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The fish is the friend of matriliny: Reef density and matrilineal inheritance☆

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ABSTRACT

This paper studies the influence of marine ecology on social institutions of inheritance and descent. In a sample of 79 small-scale horticultural fishing communities in the Solomon Islands, and in samples of 186 to 1,265 societies across the world, we find that coral reef density systematically predicts the prevalence of matrilineal inheritance. Moreover, this result likely reflects adaptation of institutions to ecological conditions, as it holds within ethno-linguistic groups. Reef density explains as much as 10% of the variation in inheritance rules across villages in the Solomon Islands. Explanations based on the sexual division of labor and on inclusive fitness arguments support our results. We also document some of the demographic consequences of matrilineal inheritance, including smaller household and village population size, but find at best weak evidence that matrilineal inheritance translates into higher female economic or political agency.

1. Introduction

The prevalence of matrilineal versus patrilineal inheritance – inheritance through the female or male line- has deep and far ranging consequences. The extent of female land ownership, which tends to prevail in matrilineal societies, affects the productivity of labour and economic efficiency (Goldstein and Udry, 2008), welfare (La Ferrara, 2007), in particular the relative welfare of women and men (Alesina et al., 2011; Alesina et al., 2013; Carranza, 2014), the effectiveness of land right reforms (Deininger et al., 2013), public good provision (Chattopadhyay and Duflo, 2004) as well as sex-biased mortality (Qian, 2008) and fertility (Alesina et al., 2011; Thomas, 1990). The prevalence of matrilineal kinship in itself is an important driver of behavioural differences between men and women (Gneezy et al., 2009; Hoffman et al., 2011) and affects household bargaining and children's welfare (Lowes, 2016). Yet, little is still known about the determinants of inheritance rules and how they evolve.

In this paper, we study how natural resources, and in particular marine resources, influence whether land will be transmitted through the male or female line. The past literature on this topic has observed that matrilineal inheritance – inheritance through the female line- is prevalent in horticultural societies, but it is rare in agricultural societies that rely on plough use and virtually absent in societies that have domesticated large animals (Aberle, 1961; Holden et al., 2003; Mace and Holden, 2005; Shenk et al., 2010), leading some to state that: "the cow is the enemy of matriliny" (Aberle, 1961, p. 680). While most existing studies have focused on how agricultural sources might affect kinship, inheritance, and gender norms in general,[1] the influence of marine resources has been largely neglected in the literature, with the exception of Dalgaard et al. (2015). A particularly neglected hypothesis is that matriliny may be associated with reliance on fishing, as observed by Aberle (1961) among North-West American matrilineal fishing groups.

We provide the first systematic empirical test of the hypothesis that the quality of reef and pelagic offshore marine resources predicts the prevalence of matrilineal inheritance. We collected micro-level data in a sample of 79 fishing and horticultural villages in the Solomon Islands. The Solomon Islands is an ideal case study to examine the origins of matrilineal descent

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[1] See among others, Olsson and Paik (2016) and Hansen et al. (2015) on the consequences of the Neolithic revolution, and Alesina et al. (2011, 2013) on the consequences of the invention of the plough.

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for a number of reasons. First, while Eurasia shows predominantly patrilocal residence and patrilineal inheritance, matrilineal descent is common among Austronesian-speaking societies of the Pacific (Burton et al., 1996), and the Solomon Islands in particular (Hviding, 1998). Moreover, in our sample, we observe variation between inheritance rules within small geographic areas (Fig. 1), and even within ethno-linguistic groups (Fig. 2).[2] Last, our sample in the Solomon Islands is indicative of traditional ways of life. Villages in our study are small, remote, coastal lowland villages, protected from the deep sea by coral reefs (Fig. 1). Villagers rely exclusively on subsistence fishing and horticulture, without plough agriculture, large domestic livestock, or substantive access to markets, and far from the reach of central government.

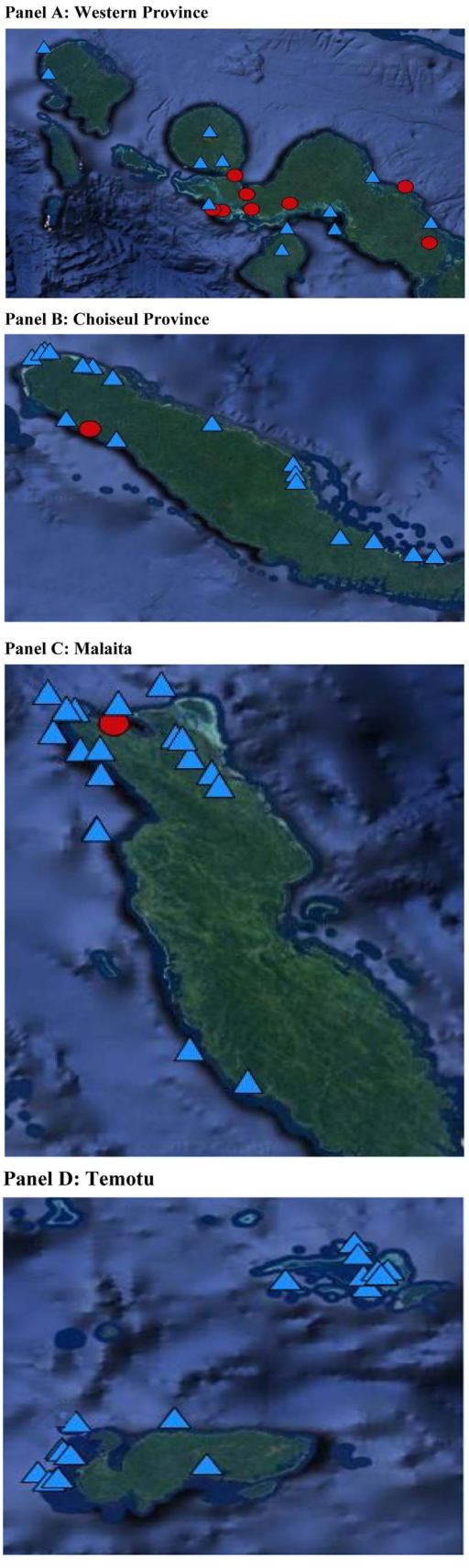
As an exogenous measure of a society's surrounding marine environment, we consider the density of coral reefs in a 10-km radius. Coral reefs are globally important ecosystems and have a large impact on fisheries and the marine environment (NOAA, 2014). The particularly rich reefs of the Solomon Islands provides almost all the animal source to human diet (Albert et al., 2015). Moreover, reef density offers a stable measure, which reflects the long-term quality of pelagic marine resources and is not responsive to fishing intensity among the small horticultural societies we study. We thereby avoid the problem that the quality of marine resources themselves may be the result of societal norms of inheritance. A 10-km radius is a limit accessible on a regular fishing trip on a paddleboat or canoe, which is the available technology in the small-scale horticultural societies we study.

We find that reef density consistently predicts the prevalence of female land inheritance. Reef density explains as much as 10% of the variation in inheritance rules across villages in the Solomon Islands, and the effect is robust to the inclusion of a battery of controls, including soil quality, political structure, and religion. Moreover, this result holds *within* ethno-linguistic groups, which we measure by analyzing the phylogenesis of languages spoken in each village. We argue that the fact that we observe variation in inheritance rules within ethno-linguistic groups likely reflects that inheritance rules have adapted to ecological conditions. A noteworthy corollary of our results is that relatively small variations in ecological resources faced by societies can result in radical differences in the nature of institutions, in particular when such institutions are of a discrete nature, as is the choice of transmitting land either through the male or female line. Last, we document some of the demographic consequences of matrilineal inheritance, including smaller household and village population size.

We then show that our findings hold in wider samples of cultures around the world, thereby conferring external validity to our findings. As our first wider sample, we utilize the Standard Cross Cultural Sample (hereafter, SCCS) (Murdock and White, 1969). The SCCS contains detailed information on 186 cultural societies of the world that were originally selected from a list of 1,265 societies in the Ethnographic Atlas. We focus on the SCCS because the wealth of information in this dataset enables us to best replicate our Solomon Islands findings. Nevertheless, we check that our results also hold across the full sample of matrilineal and patrilineal societies in the Ethnographic Atlas.

We discuss three mechanisms that may be at work in explaining why and how marine endowments influence the prevalence of matrilineal inheritance. First, the sexual division of labour could lead men to specialize in fishing and women to specialize in horticulture. In these circumstances, having women own the land improves their effort and investment incentives (Shenk et al., 2010). Second, the evolutionary benefit in terms of reproductive fitness of transmitting land to sons may be smaller when economic production moves offshore. Moreover, the amount of wealth transmission to sons relative to daughters to maximise reproductive success depends on the degree of paternity certainty, the third determinant of the prevalence of matrilineal inheritance. Because fishing encourages prolonged male absence, it also lowers paternity certainty, encouraging wealth transmission to daughters.

Our results contribute to the literature that explores how geographic



[2] Such small-scale variation rules out warfare as a potential explanatory factor for variation in inheritance rules since practices of warfare did not vary at such a small-scale level (Younger 2014).

Fig. 1. Sampled Villages in the Solomon Islands and Prevalence of Matrilineal Inheritance. **Panel A: Western Province, Panel B: Choiseul Province, Panel C: Malaita, Panel D: Temotu**. Notes: Triangles and circles indicate survey sites. Triangles indicate patrilineal inheritance, and red dots indicate matrilineal inheritance. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

endowments shape institutions and social norms (Acemoglu et al., 2001; Alesina et al., 2011, 2013; Apicella et al., 2014; Carranza, 2014; Engerman and Sokoloff,1997; Gneezy et al., 2014). Institutions and rules governing inheritance play a crucial role for social organization and economic growth (Kotlikoff and Summers, 1981; De Nardi, 2004). Our results establish that ecological conditions play a vital role in the evolution of inheritance rules, and most particularly on the prevalence of matrilineal inheritance. Given the well-studied consequences of matrilineal inheritance on female behaviour and welfare discussed at the start of this introduction, our results speak more particularly to the literature that studies the deep-rooted determinants of female rights and gender roles. Most of the economic literature before us has focussed on land characteristics, such as suitability for plough agriculture (Alesina et al., 2011, 2013), soil endowments (Carranza, 2014), or the timing of the Neolithic revolution (Hansen et al., 2015). Instead of studying land characteristics we investigate the role of marine resources. Further, to the best of our knowledge, we are the first to use variation in inheritance rules within an ethno-linguistic group, when most of the previous literature relied on comparisons across ethnic groups in different regions (as in La Ferrara, 2007) or countries (as in Gneezy et al., 2009 and Hoffman et al., 2011), across which many other ecological and cultural factors may vary. Recent papers have shown that geographic endowments influence language, which, in turn, shapes culture and gender roles (Hicks et al., 2015, Galor et al., 2015). Therefore, relying on small-scale variation within an ethno-linguistic group may be crucial to cleanly isolate the role of ecological factors from the influence of cultural factors.

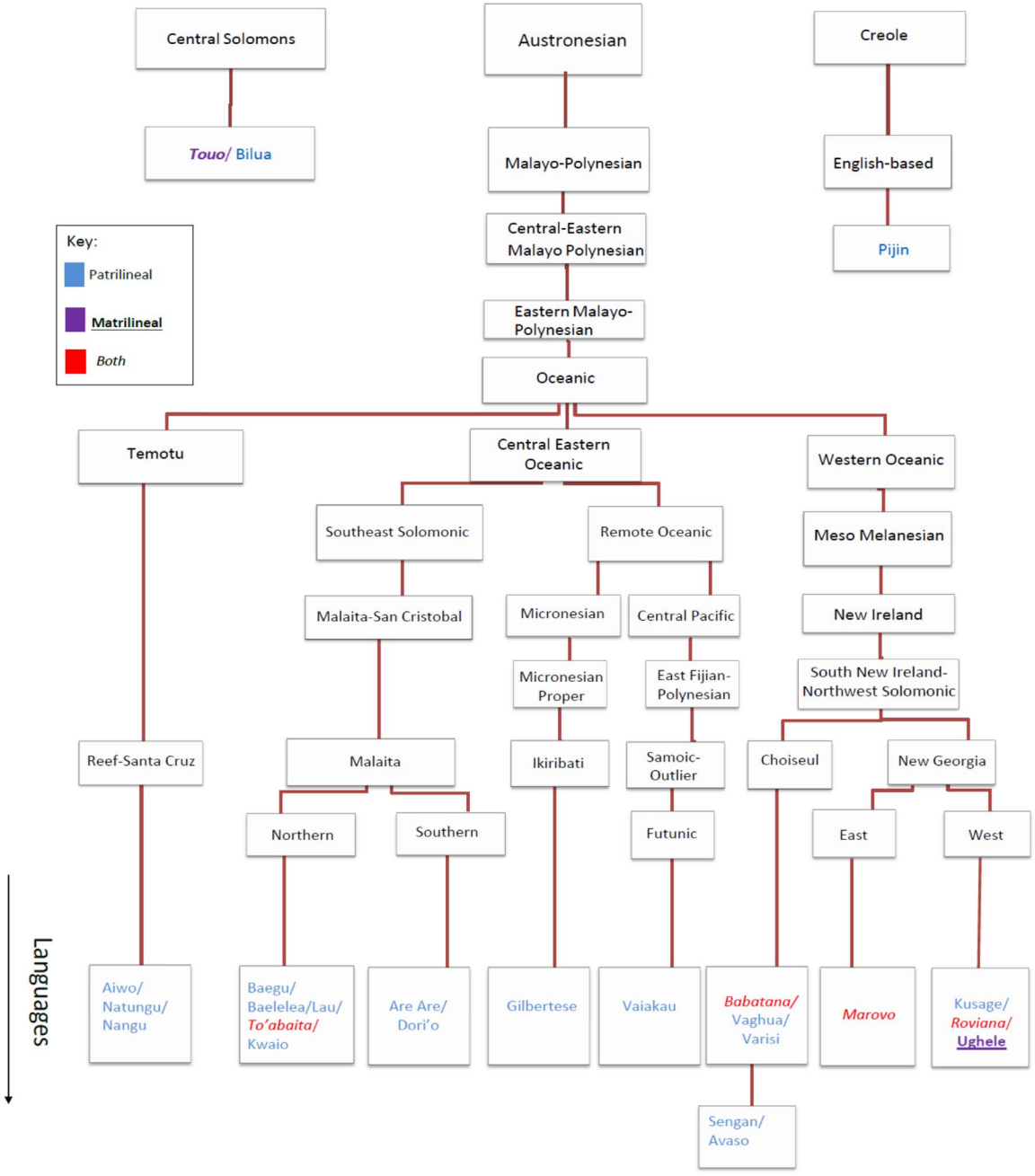


Fig. 2. Language tree of the Solomon Islands and of our sample languages.
Source: *Ethnologue* (Lewis et al. 2016). Languages in our sampled villages are the final nodes. In the final nodes, bold and underlined text indicate matrilineal inheritance, italicized text indicate both patrilineal and matrilineal inheritance, and standard text indicates patrilineal inheritance.

This paper is organized as follows: In Section 2, we provide some background on matrilineal inheritance and the study setting for our Solomon Islands sample. In Section 3, we discuss the mechanisms through which marine resources lead societies to adapt their inheritance rules. We describe the data in Section 4. In Section 5, we present the results of the analysis in the Solomon Islands and across the world, as well as robustness checks. We explore the demographic consequences of matrilineal inheritance in Section 6, before concluding in Section 7.

2. Background and study context

In this section, we provide some background on matriliny, as well as our study setting in the Solomon Islands. We also document the ancestral character of matriliny in the Solomon Islands.

2.1. Matrilineal inheritance rules

Human social organisation is an evolved process that is subject to the forces of natural selection (see among others Richerson and Boyd, 2005; Jordan et al., 2009). In particular, human social organisation has been shaped in a co-evolution process with ecological factors (Kaplan et al., 2009).

In this paper, we focus on the allocation of private property and the transmission of wealth, which are specific features of human social organisation that have widespread implications for economic development and welfare (De Nardi, 2004; Goldstein and Udry, 2008). In particular we study the determinants of matrilineal inheritance, a phenomenon where land is inherited through the female line. Figs. 3 and 4 map the distribution of matrilineal inheritance in the SCCS (Murdock and White, 1969) and the Ethnographic Atlas (Murdock, 1967). Land is transmitted through females in only 16% of the 186 societies in the SCCS and less than 13% of the 1,265 societies in the Ethnographic Atlas. 14% of our sampled villages in the Solomon Islands have a matrilineal land inheritance system, with considerable regional heterogeneity (see Fig. 1, which maps the distribution of matrilineal and patrilineal inheritance across our survey sites). In Western Province, the share of matrilineal villages is as high as 50%, while none of the villages in Temotu Province are matrilineal.

In matrilineal villages of the Solomon Islands, land is inherited by daughters from their mothers. This form of matrilineal land inheritance is the norm in matrilineal societies of the Solomon Islands, as well as in other societies in south central Africa, including large parts of Malawi, Zambia, and Mozambique and in some native American cultures (Murdock, 1967). In other matrilineal cultures, land is transferred from the mother's brother to his sister's son (this is designated by anthropologists as avunculocal residence since a male child can be expected to join his maternal uncle's residence[3]). Avunculocal residence represents a minority of matrilineal systems. In 77% of the matrilineal societies in the SCCS, and in all of our Solomon sample, matrilineal inheritance is not associated with avunculocal residence. Despite their apparent differences, these two forms of matrilineal inheritance are equivalent from a grandparent's perspective since both result in inheritance by their daughters' offspring (Holden et al., 2003).

Matriliny is prevalent in horticultural societies, but it is rare in agricultural societies that rely on plough use (Boserup, 1970) and virtually absent in societies that have domesticated large animals (Aberle, 1961; Holden et al., 2003; Mace and Holden, 2005). Mace and Holden (2005) describe how matriliny was abandoned along with cattle adoption among Bantu-speaking societies of Africa. Matriliny was prevalent among North-West American fishing groups, leading some to hypothesize that reliance on fishing has led to the selection of matrilineal inheritance as the predominant inheritance norm (Aberle, 1961). However, a systematic empirical test of this relationship is yet to be found in the literature.

2.2. Study setting in the Solomon Islands

Our study in the Solomon Islands took place in June - August 2013 in a sample of 79 randomly selected villages in four provinces in the Solomon Islands (Choiseul, Malaita, Temotu, and Western), with 20 villages sampled in each province (because of difficulty of access to one particular village, data was collected only in 19 villages in Western Province).[4]

We collected data from three different surveys in each village: an individual, household, and community leader survey. More detail on the individual and household survey is given in Beath et al. (2016). The community leader's survey was completed in the presence of both male and female village leaders. It is the main source of information on overall village characteristics, such as inheritance and post-marital residence rules, total population, religion, and political structure. All descriptive statistics are included in Table 1.

All the villages in the sample are remote, coastal lowland villages (see Fig. 1). The average travel time between villages and their respective provincial capital is six and a half hours and the average travel time to the country's capital city Honiara is two and a half days. The main mode of transport is by ship or outboard canoe; access to roads is very limited.

Similar to most villages in the Solomon Islands, the villages we surveyed are small. Individuals within the village are organised first in households and second in tribal groups. On average, each village has 464 people, organised in 76 households and between four and five tribal groups. Most villages do not have access to electricity, running water or sanitation. The vast majority (82%) of households use rainwater catchments for drinking water, have access only to solar lamps for lighting their households, and defecate in the sea or the bush.

Most of the villages (86%) are governed by traditional chiefs.[5] All villages have one or more churches, which also serve as the community hall for meetings. Religion is an important part of daily life. All survey respondents claim at least one, sometimes more than one, religious affiliation and there is at least one church service a day in most villages. In our sample, the most predominant denominations are United Church (22%) and Charismatic (Pentecostal) Church (19%), closely followed by Anglican (16%), Seventh-day Adventist and South Seas Evangelists (13% each).

Villages in our sample practice subsistence fishing and horticulture. The vast majority of villagers (81%) depend solely on subsistence.[6] As in other horticultural societies, both men and women practice horticulture.[7] However, fishing offshore is exclusively a male activity and relies on traditional techniques, with men-operated paddleboats or outboard canoes. None of the fishermen in our study have access to modern fishing techniques, nor do they use a motor to operate boats on

[3] As in the Ghana's Akan ethnic group studied by La Ferrara (2007).

[4] This project was embedded in an impact evaluation study of the Solomon Islands Rural Development Program, a US$22 million Community Driven Development Program initiative implemented by the Solomon Islands' Ministry of Development and Planning and Aid Coordination (MDPAC), and supported by AusAID, IFAD, and the World Bank. Sampled villages were drawn from the population of villages receiving funds under that program. Despite focusing on a random sample of RDP villages, selection bias is likely to be minimal, as the RDP program exists in nearly all villages and reaches 76% of the rural population.

[5] In some cases, elected leaders (26.5%) or church leaders (15%) also play an important role in village governance (there are many cases of multiple leader types within a given village).

[6] A minority of households sell some food at nearby markets. In most villages, the three most important sources of income come from selling produce (fish, crops, other sea produces), cocoa, copra, and other cash crops or from logging royalties.

[7] According to the SCCS, in 85% of horticultural societies crop tending is predominately a woman's affair, while males are primarily responsible for soil preparation (80%) and planting (69%).

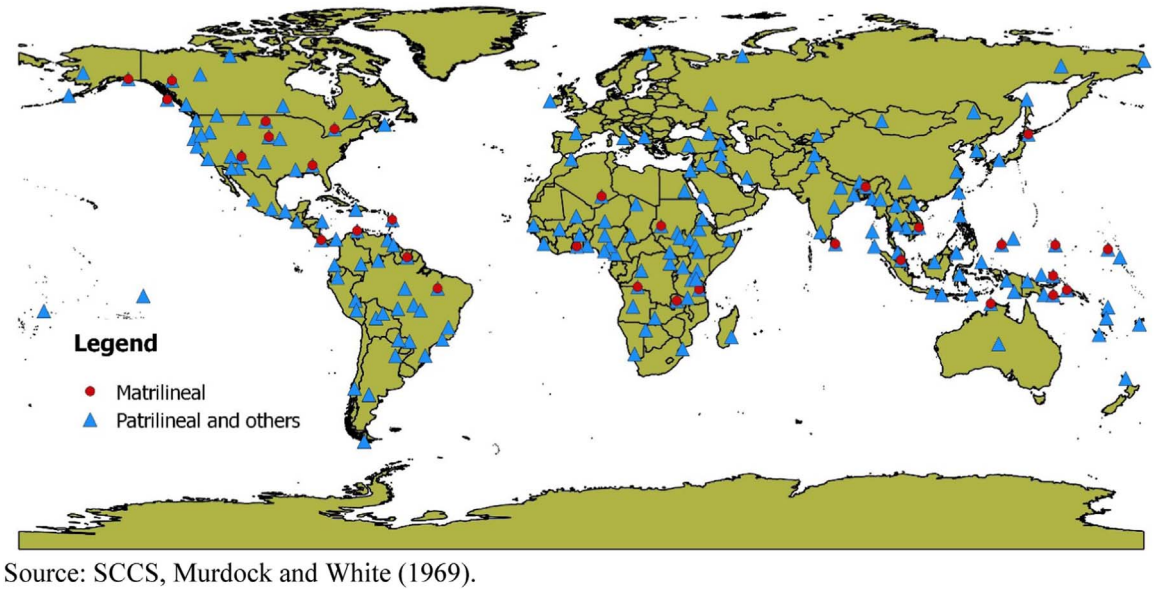


Fig. 3. Matrilineal and patrilineal societies across the world, SCCS sample.
Source: SCCS, Murdock and White (1969).

fishing expeditions. The gendered division of labour in the exploitation of marine resources has been observed in the prior literature. Quinn and Daudau (1999) provide an extensive case study of fishing in Ferafalu village of Malaita Province in the Solomon Islands, where they describe fishing as "men's work" (p. 19). Explanations given by the authors as to why only men venture out fishing reside in manual power and skill (at using "sophisticated gear", such as spears, traps, nets, and palm leaf-kites). Women's (and children's) only participation in fishing activities consists in the gleaning for molluscs, crustaceans and seaweed "in the inter-tidal flats", "close to shore" (p.19). Men fish not only in the lagoon, but also outside the reef, in wide, open, and dangerous seas. The possibility of crashing on the reef on the way out to sea or on return to shore, particularly at night makes fishing very risky.[8]

2.3. Matriliny is ancestral in the Solomon Islands

In order to understand the variation of matrilineal versus patrilineal descent, it is important to establish the original system of descent. In the case of Melanesia, the ancestral character of matrilineal descent has been well established in the literature.

Linguists and archaeologists have reconstructed ancestral social organisation patterns based on phylogenetic analysis of languages and on genetic variations. There is general agreement that Austronesian languages originated in Southeast Asia on or near Taiwan around 3,000 BC and that Austronesian-speakers dispersed through long distance sea voyage by outrigger canoe, first reaching Melanesia by 1450 BC and then Western Polynesia by 950 BC (Hage and Marck, 2003). They were agriculturalists, who possessed rice and probably more than one variety of millet and had domesticated animals, at least pigs and dogs (Blust, 1996).[9]

Based on the evidence that Polynesian mitochondrial DNA (maternal DNA) is of Asian origin while Polynesian Y chromosomes are of Melanesian (non-Austronesian) origin, Hage and Marck (2003) argue that matrilineal descent, as well as matrilocality, characterised ancestral Oceanic society. Indeed, this genetic pattern is consistent with a matri-based model in which non-Austronesian men married in groups organised by matrilineal descent along the way of the Austronesian expansion. Even though parts of Melanesia were already settled by the time of the Austronesian expansion into Oceania (Hage and Marck, 2003), intermixing between Austronesian- and proto-Austronesian-speaking populations took place within the framework of matrilocal residence and matrilineal descent. In an article aptly titled "*Matrilocal residence is ancestral in Austronesian societies*", Jordan et al. (2009) similarly argue that matrilineal descent and matrilocality was predominant in early Austronesian societies, ca 5,000–4,500 BP.[10]

The observed variation in inheritance rule in our Solomon Island sample could be explained by villages switching to patrilineal inheritance under the influence of environmental resources or of modernization. Matrilineal systems are less stable than patrilineal systems. Levi-Strauss (1984) observed the tendency of matrilineal institutions to disappear in Micronesia, while Hage and Marck (2002), in reference to both Micronesia and Polynesia, argue that wherever long distance voyaging declined or never developed, matrilineal descent gave way to patrilineal descent or mixed descent systems. More recently, Quisumbing and Otsuka (2001) note a similar transition in many parts of South Asia with the individualization of land tenure. Mixed systems of double descent are generally interpreted as transitory states between matrilineal and patrilineal institutions (Hage and Marck, 2003). Linguistic evidence from communities in Malaita, one of the islands of the Solomon Islands included in our study, reveals evidence of shifts from matrilineal to patrilineal descent, but not the converse (Blust, 1996).

3. Conceptual framework

Ecological resources can explain gender-based inheritance rules through several channels, which we describe below. The first explana-

[8] The risk involved in reef fishing is at the heart of Malinowski (1925) theory of magic, based on the author's observations in the Trobiand Islands in the Solomon sea: "there are on the shores of the open sea dangerous modes of fishing. […] In the open-sea fishing, full of danger and uncertainty, there is extensive magical ritual to secure safety and good results" (p.32). Quinn and Daudau (1999) describe some of these rituals and customs. For example, traditionally, "women were forbidden from having physical contact with their husbands prior to a fishing trip. Failure to heed such customs would bring bad luck to the fishing expedition" (p.22).

[9] Parts of Melanesia, around the Bismarck archipelago but probably not the Solomon Islands, had already been settled by non-Austronesian groups long before then, at least since 11,000 BC (Hage and Marck, 2003).

[10] The authors use a cultural phylogenetic approach, which consists of using statistical simulation methods (Bayesian MCMC) based on present day ethnographic data (from Murdock, 1967) to reconstruct the ancestral states of social organisation.

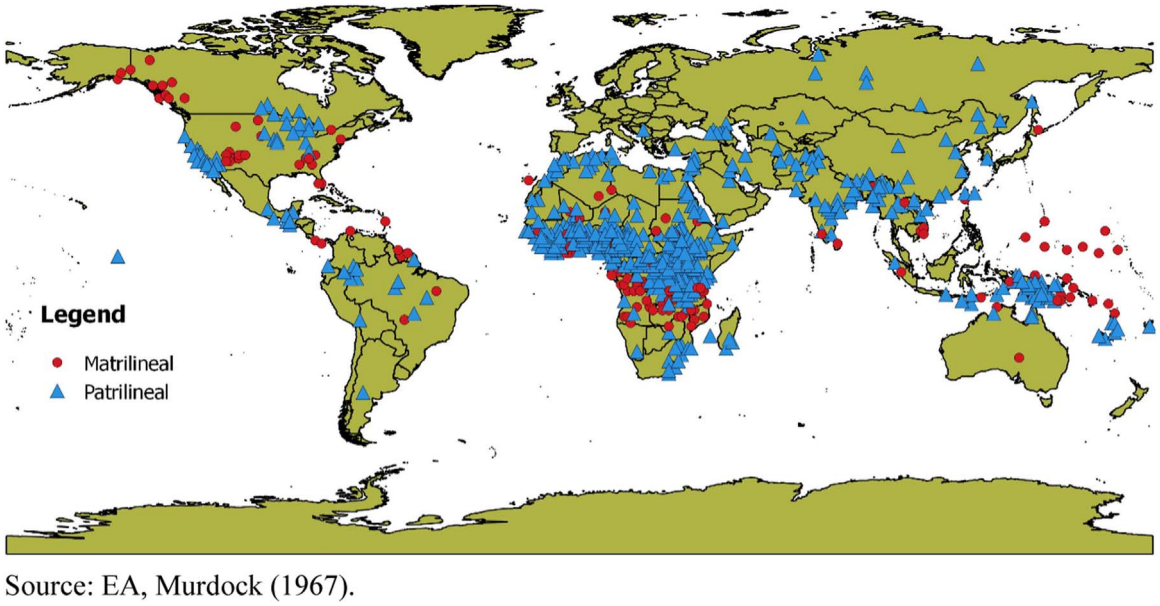


Fig. 4. Matrilineal and patrilineal societies across the world, Ethnographic Atlas sample.
Source: EA, Murdock (1967).

tion relates to the sexual division of labour. Kaplan et al. (2009) argue that many features of human social organisation are the result of sex-specific economic specialisation, which itself responds to evolutionary and ecological imperatives. The authors argue that family structure, and pair-bonding in particular, are the result of male specialisation in hunting. Hunting is incompatible with the evolutionary commitment of women to childbearing because it is risky, requires long absence and is extremely skill intensive. Because reproduction requires a woman to devote time to childbearing, she is less likely to accumulate the human capital and experience required to become an efficient hunter. Although not directly discussed in Kaplan et al. (2009), fishing shares the same characteristics with hunting: it is risky, requires long absence, and is skill intensive. For these reasons fishing is a male activity in most societies. For instance, in the SCCS dataset, women are in charge of fishing in only 5% of societies, and mostly in lakes or rivers. In our Solomon Islands sample, as we have already described in Section 2.2 fishing on pelagic offshore areas is exclusively a male activity. Women are only involved in the collection of shellfish and seagrass in the intertidal flats.

Gendered specialisation in the exploitation of resources and economic incentives for production will influence whether wealth is transmitted either via patrilineal or matrilineal systems. When transmitting wealth in the form of a productive asset (e.g., land), it is more efficient to bequeath this asset to those individuals responsible for production with the asset so that they become the residual claimant of their effort and investment. For example, as men are primarily responsible for plough agriculture (Boserup, 1970; Burton and White 1984), it is more efficient to transmit land to sons in societies using the plough (Botticini and Siow, 2003). Similarly, where male labour is devoted to fishing, the incentive to transmit land to sons is reduced, since their effort and investments are directed differentially toward other resources.

The second explanation for the prevalence of patrilineal versus matrilineal inheritance relies in the relative evolutionary benefit of wealth transmission to sons versus daughters. This evolutionary benefit is shaped by two main forces, which act in opposite directions: (i) how much that extra wealth improves males' reproductive fitness relative to females', and (ii) paternity uncertainty. The reproductive success of a man is a lot more variable than that of a woman (Trivers and Willard, 1973), namely because a man can take multiple wives (at the same time or after the death of a previous wife) more often than the other way around, and because a man does not bear the cost and risk of childbearing. For this reason, wealth often has a larger effect on male reproductive fitness than on female reproductive fitness, thus favouring the transmission of wealth to sons (Trivers and Willard, 1973). For example, cattle enhance marriage prospects of sons; even enabling them to take multiple wives in polygamous societies. In these conditions, cattle transmission to sons improves the reproductive success of sons more than that of daughters. However, the advantage of wealth transmission to sons in terms of inclusive fitness must be balanced with the potential cost due to the risk of paternity uncertainty. Paternity uncertainty always favours transmission of wealth to daughters. The degree of paternity certainty is influenced by ecological factors that determine how long males need to be away from their homes for the purposes of resource exploitation, trade, raiding, or warfare. Marriage bonds and paternity certainty are often weaker in matrilineal societies, although the extent to which this is a cause or a consequence of matrilineal descent systems is open to debate (Hartung, 1985). In the Pacific, the prevalence of matriliny has been associated with high male mortality because of warfare and/or high male absence rates due to ocean fishing and to the nature of trade networks (Hage and Marck, 2003). In our Solomon Islands sample the risk involved in ocean fishing, and the time away spent on the ocean, as well as potential prolonged absence due to the geographic isolation of our villages, are factors that make it difficult to guard mates and contribute to lower paternity certainty. In the past, warfare may have played a similar role (Younger, 2014).

Holden et al. (2003) develop a simple theoretical model, which combines the two evolutionary forces described above. When deciding to transmit an asset, such as land, to either son or daughter, parents maximise their inclusive fitness. Transmission to sons dominates transmission to daughters when the additional benefit in terms of the number of offspring that can be secured (through the acquisition of more than one wife for example) outweighs the loss in terms of paternity certainty. An important prediction of this model is that the number of offspring should be much larger in a patrilineal society than in a matrilineal society.

To sum up, reliance on fishing in a horticultural society is a favourable condition for matrilineal inheritance. The specialisation of labour, with men in fishing and women in farming, favours matrilineal inheritance. Where fishing is abundant, land is a relatively less important resource, and its transmission to sons may not improve

Table 1
Descriptive statistics, Solomon Islands sample.
Sources: Authors' data, *Ethnologue,* and UNEP-WCMC (2010).

Variable	Obs	Mean	Std. Dev.	Min	Max
Number of shallow reef in 10 km radius	79	46.68	28.28	0	97
Social organisation					
Patrilineal inheritance	78	0.83	0.38	0	1
Matrilineal inheritance	78	0.14	0.35	0	1
Mixed inheritance	78	0.03	0.16	0	1
Demographics					
Number of people	78	464.13	515.95	28	3000
Household size	78	9.34	11.73	0.33	87.26
Language					
Central Solomons	76	0.05	0.22	0	1
Central Eastern Oceanic	76	0.32	0.47	0	1
Western Oceanic	76	0.39	0.49	0	1
Temotu	76	0.20	0.40	0	1
Creole	76	0.04	0.20	0	1
Political organisation and religion					
Elected leader	79	0.27	0.44	0	1
Traditional village chief	79	0.86	0.35	0	1
Church leader	79	0.15	0.36	0	1
Village Committee	79	0.08	0.27	0	1
Anglican	79	0.16	0.37	0	1
Catholic	79	0.10	0.30	0	1
Charismatic	79	0.19	0.39	0	1
Methodist	79	0.05	0.22	0	1
SDA	79	0.13	0.33	0	1
SSEC	79	0.13	0.33	0	1
United Church	79	0.22	0.41	0	1
Subsistence					
Share HH living just from subsistence: 76–100%	73	0.81	0.40	0	1
Share HH living just from subsistence: 51–75%	73	0.12	0.33	0	1
Share HH living just from subsistence: 0–25%	73	0.03	0.16	0	1
Travel time to province capital (hours)	78	6.52	8.40	0.50	30
Iron roof	79	0.33	0.22	0	0.85
Enough food for everyone	78	0.87	0.16	0.30	1
Soil production index	79	4.35	0.48	4	5

sons' relative fitness enough to outweigh the potential negative effects on daughters' incentives. Fishing is also risky, which reduces the incentives to rely on the paternal line; and it entails male absence from the village, which increases paternity uncertainty. Several authors before us have noted that fishing and trade in the Pacific require prolonged male absence and favour the prevalence of matrilineal descent (Hage and Marck, 2003). Historical and archeological evidence in eastern North America document switches to matrilineality following among others prolonged male absence for trading, hunting and raiding.

4. Data

4.1. Balance of covariates across villages of the Solomon Islands

In Table 2, we present an analysis of the balance of covariates between matrilineal and patrilineal villages in our Solomon Islands sample. In line with the prediction that the number of offspring per family will be smaller under a matrilineal system (Holden et al., 2003), the total number of people in a village is significantly smaller in matrilineal villages. On average, matrilineal villages are nearly half as populous as patrilineal villages (mean of 293 people compared with 492 in patrilineal villages, difference in means p-value: 0.033), although neither the total number of tribal groups nor the total number of households is significantly different. Accordingly, household size is smaller in matrilineal villages, with, on average, 6.5 people per household, against more than 9.7 in patrilineal villages.

Traditional chiefs are most predominant in both types of villages. However, Church leaders and elected village committees play a more important role in patrilineal villages. There are also slight differences in the major religion practiced by matrilineal and patrilineal villages. Patrilineal villagers are more likely to follow Christian churches with broad global reaches, such as Anglican, Catholic or Methodist churches, while matrilineal villagers tend to mostly follow local Christian hybrid religions such as Charismatic Church, Solomon Island Seventh Day Adventist (SDA) and South Seas Evangelical Church (SSEC). Consistent with the higher concentration of matriliny in Western Province, we find a statistical difference in the language group across matrilineal and patrilineal villages, but this is not an issue for our analysis, as we will control for language fixed effects.

The share of households that rely solely on subsistence is higher in matrilineal than in patrilineal villages. Matrilineal villages are also more remote, with a travel time of 12 h to the provincial capital compared to 5.78 h in patrilineal villages, although this difference is not statistically significant. This is consistent with economic development and contact with Western institutions (including Western religions) leading to a transition from matrilineal to patrilineal inheritance, a phenomenon that has previously been noted by Levi-Strauss (1984) and in the Solomon Islands (Blust 1986–1987).

We will control for all statistically significant differences in observable characteristics between matrilineal and patrilineal villages in robustness tests included in the empirical analysis.

4.2. Language groups in the Solomon Islands

The strength of our Solomon Islands sample lies in the fact that we observe variation in inheritance rules within ethno-linguistic groups, which enables us to control for common ancestry. We follow the phylogenetic method and proxy ethno-linguistic characteristics by language group. Language is an important source of identification among the people of the Solomon Islands. We recorded 27 languages spoken in our sample of 79 villages but many of these languages originate from the same language group.[11] We reconstruct the phylogenesis of each language using the *Ethnologue* (Lewis et al., 2016), a database that contains the genetic classification of more than 7,000 languages. We trace back each language to two distinct main language groups: Central Solomons and Austronesian, as well as Creole. Languages of the Austronesian family in our sample consist of three subgroups: Central Eastern Oceanic, Western Oceanic, and Temotu, which we consider as three separate groups in the analysis in order to be conservative. Temotu is the name of a language group, as well as of a province, but not all languages spoken on Temotu are from the Temotu family. Fig. 2 displays the language tree representation of the *Ethnologue* (Lewis et al., 2016) for our sample of languages.

Crucial for our identification strategy, we observe variation in inheritance rules *within* language groups. This is illustrated in the final nodes of the language tree in Fig. 2. For example, Touo and Bilua are both Central Solomons languages. Yet in Touo villages, land is transmitted through mothers, whereas it is transmitted through fathers in Bilua villages.

4.3. SCCS and ethnographic atlas

4.3.1. SCCS

We use the Standard Cross Cultural Sample (SCCS) to examine a

[11] Recorded language is missing in two villages of our study and we were unable to find any reference in *Ethnologue* for two languages in our study: Mbaere (the spoken language in Tiqe village in Western), and Naa peluo (the spoken language in Nyimoa village in Temotu). We thus have valid observations in 77 villages.

Table 2:
Covariates in matrilineal and patrilineal villages, Solomon Islands.
Sources: Authors' data, *Ethnologue,* and UNEP-WCMC (2010).

Variable	Mean in matrilineal villages	Mean in patrilineal villages	Difference between matrilineal and patrilineal villages	Difference in means P-value
Number of shallow reef in 10 km radius	66.909	42.806	24.103	0.002
Demographics				
Number of people	292.5	492.194	−199.694	0.033
Household size	6.562	9.743	−3.181	0.175
Language				
Central Solomons	0.3	0.015	0.285	0.058
Central Eastern Oceanic	0.1	0.354	−0.254	0.028
Western Oceanic	0.6	0.369	0.231	0.175
Temotu	0	0.231	−0.231	0.000
Creole	0	0.031	−0.031	0.161
Political organisation and religion				
Elected leader	0.182	0.284	−0.102	0.437
Traditional village chief	0.728	0.896	−0.168	0.237
Church leader	0.363	0.104	0.259	0.092
Village Committee	0	0.090	−0.090	0.013
Anglican	0	0.194	−0.194	0.000
Catholic	0	0.119	−0.119	0.004
Charismatic	0.363	0.164	0.199	0.199
Methodist	0	0.045	−0.045	0.084
SDA	0.272	0.104	0.168	0.237
SSEC	0.181	0.119	0.062	0.617
United Church	0.091	0.239	−0.148	0.153
Subsistence				
Share HH living just from subsistence: 76–100%	1	0.790	0.210	0.000
Share HH living just from subsistence: 51–75%	0	0.129	−0.129	0.004
Share HH living just from subsistence: 0–25%	0	0.032	−0.032	0.161
Travel time to province capital (hours)	11.975	5.776	6.199	0.133
Iron roof	0.468	0.301	0.167	0.001
Enough food for everyone	0.964	0.849	0.115	0.000
Soil production index	4.182	4.388	−0.206	0.123

sample of worldwide matrilineal and patrilineal societies (Murdock and White, 1969). The SCCS dataset contains information on 186 cultural societies of the world that were originally selected from a list of 1,265 societies in the Ethnographic Atlas. The goal of the SCCS is to represent the cultural diversity of human societies—which range from contemporary hunter-gatherers to now extinct civilisations. These societies are considered largely independent of one another and arguably representative of mutually distinct cultures (Murdock and White, 1969). The dataset contains close to 1,400 variables that capture various ethnographic and cultural elements.

To determine matrilineal inheritance, we use question v836 from SCCS on the primary rule of descent in each society. Approximately 16.6% of all societies in the sample are of matrilineal inheritance while the rest are patrilineal or non-lineal. We also retain a number of political and demographic characteristics as controls in the analysis, such as: fixity of the settlement (v61),[12] dispersion of the settlement (v62), political leadership type (v76), technological specialisation (v153), suitability of soil for agriculture (v924) and the century the society existed (v838).

Similar to the SI sample we control for cultural differences using the phylogenesis method. Variable v1859 reports the language family of each society in the sample. There are 46 different language groups and 70% of these language groups contain more than one society.

[12] Fixity of the settlement refers to the stability of a society's location. The variable ranges from migratory whereby the society is at least partly nomadic to permanent in which case the society's location is fixed over time.

The SCCS dataset has several limitations for the purpose of our analysis. Firstly, the societies included in the dataset differ widely in terms of their ecological environment as well as their origins. Therefore, it is difficult to isolate the influence of the environment on cultural norms from the possibility that ancestral groups with different inheritance rules chose to settle in different environments according to the quality of the marine resources. Similar to our Solomon Island sample we attempt to control for norms using language groups. However, language categories are more imprecise in this sample relative to the Solomon Island sample. Secondly, sampling of SCCS societies is not random so that generalisations from this dataset can be difficult. Lastly, our main measure of reliance on fishing consists of the density of reefs surrounding societies throughout the world. Since the Earth is an imperfect ellipsoid, using a Geodetic datum such as WGS 84 can lead to inaccuracies in calculating distances. We use a local geodetic datum when calculating distances in the Solomon Islands dataset to overcome this issue.

4.3.2. Ethnographic Atlas

As an additional external validity test, we investigate the relationship between reef density and matrilineal inheritance in the wider Ethnographic Atlas (Murdock, 1967). To determine a society's system of descent we use v43. 12.6% of societies are matrilineal. We include a number of societal controls, such as: century the society existed (v102), fixity of the settlement (v30) and language group (v98). Language group includes 72 different language families, 82% of which contain more than one society.

It is important to note that the EA has several limitations in addition to those already outlined for the SCCS sample. Firstly, the Ethnographic Atlas records the centroid of each society as a pair of integers (latitude and longitude in degrees), whereas the SCCS and the SI sample contains more detailed location information, with latitude and longitude recorded in minutes and in some cases seconds. Without detailed location data it is difficult to accurately calculate the number of reefs around the society.[13] Secondly, detailed (non-missing) information on kinship and on the division of tasks between males and females is limited in the EA (unlike the SCCS). For this reason, much of the prior literature on the determinants of matrilineal inheritance, such as Holden et al. (2003), have used the SCCS.

Summary statistics from the SCCS and EA samples are reported in Table A1 in the Supplementary Appendix.

4.4. Reef data

To identify a village's reliance on fishing, we measure the density of coral reefs in a 10km-radius of each village. We select a 10-km radius as a reasonable limit for a regular fishing trip on a paddleboat, the main fishing technology for the individuals in the small-scale horticultural societies we study. For consistency, we also use a 10-km radius for the SCCS dataset however, since coordinates in the EA are measured in integers they may be inaccurate by as much as 55 km,[14] to overcome this limitation we estimate the number of reefs in a 60 km radius of each society. The reef data is from the Global Distribution of Coral Reefs (hereafter, GDCR), a dataset compiled in 2010 from a number of sources by the UNEP-World Conservation Monitoring Centre and the World Fish Centre, in collaboration with the World Resources Institute and The Nature Conservancy (UNEP-WCMC, 2010). It is the most comprehensive global dataset of warm-water coral reefs publicly accessible. Due to variation in quality of the GDCR data, the exact calculation of reef density for our analyses with the SCCS and EA datasets and with our Solomon Islands sample differ, each is explained in turn below.

Reef data in the vicinity of the Solomon Islands is of higher quality: it has been validated by the University of South Florida and the Institute de Recherche pour le Development (IRD) with support from NASA. The Solomon Islands reef data contains information on reef type (including barrier reef, patch reef and shelf reef) and reef depth (including whether the reef is shallow, variable or deep). Using the Solomon 1968 datum, a coordinate system for the Solomon Islands, we overlay the reef shapefile with the GPS coordinates of our sampled villages. Using both nearest neighbour techniques and a distance matrix, we calculate the number of shallow reefs within a 10 km radius of each village.

We focus our analysis on shallow reefs, as these are closest to shore and thus most accessible by villagers on canoe or paddleboat. Furthermore, other reef types are rare—each village is surrounded by on average 47 shallow reefs, compared to 0.01 deep water reefs (in a 10 km radius). Lastly, shallow water reefs are the most productive for fishing: reef-building corals generally grow best at depths shallower than 70 m, with the most productive reefs growing at depths of 18–27 m below sea level (Lalli and Parsons, 1995).

To examine the density of coral reefs in the locality of SCCS and EA societies, we map and calculate distances between the SCCS and EA societies and coral reefs. To calculate distances, we use QGIS using the World Geodetic 1984 coordinate system, which is the standard coordinate reference system used by GPS devices. Since the GDCR data is compiled from a number of sources the data varies in terms of geometry and reef information. Specifically, a number of locations do not contain information on reef type such as shallow or deep, however all sources contain the total size of each reef formation. To calculate reef density in the SCCS we create a reef distance algorithm that calculates the total square kilometres of all reef types in a 10 km radius of each village. This differs to our measure of reef density in the EA data set. Because the radius surrounding each society is larger at 60 km, a variable that measures the total square kilometres of reef is likely to be biased. For this reason, our measure of reef density in the EA data set is an indicator variable equal to one if the society is surrounded by reef in a 60 km radius.

To validate our reef measure as a proxy for reliance on fishing we use v205 from the SCCS sample. v205 is an ordinal variable that captures a society's reliance on fishing, ranging between 0–9 where higher numbers indicate greater reliance on fishing. We correlate this variable with our measure of the density of coral reefs in a 10-km ra4dius of a society. The correlation coefficient is 0.34 and is statistically significant at the 1% level. The magnitude and statistical significance of the correlation is unchanged by the addition of controls for societal characteristics.[15]

5. Empirical analysis and results

5.1. Analysis in the Solomon Islands

To test the hypothesis that greater reef density leads to matrilineal inheritance, we estimate the following specification in our Solomon Islands sample:

$$M_{ij} = \alpha_1 + \beta_1 Reef_{ij} + \delta_j + X_{ij}\Gamma_1 + \varepsilon_{ij} \quad (1)$$

where M_{ij} is a dummy variable that captures the prevalence of matrilineal inheritance in village i from language group j. $Reef_{ij}$ measures the density of reef surrounding the village (number of shallow reef in a 10-km radius). δ_j is a vector of language group fixed effects. In our main specification, we consider 5 groups: Central Solomons, Central Eastern Oceanic, Western Oceanic, Temotu and Creole. As illustrated in Fig. 2, Central Eastern Oceanic, Western Oceanic, and Temotu are all Austronesian Oceanic languages. In the robustness, we group them together and consider 3 groups only: Central Solomons, Austronesian, and Creole.

X_{ij} is a vector of village-level characteristics that could be correlated with the prevalence of matrilineal inheritance and with local geography. We include in X_{ij} the political structure of the village, religion and share of households living from subsistence.

An important concern for the interpretation of Eq. (1) is that the presence of matrilineal inheritance may rather be explained by differences in land quality, which could somehow be correlated with reef quality. To rule this out, we control for land quality. We use a raster of the FAO's Soil Production Index (United Nations, 2015). Each village has one soil production observation taken from the pixel in which the village is located. The soil quality index is a geographic projection that measures potential agricultural production and yield. More specifically, it measures the suitability of the best adapted crop to each soil condition present in each pixel. For all soils present a weighted average is then calculated.[16][17] It has a spatial resolution of

[13] This is probably not an issue in previous papers that have used this data, for example in Alesina et al. (2011, 2013) because in order to construct the geographic territory of a society the authors create a circle that is a 200km radius around the centroid. In our case, we estimate a 60km radius from a society's centroid.

[14] One degree is approximately 110km.

[15] These are fixity of settlement, dispersion of settlement, political leadership type, technology use, soil suitability for agriculture. Results are displayed in Table A3 in the online Appendix.

[16] The index is based on the formula- Soil Index= 0.9* (Crop)Very Suitable + 0.6*(Crop)Suitable+ 0.3*(Crop)Mildly Suitable+ 0*(Crop)Not Suitable. This means that within a pixel the per cent of the area that is very suitable, suitable, mildly suitable and not suitable for the best adapted crop is calculated. For instance, if within a pixel 40% of soil area is very suitable and 60% is suitable the index for that pixel is 0.9*40+0.6*0.6+0.3*0+0*0.

[17] Information on what is considered the best-adapted crop is not available in the dataset released by the FAO.

Table 3:
The ecological determinants of matrilineal inheritance, Solomon Islands.
Sources: Authors' data, *Ethnologue,* and UNEP-WCMC (2010)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Dependent variable	**Matrilineal inheritance**										
Number of shallow reefs in 10 km radius	0.004***	0.004***	0.005***	0.005**					0.003**	0.004**	0.004*
	(0.001)	(0.002)	(0.002)	(0.002)					(0.001)	(0.002)	(0.002)
Log (Number of shallow reefs in a 10 km radius)					0.090***	0.095**	0.102**	0.096**			
					(0.031)	(0.037)	(0.040)	(0.042)			
Language group	No	Yes	Yes	Yes	No	Yes	Yes	Yes	N/A	N/A	N/A
Religion and political controls	No	No	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes
Control for soil quality	No	No	No	Yes	No	No	No	Yes	No	No	Yes
Merged language group	No	No	No	No	No	No	No	No	Yes	Yes	Yes
Observations	78	75	70	70	78	75	70	70	75	70	70
R-squared	0.090	0.354	0.499	0.501	0.063	0.312	0.458	0.461	0.250	0.386	0.390
Mean dependent variable	0.141										

Notes: The unit of observation is a village. Coefficient estimates from OLS regressions. Robust standard errors corrected for heteroskedasticity are reported in parentheses. ***, **, * and + indicate statistical significance at the 1%, 5%,10%, and 15% level, respectively. Column 1–4 reports the relationship between the number of shallow reefs in a 10 km radius and matrilineal inheritance while columns 5–8 report the result for the log number of shallow reefs in a 10 km radius. Column 9–11 report the results where language groups are merged into 3 categories: Central Solomons, Austronesian (merging Central Eastern Oceanic, Western Oceanic, and Temotu), and Creole. In all other columns there are 5 categories: Central Solomons, Central Eastern Oceanic, Western Oceanic, Temotu, and Creole. For results for the full set of included controls or with standard errors corrected for clustering at the language group level see Table A2 in Appendix.

5 × 5 arc minutes. Higher values of the index indicate greater soil quality and scope for higher agricultural production. Figure A1 in the Appendix maps the soil index for the Solomon Islands. The map reveals very little variation in land quality within province, suggesting that variation in land quality is unlikely to explain the observed variation in inheritance rules. Such a lack of variation is confirmed in Table 2: there is no statistically significant difference in soil quality across matrilineal and patrilineal villages. Still, in order to be conservative, we include this control for land quality in robustness tests.

The estimation results for Eq. (1) are shown in Table 3. In the first column, we present the raw correlation between matriliny and reef density, without including any of the control variables or language group fixed effects. The relationship is statistically significant at the 1% level, and the magnitude of the result is non-negligible. One more shallow reef in a 10 km radius (a 2.14% increase at the mean) is associated with an increase in the probability of matriliny being prevalent in a village by 0.4 percentage points (a 2.86% increase at the mean). On average, raw statistics indicate that reefs are 1.6 times as dense in the vicinity of matrilineal villages compared to patrilineal villages. This result is also illustrated in the left panel of Fig. 5, which plots the difference in the mean of reef density across patrilineal and matrilineal villages in our sample. The raw number of shallow reef is much higher around matrilineal villages in our sample than around patrilineal villages (66.91 against 42.81, difference in means P-value: 0.002). The pseudo R^2 statistic in Column 1 of Table 3 indicates that our reef density measure explains as much as 10% of the variation in inheritance rules across villages.

The inclusion of language fixed effects enable us to control for differences across groups that could be due to the fact that ancestral groups with different inheritance rules chose to settle in different environments according to the quality of the marine resources. With ethno-linguistic group fixed effect, and under the assumption that ancestral characteristics are homogenous in a given group, we can remove the influence of vertically inherited norms and attribute differences in the prevalence of matriliny to adaptation to ecological conditions. Column 2 of Table 3 presents estimation results of Eq. (1) with language fixed effects for the 5 language groups in our sample: Central Solomons, Central Eastern Oceanic, Western Oceanic, Creole and Temotu. The effect of reef density remains robust to the inclusion of these fixed effects, with reef density predicting the presence of matriliny to a similar extent and with similar confidence (*p-value* < 1%, coefficient's magnitude unchanged). Adding language fixed effects increases the goodness of fit: reef density and language group, our proxy for vertically inherited cultural norms, together explain 35% of the variation in the presence of matrilineal inheritance across villages. These results show that both factors are important: inheritance rules have adapted to ecological conditions, but culture, inherited from language groups, is also an important determinant.

An immediate concern for our analysis is the potential presence of confounders that could explain the variation of inheritance rules across villages. In Section 4.2, we document that matrilineal and patrilineal villages are similar in many dimensions but they differ in a few dimensions, such as religion and subsistence patterns. If certain religions favoured a type of inheritance rule over another, and if the type of religion in a village is correlated with reef quality, this could challenge the interpretation of our results. It is therefore important for the analysis to control for the characteristics that differ across matrilineal and patrilineal villages. We do so in Column 3 of Table 3. In particular, we include controls for the main religion practiced in the village (Anglican, Catholic, Charismatic, Methodist or other), for the share of households relying solely on subsistence horticulture and fishing (broken down in 4 categories) and for political structure (traditional village chief, church leader, or village committee). Our result that reef density increases the prevalence of matrilineal inheritance is robust to the inclusion of this battery of controls. The number of observations drops slightly, as a few villages do not report some of the information, but the point estimate remains statistically significant at the 1% level. Its magnitude actually increases, from 0.004 to 0.005. We show in more detail in the next section that such movement in our point estimate suggests that the presence of other potential confounders is not of significant concern for the validity of our results. The goodness of fit increases: we are now able to explain nearly 50% of the variation in the presence of matrilineal inheritance across villages.

We also check in Column 4 that our results are robust to controlling for the index of soil quality described earlier. The inclusion of this control does not change our results at all, and barely influences the variation in the prevalence of matrilineal inheritance that we are attempting to explain.

Table A2 in the Appendix reports the full results with the coefficients associated with each control variable. As hinted above, the soil production index does not have any explanatory power in explaining the prevalence of matrilineal inheritance. Neither does any

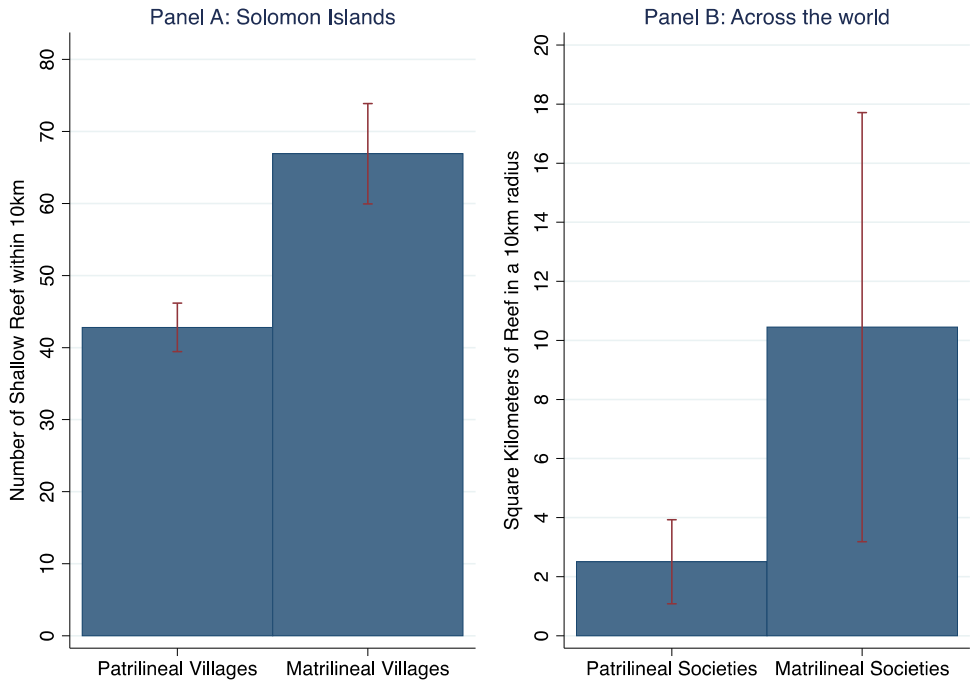


Fig. 5. : Correlation between matrilineal inheritance and reef density. *Notes:* Panel A reports reef density in our sample of the Solomon Islands. Panel B reports reef density across the world.
Source: Murdock and White (1969); UNEP-WCMC (2010), Authors' data.

of the other socio-economic and political controls discussed above, except for the presence of a village ruling committee, which is negatively correlated with the prevalence of matrilineal inheritance.

As a further robustness test we replace the soil production index with a categorical variable 'dominant soil type' and re-estimate the same model. We hypothesise that minimal variation in the dominant soil type is an indication that land quality is constant. Dominant soil type is taken from the Digital Soil Map of the World (DSMW) (United Nations, 2015), which also has a spatial resolution of 5 × 5 arc minutes and is a geographic projection. Each village is assigned a value for the major soil present in the pixel overlapping the village.[18] Our results are unchanged when we include soil types in our empirical model (results available upon request).

5.2. Robustness

5.2.1. Econometric specification

We consider whether our results are dependent on our empirical specification. We first take the log transformation of our explanatory variable, the number of shallow reefs in a 10 km radius, finding that our main results in the Solomon Islands sample remain robust (results in columns 5–8 of Table 3). Our analysis is also robust to grouping the three Austronesian languages (Central Eastern Oceanic, Western Oceanic, and Temotu) together (results in columns 9–11 of Table 3).[19]

Because of the discrete nature of the dependent variable, the OLS model estimated in Table 3 may predict values outside the 0–1 range for the dependent variable. We repeat our estimates in Table 3 with a logit regression and find little variation in results (results available upon request).

5.2.2. Influence of unobservable characteristics

Although we control for a battery of controls in Column 3 and 4 of Table 3, it is possible that there may be unobservable characteristics that are correlated with reef density and matrilineal inheritance. To test this, we use the methodology developed by Oster (2014) and compute the extent of unobservable selection that would be required to negate the effects of reef density in matrilineal villages under the assumption of proportional selection on observables and unobservables.[20] We find that the influence of unobservable variables would need to be more than 22 times as large as the influence of all controls included in Column 3 of Table 3 to explain away the influence of reef density as a predictor of the persistence of matriliny. Even under the most conservative scenario, the corresponding number is still more than seven.[21] When language groups fixed effects are included in the baseline regression (as in Table 3 Column 2), adding controls in Column 3 results in an increase in the magnitude of the coefficients, which suggests that adding more unobservable variables to the regression may move the coefficient on reef density even further away from the null of no effect.

5.2.3. Estimation of standard errors

We re-estimate all the results while clustering the standard errors by the 3 major language group - Central Solomons, Creole and Austronesian. Since we have only 3 clusters, we use the Wild cluster bootstrap method and we alter the distribution of weights in the bootstrap to a six-point distribution as proposed by Webb (2013). This method is shown to outperform the standard wild bootstrap for estimations with less than 10 clusters. Using this method, we find almost identical standard errors as in the standard model. P-values associated with the coefficient on reef density are reported at the bottom of Table A2 in the Appendix.

[18] There are 3 major soil types found in our sample: Chromic Cambisols, Orthic Ferralsols and Regosols.

[19] This robustness test brings our analysis in line with the Ethnographic Atlas analysis in the next section. Indeed, the language groups in the Ethnographic Atlas and the SCCS are defined with less precision than what we are able to do in the Solomon Islands sample. For example, the Ethnographic Atlas and the SCCS do not make any distinction within the Austronesian language family.

[20] We follow Oster's (2014) recommendation and assume that the maximum R-squared is 1.3 times the R-squared obtained with the full set of controls.

[21] This most conservative scenario assumes that the maximum R-squared is equal to 1.

Table 4:
Reef density, fishing, and matrilineal inheritance in the SCCS and Ethnographic Atlas datasets.
Sources: SCCS, Murdock and White (1969), EA, Murdock (1967) and UNEP-WCMC (2010).

	(1)	(2)	(3)	(4)	(5)	(6)
	Matrilineal	Matrilineal	Matrilineal	Matrilineal	Matrilineal	Matrilineal
	SCCS	SCCS	SCCS	EA	EA	EA
Square km of Reef in 10 km radius	0.002*	0.001***	0.001***			
	(0.001)	(0.000)	(0.000)			
Dummy for reef in a 60 km radius				0.282***	0.275***	0.307**
				(0.067)	(0.072)	(0.133)
Language group	No	Yes	Yes	No	Yes	Yes
Other controls	No	No	Yes	No	No	Yes
Observations	186	186	186	744	712	603
R-squared	0.02	0.261	0.279	0.034	0.254	0.322
Mean dependent variable		0.167		0.215	0.219	0.206

Notes: Coefficient estimates from OLS and linear probability regression presented in column 1 and 2 respectively. All regressions with a constant. Column 1 reports the relationship between the density of reefs and societies' dependence on fishing. Dependence on fishing is treated as an ordinal variable ranging between 0–9. Column 2 reports the relationship between the density of reefs and societies' land inheritance. Column 3 adds controls: fixity of settlement, dispersion of settlement, political leadership type, technology use, suitability of soil for agriculture. Robust standard errors in parentheses. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

5.3. External validity: analyses in the SCCS and ethnographic atlas datasets

In order to assess the relationship between the prevalence of matrilineal inheritance and reef density across the world, we estimate the following OLS model with the SCCS sample:

$$M_{ij} = \alpha_1 + \beta_1 Reef_{ij} + \delta_j + X_{ij}\Gamma_1 + \varepsilon_{ij} \quad (2)$$

where M_{ij} is a dummy variable that takes a value of 1 if matrilineal inheritance prevails in village i from language group j. $Reef_{ij}$ measures the square kilometres of reef in a 10 km radius of each society. δ_j is a vector of language group fixed effects. Γ_1 is a vector of controls.

Within a 10 km radius of matrilineal societies, there are on average 10.45 square kilometres of reef, compared to 2.49 in patrilineal and mixed societies (a difference that is significant at the 10% level) (see Panel B of Fig. 5). We examine the robustness of this result to the multivariate analysis described in Eq. (2) in Columns 1 to 3 of Table 4. As before, we first present the results without controls, we then include language group fixed effects, followed by the controls described in Section 4.3. The uncontrolled relationship between prevalence of matrilineal inheritance across SCCS societies and the density of coral reefs in a 10-km radius is statistically significant at the 10% level. The relationship is statistically significant at the 1% level when language group fixed effects are included and is robust to the inclusion of a number of controls including the fixity of the settlement, political leadership structure, technological specialisation and suitability of soil to agriculture. None of these controls are statistically significant (see Table A4 in Appendix). Results with the full set of controls and language group fixed effects in Column 3 suggest that a one unit increase in reef density is associated with a 0.1% increase in the probability of being matrilineal. This is a 0.06% increase at the mean.

We also check whether these results hold in the Ethnographic Atlas dataset of 1,265 societies across the world. We estimate Eq. (2) using the EA sample where M_{ij} is a dummy variable that captures the prevalence of matrilineal inheritance in society i from language group j and Γ_1 includes the century the society existed and fixity of the settlement. As before, we present the results without controls, and we then add language group fixed effects and the controls. Results are reported in Columns 4 to 6 of Table 4. In the estimation without controls the relationship between reef density and matrilineal inheritance is positive and statistically significant at the 1% level of significance. This result holds when we control for language groups and societal characteristics (column 6). Being surrounded by reef in a 60 km radius is associated with an increase in the probability of being matrilineal by between 27 and 30 percent. Table A4 in the Appendix presents the full set of results.

In summary, both the SCCS and EA results support the positive relationship between reef density and matrilineal inheritance found in the SI sample. The breadth of geographic coverage across the SCCS and EA implies that this relationship is not unique to equatorial archipelagos but prevalent in much of the world.

6. Consequences of matrilineal inheritance

In this section, we investigate some of the demographic consequences of inheritance rules, as well as other potential consequences of matrilineal inheritance on the political and economic agency of women and on schooling decision of girls and boys.

6.1. Demographic consequences

Here, we test for the prediction that family size will be higher in a patrilineal system compared to a matrilineal system (Holden et al., 2003). This hypothesis derives from explanations for inheritance rules based on the maximisation of inclusive fitness. Under a patrilineal inheritance system, the additional number of offspring that can result from transmitting an asset to sons needs to outweigh the loss in terms of paternal certainty (Holden et al., 2003). The economic literature has also stressed that land ownership improves the bargaining power of women, which in turn reduces fertility (see Duflo, 2012 for a review). Moreover, because proximity to reefs may be associated with greater female responsibility for farming, the opportunity cost of foregone agricultural production due to childbearing may also induce smaller family sizes.[22]

To test this hypothesis, we regress population size on the presence of matrilineal inheritance in our Solomon Islands sample. Results are reported in Table 5. To measure population size we use both the total population in the village and the average household size in the village. Given that there are neither transient populations nor migration other than through marriage in our villages, these measures are the best proxies for fertility available in our survey. As before, we first present the simple correlation between, on the one hand, matrilineal inheritance and on the other hand, village size (column 1) and household size

[22] It is not the aim of this paper to disentangle between these different mechanisms: this is left for future research.

Table 5:
Matrilineal inheritance and demography, Solomon Islands.
Source: Authors' data, *Ethnologue*.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	**Total Number of People in Village**				**Household size**			
Matrilineal inheritance	−199.694**	−377.557**	−433.995*	−368.846*	−3.181	−5.690+	−9.299*	−7.952**
	(91.692)	(186.543)	(225.067)	(212.219)	(2.324)	(3.457)	(4.989)	(3.938)
Language group	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Religion and political controls	No	No	Yes	Yes	No	No	Yes	Yes
Control for soil quality	No	No	No	Yes	No	No	No	Yes
Observations	77	75	70	70	77	75	70	70
R-squared	0.017	0.068	0.162	0.211	0.008	0.087	0.147	0.188
Mean dependent variable	464.128				9.339			

Notes: The unit of observation is a village. Coefficient estimates from OLS regressions. All regressions with a constant. Robust standard errors corrected for heteroskedasticity are reported in parentheses. ***, **, * and + indicate statistical significance at the 1%, 5%, 10%, and 15% level, respectively. For results for the full set of included controls or with standard errors corrected for clustering at the language group level see Table A5 in Appendix.

Table 6:
Political participation of women, female business ownership and girls education in matrilineal versus patrilineal villages, Solomon Islands sample.
Source: Authors' data, *Ethnologue*.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent variable	**Member any group**		**Total group membership**		**Share female-owned businesses in village**		**Proportion of girls enrolled in kindy**		**Proportion of girls enrolled in primary school**		**Proportion of girls enrolled in high school**	
Matrilineal inheritance	−0.042	−0.038	−0.108	−0.086	0.051	0.081+	−0.040	0.081	−0.189***	−0.204***	−0.019	−0.069
	(0.054)	(0.067)	(0.077)	(0.103)	(0.066)	(0.049)	(0.056)	(0.073)	(0.053)	(0.074)	(0.070)	(0.089)
Female	0.197***	0.213***	0.219***	0.247***								
	(0.032)	(0.033)	(0.050)	(0.053)								
Female*Matrilineal inheritance	−0.006	−0.023	−0.056	−0.087								
	(0.076)	(0.083)	(0.112)	(0.123)								
Language group	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Religion and political controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Control for soil quality	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Prop. boys enrolled in Kindy	No	No	No	No	No	No	Yes	Yes	No	No	No	No
Prop. boys enrolled in Primary	No	No	No	No	No	No	No	No	Yes	Yes	No	No
Prop. boys enrolled in high school	No	No	No	No	No	No	No	No	No	No	Yes	Yes
Observations	1,560	1,400	1,560	1,400	1,480	1,340	1,540	1,380	1,540	1,380	1,540	1,380
R-squared	0.047	0.076	0.025	0.062	0.017	0.411	0.011	0.320	0.088	0.303	0.126	0.364

Notes: The unit of observation is an individual. Coefficient estimates from OLS regressions. All regressions with a constant. Robust standard errors corrected for heteroskedasticity and clustering at the village level are reported in parentheses. ***, **, *, and + indicate statistical significance at the 1%, 5%, 10%, and 15% level, respectively. For results for the full set of included controls, see Table A6 in Appendix.

(column 5). We then control for language fixed effects (columns 2 and 6) as well as for subsistence patterns, political organisation and religion (columns 3 and 7). In columns 4 and 8, we add controls for soil quality.

We find a negative, statistically significant, and large relationship between matrilineal inheritance and our proxies for fertility. According to our estimates, switching from matrilineal to patrilineal inheritance is associated with an increase in village and household size of around 50%.

We also re-estimate the results using the wild cluster bootstrap method with a six-point distribution (Webb, 2013). Using this conservative method, we find that matrilineal inheritance is insignificant at the 12–13% level after adding controls. P-values are reported at the bottom of Table A5 in Appendix.

6.2. Some evidence on political, economic and schooling outcomes for females vs. males

6.2.1. Solomon Islands

It is generally believed that the higher economic power conferred to women through land ownership in a matrilineal society should give women more bargaining power vis-a-vis their husband (La Ferrara, 2007) and more political agency (Asiedu and Ibanez, 2014). Unfortunately, our survey does not precisely elicit measures of women's bargaining power. However, there are a few survey questions, that estimate women's political and economic agency. For example, from the individual survey, we know whether women participate in political and social organisations in the village, such as women groups,

Table 7:
Matrilineal inheritance and female empowerment, SCCS dataset.
Source: SCCS, Murdock and White (1969), *Ethnologue*.

Dependent variable	(1) Pre-marital sex	(2) Pre-marital sex	(3) Fem Part	(4) Fem Part	(5) Fem Eco Ctrl.	(6) Fem Eco Ctrl.
Matrilineal	−0.956*	−0.955*	0.108	0.101	0.063	0.052
	(0.514)	(0.562)	(0.149)	(0.150)	(0.129)	(0.133)
Fixity of Settlement		−0.193		0.003		−0.003
		(0.147)		(0.037)		(0.032)
Dispersion of Settlement		0.009		0.047		0.023
		(0.161)		(0.043)		(0.043)
Political Leadership structure						
Single leader only		0.026		0.093		−0.010
		(0.680)		(0.175)		(0.190)
Single leader and local council		−0.311		0.001		−0.032
		(0.492)		(0.140)		(0.167)
No local leader		−0.397		0.562***		0.230
		(1.084)		(0.174)		(0.235)
Other leader type		−0.562		0.042		0.339*
		(0.919)		(0.202)		(0.173)
Technological Specialization		0.435**		0.046		0.003
		(0.189)		(0.048)		(0.046)
Suitability of soil for agriculture		0.108		0.041		−0.006
		(0.158)		(0.040)		(0.046)
Century of society		−0.077		−0.033**		−0.026
		(0.050)		(0.015)		(0.017)
Language group	Yes	Yes	Yes	Yes	Yes	Yes
Observations	130	130	145	145	139	139
R-squared	0.446	0.510	0.322	0.411	0.280	0.332

Notes: The unit of observation is a society. Coefficient estimates from OLS regressions. All regressions with a constant. Robust standard errors corrected for heteroskedasticity are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

council of elders, church group, youth organisations, or school councils. We build two summary measures: a dummy variable that indicates whether a female respondent is a member of any group, and the total number of groups that a female respondent is involved in. On average, 70% of women are involved in formal groups and an average female respondent is involved in 0.85 groups (min of 0, max of 4). We also know the share of businesses owned by women: 6% of all businesses on average. Last, from the household survey, we know the proportion of children of different genders in the village who are enrolled in different stages of education, from kindergarten (20.39% of girls versus 25.46% of boys, P-value of difference in means: 0.000), to primary (47.77% of girls versus 49.77% of boys, P-value of difference in means: 0.025) and high school (25.66% of girls versus 29.07% of boys, P-value of difference in means: 0.000).

We contrast the membership in social and political organisations, female business ownership, and girls' school enrolment between matrilineal and patrilineal villages in the regressions presented in Table 6 (for the full set of results, see Table A6 in Appendix). For each outcome, we present the results of two specifications: the first without any controls, the second with language group fixed effects and the set of usual socio-political and economic controls as well as soil quality. Since the dependent variables 'member any group' and 'total group membership' (column 1–4), are taken from the individual survey, the variable of interest is the interaction between being a female respondent and living in a matrilineal village (controlling for being female and for living in a matrilineal village). When the dependent variable is the share of girls enrolled in school (column 7–12), we also control for the share of boys enrolled in the same stage. Standard errors are adjusted for clustering at the village level in all specifications.

Overall, women are more likely than men to participate in formal political and social groups. This result is driven by the fact that women groups and school council groups are included in the list of groups. However, we do not observe that women in matrilineal villages are more likely to participate in social and political groups, or to participate in a larger number of these groups, compared with women in patrilineal villages. Indeed, the interaction between being female and living in a matrilineal village is insignificant. In the same vein, results not displayed here show that women in matrilineal villages are not more likely to speak in formal village meetings. These results seem to indicate that matrilineal inheritance is not associated with more political and social engagement of women. This is somewhat at odds with Asiedu and Ibanez (2014), whose experimental findings suggest that women have lower social influence than men in patrilineal regions of Ghana compared with matrilineal regions. However, our results are not directly comparable to theirs since we are unable to measure social influence directly or cooperation within groups in which women participate. We also study variation on a much finer scale, when their results could be driven by unobservable regional or ethnic differences between matrilineal and patrilineal groups in Ghana.

In contrast with formal group membership, our results also suggest that the economic agency of women in matrilineal villages is higher. The share of businesses owned by women is greater in matrilineal villages, although the result is only borderline statistically significant.

Finally, we report the relationship between female school enrolment rates and matrilineal inheritance. We find that the share of girls enrolled in primary schools is lower in matrilineal villages. This could be explained by

the fact that girls are expected to help their mothers with the agricultural work on the plot of land they will later inherit. The share of girls enrolled in high school is also lower, although this result is not statistically significant. By contrast, there is no consistent difference in the share of girls enrolled in kindergarten, potentially because girls that young are not expected to contribute any labour to any economic activity. Another, and possibly complementary, explanation relies on the argument that land inheritance and education are alternative forms of intergenerational transfers (see namely Quisumbing and Otsuka, 2001). Our result on the lower enrolment of girls in primary school is in line with Quisumbing and Otsuka (2001), who observe a negative correlation between matrilineal inheritance and schooling investment in girls in Sumatra.

6.2.2. SCCS

We continue examining the relationship between matrilineal inheritance and three measures of female empowerment in the SCCS sample. The first measures attitudes towards the pre-marital sex of females. The variable is treated as ordinal, with a higher number indicating strong societal disapproval of female pre-martial sex. The second outcome measures the presence of female political participation within the society. The variable is dichotomous, coded as 1 if participation is present. The final outcome is a dichotomous variable equal to 1 if females have economic control of products produced by their own labour.[23] For consistency with results in Table 6, we estimate two models, firstly without controls, and secondly, adding language group fixed effects and the standard set of explanatory variables. Results are reported in Table 7.

We find that after adding controls, matrilineal societies are less likely to disapprove of the pre-marital sex of females. On the other hand, as in the Solomon Islands sample, we find little relationship between matrilineal societies and female political participation or female economic control over output. The evidence that matrilineal inheritance translates into economic and political empowerment of women compared to non-matrilineal societies is far from conclusive.

7. Conclusion

This paper uses a sample of 79 small-scale horticultural fishing communities in Melanesia and samples of 186 to 1,265 societies across the world to study how a society's surrounding marine ecology shapes social institutions. We establish that reef density, our proxy for the quality of the marine environment, systematically predicts the prevalence of female land inheritance in the Solomon Islands and across the world. Although several authors had informally hypothesized that reliance on fishing is associated with matrilineal inheritance, empirical evidence for such a relationship was sparse prior to this paper.

Moreover, we demonstrate that the effect of marine resources on matrilineal inheritance is likely causal and reflects both adaptation to ecological conditions and vertically inherited cultural norms. We observe variation between inheritance rules within ethno-linguistic groups, among which vertically transmitted cultural traits are similar. From this, we can conclude that inheritance rules adapted to ecological conditions. Yet culture is also important: ethno-linguistic group fixed effects explain a sizeable portion of the variation in inheritance rules. In the Solomon Islands sample, local ecological conditions and ethno-linguistic group fixed effects together explain as much as 35% of the variation in matrilineal versus patrilineal land inheritance.

Lastly, we document some of the demographic consequences of matrilineal inheritance, with smaller population and household sizes. This last result is consistent with previous literature, which also argues that through their influence on fertility and population, inheritance rules affect genetic diversity, which is lower in matrilineal societies (Hage and Marck, 2003). However, we find at best only weak supporting evidence that matrilineal inheritance translates into real economic and political empowerment of women.

[23] Pre-marital sex is taken from v165 in the SCCS data set, female political participation is v661 and female economic control of products of their own labor is v660.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jdeveco.2017.03.005.

References

Aberle, D.F., 1961. Matrilineal Descent in Cross-Cultural Comparison. University of California Press, Berkeley and Los Angeles.

Acemoglu, D., Johnson, S., Robinson, J.A., 2001. The colonial origins of comparative development: an empirical investigation. Am. Econ. Rev. 91 (5), 1369–1401.

Albert, J.A., Olds, A.D., Albert, S., Cruz-Trinidad, A., Schwarz, A.-M., 2015. Reaping the reef: provisioning services from coral reefs in Solomon Islands. Mar. Policy 62, 244–251.

Alesina, A., Giuliano, P., Nunn, N., 2011. Fertility and the plough. Am. Econ. Rev. 101 (3), 499–503.

Alesina, A., Giuliano, P., Nunn, N., 2013. On the origins of gender roles: women and the plough. Q. J. Econ. 128 (2), 469–530.

Apicella, C.L., Azevedo, E.M., Christakis, N.A., Fowler, J.H., 2014. Evolutionary origins of the endowment effect: evidence from hunter-gatherers. Am. Econ. Rev. 104 (6), 1793–1805.

Asiedu, E., Ibanez, M., 2014. The weaker sex? gender differences in punishment across matrilineal and patriarchal societies. GlobalFood, (Discussion Paper Series 30.l).

Beath, A., BenYishay, A., d'Adda, G., Grosjean, P., Weber, R., 2016. Decentralization, Elite Capture, and Private Contributions: Experimental Evidence from the Solomon Islands. Mimeo, U. o. N. S. Wales.

Blust, R., 1986-1987. Language and culture history: two case studies. Asian Perspect. 27 (2), 205–227.

Blust, R., 1996. Austronesian culture history: the window of language. Trans. Am. Philos. Soc. 86 (5), 28–35.

Boserup, E., 1970. Woman's Role in Economic Development. George Allen and Unwin Ltd, London.

Botticini, M., Siow, A., 2003. Why dowries? Am. Econ. Rev. 93 (4), 1385–1398.

Burton, M.L., White, D.R., 1984. Sexual division of labor in agriculture. Am. Anthr. 86 (3), 568–583.

Burton, M.L., Moore, C.C., Whiting, J.W.M., Romney, A.K., 1996. Regions based on social structure. Curr. Anthropol. 37 (1), 87–123.

Carranza, E., 2014. Soil endowments, female labor force participation, and the demographic deficit of women in India. Am. Econ. J.-Appl. Econ. 6 (4), 197–225.

Chattopadhyay, R., Duflo, E., 2004. Women as policy makers: evidence from a randomized policy experiment in India. Econometrica 72 (5), 1409–1443.

Dalgaard, C.J., Knudsen, A. and Selaya, P., 2015. The bounty of the sea and long-run development. CESifo. Working Paper Series 5547.

De Nardi, M., 2004. Wealth inequality and intergenerational links. Rev. Econ. Stud. 71 (07), 743–768.

Deininger, K., Goyal, A., Nagarajan, H., 2013. Women's inheritance rights and intergenerational transmission of resources in India. J. Human. Resour. 48 (1), 114–141.

Duflo, E., 2012. Women empowerment and economic development. J. Econ. Lit. 50 (4), 1051–1079.

Engerman, S.L., Sokoloff, K.L., 1997. Factor endowments, institutions, and differential paths of growth among New World economies. J. Econ. Hist. 57 (2), (513-513).

Galor O., Ozak, O., and Sarid, A., 2016. Geographical Origins and Economic Consequences of Language Structures, Working Papers 2016–2017, Brown University, Department of Economics.

Gneezy, U., Leonard, K.L., List, J.A., 2009. Gender differences in competition: evidence from a matrilineal and a patriarchal society. Econometrica 77 (5), 1637–1664.

Gneezy, U., Leibbrandt, A. and List, J., 2014. Ode to the sea: Evidence on the emergence of social norms from a natural experiment. Working paper. Monash University.

Goldstein, M., Udry, C., 2008. The profits of power: land rights and agricultural investment in Ghana. J. Polit. Econ. 116 (6), 980–1022.

Hage, P., Marck, J., 2002. Proto-Micronesian kin terms, descent groups, and interisland voyaging. Ocean. Linguist. 41 (1), 159–170.

Hage, P., Marck, J., 2003. Matrilineality and the melanesian origin of polynesian Y chromosomes. Curr. Anthropol. 44 (S5), S121–S127.

Hansen, C.W., Jensen, P.S., Skovsgaard, C., 2015. Modern gender roles and agricultural history: the Neolithic inheritance. J. Econ. Growth 20 (4), 365–404.

Hartung, J., 1985. Matrilineal inheritance: new theory and analysis. Behav. Brain Sci. 8 (4), 661–670.

Hicks, D.L., Santacreu-Vasut, E., Shoham, A., 2015. Does mother tongue make for women's work? Linguistics, household labor, and gender identity. J. Econ. Behav. Organ. 110, 19–44.

Hoffman, M., Gneezy, U. and List, J.A., 2011. Nurture affects gender differences in spatial abilities. Proceedings of the National Academy of Sciences of the United States of America, 108(36), 14786-14788.

Holden, C.J., Sear, R., Mace, R., 2003. Matriliny as daughter-biased investment. Evol. Human. Behav. 24 (2), 99–112.

Hviding, E., 1998. Contextual flexibility: present status and future of customary marine

tenure in Solomon Islands. Ocean Coast. Manag. 40 (2-3), 253–269.
Jordan, F.M., Gray, R.D., Greenhill, S.J. and Mace, R., 2009. Matrilocal residence is ancestral in Austronesian societies. Proceedings of the Royal Society B-Biological Sciences, 276(1664), 1957–1964.
Kaplan, H.S., Hooper, P.L., Gurven, M., 2009. The evolutionary and ecological roots of human social organization. Philos. Trans. R. Soc. B-Biol. Sci. 364 (1533), 3289–3299.
Kotlikoff, L.J., Summers, L.H., 1981. The role of intergenerational transfers in aggregate capital accumulation. J. Political Econ. 89 (4), 706–732.
La Ferrara, E., 2007. Descent rules and strategic transfers. Evidence from matrilineal groups in Ghana. J. Dev. Econ. 83 (2), 280–301.
Lalli, C.M., Parsons, T.R., 1995. Biological Oceanography: An Introduction. Butterworth-Heinemann, Oxford, UK, 220–233.
Levi-Strauss, C., 1984. Anthropology and Myth: Lectures. Oxford, 1951–1982.
Lewis, M.P., Simons, G.F., Fennig, C.D. (Eds.), 2016. Ethnologue: Languages of the WorldNineteenth edition. SIL International, Dallas, Texas, (Online version: ⟨http://www.ethnologue.com⟩).
Lowes, S., 2016. Kinship Systems, Gender Norms, and Household Bargaining: Evidence from the Matrilineal Belt (mimeo). Harvard University.
Mace, R., Holden, C.J., 2005. A phylogenetic approach to cultural evolution. Trends Ecol. Evol. 20 (3), 116–121.
Malinowski, B., 1925. Magic, science, and religion.In: James Needham (ed.), Science, Religion and Reality.
Murdock, G.P., 1967. Ethnographic Atlas - a summary. Ethnology 6 (2), 109–236.
Murdock, G.P., White, D.R., 1969. Standard cross-cultural sample. Ethnology 8 (4), 329–369.
National Oceanic and Atmospheric Administration (NOAA), 2014. Ocean Services: Coral Reefs. ⟨http://oceanservice.noaa.gov/education/tutorial_corals⟩ (Access September 2014).
Olsson, O., Paik, C., 2016. Long-run cultural divergence: evidence from the neolithic revolution. J. Dev. Econ. 122, 197–213.
Oster, E., 2014. Unobservable Selection and Coefficient Stability: theory and evidence. Working paper. Chicago Booth.
Qian, N., 2008. Missing women and the price of tea in China: the effect of sex-specific earnings on sex imbalance. Q. J. Econ. 123 (3), 1251–1285.
Quinn, N., Daudau, P., 1999. Marine knowledge and subsistence fishing practices at ferafalu village, Maana'Oba Island, Malaita Province, Solomon Islands. J. Pac. Soc. 22 (3-4), (80-63).
Quisumbing, A.R., Otsuka, K., 2001. Land inheritance and schooling in matrilineal societies: evidence from Sumatra. World Dev. 29 (12), 2093–2110.
Richerson, P.J., Boyd, R., 2005. Not by genes alone: how culture transformed human evolution. The University of Chicago Press, Chicago.
Shenk, M.K., Mulder, M.B., Beise, J., Clark, G., Irons, W., Leonetti, D., Low, B.S., Bowles, S., Hertz, T., Bell, A., Piraino, P., 2010. Intergenerational wealth transmission among agriculturalists foundations of agrarian inequality. Curr. Anthropol. 51 (1), 65–83.
Thomas, D., 1990. Intrahousehold resource-allocation - an inferential approach. J. Hum. Resour. 25 (4), 635–664.
Trivers, R.L., Willard, D.E., 1973. Natural-selection of parental ability to vary sex-ratio of offspring. Science 179 (4068), 90–92.
UNEP-WCMC, W.C., WRI, T., 2010. Global distribution of warm-water coral reefs, compiled from multiple sources including the Millennium Coral Reef Mapping Project. Cambridge (UK), United Nations Environmental Program World Conservation Monitoring Centre.
United Nations, FAO, 2015. FAO GEONETWORK. Rome, Italy, FAO.
Webb, M.D., 2013. "Reworking Wild Bootstrap Based Inference for Clustered Errors. Working Paper. Queens Economics Department.
Younger, S.M., 2014. Violence and warfare in precontact Melanesia. J. Anthropol. 2014, (Article ID 658597).