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ON THE ORIGINS OF GENDER ROLES: WOMEN AND THE  
PLOUGH\*

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The study examines the historical origins of existing cross-cultural differences in beliefs and values regarding the appropriate role of women in society. We test the hypothesis that traditional agricultural practices influenced the historical gender division of labor and the evolution of gender norms. We find that, consistent with existing hypotheses, the descendants of societies that traditionally practiced plough agriculture today have less equal gender norms, measured using reported gender-role attitudes and female participation in the workplace, politics, and entrepreneurial activities. Our results hold looking across countries, across districts within countries, and across ethnicities within districts. To test for the importance of cultural persistence, we examine the children of immigrants living in Europe and the United States. We find that even among these individuals, all born and raised in the same country, those with a heritage of traditional plough use exhibit less equal beliefs about gender roles today. *JEL* Codes: D03, J16, N30.

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## I. INTRODUCTION

This study examines an important deeply held belief that varies widely across societies: the appropriate or natural role of women in society. In some societies, the dominant belief is that women should be allowed to participate freely, and equally to males, in employment outside the home. In others, there is the very different view that the appropriate place for women is within the home, and they are discouraged from participating in activities outside the domestic sphere. These differences can be most clearly seen in surveys that report attitudes about gender roles. For example, the proportion of respondents in the World Values Survey that “agree” with the statement that “when jobs are scarce, men should have more right to a job than women” varies widely across countries, ranging from 3.6% (in Iceland) to 99.6% (in Egypt).<sup>1</sup>

Our interest is in explaining the origins of these cultural differences. Specifically, we test the hypothesis, put forth by Ester Boserup (1970), that differences in gender roles have their origins in the form of agriculture traditionally practiced in the pre-industrial period. Boserup identifies important differences between shifting cultivation and plough cultivation. Shifting cultivation is labor intensive and uses handheld tools like the hoe and the digging stick. Plough cultivation, by contrast, is much more capital intensive, using the plough to prepare the soil. Unlike the hoe or digging stick, the plough requires significant upper body strength, grip strength, and bursts of power, which are needed to either pull the plough or control the animal that pulls it. Because of these requirements, when plough agriculture is practiced, men have an advantage in farming relative to women.

Given the important role of soil preparation in agriculture, which accounts for about one-third of the total time spent in agricultural tasks, societies that traditionally practiced plough agriculture—rather than shifting cultivation—developed a specialization of production along gender lines. Men tended to work outside the home in the fields, while women specialized in

1. The figures are based on the 4th wave of the World Values Survey, which includes information from 62 countries surveyed between 1999 and 2004. Objective outcomes, like female labor force participation (FLFP), also exhibit significant variation (Antecol 2000; Fortin 2005; Fernandez 2007; Fernandez and Fogli 2009). In 2000, the FLFP rate ranged from 16.1% (Pakistan) to 90.5% (Burundi).

activities within the home. This division of labor then generated norms about the appropriate role of women in society. Societies characterized by plough agriculture, and the resulting gender-based division of labor, developed the belief that the natural place for women is within the home. These cultural beliefs tend to persist even if the economy moves out of agriculture, affecting the participation of women in activities performed outside the home, such as market employment, entrepreneurship, or participation in politics.

To test Boserup's hypothesis, we combine pre-industrial ethnographic data, reporting whether societies traditionally practiced plough agriculture, with contemporary measures of individuals' views about gender roles, as well as measures of female participation in activities outside the home. Our analysis examines variation across countries, ethnic groups, and individuals. Consistent with Boserup's hypothesis, we find a strong and robust positive relationship between historical plough use and unequal gender roles today. Traditional plough use is positively correlated with attitudes reflecting gender inequality and negatively correlated with female labor force participation, female firm ownership, and female participation in politics.<sup>2</sup>

Although these findings support Boserup's hypothesis, they are also consistent with other interpretations. For example, we would observe the same relationships if societies with attitudes favoring gender inequality were more likely to adopt the plough historically, and these attitudes persist today. To better understand whether traditional plough use has a causal impact on subsequent cultural norms, we control for an exhaustive set of observable characteristics.

In our baseline set of covariates, we include controls for a number of historical characteristics of ethnic groups, such as the suitability of their environment for agriculture, whether they had domesticated animals, the extent to which they lived in tropical climates, their level of political development, and their level of economic development. We also flexibly control for current country-level per capita GDP. We show that the results

2. Our analysis is concerned with a very specific aspect of gender equality: whether it is believed to be appropriate for women to work outside the home as it is for men. There are many other gender differences that contribute to gender inequality more broadly defined. However, throughout the paper when we refer to gender equality (or inequality), we are referring specifically to gender differences in employment outside the home.

are robust to controlling for additional historical characteristics of ethnic groups and contemporary characteristics of countries that are potentially correlated with traditional plough use and beliefs about gender roles today.

Motivated by the possibility that our cross-national results may be biased by other characteristics of countries, we move to a more micro-level analysis, examining cross-individual variation in female labor force participation and beliefs about gender equality. With this strategy, we are able to restrict the analysis to variation within countries and even variation within districts within countries. We find similar impacts when we examine this finer variation.

We then turn to an analysis of the importance of ancestral differences in specific geo-climatic characteristics that impacted what types of crops could be cultivated in the historical locations. This analysis is motivated by Pryor (1985), who argues that the benefit of using the plough differed depending on the types of crops cultivated. The plough is more beneficial for crops that require large tracts of land to be prepared in a short period of time (e.g., due to multiple-cropping), and that can be grown only in soils that are not shallow, not sloped, and not rocky.<sup>3</sup> These crops, which Pryor refers to as “plough-positive”, include teff, wheat, barley, rye, and wet rice. These can be contrasted to “plough-negative” crops, such as maize, sorghum, millet, and various types of root and tree crops, which require less land to be prepared over a longer period of time, and/or can be cultivated on thin, sloped, or rocky soils, where using the plough is difficult. Unlike plough-positive crops, plough-negative crops benefit much less from the adoption of the plough.

Using data from the Food and Agriculture Organization (FAO), we identify the geo-climatic suitability of finely defined locations for growing plough-positive cereals (wheat, barley, and rye) and plough-negative cereals (sorghum, foxtail millet, and pearl millet). Except for their benefit from plough use, the two sets of cereals are otherwise similar. Both have been cultivated in the Eastern Hemisphere since the Neolithic revolution;

3. For a recent study documenting the link between soil type and plough use in modern India, see Carranza (2010). In particular, she shows that in contemporary India, plough technology is more likely to be adopted with deep loamy soils rather than shallow clay soils, and that it is associated with less participation of women in agriculture.

require similar preparations for consumption, all being used for flour, porridge, bread, or in beverages; and produce similar yields and therefore are able to support similar population densities.

We show that, consistent with Pryor (1985), the suitability of a location for cultivating plough-positive vs. plough-negative crops predicts whether the plough was adopted. We also show that they predict gender norms today. Finally, we use ethnic groups' geo-climatic conditions for growing plough-positive and plough-negative cereals as instruments for historical plough use. Motivated by concerns that our instruments may be correlated with other geographic characteristics, we check that the estimates are robust to flexibly controlling for geographic covariates, including overall agricultural suitability, temperature, precipitation, soil depth, and slope. We find that the IV procedure generates estimates that are consistent with the OLS estimates.

Our analysis then turns to underlying mechanisms. It is possible that the long-term impact of the plough reflects persistent cultural beliefs. However, it is also possible that part of the long-term impact arises because historical plough use promoted the development of institutions, policies, and markets that are less conducive to the participation of women in activities outside the home. To distinguish these two channels, we exploit the fact that cultural norms and beliefs—unlike institutions, policies, and markets—are internal to the individual. Therefore, when individuals move, their beliefs and values move with them, but their external environment remains behind. Exploiting this fact, we examine variation in cultural heritage among children of immigrants living in either the United States or Europe. All individuals born and raised abroad have been exposed to the same institutions and markets. In effect, the analysis holds external factors constant, while examining variation in individuals' internal beliefs and values. We find that individuals from cultures that historically used the plough have less equal gender norms and that women from cultures that used the plough participate less in the workforce. These results provide evidence that part of the importance of the plough arises through its impact on internal beliefs and values.

Our findings contribute to a deeper understanding of the origins of cultural norms and beliefs. Studies have documented the continuity of cultural norms over remarkably long periods of time (e.g., Voigtlander and Voth 2012). Others show that historical factors influence the evolution of culture over time by affecting

the relative costs and benefits of different cultural traits. Guiso et al. (2008) provide evidence that the formation of medieval communes had a long-term impact on the level of social capital within Northern Italy. Similarly, Becker et al. (2010) and Grosjean (2011b) provide evidence of historical state boundaries having lasting cultural impacts. Nunn and Wantchekon (2011) show that Africa's slave trade generated a culture of distrust that continues to persist today. Nisbett and Cohen (1996) and Grosjean (2011a) show that the culture of honor in the US South has its origins in a tradition of herding among the Scots-Irish. The findings of our paper add to this line of enquiry by providing additional evidence that shows that historical factors—namely, differences in traditional farming practices—have shaped the evolution of norms and beliefs about the appropriate role of women in society.

Our focus on a historical determinant of gender roles is not meant to imply that other short-run factors are unimportant. A number of existing studies have shown the importance of determinants like economic development, medical improvements, technological change, and the production structure of the economy (e.g., Goldin 2006; Ross 2008; Albanesi and Olivetti 2007; 2009; Doepke and Tertilt 2009; Iversen and Rosenbluth 2010). As we show, accounting for these important factors, there remains a strong persistent impact of traditional plough use on gender norms today.

The paper is organized as follows. We begin, in Section II, by describing the conceptual framework underlying the hypothesis tested in the paper. Section III then documents that in societies that traditionally used plough agriculture, women did in fact participate less in farmwork and other activities outside domestic sphere. In Section IV, we then explain the procedure used to link traditional plough use, which is measured at the ethnicity level, to contemporary data on gender norms and female participation outside the home. Sections V and VI report OLS estimates of the relationship between traditional plough use and gender outcomes today, examining variation across individuals and countries. Section VII turns to the issue of causality, reporting OLS estimates that control for an extensive set of observable characteristics, as well as the IV estimates. In Section VIII, we then turn to mechanisms, using the children of immigrants in the United States and Europe to test for cultural transmission as a potential channel. Section IX offers concluding thoughts.

## II. CONCEPTUAL FRAMEWORK

The possibility that modern gender roles have their origins in the form of agriculture practiced traditionally has long been recognized. Baumann's (1928) early study examined the relationship between matriarchy and the use of the hoe in Africa. Ester Boserup (1970) further developed the observation, identifying important differences between shifting cultivation and plough cultivation. Unlike shifting cultivation, which is labor intensive and uses handheld tools like the hoe and digging stick, plough agriculture requires significant upper body strength, needed to either pull the plough or control the animal that pulls it. Because of these physical requirements, when plough agriculture is practiced, men have an advantage relative to women. This advantage is also reinforced by the fact that when the plough is used, there is less need for weeding, a task typically undertaken by women and children. In addition, child care, a task almost universally performed by women, is most compatible with activities that can be stopped and resumed easily and that do not put children in danger; characteristics that are satisfied for hoe agriculture, but not for plough agriculture, especially when animals are used to pull the plough.

Due to the importance of soil preparation, societies that traditionally practiced plough agriculture—rather than shifting hoe cultivation—tended to develop a specialization of production along gender lines. Men tended to work outside the home in the fields, while women specialized in activities within the home. This division of labor then generated norms about the appropriate role of women in society. Societies characterized by plough agriculture, and the resulting gender-based division of labor, developed a cultural belief that the natural place for women is within the home.

We view cultural beliefs as decision-making heuristics or “rules-of-thumb” that are employed in uncertain or complex environments. Using theoretical models, Boyd and Richerson (1985) show that if information acquisition is either costly or imperfect, it can be optimal for individuals to develop heuristics or rules-of-thumb in decision making. By relying on general beliefs about the right thing to do in different situations, individuals may not behave in a manner that is precisely optimal in every instance, but they save on the costs of obtaining the information necessary to always behave optimally. It is increasingly

understood that many important aspects of human behavior are guided by decision-making heuristics, which manifest themselves as values, beliefs, or gut feelings about the appropriate action in certain situations (Gigerenzer 2007; Kahneman 2011). In practice, these heuristics often take the form of deeply held traditional values or religious beliefs.

In standard models of cultural evolution (e.g., Boyd and Richerson 1985), the distribution of cultural beliefs in the population evolves through a natural-selection-like process determined by relative payoffs. Within this framework, Boserup's hypothesis suggests that in societies that engaged in plough agriculture, cultural beliefs about gender inequality were relatively beneficial. Therefore, these norms may have evolved in plough-agriculture societies but not hoe-agriculture societies. Because of the persistent nature of cultural beliefs, norms of gender inequality may persist even after the economy moves out of agriculture or industrializes, affecting the participation of women in activities performed outside the home, such as market employment, entrepreneurship, or participation in politics.

There are a number of reasons why we may observe persistence. First, the underlying cultural traits may be reinforced by policies, laws, and institutions, which affect the benefit of beliefs about gender inequality. A society with traditional beliefs about gender inequality may perpetuate these beliefs by institutionalizing unequal property rights, voting rights, parental leave policies, etc. Another source of persistence can arise from a complementarity between cultural beliefs and industrial structure. Beliefs of gender inequality may cause a society to specialize in the production of capital- or brawn-intensive industries, which in turn decreases the relative costs of norms about gender inequality, thereby perpetuating this trait.

A third explanation that does not rely on these forms of complementarity is that cultural beliefs, by definition, are inherently sticky. The benefit of decision-making rules-of-thumb is that they can be applied widely in a number of environments, saving on the need to acquire and process information with each decision. The focus of our analysis is on testing whether there is any evidence for the persistence of cultural beliefs independent of external factors that generate complementarities that cause persistence. Our subnational analysis, with either country fixed effects or subnational district fixed effects, speaks to this by accounting for external factors such as industrial structure and domestic policies and



institutions. More directly, our analysis of the children of immigrants living in the United States and Europe tests for a relationship between traditional plough agriculture and cultural beliefs while holding constant the external environment.

At first blush, some aspects of Boserup's hypothesis likely have intuitive appeal, while others may not. If one is seeking to explain differences in female participation in activities outside the home, then it is natural to examine the activity that historically has been the most important, namely, agriculture. Within agriculture, the two traditional forms are slash-and-burn hoe agriculture and intensive plough agriculture. It is possible that this important distinction had long-term impacts.

One aspect of Boserup's theory that may initially appear unappealing is that Western societies, namely Europe and its offshoots, have long practiced plough agriculture, and these societies also have extremely equal gender roles today. This observation seems to directly contradict Boserup's hypothesis that links a tradition of plough agriculture to unequal gender roles. However, the presumption that Europe and its offshoots are the most gender equal today is to a large extent a slightly misplaced Western-centric view of gender norms. Although it is true that progress has been made due to changes in the second half of the twentieth century, even today, Europe and its offshoots, although above average, are not among the most gender-equal countries. For example, the share of national political positions held by women in the United States in 2000 was 13%, which places it 50th out of the 156 countries for which data are available. The female labor force participation rate in the United States in the same year was 59.5, ranking it 47th of the 181 with available data. In addition, these statistics appear even less equal when one takes into account the high per capita income of Western nations.

### III. THE HISTORICAL IMPACTS OF TRADITIONAL PLOUGH AGRICULTURE

We begin by first confirming that societies that traditionally used plough agriculture had lower female participation in agricultural activities. We also check whether plough use was associated with differences in other activities within and outside the domestic sphere.

Our analysis uses information on pre-industrial plough use from the *Ethnographic Atlas*, a worldwide ethnicity-level database constructed by George Peter Murdock that contains ethnographic information for 1,265 ethnic groups. Information for societies in the sample has been coded for the earliest period for which satisfactory ethnographic data are available or can be reconstructed. The earliest observation dates are for groups in the Old World where early written evidence is available. For the parts of the world without a written history, the information is from the earliest observers of these cultures. For some cultures, the first recorded information is from the 20th century, but even for these cultures, the data capture as much as possible the characteristics of the ethnic group prior to European contact. For all groups in the data set, the variables are taken from the societies prior to industrialization.<sup>4</sup>

The database provides information on whether societies traditionally used the plough. Ethnicities are classified into one of three mutually exclusive categories: (1) the plough was absent, (2) the plough existed at the time the group was observed, but it was not aboriginal, and (3) the plough was aboriginal and found in the society prior to contact.<sup>5</sup> There is no evidence of groups switching from one form of agriculture to another and then back again. In other words, the use of the plough, once adopted, remains stable over time. Using this categorization, we construct an indicator variable for traditional plough agriculture that equals one if the plough was present (whether aboriginal or not) and zero otherwise.<sup>6</sup>

It is possible that the plough had a larger impact on gender norms if it was adopted early. However, because of data

4. In total, 23 ethnicities are observed during the 17th century or earlier, 16 during the 18th century, 310 during the 19th century, 876 between 1900 and 1950, and 31 after 1950. For nine ethnicities, an exact year is not provided. Appendix Table A2 (see the supplementary material online) reports the number of the ethnicities present in the *Ethnographic Atlas* by continent, and Figure A1 maps their locations. The majority of the ethnicities sampled are in Africa, followed by North America and then Asia. Fewer observations are present within the European continent, in part, because researchers felt that analysis of European cultures was history rather than ethnography (since written records existed for these cultures).

5. Of the 1,156 ethnicities for which information exists, for 997 the plough was absent, for 141 the plough was adopted and aboriginal, and for 18 it was adopted, but following European contact.

6. All of the results reported in the paper are robust to an alternative definition of traditional plough use that does not include the 18 ethnic groups that adopted the plough after European contact. See Appendix Table A7.

limitations, we are unable to test for this. From the database, we know the approximate date of adoption only if it occurred after European contact. For the others, we do not have any information on the timing of adoption. Given this, our estimates should be interpreted as the average effect of having adopted the plough among all ethnic groups that did so prior to industrialization. There may be heterogeneity within the group of adopters (e.g., based on date of adoption), but we are able to estimate only an average effect.

We measure traditional female participation in agriculture using information on the gender-based division of labor in agriculture reported in the *Ethnographic Atlas*. Ethnicities are grouped into one of the following five categories measuring relative participation in agriculture by gender: (1) males only, (2) males appreciably more, (3) equal participation, (4) females appreciably more, and (5) females only.<sup>7</sup> Using this information, we construct a variable that takes on integer values ranging from 1 to 5 and increases with female specialization in agriculture.

When examining the relationship between the gender-based division of labor in agriculture and plough use, we control for a number of characteristics of ethnic groups that may be correlated with plough use and gender roles. We control for the presence of large domesticated animals, a measure of economic development, and a measure of political complexity, all taken from the *Ethnographic Atlas*. The presence of domesticated animals is measured with an indicator variable that equals one if large domestic animals were present in the society. Economic development is measured using the density of ethnic groups' settlements. Ethnicities are grouped into the following categories: (1) nomadic or fully migratory, (2) semi-nomadic, (3) semi-sedentary, (4) compact but not permanent settlements, (5) neighborhoods of dispersed family homesteads, (6) separate hamlets forming a single community, (7) compact and relatively permanent settlements, and (8) complex settlements. With this information, we construct a variable that takes on integer values, ranging from 1 to 8 and

7. The original classification in the *Ethnographic Atlas* distinguishes "differentiated but equal participation" from "equal participation". Since this distinction is not relevant for our purposes, we combine the two categories into a single category of equal participation. In addition, for 232 ethnic groups, agriculture was not practiced and therefore there is no measure of female participation in agriculture. For an additional 315 ethnic groups, information for the variable is missing. These ethnic groups (547 in total) are omitted from the analysis.

increasing with settlement density. Political complexity is measured by the levels of jurisdictional hierarchies in the society.<sup>8</sup>

We also control for two measures of the geographic conditions of the traditional location of each ethnic group. For each ethnicity, we know the geographic coordinates of the centroid of the group historically. Using this information, we calculate the fraction of land within a 200-kilometer radius of the centroid that is defined as suitable for the cultivation of crops. The crop suitability data are from the FAO's *Global Agro-Ecological Zones (GAEZ)* 2002 database (Fischer et al. 2002), which reports suitability measures for 5 arc-minute by 5 arc-minute (approximately 56 km by 56 km) grid cells globally. We also use the same procedure to control for the proportion of land within a 200-kilometer radius that is defined as being tropical or subtropical.

OLS estimates examining the historical relationship between traditional plough use and female participation in agriculture are reported in column 1 of Table I. The specification reported includes the five control variables. The estimates identify a negative relationship between plough use and participation of women in agriculture. The use of the plough is associated with a reduction in the female participation in agriculture variable of 0.88, which is large given that its mean is 3.0 and its standard deviation is 1.0.<sup>9</sup> This is consistent with the analysis of Boserup (1970), as well as the observations of anthropologists like Bauermann (1928) and Whyte (1978).<sup>10</sup>

A natural question that arises is the exact nature of this decline in female participation in agriculture; specifically, whether the decline is in all agricultural tasks or if it is focused in only a few (such as soil preparation). Unfortunately, the *Ethnographic Atlas* does not provide information on specific tasks within agriculture. We therefore complement our analysis by using Murdock and White's (1969) *Standard Cross-Cultural Sample (SCCS)*, which does contain this information. The SCCS contains ethnographic information on 186 societies, intentionally chosen to be

8. As we report in Appendix Table A13, traditional plough use is positively associated with all three variables, and most robustly with political complexity.

9. Descriptive statistics are reported in Table A1 of the appendix.

10. Ideally, we would also like to observe the absolute participation of women in agriculture, not just their participation relative to men. Unfortunately, such ethnographic data are not widely available. In Section V, where we examine contemporary outcomes, the measures of female participation in the labor force, firm ownership, and politics are absolute measures and are not relative to men.

TABLE I  
TRADITIONAL PLOUGH USE AND FEMALE PARTICIPATION IN PRE-INDUSTRIAL AGRICULTURE

|  | (1)                  | (2)                  | (3)                 | (4)                  | (5)                  | (6)                  | (7)                  |
|--|----------------------|----------------------|---------------------|----------------------|----------------------|----------------------|----------------------|
| Dependent variable: Traditional participation of females relative to males in the following tasks: |                      |                      |                     |                      |                      |                      |                      |
| Overall agriculture  |                      |                      |                     |                      |                      |                      |                      |
| Mean of dep. var.  | 3.04                 | 2.83                 | 1.45                | 2.15                 | 2.86                 | 3.16                 | 3.23                 |
| Traditional plough agriculture   | -0.883***<br>(0.225) | -1.136***<br>(0.240) | -0.434**<br>(0.197) | -1.182***<br>(0.320) | -1.290***<br>(0.306) | -1.188***<br>(0.351) | -0.954***<br>(0.271) |
| Ethnographic controls  | yes                  | yes                  | yes                 | yes                  | yes                  | yes                  | yes                  |
| Observations   | 660                  | 124                  | 129                 | 124                  | 131                  | 122                  | 131                  |
| Adjusted R-squared   | 0.13                 | 0.19                 | 0.14                | 0.10                 | 0.09                 | 0.13                 | 0.16                 |
| R-squared  | 0.14                 | 0.23                 | 0.18                | 0.14                 | 0.13                 | 0.18                 | 0.20                 |

Notes. The unit of observation is an ethnic group. In column 1, ethnic groups are from the *Ethnographic Atlas*, and in columns 2-7, they are from the *Standard Cross-Cultural Sample*. The dependent variable measures traditional female participation in a particular agricultural activity in the pre-industrial period. The variables take on integer values between 1 and 5 and are increasing in female participation. "Traditional plough use" is an indicator variable that equals one if the plough was traditionally used in pre-industrial agriculture. For the *Ethnographic Atlas*, the mean (and standard deviation) of the traditional plough agriculture variable is 0.186 (0.390), and for the *SCCS* it is 0.234 (0.425); these correspond to the samples from columns 1 and 2, respectively. The same statistics for the other columns are slightly different. "Ethnographic controls" include: the suitability of the local environment for agriculture, the presence of large domesticated animals, the proportion of the local environment that is tropical or subtropical, an index of settlement density, and an index of political development. Finer details about variable construction are provided in the text and appendix. Coefficients are reported with robust standard errors in brackets. Column 1 reports Conley standard errors adjusted for spatial correlation. \*\*\*, \*\*, \* and \* indicate significance at the 1%, 5%, and 10% levels.

representative of the full sample, and to be historically and culturally independent from the other ethnic groups in the sample. The database was constructed by first grouping the 1,265 societies from the *Ethnographic Atlas* into 186 clusters of closely related cultures. A particularly well-documented and representative ethnic group was then chosen for each cluster, and these constitute the observations in the SCCS.<sup>11</sup>

Using the SCCS data, we first replicate the regression reported in column 1. As shown in column 2, we find a similar result: plough use is associated with a decline in female participation in agriculture of 1.14, which is roughly equal to a one-standard-deviation change in the dependent variable. In columns 3–7, we estimate the association between plough use and female participation in the following agricultural tasks: land clearance, soil preparation, planting, crop tending, and harvesting. The estimates show that plough use is associated with less female participation in all agricultural tasks, with the largest declines in soil preparation, planting, and crop tending.

In columns 1–9 of Table II, we consider the relationship between plough use and female participation in the following non-agricultural activities: caring for small animals, caring for large animals, milking, cooking, fuel gathering, water fetching, burden carrying, handicraft production, and trading.<sup>12</sup> We find that the plough tends not to be significantly correlated with female participation in other activities. The exception is that plough use is associated with significantly less female participation in burden carrying. We find some evidence of more female participation in caring for large animals, caring for small animals, and milking, although none of the coefficients is statistically significant.

These results are consistent with women working less in societies that traditionally used the plough. This interpretation of the correlations is fully consistent with Boserup's hypothesis. What is important for her argument is that when plough

11. Table A2 in the appendix reports the distribution of ethnicities in the *Ethnographic Atlas* and SCCS by continent, while Table A3 lists the names of all ethnic groups in the SCCS.

12. If an activity is not present in a society, then the dependent variable is coded as missing. This is the reason for the different number of observations in each regression.

TABLE II  
TRADITIONAL PLOUGH USE AND TRADITIONAL FEMALE PARTICIPATION OUTSIDE OF AGRICULTURE IN THE PRE-INDUSTRIAL PERIOD

|                        | (1)  | (2)                      | (3)             | (4)               | (5)               | (6)               | (7)                 | (8)               | (9)               |
|------------------------|--|--------------------------|-----------------|-------------------|-------------------|-------------------|---------------------|-------------------|-------------------|
|                        | Dependent variable: Traditional participation of females relative to males in the following tasks: |                          |                 |                   |                   |                   |                     |                   |                   |
|                        | Caring for small animals   | Caring for large animals | Milking         | Cooking           | Fuel gathering    | Water fetching    | Burden carrying     | Handicrafts       | Trading           |
| Mean of dep. var.      | 3.53   | 1.73                     | 3.25            | 4.65              | 3.90              | 4.64              | 3.47                | 2.78              | 2.47              |
| Traditional plough use | 0.14<br>(0.517)  | 0.064<br>(0.254)         | 0.63<br>(0.697) | -0.019<br>(0.108) | -0.638<br>(0.403) | -0.052<br>(0.205) | -0.962**<br>(0.378) | -0.157<br>(0.274) | -0.155<br>(0.542) |
| Ethnographic controls  | yes  | yes                      | yes             | yes               | yes               | yes               | yes                 | yes               | yes               |
| Observations           | 88   | 95                       | 48              | 173               | 159               | 154               | 135                 | 74                | 59                |
| Adjusted R-squared     | -0.02  | -0.02                    | 0.03            | 0.01              | -0.001            | 0.01              | 0.12                | 0.07              | -0.01             |
| R-squared              | 0.05   | 0.04                     | 0.14            | 0.04              | 0.04              | 0.04              | 0.16                | 0.15              | 0.10              |

Notes. The unit of observation is an ethnic group from the *Standard Cross-Cultural Sample*. The dependent variable measures traditional female participation in a particular activity in the pre-industrial period. The variables take on integer values between 1 and 5 and are increasing in female participation. "Traditional plough use" is an indicator variable that equals one if the plough was traditionally used in pre-industrial agriculture. The mean (and standard deviation) of this variable is 0.239 (0.429); this corresponds to the sample from column 1. "Ethnographic controls" include: the suitability of the local environment for agriculture, the presence of large domesticated animals, the proportion of the local environment that is tropical or subtropical, an index of settlement density, and an index of political development. Finer details about variable construction are provided in the text and appendix. Coefficients are reported with robust standard errors in brackets. \*\*\*, \*\*, \* and \* indicate significance at the 1%, 5%, and 10% levels.

agriculture is used, women participate less in work outside the home than when hoe agriculture is practiced. Whether women work more or less hours under one form than under the other has no direct effect on her argument. In addition, her hypothesis makes no claims about whether women are better or worse off under one agricultural system than under the other.

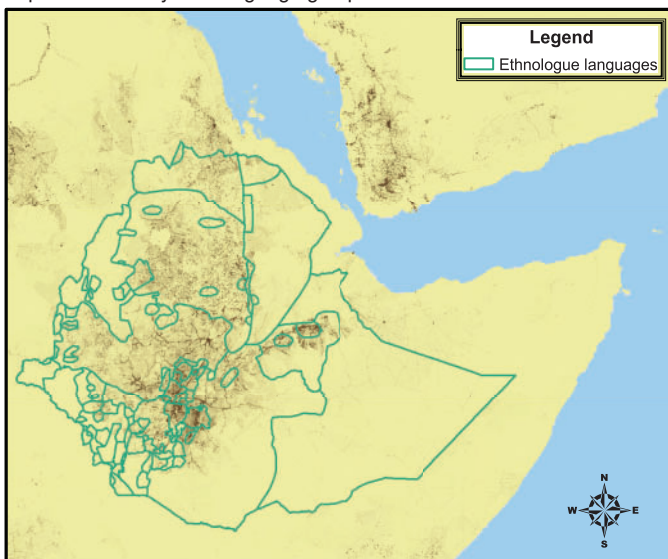
#### IV. LINKING THE PAST TO THE PRESENT: DATA AND METHODOLOGY

We next turn to an examination of the long-term impact of traditional plough use. To do this, we link historical plough use, measured at the ethnicity level, with current outcomes of interest, measured at the location level (either countries or districts within countries) today. This requires an estimate of the geographic distribution of ethnicities across the globe today. We construct this information using the 15th edition of *Ethnologue: Languages of the World* (Gordon 2005), a data source that maps the current geographic distribution of 7,612 different languages, each of which we manually matched to one of the 1,265 ethnic groups from the *Ethnographic Atlas*. The *Ethnologue* provides a shape file that divides the world's land into polygons, with each polygon indicating the location of a specific language as of 2003. We also use the *Landscan 2000* database, which reports estimates of the world's population in 2000 for 30 arc-second by 30 arc-second (roughly 1 km by 1 km) grid cells globally. We combine the *Ethnologue* shape file with the *Landscan* raster data to obtain an estimate of the distribution of language groups across the globe today. This information is used to link the historical ethnicity-level data to our current outcomes of interest, measured at the location level.

We illustrate our procedure with the example of Ethiopia. Figure 1a shows a map of the land inhabited by different ethnic groups, i.e., groups speaking different languages. Each polygon represents the approximate borders of a group (from *Ethnologue*). One should not think of the borders as precisely defined boundaries, but rather as rough measures indicating the approximate locations of different language groups. The map also shows the *Landscan* estimate of the population of each cell within the country. A darker shade indicates greater population.



(a) Population density and language groups



(b) Population density, language groups, and their traditional plough use

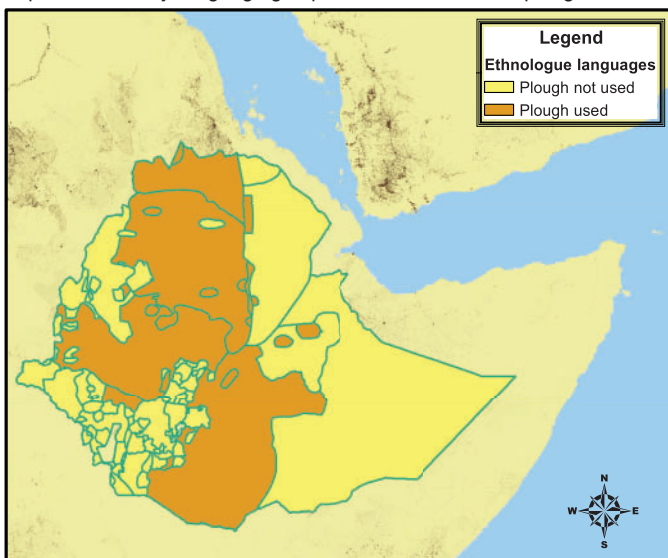


FIGURE I

Populations, Language Groups, and Historical Plough Use within Ethiopia

From the *Ethnographic Atlas*, we know whether each ethnic group used the plough historically. We define  $I_e^{plough}$  to be a variable equal to one if ethnic group  $e$  engaged in plough agriculture and zero otherwise. By matching each of the 7,612 *Ethnologue* language groups to one of the 1,265 *Ethnographic Atlas* ethnic groups, we can determine whether the ancestors of each language group engaged in plough agriculture. This information is shown in Figure 1b. We thus have an estimate of ancestral plough use among individuals across the world, observed at a level of 1 km by 1 km. We then combine this with information on modern boundaries to construct district- and country-level averages of ancestral plough use. This provides an estimate of the fraction of the population currently living in a district (or country) with ancestors that traditionally engaged in plough agriculture.

To be more precise, let  $N_{e,i,d,c}$  denote the number of individuals of ethnicity  $e$  living in grid-cell  $i$  located in district  $d$  in country  $c$ . We construct a population-weighted average of  $I_e^{plough}$  for all ethnic groups living in a district  $d$ . The district-level measure of the fraction of the population with ancestors that traditionally used the plough,  $Plough_{d,c}$ , is given by

$$(1) \quad Plough_{d,c} = \sum_e \sum_i \frac{N_{e,i,d,c}}{N_{d,c}} \cdot I_e^{plough},$$

where  $N_{d,c}$  is the total number of people living in district  $d$  in country  $c$ . The same procedure is also used to construct a country-level measure  $Plough_c$ , except that the average is taken over all grid-cells in country  $c$ .

Figure II shows the global distribution of languages based on the *Ethnologue* data, as well as the historical plough use for each group (i.e., the global version of Figure 1b). Uninhabited land is shown as dark gray.

The map highlights a number of potential concerns that we address in our empirical analysis. First, there is little variation within Europe and within sub-Saharan Africa. Therefore, there is the concern that our estimates are simply driven by broad differences between regions like Europe and Africa. Motivated by this concern, we also estimate a number of different specifications identified from within-country variation. These are reported in Section VI. We also report cross-country estimates omitting Europe and sub-Saharan Africa. These are reported in Section V.

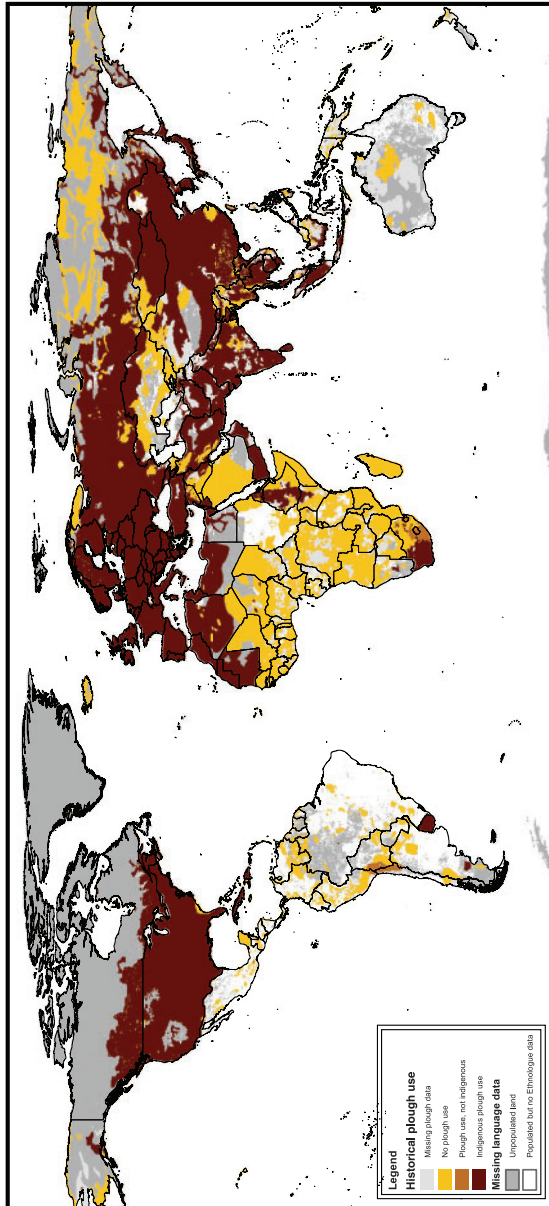


FIGURE II  
Traditional Plough Use among the Ethnic/Language Groups Globally

As well, the lack of variation in traditional plough use within Europe implies that Boserup's hypothesis and our empirical analysis cannot explain existing differences in gender role beliefs within Western Europe (and its offshoots).

Second, most of the variation appears to be at the macro level with much less variation across smaller geographic units. Although this is true in part, there is significant micro-level variation in many parts of the world, much of which cannot easily be seen at the global scale presented in Figure II. In Section VI, we show that our results are robust to examining within-country variation across ethnic groups and districts.

A third concern with the *Ethnologue* data is that information is missing for some parts of the world. This is due to uncertainty or a lack of information about the boundaries of some language groups. As is apparent from Figure II, this occurs primarily in Latin America.

We undertake a number of strategies to assess whether the missing data are systematically biasing our estimates. The first is to check the robustness of the results to omitting countries that have a significant proportion of their language data coded as missing. Another strategy is to construct alternative measures where we make assumptions regarding the missing language data. The first assumption we employ is to assume that all inhabitants in unclassified territories speak the official national language of the country. The second strategy is to impute the missing data using information on the spatial distribution of ethnic groups from the *Geo-Referencing of Ethnic Groups* (GREG) database (Weidmann et al. 2010). Like the *Ethnologue*, the GREG database provides a shape file that divides the world's land into polygons, with each polygon indicating the location of a specific ethnicity. The shortcoming of the GREG database is that ethnic groups are much less finely identified relative to the *Ethnologue* database. The GREG database identifies 1,364 ethnic groups, while the *Ethnologue* identifies 7,612 language groups. The spatial distribution of traditional plough agriculture globally using these alternative procedures is reported in Appendix Figures A2a and A2b.

The traditional plough use variables, constructed using either imputation method, are highly correlated with the baseline measure. At the country level, the correlation between: (1) our baseline variable and the measure with missing languages imputed using the country's national language is 0.89, (2) our

baseline measure and the measure imputed using ethnic groups from the GREG database is 0.91, and (3) the two variables with imputed values is 0.98.<sup>13</sup>

## V. COUNTRY-LEVEL OLS ESTIMATES

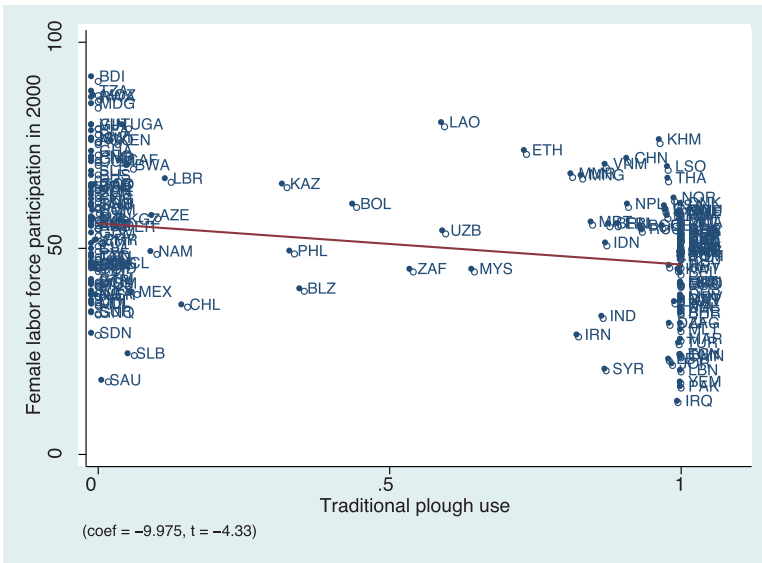
Having constructed country- and district-level measures of traditional plough use, we are able to examine the relationship between historical plough use and the role of women in societies today. We begin by examining variation at the country level. Our country-level estimates examine three outcomes of interest, all of which are intended to reflect cultural attitudes and beliefs about the role of women in society. The first measure we consider is each country's female labor force participation rate (FLFP) in 2000. We also examine women's participation in more narrowly specified activities outside the domestic sphere: entrepreneurship (measured by the share of firms with a woman among its principal owners) and national politics (measured by the proportion of seats held by women in national parliament).<sup>14</sup>

We first examine the unconditional relationship between each outcome and our measure of traditional plough agriculture. These are reported in Figure III. For two of the three outcomes of interest, we find that the relationship is in the hypothesized direction and statistically significant. Traditional plough use is associated with less female labor force participation and less female firm ownership. Both relationships are statistically significant. However, the bivariate relationship between female participation in politics and traditional plough use is insignificant and positive.

13. Appendix Figures A3a–A3c report maps showing the country-level averages for each of the three plough variables.

14. Female labor force participation is taken from the World Bank's *World Development Indicators*. The variable is measured as the percentage of women aged 15 to 64 that are in the labor force; it ranges from 0 to 100. The share of a country's firms with some female ownership is measured as the percentage of surveyed firms with a woman among the principal owners. The measures are from the World Bank *Enterprise Surveys*, which were undertaken between 2005 and 2011, depending on the country. The proportion of seats in national parliament is measured as the percent of parliamentary seats, in a single or lower chamber, held by women. The variable, measured in 2000, is taken from the United Nations' *Women's Indicators and Statistics Database*. The sample of countries for each variable is reported in Table A4 of the appendix.

(a) Female labor force participation in 2000



(b) Female firm ownership, 2003–2010

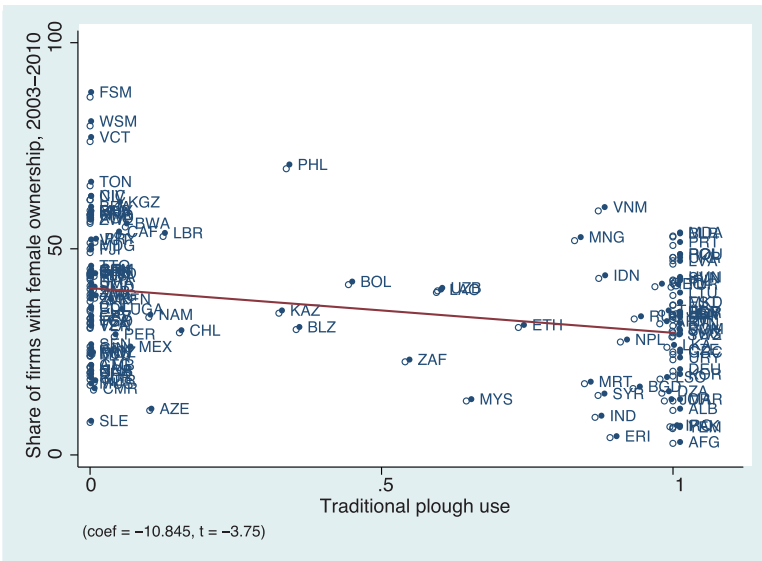


FIGURE III

Bivariate Correlations with Traditional Plough Use

(c) Female participation in politics in 2000

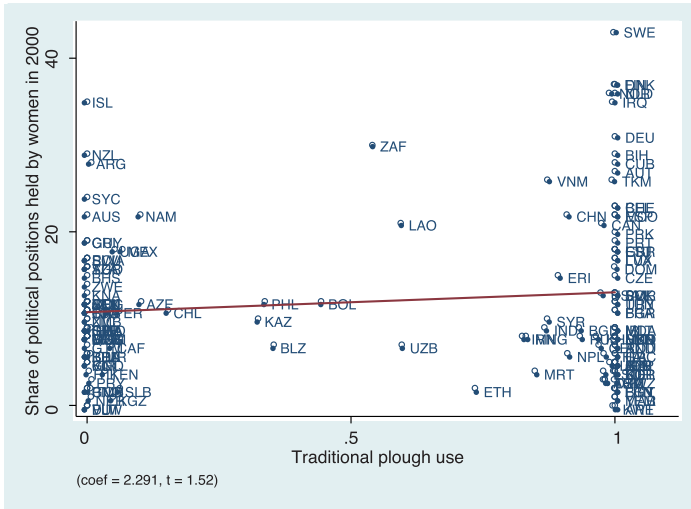


FIGURE III  
Continued

In Appendix Figure A4, we show that the relationships are similar if we condition on continent fixed effects (North America, South America, Europe, Asia, Africa, and Oceania). The one difference is that the relationship between traditional plough use and female participation in politics is now negative—consistent with Boserup’s hypothesis—although it remains statistically insignificant.

We test Boserup’s hypothesis by estimating the following equation:

$$(2) \quad y_c = \alpha + \beta \text{Plough}_c + \mathbf{X}_c^H \Gamma + \mathbf{X}_c^C \Pi + \varepsilon_c,$$

where  $y_c$  is an outcome of interest,  $c$  denotes countries, and  $\text{Plough}_c$  is our measure of the traditional use of the plough among the ancestors of the citizens in country  $c$ .  $\mathbf{X}_c^H$  and  $\mathbf{X}_c^C$  are vectors of historical ethnographic and contemporary control variables, each measured at the country level.

The ethnographic control variables  $\mathbf{X}_c^H$  are intended to capture historical differences between societies that had adopted

TABLE III  
COUNTRY-LEVEL OLS ESTIMATES WITH HISTORICAL CONTROLS

|                             | (1)                                      | (2)                   | (3)   | (4)                   | (5)  | (6)                  | (7)                       | (8)                  |
|-----------------------------|--|-----------------------|---|-----------------------|--|----------------------|---------------------------|----------------------|
|                             | Dependent variable:                      |                       |   |                       |  |                      |                           |                      |
|                             | Female labor force participation in 2000 |                       | Share of firms with female ownership, 2003–2010 |                       | Share of political positions held by women in 2000 |                      | Average effect size (AES) |                      |
| Mean of dep. var.           | 51.03                                    |                       | 34.77   |                       | 12.11  |                      |                           | 2.31                 |
| Traditional plough use      | -14.895***<br>(3.318)                    | -15.962***<br>(3.881) | -16.243***<br>(3.854)                           | -17.806***<br>(4.475) | -2.522<br>(1.967)                                  | -2.303<br>(2.353)    | -0.736***<br>(0.084)      | -0.920***<br>(0.100) |
| <i>Historical controls:</i> |  |                       |   |                       |  |                      |                           |                      |
| Agricultural suitability    | 9.407**<br>(3.885)                       | 9.017**<br>(4.236)    | 1.514<br>(5.358)                                | 4.619<br>(5.836)      | 1.009<br>(2.799)                                   | -0.687<br>(2.925)    | 0.312**<br>(0.129)        | 0.325**<br>(0.133)   |
| Tropical climate            | -8.644***<br>(2.698)                     | -12.389***<br>(3.302) | -11.091***<br>(3.608)                           | -3.974<br>(5.542)     | -7.671***<br>(2.370)                               | -5.618***<br>(2.265) | -0.322***<br>(0.083)      | -0.004<br>(0.102)    |
| Presence of large animals   | 10.903**<br>(5.032)                      | 2.35<br>(5.956)       | -0.649<br>(9.130)                               | 4.475<br>(10.034)     | -9.152**<br>(4.052)                                | -7.338<br>(4.774)    | 0.174<br>(0.111)          | 0.296**<br>(0.145)   |
| Political hierarchies       | -0.787<br>(1.622)                        | 0.447<br>(1.624)      | 1.502<br>(1.845)                                | 0.52<br>(1.773)       | 0.906<br>(0.740)                                   | 0.699<br>(0.777)     | 0.080**<br>(0.040)        | 0.062<br>(0.043)     |
| Economic complexity         | 0.170<br>(0.849)                         | 1.157<br>(0.859)      | 1.810*<br>(1.023)                               | 0.517<br>(1.351)      | 1.082**<br>(0.491)                                 | 0.727<br>(0.510)     | 0.048**<br>(0.021)        | 0.018<br>(0.026)     |
| Continent fixed effects     | no                                       | yes                   | no  | yes                   | no   | yes                  | no                        | yes                  |
| Observations                | 177                                      | 177                   | 128   | 128                   | 153  | 153                  | 153                       | 153                  |
| Adjusted R-squared          | 0.20                                     | 0.24                  | 0.14  | 0.16                  | 0.14   | 0.14                 | 0.24                      | 0.27                 |
| R-squared                   | 0.22                                     | 0.28                  | 0.18  | 0.23                  | 0.17   | 0.20                 | 0.25                      | 0.30                 |

Notes. OLS estimates are reported with robust standard errors in brackets. The unit of observation is a country. "Traditional plough use" is the estimated proportion of citizens with ancestors that used the plough in pre-industrial agriculture. The variable ranges from 0 to 1. The mean (and standard deviation) for this variable is 0.522 (0.473); this corresponds to the sample from columns 1 and 2. "Female labor force participation" is the percentage of women in the labor force, measured in 2000. The variable ranges from 0 to 100. "Share of firms with female ownership" is the percentage of firms in the World Bank Enterprise Surveys with some female ownership. The surveys were conducted between 2003 and 2010, depending on the country. The variable ranges from 0 to 100. "Share of political positions held by women" is the proportion of seats in parliament held by women, measured in 2000. The variable ranges from 0 to 100. The number of observations reported for the AES is the average number of observations in the regressions for the three outcomes. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels.



plough agriculture and those that had not. They include the presence of large domesticated animals, economic development measured by the density of settlement, levels of political authority in the society, agricultural suitability, and the presence of a tropical climate. These are the same set of historical controls as in the regressions reported in Tables I and II. We construct country-level measures of each variable using the same procedure that is used to construct the historical plough use variable. Thus, the ethnographic controls capture the historical characteristics of a country's ancestors. OLS estimates of equation (2) controlling for historical control variables  $\mathbf{X}_c^H$  are reported in Table III. The even-numbered columns also include controls for continent fixed effects.<sup>15</sup>

The contemporary control variables  $\mathbf{X}_c^C$  include the natural log of a country's real per capita GDP measured in 2000, as well as the variable squared. Allowing for a non-linear relationship is motivated by the observed U-shaped bivariate relationship between economic development and female labor force participation (Goldin 1995). Estimates of equation (2) including the contemporary controls are reported in Table IV.

The estimates show that in countries with a tradition of plough use, women are less likely to participate in the labor market, are less likely to own firms, and are less likely to participate in national politics.<sup>16</sup> Although the estimated relationships between traditional plough use and either female labor force participation or female firm ownership are similar with or without the contemporaneous income controls, this is not true for female participation in politics. Once we control for per capita income, the magnitude of the relationship between traditional plough use and female participation in politics roughly doubles and becomes statistically significant. This can be explained by the fact that there is a positive relationship between per capita income and female participation in politics ( $\rho = 0.44$ ) and between plough

15. One concern with the reported estimates is that many of the control variables are potentially endogenous to traditional plough use. The results are similar if we control only for the geographically determined historical covariates, namely, agricultural suitability and the presence of a tropical climate. Estimates with only these controls are reported in Appendix Table A5.

16. Many countries have introduced quotas to increase the participation of women in politics. We have checked the robustness of our results excluding countries with gender quotas. For the restricted sample of 104 countries, the estimated coefficient is  $-5.91$  with a standard error of  $1.97$ .

TABLE IV  
COUNTRY-LEVEL OLS ESTIMATES WITH HISTORICAL AND CONTEMPORARY CONTROLS

|                             | (1)  | (2)                   | (3)                   | (4)                   | (5)   | (6)                 | (7)                  | (8)                  |
|-----------------------------|--|-----------------------|-----------------------|-----------------------|---|---------------------|----------------------|----------------------|
|                             | Dependent variable:                                |                       |                       |                       |   |                     |                      |                      |
|                             | Female labor force participation in 2000           |                       |                       |                       | Share of firms with female ownership, 2003–2010 |                     |                      |                      |
|                             | Share of political positions held by women in 2000 |                       |                       |                       | Average effect size (AES)                       |                     |                      |                      |
| Mean of dep. var.           | 51.35  |                       | 35.17                 | 11.83                 |   |                     |                      | 2.31                 |
| Traditional plough use      | -12.401***<br>(2.964)                              | -12.930***<br>(3.537) | -15.241***<br>(4.060) | -16.587***<br>(4.960) | -4.821***<br>(1.782)                            | -5.129**<br>(2.061) | -0.743***<br>(0.080) | -0.845***<br>(0.091) |
| <i>Historical controls:</i> |  |                       |                       |                       |   |                     |                      |                      |
| Agricultural suitability    | 6.073<br>(3.696)                                   | 7.181*<br>(4.175)     | 0.803<br>(5.447)      | 4.322<br>(6.071)      | 2.198<br>(2.605)                                | 1.081<br>(2.548)    | 0.262*<br>(0.139)    | 0.342**<br>(0.139)   |
| Tropical climate            | -9.718***<br>(2.487)                               | -10.906***<br>(3.070) | -10.432***<br>(3.762) | -3.712<br>(5.711)     | -6.086***<br>(2.094)                            | -4.169*<br>(2.396)  | -0.362***<br>(0.084) | -0.06<br>(0.101)     |
| Presence of large animals   | -2.015<br>(5.372)                                  | -2.166<br>(6.072)     | 2.707<br>(9.745)      | 5.610<br>(10.417)     | -5.718<br>(3.565)                               | -4.688<br>(4.132)   | 0.005<br>(0.121)     | 0.201<br>(0.146)     |
| Political hierarchies       | 0.779<br>(1.515)                                   | 1.181<br>(1.482)      | 1.128<br>(1.941)      | 0.207<br>(1.878)      | 0.744<br>(0.822)                                | 0.656<br>(0.807)    | 0.102***<br>(0.040)  | 0.070*<br>(0.042)    |
| Economic complexity         | 1.157<br>(0.793)                                   | 1.411*<br>(0.815)     | 1.693<br>(1.129)      | 0.764<br>(1.382)      | 0.454<br>(0.487)                                | 0.333<br>(0.502)    | 0.063***<br>(0.023)  | 0.027<br>(0.026)     |

TABLE IV  
(CONTINUED)

|                               | (1)                                      | (2)   | (3)   | (4)  | (5)                       | (6)               | (7)                  | (8)                  |
|-------------------------------|--|---|---|--|---------------------------|-------------------|----------------------|----------------------|
|                               | Dependent variable:                      |   |   |  |                           |                   |                      |                      |
|                               | Female labor force participation in 2000 | Share of firms with female ownership, 2003–2010 | Share of firms with female ownership, 2003–2010 | Share of political positions held by women in 2000 | Average effect size (AES) |                   |                      |                      |
| <i>Contemporary controls:</i> |  |   |   |  |                           |                   |                      |                      |
| ln income in 2000             | -34.612***<br>(6.528)                    | -32.685***<br>(7.023)                           | 10.766<br>(9.986)                               | 6.385<br>(10.482)                                  | -6.530<br>(4.071)         | -6.616<br>(4.335) | -0.776***<br>(0.221) | -0.815***<br>(0.231) |
| ln income in 2000 squared     | 2.038***<br>(0.406)                      | 1.936***<br>(0.431)                             | -0.707<br>(0.688)                               | -0.523<br>(0.706)                                  | 0.539**<br>(0.271)        | 0.535*<br>(0.281) | 0.051***<br>(0.015)  | 0.051***<br>(0.015)  |
| Continent fixed effects       | no                                       | yes   | no  | yes  | no                        | yes               | no                   | yes                  |
| Observations                  | 165                                      | 165   | 123   | 123  | 144                       | 144               | 144                  | 144                  |
| Adjusted R-squared            | 0.37                                     | 0.36  | 0.11  | 0.13   | 0.27                      | 0.27              | 0.26                 | 0.30                 |
| R-squared                     | 0.40                                     | 0.41  | 0.16  | 0.22   | 0.31                      | 0.34              | 0.28                 | 0.33                 |

Notes. OLS estimates are reported with robust standard errors in brackets. The unit of observation is a country. "Traditional plough use" is the estimated proportion of citizens with ancestors that used the plough in pre-industrial agriculture. The variable ranges from 0 to 1. The mean (and standard deviation) of this variable is 0.525 (0.472); this corresponds to the sample from columns 1 and 2. "Female labor force participation" is the percentage of women in the labor force, measured in 2000. The variable ranges from 0 to 100. "Share of firms with female ownership" is the percentage of firms in the World Bank Enterprise Surveys with some female ownership. The surveys were conducted between 2003 and 2010, depending on the country. The variable ranges from 0 to 100. "Share of political positions held by women" is the proportion of seats in parliament held by women, measured in 2000. The variable ranges from 0 to 100. The number of observations reported for the AES is the average number of observations in the regressions for the three outcomes. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels.

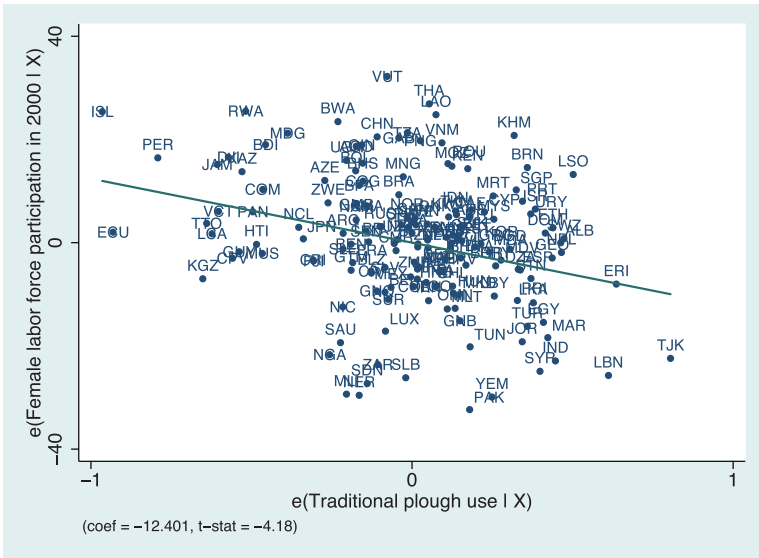
use and per capita income ( $\rho = 0.35$ ). In other words, even if traditional plough use has a negative impact on female participation in politics, countries with a tradition of plough use also tend to be richer, and therefore, all else equal, have more female participation in politics. Therefore, the strength of the coefficient for plough use depends on whether we control for contemporary income.

The reason that the estimates for the two other outcomes of interest—female firm ownership and female labor force participation—are not sensitive to conditioning on per capita income is due to the fact that the relationship between per capita income and the other outcomes is either zero (i.e., female firm ownership) or U-shaped (FLFP), both of which result in a zero correlation between the dependent variable and per capita income.

The partial correlation plots for traditional plough use are shown in Figures IVa–IVc (for columns 1, 3, and 5 of Table IV). From the figures it is clear that the coefficients for traditional plough use are not being influenced by a small number of countries. The plots also show that the coefficient estimates are not identified only from broad differences across regions, but from finer within-region variation. For example, we observe African countries in the Northwest corner (e.g., Rwanda, Madagascar) and in the Southeast corner (e.g., Eritrea, Mauritania, Ethiopia, etc.). This is confirmed by the fact that the point estimates controlling for continent fixed effects are essentially identical to the estimates without the fixed effects (comparing the odd-numbered columns to the even-numbered columns in Tables III and IV).

Not only are the coefficient estimates statistically significant, but they are also economically meaningful. Based on the estimates from column 1, a one-standard-deviation increase in traditional plough use (0.472) is associated with a reduction of female labor force participation (FLFP) of 5.85 percentage points ( $12.401 \times 0.472$ ), which is equal to 11.4% of the sample mean for FLFP and 38% of its standard deviation. The impact of the same increase in traditional plough use on the share of firms with some female ownership (based on the column 3 estimate) is a reduction of 7.19 percentage points, which is 20% of the outcome's mean and 48% of its standard deviation. The reduction on the participation of women in politics (using the column 5 estimate) is 2.28 percentage points, which is 19% of the outcome's mean and 25% of its standard deviation.

(a) Traditional plough use and current FLFP



(b) Traditional plough use and current female firm ownership

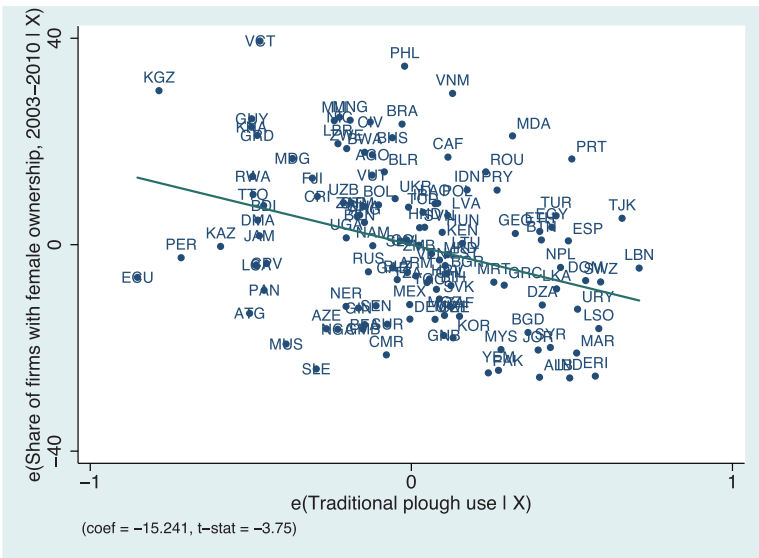
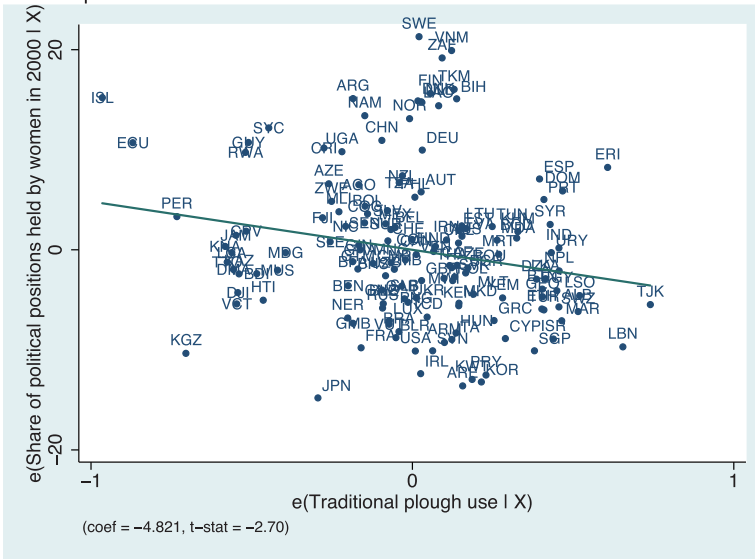


FIGURE IV  
Partial Correlation Plots

(c) Traditional plough use and current female participation in politics



(d) Traditional female participation in agriculture and current FLFP

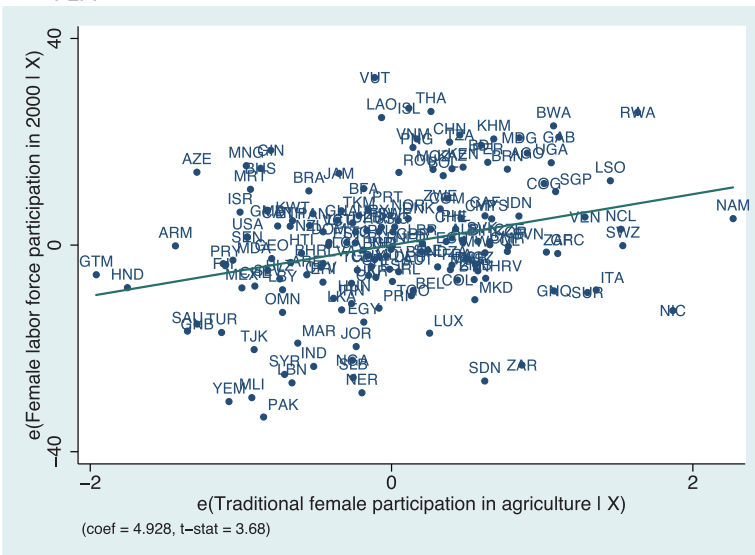


FIGURE IV  
Continued

An alternative way to assess the magnitude of the estimates is to calculate the proportion of the total variation that they explain. By this metric, traditional plough use also explains a sizable proportion of differences in gender roles across countries. When female labor force participation is the dependent variable (column 1 of Table IV), the inclusion of the historical plough use variable increases the  $R$ -squared by 0.06 (from 0.34 to 0.40). Therefore, a tradition of plough agriculture accounts for 6% of the total variation in FLFP and 9.1% of the residual variation left unexplained by the control variables.<sup>17</sup> For the share of firms with female ownership, traditional plough use accounts for 11% of the total variation and 11.6% of the residual variation. For women's participation in politics, historical plough use explains 3% of the total variation and 4.2% of the residual variation.

Columns 9 and 10 of Tables III and IV report the estimated average effect size (AES) for the three outcomes of interest (Kling et al. 2007).<sup>18</sup> The AES estimates are very similar to the OLS estimates. According to the estimate from column 7, a one-standard-deviation increase in traditional plough use is associated with an average decrease (across the three outcomes) equal to approximately  $0.472 \times 0.743 = 0.351$  standard deviations.

#### V.A. *The Persistence of Female Labor Force Participation*

Up to this point, we have shown that historical plough use is associated with less female participation in agriculture historically and with less female participation in the labor force today. These two correlations suggest long-term persistence in female participation in activities outside the home. To confirm this, we regress female labor force participation today on the measure of women's historical participation in agriculture constructed from the *Ethnographic Atlas*. The regression also controls for our full set of covariates from equation (2). The partial correlation plot illustrating the relationship between the two variables is shown in Figure IVd. As is apparent from the figure, there is strong persistence over time. Female labor force participation today

17. This is calculated as  $(0.40 - 0.34)/(1 - 0.34) = 0.091$  or 9.1%.

18. In implementation, we follow Kling et al. (2007) and Clingingsmith et al. (2009) and calculate the AES as  $\frac{1}{K} \sum_{k=1}^K \frac{\beta^k}{\sigma^k}$ , where  $K$  is the total number of outcome variables,  $\beta^k$  is the estimated plough use coefficient for outcome variable  $k$ , and  $\sigma^k$  is the standard deviation of outcome  $k$ . To properly calculate the sample variance of the AES, the coefficients  $\beta^k$  are jointly estimated in a seemingly unrelated regression framework.

and female participation in agriculture in the past are very strongly correlated.

Despite the evidence of persistence over time on average, it is important to recognize that there are well-documented exceptions to this rule. For example, Goldin and Sokoloff (1984) document that within the northeastern United States, the low relative productivity of women and children in agriculture (and their low participation in this sector) allowed them to actively participate in the manufacturing sector. In this setting, initial female labor force participation in agriculture is inversely related to subsequent participation in manufacturing, showing a lack of continuity of female labor force participation over time as industrialization occurred.

### *V.B. Robustness Checks*

We first consider the robustness of our results to the use of alternative plough measures. Using either of the two methods described above for imputing missing language data—either official language or GREG ethnicity—yields estimates that are qualitatively identical to the estimates using our baseline variable. As reported in Appendix Table A6, the alternative measures yield nearly identical point estimates that are highly significant. We also test the robustness of our results to defining traditional plough use in a slightly different manner. Our baseline variable equals one if an ethnic group traditionally used the plough in pre-industrial agriculture, whether or not adoption occurred prior to European contact. We alternatively code the indicator variable to equal one only if adoption occurred prior to European contact. The estimates using this alternative definition, reported in Appendix Table A7, are virtually identical to our baseline estimates.

We also check the robustness of our results to the use of different samples. First, to ensure that our findings are not being driven by measurement error, we omit 17 countries that have a significant proportion of missing language data. The countries include Australia, Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, New Zealand, Nicaragua, Panama, Paraguay, Peru, and Venezuela. The estimates reported in panel A of Appendix Table A8 show that the estimated impact of the plough remains robust.



Motivated by the fact that there is little variation in plough use within Europe, we also test the robustness of our results to the omission of European countries and neo-European countries (United States, Canada, Australia, and New Zealand) from the sample. As reported in panel B of Appendix Table A8, the results remain robust.

Examining Figure II, it is apparent that many of the countries with ancestors that traditionally did not use the plough are located in sub-Saharan Africa. We also check that our results do not reflect differences only between sub-Saharan Africa and the rest of the world by re-estimating equation (2) after omitting all sub-Saharan African countries (panel C of Appendix Table A8). We obtain very similar estimates when we omit these countries from the sample.<sup>19</sup> An alternative strategy is to disaggregate the African continent indicator variable into an indicator variable for sub-Saharan Africa and an indicator variable for Northern Africa. The estimates are also robust to this procedure (panel D of Appendix Table A8).

Today's industrial countries have witnessed dramatic changes in gender roles in recent decades. For example, within the United States, social norms regarding women's employment outside the home began to change dramatically in the late 1960s and 1970s. This is reflected by female labor force participation rates, which increased from 25 to 46 percent (among women age 35–44) from 1950 to 1970 (Goldin 2006, 6–8). In light of these recent changes, it is important to check that we find a similar impact of the plough on gender norms prior to these changes. We therefore also examine female labor force participation and female participation in politics in the 1950s and 1960s. We are unable to examine female firm ownership due to a lack of data prior to the 2000s. As detailed in Section A5 of the online appendix, we obtain qualitatively and quantitatively similar estimates when we examine this earlier time period.

## VI. SUBNATIONAL ESTIMATES

### VI.A. *Evidence from the World Values Surveys*

We now turn to specifications that examine variation across individuals, linking them to a tradition of plough agriculture

19. We also obtain similar estimates if we omit all African countries, not just sub-Saharan African countries.

using the district in which they live. The analysis relies on data from the *World Value Survey* (WVS), a compilation of national individual-level surveys on a wide variety of topics, including attitudes and preferences. They also include information on standard demographic characteristics, such as gender, age, education, labor market status, income, and religion.<sup>20</sup> Using the WVS, we construct an indicator variable that equals one if a woman is in the labor force, which is defined as full-time, part-time, or self-employment. Women are not in the labor force if they report being retired, a housewife, or a student.<sup>21</sup>

We also examine two measures of individual (male and female) attitudes about the appropriate role of women in society. The first measure is based on each respondent's view of the following statement: "When jobs are scarce, men should have more right to a job than women." The respondents are asked to choose among "agree," "disagree," "neither," or "don't know." We omit observations for which the respondents answered "neither" or "I don't know," and code "disagree" as 0 and "agree" as 1.<sup>22</sup>

We also consider a second variable derived from survey responses to the following statement: "On the whole, men make better political leaders than women do." Respondents are asked to choose among "strongly disagree," "disagree," "agree," "agree strongly," or "don't know." We omit observations in which the respondent answered "don't know" and create a variable that takes the value of 1 for "strongly disagree," 2 for "disagree," 3 for "agree," and 4 for "agree strongly." By construction, both attitude variables are increasing in the extent to which a respondent's view reflects a belief of gender inequality.

20. Five waves of the WVS were carried out between 1981 and 2007. In our analysis, we use the four most recent waves of the survey, since the first wave does not contain information on the districts in which respondents live. Because regional classifications often vary by wave, we use the wave with the most finely defined location data. A list of countries for each question is reported in Table A9 of the appendix.

21. The results are qualitatively identical if we exclude retired women and students from the sample.

22. We omit observations for which the respondent answered "neither" since it is unclear whether this represents an intermediate view, whether they have chosen not to answer the question, or whether they do not know their answer. If we interpret this response as reflecting an intermediate position and code a variable that takes the values 0, 1, or 2, we obtain qualitatively identical results to what we report here.

An appealing characteristic of the two WVS variables is that they measure the values that underlie the objective outcomes examined in the cross-country analysis. The first question reflects differences in individual beliefs about whether women should have equal access to jobs, which is likely an important factor underlying observed differences in female labor force participation across countries. The second question reflects values about the ability of women to take on roles of leadership and responsibility, which likely affects observed differences in female participation in politics and female firm ownership. Therefore, there is a close link between the objective measures from the country-level analysis and the subjective measures in the individual-level analysis.

Examining the three outcomes—female participation in the labor force, attitudes about female employment, and attitudes about female leadership—we estimate the following individual-level equation:

$$(3) \quad y_{i,d,c} = \alpha_c + \beta \text{Plough}_d + \mathbf{X}_d^H \Pi + \mathbf{X}_i \Phi + \varepsilon_{i,d,c},$$

where  $i$  denotes an individual,  $d$  a district, and  $c$  a country.  $\text{Plough}_d$  is our measure of traditional plough use among the ancestors of individuals living in district  $d$ .  $\alpha_c$  denotes country fixed effects.  $\mathbf{X}_d^H$  includes the same historical ethnographic variables as in equation (2), but measured at the district level rather than the country level.  $\mathbf{X}_i$  denotes current individual-level controls: age, age squared, marital status fixed effects, educational attainment fixed effects, and gender (for the attitude regressions only). Standard errors are clustered at the district level.

The odd numbered columns of Table V report OLS estimates of equation (3), but with continent fixed effects rather than country fixed effects. In this specification, we include  $\mathbf{X}_c^C$ , the same contemporary country-level controls as in equation (2). We find a negative relationship between traditional plough use and current female labor force participation, and a positive relationship between plough use and attitudes reflecting gender inequality. All three relationships are statistically significant. The estimated magnitudes of the female labor force participation effects are similar to the cross-country estimates reported in columns 1 and 2 of Table IV. A one-standard-deviation increase in traditional plough use (0.415) implies a reduction in female labor force participation of 0.073 or 7.3 percentage points, roughly

TABLE V  
INDIVIDUAL-LEVEL OLS ESTIMATES USING WVS DATA

|   | (1)                             | (2)               | (3)                 | (4)                                     | (5)                 | (6)                 |
|---|---------------------------------|-------------------|---------------------|---|---------------------|---------------------|
|   | Dependent variable:             |                   |                     |   |                     |                     |
|   | When jobs are scarce, 1995–2007 |                   |                     | Men better political leaders, 1995–2007 |                     |                     |
| Female labor force participation, 1995–2007 |                                 | 0.55              | 0.46                | 0.47                                    | 2.62                | 2.64                |
| Mean of dep. var.                           | 0.55                            | 0.55              | 0.46                | 0.47                                    | 2.62                | 2.64                |
| Traditional plough use                      | -0.177***<br>(0.035)            | -0.002<br>(0.031) | 0.193***<br>(0.033) | 0.100*<br>(0.059)                       | 0.224***<br>(0.069) | 0.304***<br>(0.117) |
| Individual & district controls              | yes                             | yes               | yes                 | yes                                     | yes                 | yes                 |
| Contemporary country controls               | yes                             | n/a               | yes                 | n/a                                     | yes                 | n/a                 |
| Fixed effects                               | continent                       | country           | continent           | country                                 | continent           | country             |
| Number of countries                         | 73                              | 78                | 74                  | 79                                      | 50                  | 55                  |
| Number of districts                         | 672                             | 698               | 674                 | 700                                     | 453                 | 479                 |
| Observations                                | 43,801                          | 47,587            | 80,303              | 87,528                                  | 64,215              | 72,152              |
| Adjusted R-squared                          | 0.17                            | 0.27              | 0.21                | 0.28                                    | 0.19                | 0.26                |
| R-squared                                   | 0.17                            | 0.27              | 0.21                | 0.28                                    | 0.19                | 0.26                |

Notes: The table reports OLS estimates, with standard errors clustered at the district level. The unit of observation is an individual. In columns 1 and 2, the sample includes women only and the dependent variable is an indicator variable that equals one if she is in the labor force. The estimates in columns 3–6 include men and women. The dependent variables measure respondents' self-report attitudes regarding gender roles. A higher value indicates beliefs about greater inequality between men and women. "When jobs are scarce" takes on the value of zero or one, while "men better political leaders" takes on integer values between 1 and 4. "Individual controls" are: age, age squared, dummies for primary and secondary education (the excluded group is tertiary education), gender (for gender attitude dependent variables only) and an indicator variable for marital status. "Traditional plough use" is the estimated proportion of individuals living in a district with ancestors that used the plough in pre-industrial agriculture. The mean (and standard deviation) of this variable is 0.724 (0.425), this corresponds to the sample from column 1. "District controls" include district-level measures of: ancestral suitability for agriculture, fraction of ancestral land that was tropical or subtropical, ancestral domestication of large animals, ancestral settlement patterns, and ancestral political complexity. "Contemporary country controls" include: the natural log of real per capita GDP, and its square, measured in the same year as the dependent variable. \*\*\*, \*\*, \* and \* indicate significance at the 1%, 5%, and 10% levels.

equal to 13% of the sample average. The impact of a one-standard-deviation increase in the two attitude measures is 0.08 and 0.09 (equal to 17 and 4% of the sample averages of these variables).

In the even-numbered columns of Table V, we control for country fixed effects. We continue to find a positive and significant relationship between traditional plough agriculture and attitudes reflecting gender inequality. Although we estimate a negative relationship between traditional plough use and female labor force participation, the estimated magnitude is small and the coefficient is statistically insignificant. For approximately half of the countries in the sample, there is no subnational variation in the district-level plough measure. As we report in Appendix Table A10, we obtain similar estimates when we omit these countries from the sample or when we restrict the sample further, additionally dropping countries with the least amount of subnational variation.

#### VI.B. Evidence from IPUMS-International

One explanation for the weaker WVS estimates—particularly the insignificant estimates for female labor force participation—is attenuation bias arising from the imperfectly constructed plough use variable. Because we do not observe individual ethnicity, we are forced to use an individual's district of residence as an imperfect proxy. We now turn to another data source, IPUMS-International Census data, that records respondents' ethnic identity as well as their employment status. This allows us to examine female labor force participation using a more accurate measure of ancestral plough use. Because the IPUMS surveys do not record information about gender-role beliefs, we are unable to examine these outcomes.

Our estimating equation is

$$(4) \quad y_{i,d,e} = \alpha_d + \beta \text{Plough}_e + \mathbf{X}_e^H \Pi + \mathbf{X}_i \Phi + \varepsilon_{i,d,e},$$

where  $i$  denotes an individual,  $d$  denotes a district within a country, and  $e$  is ethnicity.  $\text{Plough}_e$  is our measure of traditional plough use among the ancestors of individuals of ethnicity  $e$ .  $\alpha_d$  denotes district fixed effects.<sup>23</sup> The vector  $\mathbf{X}_e^H$  includes the same historical

23. For three countries—Mongolia, Uganda, and Malaysia—there are multiple survey years. For these countries, we also include survey-year fixed effects and

TABLE VI  
INDIVIDUAL-LEVEL OLS ESTIMATES USING IPUMS-INTERNATIONAL DATA

|                                    | (1)  | (2)                  | (3)                 | (4)                         | (5)                     | (6)                  | (7)                  | (8)                   | (9)                  |
|------------------------------------|--|----------------------|---------------------|-----------------------------|-------------------------|----------------------|----------------------|-----------------------|----------------------|
|                                    | Dependent variable: Female labor force participation indicator |                      |                     |                             |                         |                      |                      |                       |                      |
|                                    | Bolivia<br>2001  | Chile,<br>2002       | Cambodia,<br>2008   | Malaysia,<br>70, 80, 91, 00 | Mongolia,<br>1989, 2000 | Nepal,<br>2001       | Philippines,<br>1990 | Uganda,<br>1991, 2002 | All<br>countries     |
| Mean of dep. var.                  | 0.44   | 0.40                 | 0.78                | 0.40                        | 0.38                    | 0.54                 | 0.39                 | 0.56                  | 0.49                 |
| Traditional plough use             | -0.035***<br>(0.002)   | -0.073***<br>(0.003) | -0.064**<br>(0.027) | -0.080***<br>(0.016)        | -0.006<br>(0.013)       | -0.100***<br>(0.043) | 0.035<br>(0.023)     | -0.079***<br>(0.020)  | -0.040***<br>(0.019) |
| Individual & ethnicity<br>controls | yes  | yes                  | yes                 | yes                         | yes                     | yes                  | yes                  | yes                   | yes                  |
| District fixed effects             | 9  | 26                   | 24                  | 15                          | 23                      | 14                   | 77                   | 4                     | 192                  |
| Ethnic groups                      | 6  | 5                    | 11                  | 21                          | 10                      | 16                   | 21                   | 60                    | 150                  |
| Observations                       | 173,804  | 505,114              | 432,481             | 319,580                     | 125,349                 | 710,662              | 1,266,363            | 1,003,321             | 4,536,674            |
| Adjusted R-squared                 | 0.07   | 0.17                 | 0.19                | 0.10                        | 0.50                    | 0.19                 | 0.13                 | 0.09                  | 0.15                 |
| R-squared                          | 0.07   | 0.17                 | 0.19                | 0.10                        | 0.50                    | 0.19                 | 0.13                 | 0.09                  | 0.15                 |

Notes. OLS estimates are reported, with standard errors clustered at the ethnicity level in brackets. The unit of observation is a female individual. The dependent variable is an indicator variable that equals one if the individual is reported to be in the labor force. The time period differs for each country: Bolivia, 2001; Chile, 2002; Cambodia, 2008; Malaysia, 1970, 1980, 1991, and 2000; Mongolia, 1989 and 2000; Nepal, 2001; the Philippines, 1990; and Uganda, 1991, 2002. "Traditional plough use" indicates whether the ethnic group to which each individual belongs used the plough in pre-industrial agriculture. The mean (and standard deviation) of this variable is: for Bolivia, 0.517 (0.500); for Chile, 0.959 (0.197); for Cambodia, 0.989 (0.103); for Malaysia, 0.929 (0.257); for Mongolia, 0.884 (0.320); for Nepal, 0.971 (0.167); for the Philippines, 0.327 (0.469); and for Uganda, 0.065 (0.247). "Individual controls" include: age, age squared, fixed effects for educational attainment, an indicator variable for marital status, and an urban/rural indicator variable. "Ethnicity controls" include: ancestral suitability for agriculture, fraction of ancestral land that was tropical or subtropical, ancestral domestication of large animals, ancestral settlement patterns, and ancestral political complexity. For countries with data available for more than one wave, we also control for survey-wave fixed effects and district-wave fixed effects. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels.

ethnographic variables as in equation (2), but measured at the ethnicity level rather than the country level.  $\mathbf{X}_i$  denotes current individual-level controls: age, age squared, marital status, educational attainment fixed effects, and an urban/rural indicator variable. We estimate equation (4) separately for each country, clustering standard errors at the ethnicity level. We also estimate a pooled regression that includes all countries. The sample includes all countries in IPUMS-International that report information on respondents' ethnicity at a sufficiently fine level and that have within-country variation in traditional plough use.

Estimation results are reported in Table VI. In total there are eight countries: five from Asia, two from Latin America, and one from Africa. Columns 1–8 report separate estimates for each country, while column 9 reports the average effect across all countries. The results show that overall there is a negative and statistically significant relationship between female participation in the labor force and a tradition of ancestral plough use. This is the case for six of the eight countries in the country-by-country regressions. Although there is significant heterogeneity in the magnitude of the estimated impact of the plough on FLFP, the effect of a switch from non-plough use to plough use generally ranges from 4 to 10 percentage points (and the average effect from column 9 is 4 percentage points). These magnitudes are approximately half the size of the effect found in the cross-country analysis.<sup>24</sup>

For two countries, Mongolia and the Philippines, the coefficient is not statistically different from zero. The lack of a relationship within Mongolia is explained by the fact that agriculture was relatively unimportant within this region, with animal husbandry being the primary form of subsistence. For the ethnic groups that had adopted the plough, only 6–15% of

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allow the district fixed effects to vary by survey year. The specific time periods covered are different for each country. Full details are reported in the appendix.

24. It is also possible to generate estimates for Belarus, although only two ethnic groups, accounting for 0.2% of the total population, did not use the plough traditionally. Given the imbalance in traditional plough use, we do not report these estimates. Consistent with Boserup's hypothesis, the estimated coefficient is negative and statistically significant, although the estimated magnitude is extremely large. The coefficient is  $-0.522$  with a standard error of  $0.198$ . The estimated average effect across all countries is identical if Belarus is also included (coeff:  $-0.40$ ; s.e.:  $0.019$ ).

subsistence consumption was from agriculture. Therefore, although the plough had been adopted, its impact appears to have been muted because of the relative unimportance of agriculture. In this respect, Mongolia is very different from the rest of the countries in the sample. Among the other seven countries, agriculture accounted for at least 46% of each ethnic group's food consumption.

The reason for the different relationship within the Philippines remains unclear. However, it is interesting that in terms of gender relations the Philippines is exceptional in many dimensions. For example, the Philippines (along with Mongolia) are the only East Asian countries for which educational attainment is higher for girls than for boys (Estudillo et al. 2001, World Bank, 2012). In addition, the Philippines consistently ranks among the top 5–10 most gender-equal countries globally, which is significantly higher than other Asian countries and other countries at a similar level of economic development (Hausman et al. 2012).

## VII. ADDRESSING THE ISSUE OF CAUSALITY

### VII.A. *Controlling for Observable Characteristics*

A potential concern with the OLS estimates reported up to this point is that locations that historically had less equal gender-role attitudes may have had a higher likelihood of inventing or adopting the plough. This would bias the OLS estimates away from zero. It is also possible that locations that were economically more developed were more likely to have adopted the plough. Since these areas today tend to be richer and more prone to equal gender-role attitudes, this would tend to bias the OLS estimates toward zero. Our first strategy to address these, and related, concerns is to control for observable characteristics.

Our analysis makes a distinction between traditional plough agriculture and all other forms of subsistence. In our coding, non-plough societies include both agricultural societies practicing shifting hoe agriculture as well as societies not engaged in agriculture, such as hunter-and-gatherer and herding societies. It is possible that the status of women is also affected by the extent to which a society participates in these non-agricultural activities. We account for this by constructing two variables that measure the proportion of ancestors' subsistence that was provided by



TABLE VII  
ROBUSTNESS OF OLS ESTIMATES TO ADDITIONAL COVARIATES

|   | (1)  | (2)                   | (3)                   | (4)                   | (5)                   | (6)                   | (7)                  | (8)                  |
|---|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------------|----------------------|
|   | Dependent variable: Female labor force participation in 2000 |                       |                       |                       |                       |                       |                      |                      |
| Mean of dep. var.                         | 51.35  | 51.55                 | 51.35                 | 51.48                 | 51.26                 | 52.09                 | 51.48                | 52.13                |
| Traditional plough use                    | -10.892***<br>(3.848)  | -12.714***<br>(3.255) | -12.356***<br>(2.993) | -12.336***<br>(3.019) | -12.721***<br>(3.364) | -14.618***<br>(3.482) | -9.913***<br>(3.160) | -9.234***<br>(4.301) |
| <i>Historical controls:</i>               |  |                       |                       |                       |                       |                       |                      |                      |
| Practices intensive agriculture           | yes  |                       |                       |                       |                       |                       |                      | yes                  |
| Prop. of subsist. from herding            | yes  |                       |                       |                       |                       |                       |                      | yes                  |
| Prop. of subsist. from hunting            | yes  |                       |                       |                       |                       |                       |                      | yes                  |
| Absence of private property               |  | yes                   |                       |                       |                       |                       |                      | yes                  |
| Patrilineal marriages                     |  | yes                   |                       |                       |                       |                       |                      | yes                  |
| Matrilocal marriages                      |  | yes                   |                       |                       |                       |                       |                      | yes                  |
| Nuclear family structure                  |  | yes                   |                       |                       |                       |                       |                      | yes                  |
| Extended family structure                 |  | yes                   |                       |                       |                       |                       |                      | yes                  |
| Year ethnicity sampled                    |  |                       | yes                   |                       |                       |                       |                      | yes                  |
| <i>Contemporary controls:</i>             |  |                       |                       |                       |                       |                       |                      |                      |
| Years of civil conflicts (1816-2007)      |  |                       |                       | yes                   |                       |                       |                      | yes                  |
| Years of interstate conflicts (1816-2007) |  |                       |                       | yes                   |                       |                       |                      | yes                  |
| Ruggedness                                |  |                       |                       | yes                   |                       |                       |                      | yes                  |
| Communism indicator                       |  |                       |                       |                       | yes                   |                       |                      | yes                  |

TABLE VII  
(CONTINUED)

|                                    | (1)  | (2)  | (3)  | (4)  | (5)  | (6)  | (7)  | (8)  |
|------------------------------------|------|------|------|--|------|------|------|------|
|                                    |      |      |      | Dependent variable: Female labor force participation in 2000 |      |      |      |      |
| Fraction of European descent       |      |      |      |  | yes  |      |      | yes  |
| Oil production per capita          |      |      |      |  |      | yes  |      | yes  |
| Agricultural share of GDP          |      |      |      |  |      | yes  |      | yes  |
| Manufacturing share of GDP         |      |      |      |  |      | yes  |      | yes  |
| Services share of GDP              |      |      |      |  |      | yes  |      | yes  |
| Fraction of pop. Catholic          |      |      |      |  |      |      | yes  | yes  |
| Fraction of pop. Protestant        |      |      |      |  |      |      | yes  | yes  |
| Fraction of pop. Christian (other) |      |      |      |  |      |      | yes  | yes  |
| Fraction of pop. Muslim            |      |      |      |  |      |      | yes  | yes  |
| Fraction of pop. Hindu             |      |      |      |  |      |      | yes  | yes  |
| Baseline controls                  | yes  | yes  | yes  | yes  | yes  | yes  | yes  | yes  |
| Observations                       | 165  | 163  | 165  | 163  | 153  | 154  | 163  | 142  |
| Adjusted R-squared                 | 0.39 | 0.38 | 0.36 | 0.35   | 0.42 | 0.35 | 0.51 | 0.54 |
| R-squared                          | 0.43 | 0.43 | 0.40 | 0.40   | 0.46 | 0.40 | 0.55 | 0.64 |

*Notes.* OLS estimates are reported with robust standard errors in brackets. The unit of observation is a country. "Traditional plough use" is the estimated proportion of citizens with ancestors that used the plough in pre-industrial agriculture. The variable ranges from 0 to 1. The mean (and standard deviation) of this variable is 0.548 (0.468); this corresponds to the sample from columns 1 and 3. "Female labor force participation" is the percentage of women in the labor force. The variable ranges from 0 to 100. Each regression includes the full set of control variables (historical and contemporary). The historical controls include: ancestral suitability for agriculture, fraction of ancestral land that was tropical or subtropical, ancestral domestication of large animals, ancestral settlement patterns, and ancestral political complexity. The contemporary controls include the natural log of real per capita GDP and its square, measured in the same year as the dependent variable. The coefficients and standard errors for the control variables are reported in the online appendix. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels.

hunting and by the herding of large animals.<sup>25</sup> In addition, we also address the possibility that our plough measure is simply capturing the intensity of agriculture by directly controlling for agricultural intensity. As shown in column 1 of Table VII, the inclusion of these three control variables has little impact on the coefficient of interest.<sup>26</sup>

A prominent determinant of cultural differences in gender-role attitudes was proposed by Frederick Engels (1902). He argued that gender inequality arose due to the intensification of agriculture, which resulted in the emergence of private property, which was monopolized by men. The control of private property allowed men to subjugate women and to introduce exclusive paternity over their children, replacing matriliney with patrilineal descent, making wives even more dependent on husbands and their property. As a consequence, women were no longer active and equal participants in community life. To account for this alternative determinant, we control for the proportion of a country's ancestors without land inheritance rules; with patrilocal post-marital residence rules; and with matrilineal post-marital rules. We also control for the proportion of a country's ancestors with a nuclear family structure and with an extended family structure. As shown in column 2, the results remain robust to the inclusion of these additional controls.

In column 3, we control for the fact that in the *Ethnographic Atlas* ethnicities are observed at different points in time. In general, less-developed ethnic groups, without written records or with less external contact, tend to have information from more recent time periods. Although the characteristics of interest tend to be slow-moving and typically do not change significantly in short periods of time, this could still introduce some measurement error. Motivated by this concern, we check that the results remain robust to controlling for the average date of observation of ancestors in the *Ethnographic Atlas*. The estimates are very similar with this additional control.

We next turn to the possibility that warfare may have a systematic impact on beliefs about gender roles. Theoretically, the

25. The sources and method of construction of all control variables from Table VII are documented in the online appendix.

26. For brevity, we report only the estimates with female labor force participation as the dependent variable. In addition, we do not report the coefficient estimates for the control variables. For the interested reader, these are reported in Table A11 of the appendix.

expected direction of the effect is unclear (Whyte 1978). Involvement in warfare may cause societies to become more hierarchical and male dominated, suggesting a negative relationship between conflict and female work outside the home. On the other hand, being involved in warfare can generate a greater need for female involvement outside the home, which may in turn affect the evolution of beliefs about gender. We control for the potential impacts of warfare, by calculating, for each country, the number of years since 1816 (the first year data are available) that the country was involved in either internal or interstate warfare. To control for the possibility that invasions are easier on the types of flat ground that could also favor the diffusion of the plough, we also control for Nunn and Puga's (2012) terrain ruggedness index. The results, reported in column 4, show that the impact of traditional plough use is robust to controlling for a country's exposure to warfare during the 19th and 20th centuries.

Communism and large historical migrations (most notably mass European migrations during the 17th to the 20th centuries) are other recent historical episodes that may have had a large impact on beliefs about gender. Communist regimes typically implemented policies to eliminate gender differences in the economy and promote female participation outside the home. For many parts of the world, the adoption of the plough may be associated with the diffusion of other aspects of Western European societies. In column 5, we include an indicator variable that equals one if the country was under a communist regime in the post-WWII period. We also control for the fraction of each country's population in 2000 with ancestors from Western Europe. The estimates show that the results remain robust. This finding is consistent with the more brute-force strategy, reported in Table A8 of the appendix, that omits all European and neo-European countries (Australia, New Zealand, Canada, and the United States) from the sample.

Ross (2008) argues that a country's endowment of oil reserves is an important determinant of beliefs about the role of women in society. According to his hypothesis, oil causes a country's domestic currency to strengthen, making exports less competitive and causing a decline in light manufacturing, a sector particularly well suited for female employment. We account for the importance of oil by controlling for per capita oil production in 2000. To capture in a more general way the phenomenon Ross (2008) argues for—namely, that a country's economic structure can

affect female labor force participation—we also include the share of a country's GDP that is in agriculture, in manufacturing, and in services. As shown in column 6, the impact of the plough remains robust.

The last factor that we consider is religion. For all of our control variables there is the concern that they may be endogenous to traditional plough agriculture and thus we are in danger of over-controlling. However, this is particularly true for religion, which is an important part of Boserup's (1970) hypothesized mechanism. She argues that the plough had an impact on religious practices, in particular women's wearing of the veil and the burqa. She explains that plough cultivation "shows a predominantly male labor force. The land is prepared for sowing by men using draught animals, and this . . . leaves little need for weeding the crop, which is usually the women's task . . . Because village women work less in agriculture, a considerable fraction of them are completely freed from farm work. Sometimes such women perform purely domestic duties, living in seclusion within their own homes only appearing in the street wearing a veil, a phenomenon associated with plough culture and seemingly unknown in regions of shifting cultivation where women do most of the agricultural toil" (13–14).

Braudel (1998) also argues that, historically, religious beliefs were endogenous to the practice of plough agriculture. He describes how the adoption of the plough in Mesopotamia around the fourth millennium BCE was accompanied not only by a movement of women out of agriculture and a shift from matriarchy to patriarchy, but also by a change in religious beliefs. There was a shift away from "the reign of the all-powerful mother goddesses and immemorial fertility cults presided over by priestesses" and toward "male gods and priests" (Braudel 1998, 71). More generally, religious beliefs can be interpreted as one manifestation of a society's overall cultural views.

With this caveat in mind, we examine how the inclusion of religion affects the OLS estimates of the impact of traditional plough agriculture. In column 7, we control for five variables that measure the proportion of a country's population that is Catholic, Protestant, other Christian, Muslim, and Hindu. Controlling for religion, traditional plough agriculture continues to have a sizable and statistically significant impact, although the estimated magnitude decreases to 9.9 (from 12.4), a decline of 20%. This is consistent with religion and its transmission over

time being one of the mechanisms underlying the persistent impact of traditional plough use.

In column 8, we include all covariates in one specification. Although the plough use coefficient decreases slightly, it remains highly significant. Overall, the estimated impact of the plough remains highly robust across the various specifications reported in Table VII. The coefficient is always negative and statistically significant, and the point estimates remain fairly stable, ranging from  $-9.2$  to  $-14.6$ .

### *VII.B. The Importance of Ancestral Geo-Climatic Conditions*

It has been hypothesized that an important determinant of whether the plough was adopted was the characteristics of crops that could be grown in a particular location (Pryor 1985). The primary benefit of the plough is that it facilitates the cultivation of larger amounts of land over a shorter period of time. This capability is more advantageous for crops that require specific planting conditions that are met only during narrow windows of time or for crops that require larger tracts of land to cultivate a given amount of calories. The benefit of the plough is also reduced for crops grown in swampy, sloped, rocky, or shallow soils, all of which make the plough less efficient or impossible to use. Taking these factors into consideration, Pryor (1985) has classified crops into those whose cultivation benefits greatly from the adoption of the plough—he calls these plough-positive crops—and those whose cultivation benefits less—called plough-negative crops. Plough-positive crops, which include wheat, teff, barley, and rye—tend to have shorter growing seasons and tend to be cultivated on relatively large expanses of land (per calorie of output) that tends to be flat and with deep soil that is not too rocky or swampy. Plough-negative crops, which include sorghum, maize, millet, roots, tubers, and tree crops, tend to yield more calories per acre, have longer growing seasons, and can be cultivated on more marginal land (Pryor 1985, 732).

We examine Pryor's hypothesis empirically by first measuring the average suitability of the ancestral environment for cultivating plough-positive cereal crops—wheat, barley, and rye and plough-negative cereals—foxtail millet, pearl millet, and sorghum. We choose these two groups of crops because they are comparable in many other dimensions except for the extent to which

they benefit from the use of the plough. For example, we are not comparing cereals to ground crops, which according to Scott (2009) are important for the practice of “escape agriculture” and state formation. Both sets of crops are cereals that have been cultivated in the Eastern Hemisphere since the Neolithic revolution (Mazoyer and Roudart, 2006, 71–99; Crawford, 2009; Lu et al. 2009). Both sets of crops require similar preparations for consumption, all being used for flour, porridge, bread, or in beverages (Recklein 1987). Both sets also produce similar yields, and therefore neither clearly dominates the other in terms of the population it can support (Pryor 1985, 732).

Information on the suitability of a location for cultivating plough-positive and plough-negative cereal crops is taken from the FAO’s *Global Agro-Ecological Zones* (GAEZ) 2002 database (Fischer et al. 2002). The database reports, for 5 arc-minute by 5 arc-minute grid-cells globally, the suitability of the location for cultivating a variety of different crops. The data are constructed using information on a location’s precipitation, frequency of wet days, mean temperature, daily temperature range, vapor pressure, cloud cover, sunshine, ground-frost frequency, wind speed, soil slope, and soil characteristics. These characteristics are combined with the specific growing requirements of crops to produce a measure of whether each crop can be grown in each location, and if so, how productively.

It is important to note that the models of crop growth are based solely on technical requirements and constraints for crop growth. The model’s parameters, and the final measures, are not affected by which crops are actually grown in a particular location. The final estimates are not simple functions of the geographic characteristics used, but are based on precise, highly non-linear crop-specific models of evapotranspiration, water balance, temperature profiles, temperature growing periods, length of growing period, and thermal regimes. This last point is particularly important as it allows us to check the robustness of our findings to controlling directly for important geo-climatic characteristics which may differ systematically in plough-positive and plough-negative environments.

We construct the instruments by first identifying the land traditionally inhabited by each ethnic group in the *Ethnographic Atlas*. We use all land within 200 kilometers of an ethnic group’s centroid and measure the amount of land within this area that can grow each of the cereal crops that comprise the

instruments.<sup>27</sup> Let  $x_e^w$ ,  $x_e^b$ ,  $x_e^r$ ,  $x_e^s$ ,  $x_e^{fm}$ , and  $x_e^{pm}$  denote the amount of land that can cultivate wheat, barley, rye, sorghum, foxtail millet, and pearl millet, respectively. Further, let  $x_e^{all}$  be the amount of land that could grow any of the crops (i.e., the amount of arable land). The ethnicity-level measures of suitability for plough-positive crops is given by:  $Area_e^{pos} = \frac{1}{3}(x_e^w + x_e^b + x_e^r)/x_e^{all}$ , while the ethnicity-level measure of suitability for plough-negative crops is  $Area_e^{neg} = \frac{1}{3}(x_e^s + x_e^{fm} + x_e^{pm})/x_e^{all}$ . Intuitively, the instruments measure the average suitability for each type of crop, normalized by the overall suitability for cultivation in general.<sup>28</sup>

Using the procedure explained by equation (1), we then construct district- and country-level averages of our plough-positive and plough-negative ancestral suitability. The variables measure the proportion of the population with ancestors that lived in climates that could grow plough-positive cereals (wheat, barley, and rye) and the proportion that lived in climates that could grow plough-negative cereals (sorghum, foxtail millet, and pearl millet).

We begin by testing Pryor's (1985) hypothesis that crop type affected the adoption of the plough. Panel A of Table VIII reports estimates of the specifications from Table III, but with traditional plough use as the dependent variable and the two crop suitability measures as additional explanatory variables. The estimates show that the adoption of the plough is positively correlated with an environment suitable for the cultivation of plough-positive cereals, but not with plough-negative cereals. In all specifications, the difference between the two coefficients is statistically significant. These estimates provide confirmation for Pryor's hypothesis.

Next, we consider the relationship between crop suitabilities and current gender roles. Panel B of Table VIII reports these reduced-form estimates. Consistent with their impacts on plough use shown in Panel A, we find that having an ancestral environment that was better able to cultivate plough-positive crops is always associated with less-equal gender roles today.

27. The GAEZ database measures suitability as a proportion of maximum attainable yield. We define locations that obtain at least 40% of the maximum yield as suitable. The suitability for each crop is shown in Appendix Figures A5 and A6.

28. Our procedure assumes that the GAEZ data provide an unbiased measure of relative historical suitability. In a different context, Nunn and Qian (2011) provide evidence of the validity of this assumption, showing that the GAEZ suitability measure for potatoes is highly correlated with historical potato production.



TABLE VIII  
COUNTRY-LEVEL 2SLS AND REDUCED-FORM ESTIMATES

|   | (1)                   | (2)                   | (3)                   | (4)                  | (5)                 | (6)                 | (7)                  | (8)                  |
|---|-----------------------|-----------------------|-----------------------|----------------------|---------------------|---------------------|----------------------|----------------------|
| Panel A. First stage 2SLS estimates. Dependent variable: Traditional plough use |                       |                       |                       |                      |                     |                     |                      |                      |
| Mean of dep. var.   |                       | 0.53                  |                       | 0.44                 |                     | 0.54                |                      | 0.51                 |
| Plough-positive environment   | 0.744***<br>(0.084)   | 0.629***<br>(0.089)   | 0.861***<br>(0.078)   | 0.673***<br>(0.103)  | 0.820***<br>(0.082) | 0.685***<br>(0.104) | 0.874***<br>(0.089)  | 0.717***<br>(0.118)  |
| Plough-negative environment   | 0.119<br>(0.122)      | 0.185<br>(0.133)      | 0.100<br>(0.166)      | 0.115<br>(0.171)     | 0.132<br>(0.130)    | 0.187<br>(0.141)    | 0.129<br>(0.181)     | 0.142<br>(0.188)     |
| Equality of coefficients (p-value)  | 0.00                  | 0.00                  | 0.00                  | 0.00                 | 0.00                | 0.00                | 0.00                 | 0.00                 |
| <i>F-stat (plough variables)</i>  | 40.21                 | 25.06                 | 66.80                 | 21.88                | 51.96               | 21.88               | 49.54                | 18.52                |
| Dependent variable (panels B & C):  |                       |                       |                       |                      |                     |                     |                      |                      |
| Share of firms with female ownership, 2005–2011                                 |                       |                       |                       |                      |                     |                     |                      |                      |
| Female labor force participation in 2000  | 51.10                 | 35.04                 |                       |                      | 11.86               |                     |                      | 2.31                 |
| Share of political positions held by women in 2000                              |                       |                       |                       |                      |                     |                     |                      |                      |
| Average effect size (AES)   |                       |                       |                       |                      |                     |                     |                      |                      |
| Panel B. Reduced-form estimates   |                       |                       |                       |                      |                     |                     |                      |                      |
| Plough-positive environment   | -10.644***<br>(3.816) | -11.299***<br>(4.285) | -13.164***<br>(5.610) | -12.692**<br>(6.214) | -5.800**<br>(2.534) | -6.840**<br>(2.790) | -0.639***<br>(0.214) | -0.774***<br>(0.288) |

TABLE VIII  
(CONTINUED)

|                                      | Dependent variable (panels B & C):       |   |  |                           |                      |
|--------------------------------------|--|---|--|---------------------------|----------------------|
|                                      | Female labor force participation in 2000 | Share of firms with female ownership, 2005-2011 | Share of political positions held by women in 2000 | Average effect size (AES) |                      |
| Plough-negative environment          | 18.928***<br>(6.506)                     | 6.072<br>(9.926)                                | 9.134<br>(10.401)                                  | -2.975<br>(6.093)         | 0.607<br>(0.391)     |
| Equality of coefficients (p-value)   | 0.00                                     | 0.02  | 0.02   | 0.56                      | 0.00                 |
| F-stat (plough variables)            | 14.87                                    | 5.41  | 4.46   | 3.44                      | 9.19                 |
|                                      |  |   |  |                           | 7.11                 |
| Panel C. Second-stage 2SLS estimates |  |   |  |                           |                      |
| Traditional plough use               | -21.630***<br>(5.252)                    | -17.486***<br>(5.533)                           | -22.689***<br>(7.620)                              | -6.460***<br>(2.334)      | -0.918***<br>(0.225) |
| Hausman test (p-value)               | 0.02                                     | 0.04  | 0.40   | 0.22                      | 0.33                 |
| Hansen J                             | 0.00                                     | 0.00  | 0.31   | 0.72                      | 0.06                 |
| Historical & contemporary controls   | yes                                      | yes   | yes  | yes                       | yes                  |
| Continent FEs                        | no                                       | no  | yes  | no                        | no                   |
| Observations                         | 160                                      | 160   | 122  | 140                       | 104                  |

Notes. Two-stage least squares estimates are reported with robust standard errors in brackets. The unit of observation is a country. "Traditional plough use" is the estimated proportion of citizens with ancestors that traditionally used the plough in pre-industrial agriculture. The variable ranges from 0 to 1. The mean (and standard deviation) of this variable is 0.530 (0.471); this corresponds to the sample from columns 1 and 2. "Plough-positive environment" is the average fraction of ancestral land that was suitable for growing barley, rye, and wheat divided by the fraction that was suitable for any crops. "Plough-negative environment" is the average fraction of ancestral land that was suitable for growing foxtail millet, pearl millet, and sorghum divided by the fraction that was suitable for any crops. "Female labor force participation" is the percentage of women in the labor force. The variable ranges from 0 to 100. "Share of firms with female ownership" is the percentage of firms in the World Bank Enterprise Surveys with some female ownership. The surveys were conducted between 2005 and 2011, depending on the country. The variable ranges from 0 to 100. "Share of political positions held by women" is the proportion of seats in parliament held by women. The measure also ranges from 0 to 100. "Historical controls" include: ancestral suitability for agriculture, fraction of ancestral land that was tropical or subtropical, ancestral domestication of large animals, ancestral settlement patterns, and ancestral political complexity. "Contemporaneous controls" include the natural log of real per capita GDP and its square, measured in the same year as the dependent variable. The number of observations reported for the AES is the average number of observations in the regressions for the three outcomes. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels.

A better environment for growing plough-negative crops is generally associated with more-equal gender roles today.

If one is willing to assume that the difference between ancestral suitability for plough-positive and plough-negative crops is correlated with gender role attitudes today (conditional on covariates) only through their impact on the plough, then we can use the two measures to provide IV estimates of the impact of traditional plough use on current gender attitudes. Although this assumption (i.e., the validity of the exclusion restriction) cannot be taken for granted, we feel that with appropriate caveats, the IV estimates are informative. Recall that the controls already include the proportion of land historically inhabited by an ethnic group that was tropical or subtropical, as well as its overall suitability. In addition, further analysis discussed below flexibly controls for additional geographic characteristics that may be correlated with the suitability instruments and have an independent effect on gender norms today.

One important difference between plough-positive and plough-negative crops is that in many countries today, sorghum and millet are often less preferred to rice and wheat (Nadkarni 1986; Kennedy and Reardon 1994). Although the reason for this is not yet well understood, the inferior status is not due to lower nutritional value or greater output volatility (Nadkarni 1986, A113).

Panel C of Table VIII reports the IV estimates, which confirm the OLS estimates. Historical plough use is associated with less female labor force participation, less female firm ownership, and less female participation in politics.<sup>29</sup> The magnitudes of the IV coefficients are consistently greater than the OLS estimates. A potential explanation for this is selection arising from the endogeneity of plough adoption. All else equal, historically advanced societies were more likely to adopt the plough.<sup>30</sup> Furthermore, they are more likely to be advanced today, with higher per capita income and more female participation in the labor market. Therefore, selection introduces a positive relationship

29. The results are similar if we do not control for current per capita GDP. See Appendix Table A12.

30. This fact can be seen in Appendix Table A13, which reports the relationship between traditional plough use and various ethnicity characteristics. Political development, and to some extent economic development, as measured by settlement complexity, are both positively correlated with a tradition of plough use.

between historical plough use and female labor force participation today, biasing the negative OLS estimates toward zero.

The validity of the IV estimates rests on the assumption that holding overall agricultural suitability constant, the specific type of cereal crop that a location could grow only impacts long-term gender attitudes only through the past adoption of the plough. The primary concern with this strategy is that the difference between plough-positive and plough-negative environments may be correlated with geographic features that affect gender attitudes today through channels other than the plough. We check the robustness of our results to this concern by controlling for geographic characteristics that are potentially correlated with the suitability of the environment for plough-positive and plough-negative crops. Our controls include the terrain slope, soil depth, average temperature, and average precipitation of locations inhabited by each country's ancestors. The estimates, reported in Appendix Table A14, show that the IV estimates remain robust to the inclusion of these geo-climatic characteristics, controlling for the measures linearly, non-linearly, or allowing for interactions between the characteristics.

#### VIII. CULTURAL TRANSMISSION AS PART OF THE MECHANISM: EVIDENCE FROM THE CHILDREN OF IMMIGRANTS

We now turn to a closer analysis of the causal mechanisms underlying our results. It is likely that part of the long-term impacts of traditional plough use may not be solely due to the evolution and persistence of cultural norms, but also to the development of institutions, policies, laws, and markets that are less conducive to the participation of women in activities outside the domestic sphere. Through this channel, the plough causes less female participation in market activities because it affects the costs and benefits of these activities, not because it affects individuals' beliefs about whether these are appropriate activities for women. Our individual-level estimates, by controlling for country fixed effects (WVS estimates) and even subnational district fixed effects (IPUMS estimates), provide evidence consistent with a tradition of plough use having some impact on internal values and beliefs.

We undertake an alternative strategy to better isolate the causal impact of ancestral plough agriculture on cultural beliefs and values, and examine variation among the children of immigrants, a group of individuals from diverse cultural backgrounds and different histories of ancestral plough use, but facing the same external environment, including markets, institutions, laws, and policies.

The benefit of this exercise is that by-and-large we are holding constant the external environment, while examining individuals from diverse cultural backgrounds. One shortcoming is that the children of immigrants are not a random sample of the full population in the home country. Therefore, the results should be understood with this in mind: they are an average effect of the sample we consider. Second, if immigrants and their children tend to live in locations with many co-ethnics, then it is possible that informal institutions may be recreated in these areas, explaining some of the persistence of traditional plough use. Again, the results should be understood with this possibility in mind.

The analysis examines the children of immigrants living in the United States and Europe. That is, we examine individuals born in the country, but whose parents were born abroad. An individual's ancestry is defined by the country of birth of their parents. The US data are from the March Supplement of the *Current Population Survey* (CPS).<sup>31</sup> The European data are from the *European Social Survey* (ESS).

#### VIII.A. Evidence from the United States

The sample of children of US immigrants includes women aged 15 to 64. The outcome of interest is the labor force participation of women in the sample. Because this decision is likely very different for married women, we also examine this group separately. Our estimating equation is given by

$$(5) \quad y_{i,s,c} = \alpha_s + \beta \text{Plough}_c + \mathbf{X}_c^C \Gamma + \mathbf{X}_c^H \Pi + \mathbf{X}_i \Phi + \varepsilon_{i,s,c},$$

where  $i$  denotes the daughter of an immigrant parent (or immigrant parents) who currently lives in state  $s$ , with country of

31. Because the Census stopped asking questions about parents' country of origin in 1970, this source cannot be used for the analysis. Starting in 1994, the CPS asks individuals about their country of origin and their parents' country of origin. We use all the years available since 1994.

ancestry  $c$ . Country of ancestry is defined using either the mother's country of birth or the father's country of birth. A list of the countries of ancestry and the number of children of immigrants for each country is provided in Appendix Table A16.

The dependent variable,  $y_{i,s,c}$ , is an indicator variable that equals one if woman  $i$  is in the labor market. As in equation (2),  $\text{Plough}_c$  denotes ancestral plough use of those from country  $c$ .  $\alpha_s$  denotes state fixed effects, which control for state-varying differences in labor markets, laws, regulations, institutions, etc.<sup>32</sup>  $\mathbf{X}_c^C$  and  $\mathbf{X}_c^H$  denote the same vectors of current and historical controls as in equation (2).  $\mathbf{X}_i$  indicates a vector of individual-level controls: fixed effects for educational attainment, a quadratic for age, marital status, fixed effects for whether the person lives in a metropolitan or rural area, and fixed effects for the year of the survey. When we examine the sample of married women, we also include controls for characteristics of the husband: a quadratic of the husband's age, the husband's education, and the natural log of his wage income. Because our variable of interest,  $\text{Plough}_c$ , varies only at the country-of-origin level, standard errors are clustered at this level.

OLS estimates of equation (5) are reported in Table IX. Columns 1–3 report estimates using the full sample of women. Column 1 identifies an individual's ancestry by her father's country of birth, while column 2 uses the mother's country of birth. In column 3, we restrict the sample to women whose parents were both born in the same country. For all three specifications, we estimate a negative relationship between a tradition of plough use in the home country and participation in the labor force. Columns 4–9 report estimates for the sample of married women. Columns 4–6 reproduce the estimates of columns 1–3 with the married sample. We continue to find a negative impact of traditional plough use on female labor force participation. For both specifications, we find that the estimated impact of traditional plough use is stronger when both parents have the same ancestry.

We also consider the possibility that a wife's participation in the labor market may be influenced by her husband's beliefs and

32. We include state fixed effects to account for the potential selection of immigrants (and their children) to different states. As shown in Appendix Table A18, we obtain similar estimates when we exclude these fixed effects. Our European results are also similar with or without destination-country fixed effects. See Appendix Table A20.

TABLE IX  
DETERMINANTS OF FEMALE LABOR FORCE PARTICIPATION FOR US CHILDREN OF IMMIGRANTS

| (1)  | (2)                 | (3)                  | (4)                  | (5)                  | (6)                  | (7)                  | (8)                 | (9)                  |
|--|---------------------|----------------------|----------------------|----------------------|----------------------|----------------------|---------------------|----------------------|
| Dependent variable: Labor force participation indicator, 1994–2011 |                     |                      |                      |                      |                      |                      |                     |                      |
| All women  |                     |                      |                      |                      |                      |                      |                     |                      |
| Woman's ancestry   |                     |                      | Woman's ancestry     |                      |                      | Husband's ancestry   |                     |                      |
| Father's country   | Mother's country    | Parents same country | Father's country     | Mother's country     | Parents same country | Father's country     | Mother's country    | Parents same country |
| 0.63   | 0.63                | 0.60                 | 0.68                 | 0.69                 | 0.69                 | 0.70                 | 0.71                | 0.70                 |
| -0.044***<br>(0.015)   | -0.043**<br>(0.018) | -0.062***<br>(0.020) | -0.094***<br>(0.046) | -0.118***<br>(0.043) | -0.136**<br>(0.054)  | -0.065***<br>(0.024) | -0.045**<br>(0.022) | -0.058**<br>(0.024)  |
| 57,138   | 55,341              | 32,776               | 10,206               | 9,508                | 6,835                | 35,393               | 35,158              | 23,124               |
| 0.23   | 0.23                | 0.25                 | 0.10                 | 0.10                 | 0.11                 | 0.08                 | 0.08                | 0.08                 |
| 0.23   | 0.23                | 0.26                 | 0.11                 | 0.11                 | 0.12                 | 0.09                 | 0.08                | 0.09                 |
| Mean of dep. var.  |                     |                      |                      |                      |                      |                      |                     |                      |
| Traditional plough use   |                     |                      |                      |                      |                      |                      |                     |                      |
| Observations   |                     |                      |                      |                      |                      |                      |                     |                      |
| Adjusted R-squared   |                     |                      |                      |                      |                      |                      |                     |                      |
| R-squared  |                     |                      |                      |                      |                      |                      |                     |                      |

Notes. OLS estimates are reported with standard errors clustered at the country level. An observation is a daughter of an immigrant to the United States, surveyed between 1994 and 2011. "Traditional plough use" is the fraction of citizens with ancestors that used the plough in pre-industrial agriculture in the father's country of origin of the children of immigrants. The mean (and standard deviation) for this variable is 0.570 (0.454); this corresponds to the sample from column 1. All regressions include: state-of-residence fixed effects, individual controls (age, age squared, educational attainment fixed effects for less than high school, high school, more than high school, an indicator variable for being single, year of survey fixed effects, and metropolitan fixed effects for within metropolitan central city, outside of metropolitan central city, and not living in a metropolitan area), historical country controls (ancestral suitability for agriculture, fraction of ancestral land that was tropical or subtropical, ancestral domestication of large animals, ancestral settlement patterns, and ancestral political complexity), and contemporaneous country controls (the natural log of real per capita GDP and its square, measured in the same year as the dependent variable). Columns 4–9 also include husband controls (husband's age, age squared, husband's educational attainment fixed effects for less than high school, high school, and more than high school, and husband's natural log of real wage income). \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels.

values, which were transmitted from his parents. Columns 7–9 reproduce the estimates of columns 4–6, but identify ancestry using the husband’s parents rather than the wife’s parents. The estimates provide evidence that a tradition of plough use among the husband’s ancestors also affects the wife’s participation in the labor market.<sup>33</sup>

By examining the children of immigrants, we are able to estimate the impact of traditional plough use on FLFP, while holding constant external factors that vary at the state level. This provides increased confidence that the estimated impact more closely approximates the true impact of the plough working through cultural transmission. Therefore, a comparison of the magnitudes of the children-of-immigrant estimates to the country-level estimates allows us to glean evidence of the importance of cultural transmission, relative to other channels.<sup>34</sup> The impact of the plough on the daughters of immigrants to the United States is much smaller than the estimated impact from the country-level regressions. Consider the estimated impact on female labor force participation from a one-unit increase in historical plough use. Using the country-level OLS estimates (column 1 of Table IV), this is associated with an increase in FLFP by 12.4 percentage points. The magnitudes from the children-of-immigrant estimates are much smaller, generally ranging from 4.3 to 6.2 (for the sample of all women). Although one must interpret these findings with appropriate caution, they suggest that the transmission of internal norms (as identified in the children-of-immigrant regressions) may account for roughly 35–50 percent of the total effect.

### VIII.B. *Evidence from Europe*

We now turn to the European sample of children of immigrants from the ESS. One advantage of the sample is that the ESS, like the WVS, asks respondents their view about the statement “When jobs are scarce, men should have more right to a job than women.” The potential responses, however, are slightly

33. As we show in Appendix Table A17, we obtain similar results if we do not control for origin country contemporaneous per capita income.

34. To facilitate such a comparison, we intentionally construct the country-level, individual-level, and children-of-immigrants estimating equations to be as similar as possible. For example, they all include exactly the same country-level historical and contemporary control variables.



different than in the WVS. The respondents are asked to choose among “agree strongly,” “agree,” “neither agree nor disagree,” “disagree,” and “disagree strongly.”<sup>35</sup> From the survey question, we construct two measures. The first variable takes integer values from 1 to 5 and is increasing in the strength of agreement with the statement. The second variable is an indicator that equals one if the individual agrees or strongly agrees with the statement and zero if he or she disagrees or strongly disagrees; people who neither agree nor disagree are excluded from the sample.<sup>36</sup> The second variable, although less precise than the first, is constructed in the same manner as the dependent variable used in the individual-level analysis, providing the best comparison of the children-of-immigrant regressions with these estimates.

We estimate the impact of the plough on the children of immigrants using the following equation:

$$(6) \quad y_{i,d,c} = \alpha_d + \beta \text{Plough}_c + \mathbf{X}_c^C \Gamma + \mathbf{X}_c^H \Pi + \mathbf{X}_i \Phi + \varepsilon_{i,d,c},$$

where  $i$  denotes the child of an immigrant who is currently living in destination-country  $d$  with country of ancestry  $c$ . The dependent variable,  $y_{i,d,c}$  is the gender role attitude measure described above.  $\text{Plough}_c$  denotes traditional plough use in country  $c$ ;<sup>37</sup>  $\alpha_d$  denotes destination-country fixed effects;  $\mathbf{X}_c^C$  and  $\mathbf{X}_c^H$  denote the same vectors of current and historical controls as in equation (5); and  $\mathbf{X}_i$  denotes a vector of individual-level control variables that includes years of education, age, age squared, gender, marital status, fixed effects for city size, and fixed effects for the year of the survey.

The OLS estimates are reported in Table X. The odd-numbered columns report estimates using the dependent variable that ranges from one to five, and the even-numbered columns report estimates using the indicator variable. Columns 1–2 identify a person’s ancestry by their father’s country of birth, and columns 3–4 use the mother’s country of birth. In columns 5–6, we restrict the sample to individuals for whom both parents were born in the same country. In all six specifications, we estimate a positive relationship between traditional plough use and

35. The responses in the WVS are “agree,” “disagree,” “neither,” or “don’t know.”

36. The estimates for the 1-to-5 integer variable are similar if we omit people who “neither agree or disagree”.

37. The origin countries and the number of observations from each are reported in Appendix Table A16.

TABLE X  
DETERMINANTS OF GENDER ATTITUDES OF EUROPEAN CHILDREN OF IMMIGRANTS

|                        | (1)                |                    | (2)                |                    | (3)                 |                    | (4)                 |                    | (5)                 |                    | (6)                 |                    |
|------------------------|--------------------|--------------------|--------------------|--------------------|---------------------|--------------------|---------------------|--------------------|---------------------|--------------------|---------------------|--------------------|
|                        | 1-5 scale          | Indicator          | 1-5 scale          | Indicator          | 1-5 scale           | Indicator          | 1-5 scale           | Indicator          | 1-5 scale           | Indicator          | 1-5 scale           | Indicator          |
|                        | Father's country   |                    | Mother's country   |                    | Same country        |                    | Same country        |                    | Same country        |                    | Same country        |                    |
| Mean of dep. var.      | 2.54               | 0.32               | 2.53               | 0.32               | 2.62                | 0.35               | 2.62                | 0.35               | 2.62                | 0.35               | 2.62                | 0.35               |
| Traditional plough use | 0.219**<br>(0.091) | 0.073**<br>(0.034) | 0.214**<br>(0.086) | 0.070**<br>(0.033) | 0.298***<br>(0.096) | 0.094**<br>(0.038) | 0.298***<br>(0.096) | 0.094**<br>(0.038) | 0.298***<br>(0.096) | 0.094**<br>(0.038) | 0.298***<br>(0.096) | 0.094**<br>(0.038) |
| Observations           | 15,545             | 13,024             | 15,260             | 12,788             | 10,535              | 8,780              | 10,535              | 8,780              | 10,535              | 8,780              | 10,535              | 8,780              |
| Adjusted R-squared     | 0.18               | 0.16               | 0.17               | 0.16               | 0.17                | 0.16               | 0.17                | 0.16               | 0.17                | 0.16               | 0.17                | 0.16               |
| R-squared              | 0.18               | 0.17               | 0.17               | 0.16               | 0.17                | 0.16               | 0.17                | 0.16               | 0.17                | 0.16               | 0.17                | 0.16               |

Notes. The table reports OLS estimates, with standard errors clustered at the country level. An observation is the child of an immigrant, reported in three waves of the European Social Survey (ESS). The three waves include the second (2004-2005), the fourth (2008-2009), and the fifth (2010-2011). "Traditional plough use" is the fraction of citizens with ancestors that used the plough in pre-industrial agriculture in the father's country of origin of the children of immigrants. The mean (and standard deviation) for this variable is 0.891 (0.275); this corresponds to the sample from column 1. All regressions control for 33 country-of-destination fixed effects, two survey-year fixed effects for 3 different survey waves, individual controls (age, age squared, the number of years of education, a gender indicator variable, an indicator variable for being single, and two city size indicator variables), historical origin-country controls (ancestral suitability for agriculture, fraction of ancestral land that was tropical or subtropical, ancestral domestication of large animals, ancestral settlement patterns, and ancestral political complexity), and contemporaneous origin-country controls (the natural log of real per capita GDP and its square, measured in the same year as the dependent variable). \*\*\*, \*\*, \* and \* indicate significance at the 1%, 5%, and 10% levels.

beliefs about gender inequality. The estimated impact of traditional plough use is stronger when both parents come from the same country.<sup>38</sup>

As with the US sample, the estimated impact of the plough is smaller when examining variation across the children of immigrants. The immigrant estimates that are most directly comparable to the individual-level estimate (i.e., column 3 of Table V) are the even-numbered columns of Table X. The estimated impact from the individual-level regression is 0.193, while the impacts from the children-of-immigrants regressions range from 0.070 to 0.094. This suggests that between 36 and 49 percent of the total impact identified in Table V may be explained by cultural persistence. This is similar to the figure for female labor force participation using the US children-of-immigrants sample (35 to 50 percent).

## IX. CONCLUSIONS

It has long been hypothesized that the traditional use of shifting hoe cultivation vs. plough agriculture was an important determinant of the evolution and persistence of traditional gender norms. We formally test this hypothesis by combining ethnographic data on traditional plough use with contemporary data, measuring gender norms and female participation outside the domestic sphere.

Our findings provide evidence that current differences in gender attitudes and female behavior are indeed shaped by differences in traditional agricultural practices. Specifically, we have shown that individuals, ethnicities, and countries whose ancestors engaged in plough agriculture have beliefs that exhibit greater gender inequality today and have less female participation in non-domestic activities, such as market employment, firm ownership, and politics. In an effort to better identify a channel of cultural persistence, we examined the children of immigrants. We find that among these individuals who face the same labor markets, institutions, and policies, a heritage of traditional

38. Unlike the US estimates, the European estimates are sensitive to conditioning on origin-country contemporaneous per capita income. As we show in Appendix Table A19, if we do not control for this variable, the magnitude of the relationship between traditional plough use and gender attitudes is reduced by approximately one-half.

plough agriculture is still associated with more unequal gender attitudes and less female labor force participation.

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#### SUPPLEMENTARY MATERIAL

An Online Appendix for this article can be found at QJE online ([qje.oxfordjournals.org](http://qje.oxfordjournals.org)).

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