transfer. We don't find that historical trade patterns or the introduction of the plantation system are positively or negatively related to current income. We do, however, find that the replacement of natives by settlers was important. Interestingly, this result seems to be insensitive to whether the transferred population was white or black.

Columns (1) through (3) ask whether sugar-slave islands are worse off today than other islands and the answer is no. Taken apart or together, dummies for sugar exporting and the use of imported slaves have insignificant coefficients and positive rather than negative point estimates. The inclusion of these controls has no impact on our base result. This is consistent with what we noted in the introduction, namely that some of the

richest Carribbean islands (St. Kitts, The Bahamas, Turks and Caicos, Sint Martin) and some of the poorest (Haiti, Jamaica, and Dominica) are former plantation islands.

Column (4) looks at the impact of historical trade using dummy variables for the export of agricultural products (cotton, sugar coffee, tobacco), for mining and for large scale raising of livestock. Trade in these categories is not significantly associated with current income though each has a positive point estimate. They are jointly insignificant. These controls have no affect on the coefficient on number of centuries of colonization.

Columns (5) and (6) examine whether democratic institutions matter. Column (5) includes the year of the first elected legislature as an additional control. Column (7) includes dummies for having a legislature by 1800 or 1900. We do not find evidence that islands which got elected legislatures more quickly have higher per capita income.

The final two columns of Table VII examine the relationship between modern ethnic composition and income. Column (7) includes the proportion of the modern population that is black, white, Asian, or mixed. The excluded category is native. Interestingly, all 4 coefficients are significantly positive and nearly identical. This suggests that the transfer of population to the islands by European settlement is correlated with higher income. Amazingly, the coefficient on blacks and whites are statistically identical. Column (8) just includes the native population. The coefficient is extremely large. An island with a population comprised entirely of natives has GDP per capita 230% lower than an island comprised of any other group.

In Table VIII we turn to the question of whether the historical presence of mission schools is related to current income. In column (1) we look at the effect of missionaries per thousand people on current income and find a coefficient of 0.92 which is significant at the 1 percent level. The standard deviation of missionaries per thousand is 0.33, so a one standard deviation increase in missionaries per thousand is associated with GDP per capita that is 30 percent higher today. This is economically meaningful and a bit smaller than the effect of an additional century of colonization. In column (2) we control for

number of centuries as a colony and the coefficient on missions per thousand is reduced to 0.52 and remains highly significant. The coefficient on number of centuries as a colony is 0.44 which is close to our baseline specification level of 0.49.

We interpret this as saying that an island's history of formal schooling has a large effect on current output that comes in addition to the other effects of colonial history. One of the positive effects to income from European contact is the introduction of literacy and schooling. But in a mechanical sense, the level of mission schools only "explains" about 8 percent of our baseline effect from years of colonialism. One interpretation is that multiple forms of human capital arrived with the Europeans. Schooling is only one form, while human capital in the form of knowledge of agricultural methods, metal working, tool construction other practical knowledge also matters a great deal. And these forms of human capital are being partly captured by the length of colonial history and intensity of settlement.

Another possible explanation for our results is that missionaries affect output through increasing people's beliefs in heaven and hell. [Barro and McCleary (2003)]. This is not our preferred explanation because we do not find a direct effect of religious adherence on income. We do find that the historical presence of Protestant missionaries increases an island's percent Protestant today. Regressing fraction Protestant on Protestant missionaries per thousand in 1925 yields a statistically significant coefficient of .11 (results not shown). However as we show in column (3), current percent Protestant or percent Catholic does not correlate with current income. This finding does not accept or reject Barro and McCleary's hypothesis which is that increases in religious beliefs raise income while increases in attendance lower income. It's certainly possible that missionaries are affecting beliefs and culture more than attendance.

We summarize the results on potential mechanisms (Tables IV-VIII) in Appendix Table V. The results are most supportive of both the institutional quality theory and the human capital theories of colonialism. On the human capital side, missionaries (and hence mission schools) per capita matter. The fact the intensity of settlement matters supports

both a human capital and an institutional quality story. The facts that the timing of colonialism matters (post enlightenment is better and current colonial status is very positive) and that the colonizer's identity matters supports the institutional quality story. Years of colonial administration matter more than other colonial years. This fact supports both the institutions story and the human capital story since years of administration are correlated with both the intensity of settlement and the level of governmental organization on the ground

We find little evidence that historical inequality is correlated with modern income. Sugar islands do no better or worse than other islands and percent black is uncorrelated with current income. Similarly we can't find evidence that the introduction of specific trade products (most of which are not economically important to these islands today) matters for modern income. The missionaries result might suggest that religion matters, but religious adherence itself (as measured by percent Catholic and percent Protestant) does not matter. For this reason we don't see strong support for the theory that colonialism is affecting income through religiosity.

VII.B. A Broader Sample of Countries

Our results suggest that the length of colonial experience is positively correlated with per capita GDP in a sample of islands. The IV results further suggest that these results are not being driven by the selective colonization of islands that have features conducive to good modern outcomes. Given the similarity of the IV and OLS results, it may be instructive to check the basic results against a larger more traditional sample of countries. Table IX shows the results from regressing per capita GDP against the number of years a country was a colony for a sample of non-island developing countries. This sample is consistent with the countries included in Acemoglu, Johnson, and Robinson.

The basic results match quite nicely with our island results. Each additional century of colonial tenure is associated with a 40 percent increase in GDP. This is not statistically significantly different from the 42 percent coefficient found in the island sample. Including latitude as a control does not significantly change this coefficient. One

advantage of using this sample is that standard measures of modern institutional quality can be included. Column (3) of Table IX includes expropriation risk as an additional regressor. Expropriation risk is significant and negative, as expected. This reduces the point estimate on colonial tenure, but it remains large and significant. In column (4) we include the Acemoglu, Johnson and Robinson measure of log settler mortality with similar results.

While the results from this sample are not as well identified as from the islands sample, they are still instructive. The basic relationship appears to extend beyond our island sample. The results are robust to the inclusion of standard modern institutional measures and geographic controls.

VIII. Concluding Remarks

We have argued for an "islands as experiments" approach where random variation in the colonial experiences of islands can be used to think about the long run effects of colonial history on economic performance. The most interesting fact in our sample is a robust positive relationship between the years of European colonialism and current levels of income. While some of this relationship could be driven by smart selection of islands by colonizers, we suspect that part of the relationship is causal. When we instrument for colonization and settlement using wind patterns, we obtain coefficients on years of colonization that are identical to our OLS results.

While the basic results suggest that longer European colonial exposure is good for the modern inhabitants of the islands in our sample, we also bring additional facts to bear to think about why. First, quality differences in the colonial experience seem to matter. These findings are consistent with the Acemoglu et al. result that the quality of the colonial experience is important for modern outcomes. There is a discernable pecking order amongst the colonizers. Years under US and Dutch colonial rule are significantly better than years under the Spanish and Portuguese.

Second, later years of colonialism are associated with a much larger increase in modern GDP than years before 1700. It is not difficult to believe that colonialism in the post-enlightenment era led to more efficient and beneficial institution transfer than colonialism under the *encomienda* system and its contemporaries. This is not to say that we find the early colonial years to be detrimental to modern GDP – we do not. However, given the human toll on the early natives, it is not unreasonable to think that pre 1700 colonialism should be considered as a net negative.

We also find that the intensity of the colonial experience matters. Years under direct colonial administration matter more than do other colonial years. The intensity of settlement matters. The more people transported to each island by the Europeans – be

they white settlers or black slaves – the higher modern income. This is consistent with the Acemoglu et al. results linking settlement and better institutions. However, the fact that slave economies do not have lower performance today suggests that the transfer of institutions is extremely multi-dimensional. The sugar-slave plantation system is not an institutional structure that we consider beneficial, yet it does not appear to have hindered other more benign transfers.

Formal schooling does matter, though it is not necessarily a significant channel for our main result. We find evidence that the missionaries and missionary schools are strongly correlated with current income. This result, however, appears to be unrelated to our basic finding about colonialism. The missions appear to have an independent effect. The evidence also suggests that the missionary effect is through schooling and not through changes in the religious patterns of current island inhabitants.

The facts seem to be most consistent with variation in institutional quality and in human capital brought by settlers helping determine variation in current income. We think that historical trade policy, historical inequality and conversion of natives to Christianity matter less for current income. While any attempt to get at root causes of the paper's central fact are partly speculative, we hope that the basic facts and data generated by this examination of islands will further the understanding of long run growth.

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Table I
Summary Statistics

These are summary statistics for the variables in the islands database. See the text for details on variable sources and construction. Islands still without an elected legislature are coded as getting a legislature in 2005.

Variable	Obs	Mean	Std. Dev.	Min	Max
Island's GDP per Capita 2000	81	8,279.43	9,327.29	264.00	53,735.01
Log (GDP Capita)	81	8.45	1.14	5.58	10.89
Infant Mortality 2002	81	18.53	15.17	4.00	79.00
Number of Centuries as a Colony	81	2.24	1.53	0.13	5.11
Northerly Vector of Prevailing Wind	81	0.17	1.27	-1.55	4.20
Easterly Vector of Prevailing Wind	81	-4.20	2.01	-6.88	4.42
No Historical (1500-1820) Off Island Trade Except Fish or Coconuts (0-1)	81	0.47	0.50	0.00	1.00
Agriculture Used Imported Slaves	81	0.40	0.49	0.00	1.00
Year of First Elected Legislature	81	1938.53	68.40	1639.00	2004.00
Had Legislature by 1800	81	0.07	0.26	0.00	1.00
Had Legislature by 1900	81	0.15	0.36	0.00	1.00
Percent Current Pop Native	81	46.71	45.15	0.00	100.00
Percent Current Pop White	81	0.11	0.22	0.00	1.00
Percent Current Pop Black	81	0.23	0.36	0.00	0.95
Percent Current Pop Mixed	81	12.26	23.59	0.00	93.20
Number of Centuries British	81	0.89	1.26	0.00	3.95
Number of Centuries French	81	0.44	0.89	0.00	3.70
Number of Centuries Spanish	81	0.38	0.94	0.00	4.05
Ever British	81	0.64	0.48	0.00	1.00
Ever French	81	0.31	0.46	0.00	1.00
Ever Spanish	81	0.25	0.43	0.00	1.00
Absolute Value of Latitude	81	15.73	7.68	0.50	51.92
Island Area (1000s sq km)	81	0.01	0.02	0.00	0.11
Island Population	70	302,720	1,394,832	102	11,000,000
Island is in Pacific	81	0.49	0.50	0.00	1.00
Island is in Atlantic	81	0.43	0.50	0.00	1.00
Island is in Indian	81	0.07	0.26	0.00	1.00
Number of Centuries of Colonial Admin	81	1.54	1.23	0.00	4.96
Island Had 10%+ Settlers by 1850	81	0.57	0.50	0.00	1.00
Mission Stations Per 1,000 People 1925	81	0.25	0.33	0.00	1.00
Current Percent Protestant	81	0.46	0.33	0.00	1.00
Current Percent Catholic	81	0.35	0.30	0.00	0.95

Table II
Outcomes Regressed on Years of Colonization

We regress Log GDP per capita and infant mortality on the number of years the island spent as a colony of a European power. Columns (1), (2), (4), (6) and (7) are OLS. Columns (3), (5) and (8) are two stage least squares where we instrument for centuries of colonial rule or the first year as a colony using the 12 month average and standard deviation of the east-west wind speed for each island.

	(1) Log GDP Capita	(2) Log GDP Capita	(3) Log GDP Capita - IV	(4) Log GDP Capita	(5) Log GDP Capita- IV	(6) Infant Mortality Per 1000	(7) Infant Mortality Per 1000	(8) Infant Mortality Per 1000- IV
Number of Centuries a Colony	0.42	0.491	0.665			-3.331	-3.885	-13.47
	(0.076)**	(0.110)**	(0.238)**			(1.183)**	(1.472)*	(5.434)*
First Year a Colony				-0.342	-0.626			
				(0.108)**	(0.304)*			
Final Year A Colony				0.409	0.527			
				(0.755)	(0.874)			
Remained A Colony in 2000				0.954	0.81			
				(0.311)**	(0.373)*			
Abs(Latitude)		0.053	0.054	0.038	0.046		-0.797	-0.841
		(0.012)**	(0.011)**	(0.012)**	(0.015)**		(0.207)**	(0.225)**
Area in millions of sq km		-20.374	-21.738	-15.071	-20.769		266.288	325.479
		(3.894)**	(3.970)**	(5.383)**	(7.148)**		(147.186)+	(138.716)*
Island is in Pacific		0.752	1.018	0.664	1.043		-8.476	-20.036
		(0.464)	(0.559)+	(0.491)	(0.641)		(9.329)	(14.379)
Island is in Atlantic		0.425	0.188	0.319	0.043		-5.161	5.14
		(0.395)	(0.477)	(0.383)	(0.481)		(8.540)	(8.501)
Constant	7.472	6.033	5.484	4.879	7.406	26.268	44.914	68.754
	(0.205)**	(0.552)**	(0.834)**	(15.218)	(17.308)	(3.822)**	(11.085)**	(21.610)**
Observations	81	81	81	81	81	81	81	81
R-squared	0.273	0.527	0.498	0.655	0.616	0.097	0.371	0.063

Robust standard errors in parentheses. We cluster at the island group level since several of the islands (e.g. the Cook Islands and the Federated States of Micronesia) are used as separate observations from a cluster of politically related yet geographically distinct islands.

+ significant at 10%; * significant at 5%; ** significant at 1%

Table III
Comparison of different Samples

Column (1) is the base sample used in the rest of the paper. Column (2) uses only GDP figures obtained from the UN, but includes disaggregation of islands that are part of a group. Column (3) uses only the raw UN GDP data. Columns (4) and (5) limit the sample to the Pacific and Atlantic Oceans. Columns (6) and (7) are two stage least squares for each ocean where we instrument for centuries of colonial rule using the 12 month average and standard deviation of the east-west wind vector for each island.

	(1) Log GDP per Capita	(2) Log GDP per Capita	(3) Log GDP per Capita	(4) Log GDP per Capita	(5) Log GDP per Capita	(6) Log GDP per Capita	(7) Log GDP per Capita
Sample	Base	UN data - disaggregated groups	UN data	Pacific	Atlantic	Pacific - IV	Atlantic-IV
Number of centuries a colony	0.491	0.636	0.503	0.599	0.268	0.652	0.754
	(0.110)**	(0.174)**	(0.148)**	(0.129)**	(0.191)	(0.294)*	(0.281)*
Abs(Latitude)	0.053	0.062	0.067	0.069	0.042	0.068	0.054
	(0.012)**	(0.016)**	(0.020)**	(0.021)**	(0.017)*	(0.019)**	(0.014)**
Area in millions of sq km	-20.374	-20.966	-21.838	-19.471	-21.549	-20.208	-22.178
	(3.894)**	(3.992)**	(3.845)**	(3.506)**	(6.715)**	(4.763)**	(6.286)**
Island is in Pacific	0.752	0.957	1.086				
	(0.464)	(0.702)	(0.575)+				
Island is in Atlantic	0.425	0.216	0.177				
	(0.395)	(0.559)	(0.527)				
Constant	6.033	5.526	5.535	6.437	7.471	6.389	5.532
	(0.552)**	(0.803)**	(0.643)**	(0.272)**	(0.709)**	(0.416)**	(1.118)**
Observations	81	62	62	40	35	40	35
R-squared	0.527	0.563	0.509	0.492	0.398	0.49	0.211

Robust standard errors in parentheses. Standard errors are clustered at the island group level.
+ significant at 10%; * significant at 5%; ** significant at 1%

Table IV
Effects of Colonial Administration Versus Settlement

	(2)	(3)	(4)
	Log gdp per Capita	Log gdp per Capita	Log gdp per Capita
Centuries of Colonial Administration	0.635	0.633	
and Settlers on the Ground	(0.117)**	(0.120)**	
Centuries as a Colony with Settlers	0.317	0.322	
But Not Administration	(0.105)**	(0.108)**	
Colonists Represent 10 Percent of			1.094
More of Population			(0.487)*
Percent White		0.001	
		(0.005)	
Percent Black		-0.001	
		(0.003)	
Absolute Value of Latitude	0.056	0.054	0.042
	(0.011)**	(0.011)**	(0.015)**
island area - sq km	-22.720	-22.776	-20.739
	(2.804)**	(2.780)**	(4.890)**
island is in Pacific ocean	0.819	0.824	0.726
	(0.502)	(0.506)	(0.597)
island is in Atlantic ocean	0.254	0.279	0.673
	(0.469)	(0.480)	(0.392)+
Constant	5.996	6.007	6.632
	(0.581)**	(0.586)**	(0.565)**
Observations	81	81	81
R-squared	0.580	0.580	0.458

Robust standard errors in parentheses. Standard errors are clustered at the island group level.
+ significant at 10%; * significant at 5%; ** significant at 1%

Table V
The Effect of Colonialism by Colonizing Countries

	(1)	(2)
	Log GDP per Capita	Log GDP per Capita
Centuries US	2.145	
	(0.394)**	
Centuries Dutch	0.66	
	(0.117)**	
Centuries British	0.512	
	(0.155)**	
Centuries French	0.586	
	(0.144)**	
Centuries Spanish	0.204	
	(0.089)*	
Centuries Portuguese	-0.813	
	(0.169)**	
Centuries German	1.332	
	(1.199)	
Centuries Japanese	-1.17	
	(0.781)	
Centuries British Legal		0.255
		(0.192)
Centuries French Legal		0.392
		(0.141)**
Centuries German Legal		0.406
		(0.629)
Abs(Latitude)	0.054	0.055
	(0.013)**	(0.014)**
Area in millions of sq km	-13.94	-22.117
	(5.851)*	(4.054)**
Island is in Pacific	0.703	0.626
	(0.530)	(0.539)
Island is in Atlantic	0.472	0.738
	(0.444)	(0.493)
Constant	5.849	6.348
	(0.636)**	(0.654)**
Observations	81	81
R-squared	0.645	0.497

Robust standard errors in parentheses. Standard errors are clustered at the island group level.
+ significant at 10%; * significant at 5%; ** significant at 1%

Table VI
The Timing of Colonialism

	(1) Log GDP per Capita	(2) Log GDP per Capita	(3) Log GDP per Capita
Centuries a Colony before 1700	-0.152	-0.02	-0.097
	(0.177)	(0.210)	(0.221)
Centuries a Colony after 1700	1.146		
	(0.163)**		
Centuries a Colony 1700-1900		0.84	0.875
		(0.244)**	(0.233)**
Centuries a Colony after 1900		2.246	-0.354
		(0.536)**	(0.975)
Remained a Colony in 2000			1.07
			(0.346)**
Area in millions of sq km	-14.99	-6.892	-17.582
	(6.370)*	(7.547)	(6.425)**
Abs(Latitude)	0.049	0.044	0.036
	(0.011)**	(0.011)**	(0.011)**
Island is in Pacific	1.295	1.005	1.09
	(0.391)**	(0.429)*	(0.415)*
Island is in Atlantic	0.316	0.31	0.304
	(0.337)	(0.336)	(0.338)
Constant	4.843	4.353	6.218
	(0.493)**	(0.580)**	(0.759)**
Observations	81	81	81
R-squared	0.638	0.663	0.693

Robust standard errors in parentheses. Standard errors are clustered at the island group level.
+ significant at 10%; * significant at 5%; ** significant at 1%

Table VII
The Effects of Historical Trade Products, Democracy, and Ethnic Composition

	Log GDP Per Capita	Log GDP Per Capita	Log GDP Per Capita	Log GDP Per Capita	Log GDP Per Capita	Log GDP Per Capita	Log GDP Per Capita	Log GDP Per Capita
number of centuries a colony	0.474	0.477	0.470	0.401	0.480	0.483	0.321	0.310
	(0.112)**	(0.118)**	(0.113)**	(0.135)**	(0.117)**	(0.117)**	(0.119)**	(0.117)*
Sugar Producer During Colonial Era	0.359		0.353					
	(0.305)		(0.315)					
Agriculture Used Imported Slaves		0.131	0.040	0.089	0.150	0.105		
		(0.372)	(0.365)	(0.366)	(0.402)	(0.411)		
Mining During Colonial Period				0.465				
				(0.357)				
Organized Agriculture During Colonial Era				0.478				
				(0.338)				
Livestock During Colonial Era				0.193				
				(0.441)				
Year Of First Elected Federal Legislature (divided by 100)					0.058			
					(0.174)			
Had Elected Legislature by 1800						-0.276		
						(0.663)		
Had Elected Legislature by 1900						0.122		
						(0.640)		
Percent White							0.020	
							(0.005)**	
Percent Black							0.020	
							(0.006)**	
Percent Asian							0.018	
							(0.009)+	
Percent Mixed or Other							0.025	
							(0.006)**	
Percent Native								-0.022
								(0.005)**
abslat	0.054	0.054	0.054	0.051	0.055	0.053	0.042	0.040
	(0.012)**	(0.011)**	(0.012)**	(0.013)**	(0.011)**	(0.011)**	(0.010)**	(0.011)**
island area - sq km	-22.130	-20.491	-22.141	-23.497	-20.312	-20.824	-19.858	-18.880
	(4.111)**	(3.909)**	(4.126)**	(4.697)**	(3.783)**	(3.934)**	(4.279)**	(4.296)**
island is in Pacific ocean	0.881	0.800	0.894	0.889	0.772	0.806	1.189	1.093
	(0.436)*	(0.471)+	(0.451)+	(0.473)+	(0.487)	(0.497)	(0.459)*	(0.391)**
island is in Atlantic ocean	0.369	0.391	0.359	0.448	0.362	0.432	-0.457	-0.594
	(0.385)	(0.410)	(0.401)	(0.389)	(0.433)	(0.442)	(0.407)	(0.418)
Constant	5.896	5.990	5.884	5.926	4.882	5.984	5.654	7.943
	(0.508)**	(0.539)**	(0.509)**	(0.511)**	(3.351)	(0.567)**	(0.495)**	(0.557)**
Observations	81	81	81	81	81	81	81	81
R-squared	0.540	0.528	0.541	0.562	0.529	0.530	0.636	0.626

Robust standard errors in parentheses. Standard errors are clustered at the island group level.
+ significant at 10%; * significant at 5%; ** significant at 1%

Table VIII
The Effects of Missionaries And Percent Protestant And Catholic

	(2) Log gdp per Capita	(3) Log gdp per Capita	(5) Log gdp per Capita
Missionaries Per 1000 People	0.916	0.518	
	(0.228)**	(0.230)*	
Mission Pupils Per Capita in 1925			
Percent Catholic Current			0.258
			(0.516)
Percent Protestant Current			-0.195
			(0.459)
number of centuries a colony		0.441	0.422
		(0.104)**	(0.114)**
Absolute Value of Latitude	0.054	0.057	0.059
	(0.016)**	(0.012)**	(0.011)**
island area - sq km	-15.855	-19.701	-22.726
	(4.650)**	(3.980)**	(4.130)**
island is in Pacific ocean	-0.082	0.630	0.850
	(0.495)	(0.493)	(0.515)
island is in Atlantic ocean	0.862	0.417	0.533
	(0.485)+	(0.390)	(0.456)
Constant	7.156	6.077	6.059
	(0.506)**	(0.547)**	(0.554)**
Observations	81	81	81
R-squared	0.437	0.561	0.552

Robust standard errors in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%

Table IX
GDP and Colonialism within Non-island Developing Countries

We started with the Acemoglu-Robinson-Johnson [2001] database and added our own measure of length of colonial period. We dropped the three island countries that were in AJR and our islands database.

	(1) Log GDP Per Capita	(2) Log GDP Per Capita	(3) Log GDP Per Capita	(4) Log GDP Per Capita
Number of Centuries a Colony	0.401	0.358	0.287	0.232
	(0.097)**	(0.090)**	(0.072)**	(0.084)**
Abs(Latitude)		2.952	1.406	1.825
		(0.883)**	(0.746)+	(0.822)*
Mean Temperature		-0.023	-0.013	0.005
		(0.023)	(0.019)	(0.021)
Expropriation Risk			0.404	
			(0.067)**	
Log Settler Mortality (AJR)				-0.403
				(0.093)**
Constant	7.276	7.344	4.873	9.034
	(0.215)**	(0.686)**	(0.682)**	(0.728)**
Observations	64	64	64	60
R-squared	0.22	0.40	0.63	0.56

Robust standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%

Appendix I
IV First Stage Regression and Reduced Form Regression

Columns (1) and (2) are OLS. Column (1) is the first stage regression using our preferred set of instruments. We regress the islands' number of centuries as a colony on the northerly and easterly vectors of the island's prevailing wind. Column (2) is a reduced form in which we show the direct effect of wind on modern day GDP.

	(1) Number Of Centuries A Colony	(2) Log GDP Per Capita
East-West Vector Of Wind	-0.246	-0.167
	(0.072)**	(0.071)*
Monthly StDev of East-West Vector	0.651	0.395
	(0.265)**	(0.271)
Area in millions of sq km	8.532	-15.606
	(4.671)+	(4.664)**
Abs(Latitude)	0.015	0.064
	(0.013)	(0.014)**
Island is in Pacific	-1.494	-0.033
	(0.354)**	(0.524)
Island is in Atlantic	0.782	0.778
	(0.362)*	(0.553)
Constant	0.756	5.968
	(0.833)	(0.913)**
Observations	81	81
R-Squared	0.681	0.435
F Statistic for Instruments	6.00	
Prob > F =	.004	

Robust standard errors in parentheses. Standard errors are clustered at the island group level.
+ significant at 10%; * significant at 5%; ** significant at 1%

Appendix II
IV Results Using Alternative Sets of Wind Based Instruments

In addition to specifying the prevailing wind as two vectors per island, we also tried several other measures of wind speed and direction and used these to instrument for an islands' years of colonization. Below are the second stage results and F-statistics for three different types of wind related instruments. Column (1) is the simplest possible instrument, the east-west vector of the wind. Column (2) takes eight compass headings and measures the knots of prevailing wind along each heading and each month. The instrument is the sum of knots*months that the prevailing wind blew on that heading. We use knot*months along headings 2,4,6,8 as the set of instruments. In column (3) we use the knot*months of wind at each of the four compass headings and measure the wind as negative if it blew away from a compass heading instead of towards it. In other words, we have only 4 headings but the wind speed can be positive or negative. We use all four points as instruments.

	(1)	(2)	(3)
	Log GDP Capita	Log GDP Capita	Log GDP Capita
	(2SLS)	(2SLS)	(2SLS)
Number Centuries a Colony	0.681	1.201	0.877
	(0.291)*	(0.282)**	(0.353)*
Area in 1000s Sq km	-21.55	-24.76	-22.76
	(4.019)**	(5.104)**	(4.429)**
Abs(Latitude)	0.054	0.057	0.055
	(0.011)**	(0.013)**	(0.011)**
Island is in Pacific	0.982	1.609	1.218
	(0.594)	(0.632)*	(0.660)+
Island is in Atlantic	0.22	-0.338	0.01
	(0.460)	(0.539)	(0.526)
Constant	5.559	4.266	5.072
	(0.891)**	(0.955)**	(1.072)**
Observations	81	81	81
R-squared	0.505	0.226	0.438
F Statistic for Instruments in First Stage	8.20	6.79	1.93
Prob > F =	0.0058	0.0001	0.117

Robust standard errors in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%

Appendix III
List of Islands in Our Dataset

Island	Island Group	Country	First Year Colony	Number Years Colony	GDP Capita 2000
Aitutaki	Cook Islands	Cook Islands	18.88	0.13	2,814
Andros, North	Bahamas	Bahamas	14.94	4.79	14,296
Anguilla	Anguilla	United Kingdom	16.5	3.54	9,617
Antigua	Antigua and Barbuda	Antigua and Barbuda	16.32	3.49	7,653
Ascension	Ascension	United Kingdom	15.01	1.89	2,500
Atiu	Cook Islands	Cook Islands	18.88	0.13	1,930
Barbados	Barbados	Barbados	15	3.84	9,739
Bermuda	Bermuda	Bermuda	16.09	3.95	53,735
Bonaire	Netherlands Antilles	Netherlands	15.26	4.78	15,931
Cuba	Cuba	Cuba	15.11	3.89	2,535
Curacao	Netherlands Antilles	Netherlands	15.27	4.92	15,931
Dominica	Dominica	Dominica	17.63	2.46	3,484
East Falkland	East Falkland	United Kingdom	17.64	2.31	25,000
Efate	Vanuatu	Vanuatu	18.87	1.86	1,164
Fefan	Federated States of Micronesia	Federated States of Micronesia	18.85	1.01	1,335
Funafuti	Tuvalu	Tuvalu	19.16	0.62	1,204
Futuna	Futuna	France	18.88	1.17	3,700
Grand Cayman	Grand Cayman	United Kingdom	16.35	3.69	34,173
Grande Comore	Comoros	Comoros	18.86	0.88	264
Grande Terre	Guadeloupe	France	16.35	3.76	7,900
Grenada	Grenada	Grenada	16.5	3.44	3,440
Guam	Guam	United States	15.65	4.43	21,000
Hawaii	hawaii	United States	19	1.05	34,364
Hispaniola DOM	Dominican Republic	Dominican Republic	14.95	3.13	3,029
Hispaniola HTI	Hispaniola	Haiti	14.92	3.31	485
Huvadu	Huvadu	Maldives	15.58	3.35	2,151
Jamaica	Jamaica	Jamaica	14.94	4.68	3,056
Kadavu	Fiji	Fiji	18.75	0.95	2,031
Kosrae	Federated States of Micronesia	Federated States of Micronesia	18.85	1.01	2,751
Lifou	Loyalty Islands	France - New Caledonia	17.74	2.31	12,455
Luzon	Philippines	Philippines	15.65	2.97	1,002
Mahe	Seychelles	Seychelles	17.56	2.2	7,764
Majuro	Marshall Islands	Marshall Islands	18.86	1	1,896
Malaita	Solomon Islands	Solomon Islands	18.93	0.86	791
Mangaia	Cook Islands	Cook Islands	18.88	0.13	2,171
Mangareva	Gambier Is	France - French Polynesia	18.81	1.24	13,955
Manihiki	Cook Islands	Cook Islands	18.88	0.13	2,895
Martinique	Martinique	France	16.35	3.71	14,400
Mauke	Cook Islands	Cook Islands	18.88	0.13	2,493
Mauritius	Mauritius	Mauritius	16.38	3.19	3,839
Mayotte	Mayotte	France	18.43	1.61	2,600
Mitiaro	Cook Islands	Cook Islands	18.88	0.13	2,734

Appendix III
List of Islands in Our Dataset (continued)

Moen	Federated States of Micronesia	Federated States of Micronesia	18.99	0.87	1,335
Montserrat	Montserrat	United Kingdom	16.32	3.72	8,919
Nauru	Nauru	Nauru	18.88	0.78	2,702
New Britain	Papua New Guinea	Papua New Guinea	18.7	0.61	729
New Caledonia	New Caledonia	France	17.74	2.31	12,455
Niue	Niue	Niue	19.01	0.73	3,600
North Caicos	Turks and Caicos Islands	United Kingdom.	17.66	2.38	9,600
Oreor	Palau	Palau	18.85	1.2	6,076
Palmerston	Cook Islands	Cook Islands	18.88	0.13	2,493
Penrhyn	Cook Islands	Cook Islands	18.88	0.13	989
Pohnpei	Federated States of Micronesia	Federated States of Micronesia	18.85	1.01	2,711
Puerto Rico	Puerto Rico	United States - Puerto Rico	14.93	5.11	18,047
Pukapuka	Cook Islands	Cook Islands	18.88	0.13	724
Rakahanga	Cook Islands	Cook Islands	18.88	0.13	1,528
Rarotonga	Cook Islands	Cook Islands	18.88	0.13	6,433
Reunion	Reunion	France - Reunion	16.63	3.41	6,200
Rurutu	Austral Is	France - French Polynesia	18.89	1.16	13,955
Saba	Netherlands Antilles	Netherlands	16.32	3.72	15,931
Saipan	Northern Mariana Islands	United States	15.65	4.4	12,500
Sint Maartin	Netherlands Antilles	Netherlands	16.48	3.56	16,000
St Croix	US Virgin Islands	United States	16.66	2.5	11,868
St Eustatius	Netherlands Antilles	Netherlands	16.32	3.75	15,931
St Helena	St Helena	United Kingdom	15.02	4.94	2,500
St John	US Virgin Islands	United States	16.66	2.5	18,012
St Kitts	St. Kitts and Nevis	St. Kitts and Nevis	16.23	3.6	8,132
St Lucia	St Lucia	St Lucia	16.5	4.81	4,424
St Martin	Netherlands Antilles	Netherlands	16.48	3.56	9,200
St Thomas	US Virgin Islands	United States	16.66	2.5	14,061
St Vincent	St Vincent	St Vincent	16.8	2.99	2,891
Tahiti	Society Is	France - French Polynesia	18.43	1.62	13,955
Tahuata	Marquesas	France - French Polynesia	18.42	1.63	13,955
Tarawa	Kiribati - Line Islands	Kiribati	18.96	0.85	538
Tol	Federated States of Micronesia	Federated States of Micronesia	18.85	1.01	1,335
Tongatapu	Tonga	Tonga	19	0.7	1,430
Tortola	British Virgin Islands	United Kingdom	16.48	3.56	33,671
Trinidad TTO	Trinidad and Tobago	Trinidad and Tobago	16.87	2.89	6,347
Tristan da Cunha	Tristan da Cunha	United Kingdom	18.16	1.88	2,500
Tutuila	American Samoa (Tutuila Swain)	United States	19	1.05	8,000
Yap	Federated States of Micronesia	Federated States of Micronesia	18.85	1.01	2,751

Appendix IV
GDP by Sector

This is for a subsample of islands in the database. Source is CIA World Factbook 2002, which in turn uses both UN Data and national government statistics from the relevant countries.

island	ocean	GDP	Agriculture	Industry	Services
Bermuda	Atlantic	36 B	1%	10%	89%
Grand Cayman	Atlantic	1.27 B.	1%	3%	95%
Jamaica	Atlantic	10.21 B.	6%	24%	70%
Anguilla	Atlantic	104 Mill	4%	18%	78%
New Britain	Pacific	11.4 B.	32%	36%	32%
Majuro	Pacific	115 Mill	14%	16%	70%
Mauritius	Indian	13.85 B.	6%	33%	61%
US Virgin Islands	Atlantic	2.4 B.	1%	19%	80%
Tongatapu	Pacific	236 Mill	26%	12%	62%
Pohnpei	Pacific	277 Mill	50%	4%	46%
Montserrat	Atlantic	29 Mill	5%	14%	81%
New Caledonia	Pacific	3.158 B.	5%	30%	65%
Guam	Pacific	3.2 B.	7%	15%	78%
Cuba	Atlantic	31.59 B.	8%	35%	58%
British Virgin Islands	Atlantic	320 Mill	2%	6%	92%
St Vincent	Atlantic	339 Mill	10%	26%	64%
Dominica	Atlantic	380 Mill	18%	24%	58%
Barbados	Atlantic	4.496 B.	6%	16%	78%
Grenada	Atlantic	440 Mill	8%	24%	68%
Kadavu	Pacific	5.007 B.	17%	22%	61%
Martinique	Atlantic	6.117 B.	6%	11%	83%
Puerto Rico	Atlantic	65.28 B.	1%	42%	57%
Antigua	Atlantic	750 Mill	4%	19%	77%
Tarawa	Pacific	79 Mill	30%	7%	63%
Malaita	Pacific	800 Mill	42%	11%	47%
St Lucia	Atlantic	866 Mill	7%	20%	73%
Reunion	Indian	9.387 B.	8%	19%	73%

Appendix V
Theories of Colonialism's Impact on Income and Possible Tests

This is a quick summary of Tables IV through VIII in which we attempt to group our various right hand side variables by each theory of colonialism.

Determinants of Income	Mechanisms	Tests (Controlling for Colonization)	Results (Yes, No, A Bit)
Governmental Institutions	Via European Settlement	Years of Colonial Administration Matter?	Yes
		Early Versus Late Colonialism?	Yes
		Does Intensity of Settlement Matter	Yes
Religious Institutions	Missionaries	Do Missionaries Matter	Yes
	European Settlement	Does Percent Catholic or Percent Protestant Matter?	No
Human Capital	Transfer Via European Settlement	Does Intensity of Settlement Matter	Yes
		Does Modern Percent of non-native inhabitants matter?	Yes
	Missionaries	Do missionaries per capita matter?	Yes
		Do missionaries affect modern human capital?	Couldn't test yet
Inequality	Sugar Slave Economy	Do former sugar / plantation islands underperform?	NO!
		Does modern percent black matter?	No
Introduction of Trade		Does trade in any particular good matter?	No
		Does trade in complex goods matter	No

Figure 1
GDP Per Capita versus Years of Colonialism

Circles represent islands in the Atlantic, triangles are islands in the Pacific and squares are islands in the Indian Ocean.

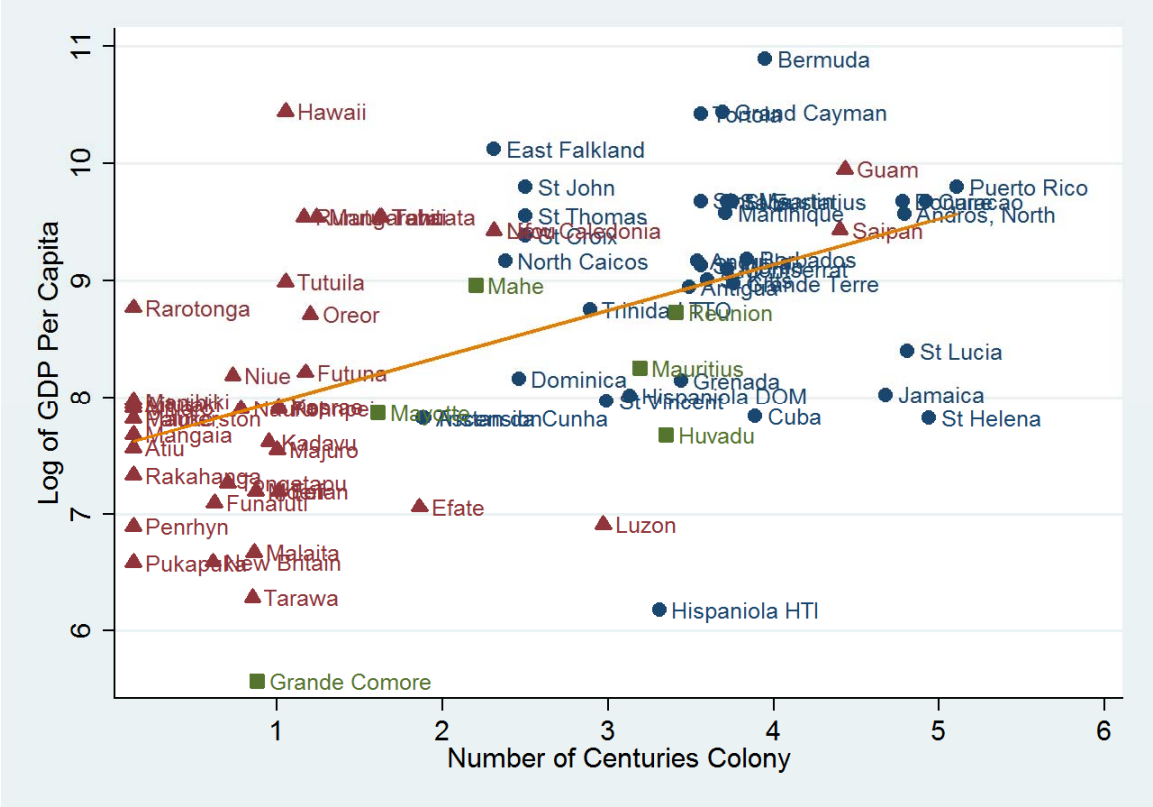

Figure 2
Years of Colonialism Versus Easterly Vector of Wind

Circles represent islands in the Atlantic, triangles are islands in the Pacific and squares are islands in the Indian Ocean.