A strictly economic explanation of gender norms: The lasting legacy of the plough[*]

Alessandro Cigno[†]
University of Florence, CESifo and IZA

Abstract

We show that the descendants of primeval plough users have an interest in maintaining the gender division of labour which was originally justified on comparative-advantage grounds, even though in a modern economy individual productivity depends on education rather than physical characteristics. The result rests on the argument that the contract enforcement institutions developed in response to the availability of the plough serve a purpose also in a modern economy because of a possible hold-up problem in the implemenation of a Nash-bargaining equilibrium with domestic division of labour.

Key-words: Plough, comparative advantage, matching, hold-up problem, migration.

JEL Codes: C78, D02, J16, J61

[†]Department of Economics and Management, University of Florence. Email: alessandro.cigno@unifi.it

1   Introduction

An influential article, Alesina et al. (2013), brings empirical evidence in support of the hypothesis advanced by Boserup (1970) that the gendered division of labour, whereby men work outside the home in income raising activities, while women specialize in domestic, prevalently child raising activities, draws its origins from the introduction of the plough some four thousand years ago. Unlike shifting cultivation, which is very labour intensive but requires no special physical characteristics, plough cultivation is in fact less labour intensive but requires "upper body strength, grip strength, and bursts of power" which are more likely to be found in men than in women. That gave the former a comparative advantage over the latter in agricultural production. Alesina, Giuliano and Nunn report that European and US residents descending from populations who introduced the plough such a long time ago in their countries of origin display still today, in their country of destination, less equal gender attitudes than those descending from populations who did not experience that innovation. That is amazing. Why is the legacy of the plough still felt after countless other innovations have drastically reduced the importance of physical characteristics, and the weight of the agricultural sector? Why was this legacy not lost when migration offered the descendants of ancient plough users the opportunity to marry members of different ethnic groups?

The often heard argument that women are genetically programmed to like raising children more than men do is irrelevant in the present context, because it should apply to everybody, not just to the descendants of ancient plough users. Another often heard argument is that men took advantage of the power achieved when physical strength mattered to create institutions that allowed them to continue indulging their taste for gender discrimination when the original comparative-advantage justification ceased to apply. The problem with this argument is that discrimination in general has an efficiency cost (Becker, 1957), and that the cost of discriminating against women in particular increases as technological progress makes education, rather than physical characteristics, the main determinant of individual productivity. Even assuming that at least some men enjoy discriminating against women, sooner or later the price they have to pay for this pleasure will become prohibitively high. Social norms also can be discriminatory. Boserup (1970) and Alesina et al. (2013) effectively argue that norms originating from the introduction of the plough survived their usefulness. But why? Should the principle that discrimination ceases when its efficiency-cost becomes sufficiently large not apply to social norms too?

The present paper offers an explanation that does not rely on men's

2

taste for discriminating against women, nor on the assumption that a social norm may become established and survive even if it is inefficient.

2 Modern economies

Parents and their children play a two-stage game. At stage 1, i's parents give i a certain amount of cash or other durables, b_i, and a certain amount of education, z_i. At stage 2, i's wage rate will be $w_i = w^H$ with probability $\pi(z_i)$, and $w_i = w^L < w^H$ with probability $1 - \pi(z_i)$, where $\pi(.)$ is increasing and concave, and $\pi(0) = 0$. If education is compulsory up to a certain level, z_i is measured from that minimum.

When w_i is revealed, i may choose to marry or stay single. If the latter, the utility function is

$$U_i = c_i,$$

where c_i denotes i's consumption. If the former, the utility function is

$$U_i = c_i + ng, \tag{1}$$

where n denotes the number, and g the quality, of i's children. Quality depends on the amount of money (optimally allocated between cash-in-hand and educational expenditure), y, and the amount of attention, a, that each child receives from i and i's spouse jointly,

$$g = \ln y + \gamma \ln a, \ \gamma > 0.$$

Notice that children are a couple-specific public good as in Folbre (1994) and many other articles by many other authors after that. Notice also that parents do not differentiate between sons and daughters.

Given that our focus in on the allocation of a between mother and father, we treat the number of children born to them as a constant,

$$n = 2.$$

The probability that a child is born female is the same as the probability that he is born male, but a couple may end up having two boys, two girls, or one of each. The model is solved by backward induction.

2.1 Stage 2

At this stage, i is endowed with one unit of time and b_i units of cash, and commands a known wage rate w_i. If i stays single, her or his maximized utility is

$$R_i = b_i + w_i.$$

If i marries, the couple thus formed Nash-bargain the allocation of their joint time and money endowments, and the distribution of their joint income. A spouse's reservation utility is equal to her or his maximized utility as a single. We plausibly assume that men and women are matched by their reservation utilities, and that the distribution of these utilities is the same for men and women. If several individuals of each sex have the same reservation utility, they are sorted into couples in such a way, that i's utility is maximized given R_i. This makes sense, but we will see that it may not lead to an efficient matching because of a possible hold-up problem.

Take the couple formed by a particular woman, f, and a particular man, m. Given that

$$R_f = R_m = R,$$

it follows that

$$w_m - w_f = b_f - b_m.$$

The Nash-bargaining (NB) equilibrium maximizes

$$N = (U_f - R)(U_m - R),$$

subject to f's and m's budget constraints,

$$c_f = b_f + (1 - 2\delta a)w_f - y + T$$

and

$$c_m = b_m + [1 - 2(1 - \delta)a]w_m - y - T,$$

where $0 \leq \delta \leq 1$ denotes f's share of a, and T is defined as a transfer (positive, negative or zero) from m to f. Each parent is conventionally assigned the monetary cost of one child, y, but the amount effectively contributed will depend on the sign and size of T. Given that m's and f's attention are perfect substitutes in the production of g, the choice of δ will be either at a corner, or indeterminate. This is a simplifying assumption. If the mother's and the father's time contributions substituted at a diminishing marginal rate, the solution would be interior, and the specialization could be less than full, but this would make no difference of substance to the results.

For any given δ, the first-order conditions on the choice of a, y and T are, respectively,

$$\left(-2\delta w_f + 2\frac{\gamma}{a}\right)(U_m - R) + \left[-2(1-\delta)w_m + 2\frac{\gamma}{a}\right](U_f - R) = 0, \quad (2)$$

$$\left(-1 + \frac{2}{y}\right)(U_m - R) + \left(-1 + \frac{2}{y}\right)(U_f - R) = 0 \quad (3)$$

and

$$(U_m - R) - (U_f - R) = 0. \tag{4}$$

The equilibrium value of y is

$$y = 2. \tag{5}$$

Those of a and T depend on the choice of δ.

For

$$w_f = w^L, \ w_m = w^H,$$

the couple choose

$$\delta = 1, \ a = \frac{2\gamma}{w^L}, \ T = 2\gamma.$$

In this case, f does all the domestic work, and m all the market work. Consequently, he compensates her for the forgone earnings. Their common utility level is

$$U^* (R) := R - 2(1 + \gamma) + 2 \left(\ln 2 + \gamma \ln \frac{2\gamma}{w^L} \right).$$

In the opposite case, where

$$w_f = w^H, \ w_m = w^L,$$

the couple choose

$$\delta = 0, \ a = \frac{2\gamma}{w^L}, \ y = 2, \ T = -2\gamma.$$

The only difference between this and the previous case is that, as m now does all the domestic work, and f all the market work, it is now her who compensates him for the loss of earnings. But the common utility level is still $U^* (R)$.

For

$$w_f = w_m = w, \ w = w^H, w^L,$$

the couple are indifferent between splitting domestic and market work equally between them, or spinning a coin. Assuming the former,

$$\delta = \frac{1}{2}, \ a = \frac{2\gamma}{w}, \ y = 2, \ T = 0$$

There is no compensation. If two low-wage person marry, the couple's common utility level is again $U^* (R)$. But, if two high-wage persons married, their common utility level would be only

$$U^\circ (R) := R - 2(1 + \gamma) + 2 \left(\ln 2 + \gamma \ln \frac{2\gamma}{w^H} \right) < U^* (R)$$

because the opportunity-cost of the children would be higher than in the other cases for any given R.

Therefore, a marriage between two high-wage persons is inefficient. In an efficient matching, a high-wage person is always married to a low-wage person, because the latter is indifferent between marrying a high-wage or a low-wage person with the same R, but the former is better-off marrying a low-wage person with the same R. Realistically assuming that children are born at the start of stage 2, but wages are paid at the end (or at any rate in the course) of it, however, an NB equilibrium where the spouses have different wage rates may not be implementable. Given that once the children are born they cannot be sent back, and making the usual assumption that a complete, legally enforceable pre-marital contract is out of the question because the transactions cost is prohibitively high for ordinary folks,[1] the low-wage spouse will in fact demand to be paid at front. But, this payment will not be forthcoming if the high-wage spouse's money endowment is lower than the compensation due, and credit is rationed. If that is the case, there we have a hold-up problem. For $w_i = w^L$, i will then marry a high-wage member of the opposite sex with b greater than 2γ or, if there are not enough of them, another low-wage person. In either case, i will get the utility level $U^*(R_i)$. By contrast, if $w_i = w^H$, i will have no choice but to marry another high-wage person, and get the utility level $U^\circ(R_i)$, which is not as good as $U^*(R_i)$, but still better than remaining single and getting only R_i.

It may be argued that, in a developed society, there are legal instruments, other than a court-enforceable contract, which may obviate the emergence of a hold-up problem. Cigno (2012) shows that marriage may substitute for a fully contingent pre-marital contract if divorce is sufficiently inexpensive, and divorce courts can be relied upon to award compensation to the party who sacrificed her or his career prospects in order to specialize in domestic activities, because the party in question can then credibly threaten divorce if the other party does not deliver the compensation voluntarily. But this is unavoidably uncertain, because there are verifiability problems, and also because of court discretionality. Besides, even if it were certain that a divorce court would award compensation to the main caregiver, the allocation would not be necessarily efficient (it would depend on the property regime). Therefore, the availability of low-cost divorce, and the possibility that the compensation for the spouse who specialized in domestic work would be mandated by a divorce court, reduces but does not eliminate the probability of a

---

[1] The transactions cost is not only financial. There is also the psychological stress of having to envisage all possible contingencies, including infidelities.

hold-up problem, and does not guarantee efficiency in any case.

2.2 Stage 1

At stage 1, i's parents choose b_i and z_i, subject to

$$b_i + z_i = \overline{y}_i, \tag{6}$$

where $\overline{y}_i$, is the amount of money they have allotted to i (solving a problem analogous to the one that i and her or his partner will solve at stage 2), and to the further restriction that b_i must be large enough to unable i, at the next stage, to specialize in income raising activities by paying his or her spouse the equilibrium amount of compensation $T = 2\gamma$ at front if it so happens that $w_i = w^H$,

$$\overline{y}_i - z_i \geq 2\gamma. \tag{7}$$

Given that w_i is still uncertain, and assuming risk aversion, i's parents then maximize the expected value of $V\left(U\left(R_i\right)\right)$, where $V\left(.\right)$ is a concave function. That is the same as maximizing

$$EV\left(R_i\right) = \overline{y}_i - z_i + \pi\left(z_i\right)V\left(w^H\right) + \left[1 - \pi\left(z_i\right)\right]V\left(w^L\right) \tag{8}$$

subject to (7). If this constraint is not binding, the parents' optimization has an interior solution at $z_i = z^* \geq 0$, where z^* solves

$$\pi'\left(z_i\right) = \frac{1}{V\left(w^H\right) - V\left(w^L\right)}. \tag{9}$$

Otherwise, the solution is at the $z_i = 0$ corner.

Therefore, some children get an education (above the compulsory minimum), and some do not. If i does,[2] her or his (maximized) expected utility is

$$EU^*\left(\overline{y}_i - z^* + w_i\right) = \pi\left(z^*\right)w^H + \left[1 - \pi\left(z^*\right)\right]w^L - z^* - 2\gamma + 2\left(\ln 2 + \gamma\ln\frac{2\gamma}{w^L}\right).$$

Otherwise, i's utility will be

$$U^\circ\left(\overline{y}_i + w^L\right) = w^L - 2\gamma + 2\left(\ln 2 + \gamma\ln\frac{2\gamma}{w^L}\right) < EU^*\left(\overline{y}_i - z^* + w_i\right)$$

for certain. Even assuming

$$\pi\left(z^*\right)w^H + \left[1 - \pi\left(z^*\right)\right]w^L \geq z^*,$$

sufficiently risk-averse parents will then prefer to give a child cash rather than an education. Notice that this applies equally to boys and girls.

---

[2] If i receives an education, it must mean that this form of investment is profitable,

$$\pi\left(z^*\right)w^H + \left[1 - \pi\left(z^*\right)\right]w^L \geq z^*.$$

3 From primitive to modern economies

A primitive agrarian economy differs from a modern industrial one in that a person's wage rate or physical productivity is independent of education. Parents may then give a child cash or other durables, but never an education,[3]

$$b_i = \overline{y}_i.$$

Continuing to assume that couples are matched as in the last section, all that was said there about the need to guarantee the actual delivery of T for an NB equilibrium with domestic division of labour to be implementable still applies. Let there be two such economies, A and B. For geographical reasons, the plough is used in country B, but not in country A.[4] In the latter, the wage rate is equal to w^L for everybody, and domestic work is shared equally between the spouses ($\delta = \frac{1}{2}$). There is thus no question of one spouse having to compensate the other, and no possibility of a hold-up problem. In country B, by contrast, a man's wage rate is w^H thanks to the plough technology, while a woman's wage rate is w^L. Therefore, the man has a comparative advantage in agricultural work, and the woman in domestic work. In an efficient NB equilibrium, the wife does all the domestic work ($\delta = 1$) in order to release the husband's time for agricultural production. If (7) does not hold, there is then a hold-up problem. The efficient equilibrium cannot be implemented.

In the traditional societies that we normally associate with primitive economies, however, there is usually the possibility of a pre-marital contract, not between the betrothed, but between their families of origin (this does not imply that marriages are arranged between the two families of origin, but that is typically the case). The contract is enforced, with the community's tacit or overt approval, by extra-legal means ranging from ostracism to the threat or actual use of violence. These extra-legal measures may be buttressed by legal institutions designed to protect the wife's money endowment ("dowry") from the husband's incursions.[5] This combination of legal and extra-legal institutions are the community's collectively rational response to a situation where it is in everyone's interest that the man should be allowed to follow his compara-

---

[3]That is another simplification. In reality, a small minority of prospective priests, scribes and astrologers will receive an education of sorts.

[4]Using a wealth of archaeological and linguistic evidence, Diamond (2005) argues that the reason why agriculture and certain agricultural technologies developed in certain parts of the world rather than others, and spread in certain directions rather than others, is due to geographical factors.

[5]In many parts of Europe until not very long ago, the dowry could not be disposed of without court consent, and it had to be returned intact to the family of origin in the event of divorce or separation.

tive advantage in production activities, but not to turn this comparative advantage into a bargaining advantage at his wife's expense.[6]

Now suppose that i migrates from A or B to a modern economy. To simplify, we assume that i is already married, and that the couple migrate together (in reality, one of the spouses may arrive a little later). Given that i is uneducated, in the destination country, $w_i = w^L$. Observing that, in their new country, educated workers command a higher wage rate than uneducated ones, immigrant couples will consider the merits of investing in their children's education. If they originate from country A, they have no reason to treat their daughters differently from their sons. These parents will then behave like native couples. Not so, however, if the couple originate from country B, because they then know that, if a child of theirs marries the child of another immigrant couple from the same country, their ancestral contract enforcement institutions will guarantee the implementation of an NB equilibrium where the woman specializes in domestic work, but not of one where the man does. This introduces a gender asymmetry in the game that immigrant parents from country B play with their children. Notice that both sets of parents must come from country B, because they are the ones who have negotiate and guarantee the delivery of the compensation if the marriage arrangement involves specialization.

If j is the son of an immigrant couple from B, his parents maximize (8), and consequently choose $z_j = z^* \geq 0$ no matter whether $\bar{y}_j - z^*$ is higher or lower than 2γ. He will then marry the low-wage daughter of another immigrant couple from B, and specialize in market work. Different story if j is the daughter of an immigrant couple from B. For $b_j = \bar{y}_j - z^*$ lower than 2γ, j will never be able to specialize in income raising activities. Therefore, her parents will set $z_j = 0$, and her wage rate will be w^L for certain. On the face of it, it would thus seem that j's utility will be $U^* \left(\bar{y}_j + w^L \right)$ no matter who she marries. That is not true, however, because, in setting up the intergenerational game

---

described in Section 2, we assumed that j's parents care about what will happen to j, and thus, implicitly, that j cares about what will happen to her own children. Being aware that, if she marries outside her ethnic group, her children will not benefit from her ancestral contract enforcing institutions (and will consequently face the (7) constraint), j will then marry the son of another immigrant couple from country B. What happens if $b_j = \overline{y}_j - z^*$ is at least as large as 2γ? If her parents set $z_i = z^*$, her wage rate could turn out to be either w^H or w^L. By contrast, if they set $z_i = 0$, her wage rate would be w^L for certain. Even if $EU^* \left(\overline{y}_i - z^* + w_i \right)$ were greater than $U^* \left(\overline{y}_i + w^L \right)$, sufficiently risk-averse parents would then prefer to give their daughter cash rather than an education. But, j's expected utility would be $EU^* \left(\overline{y}_i - z^* + w_i \right)$ only if she married the son of another immigrant couple from B. Otherwise, her expected utility would be less than $EU^* \left(\overline{y}_i - z^* + w_i \right)$ because her own children would not benefit from the contract enforcement facilities that their grandparents brought over with them from their country of origin. Therefore, j would marry inside her ethnic group and specialize in raising children even if her wage rate turned out to be high. But it will not be high because, anticipating j's behaviour, her parents will not invest in her education.

Summing up, natives and the children of immigrants from country A have no reason to marry among themselves in preference to marrying others. Only some of these couples – those where the high-wage spouse satisfies (7) – will specialize, but the high-wage spouse could in that case be the wife just as well as the husband. The rest share income and child raising activities equally between husband and wife. Therefore, the members of these two ethnic groups may not be efficiently matched. By contrast, immigrants from country B have an interest in marrying each other, because that will allow them to take advantage of the contract enforcement facilities developed in their country of origin, and to pass this advantage on to their children. The couples formed by these immigrants or their descendants practice their traditional gender division of labour, because their extra-legal contract enforcement institutions relax (7) if the high-wage spouse is the husband, but not if the high-wage spouse is the wife, and this induces parents to educate their sons, but not their daughters, above the minimum prescribed by the law. Under the assumption incorporated in (1) that people do not care where their income comes from, and regard the time spent with their children as a cost, the matching and associated time allocation achieved by country B immigrants and their descendants are thus efficient. This matching is assortative in ethnic origin as well as in R.

10

4 Discussion

Using a strictly economic argument, we have shown that the descendants of ancient plough users have an interest in marrying among themselves and maintaining the gender division of labour which was justified on comparative advantage grounds in an agrarian economy, but not in a modern economy where productivity depends on education rather than gender. We have not assumed that employers derive utility from discriminating against women workers, or parents from giving daughters less education than sons. Nor have we assumed that ancient ploughmen somehow turned their initial comparative advantage into a permanent bargaining advantage. Most importantly, we have not assumed that a social norm, once established, remains such even when changed circumstances make it inefficient. The reason for not assuming any of this is not that it is not true, but that it is neither necessary nor sufficient to explain the persistent legacy of the plough.

Our argument is that, if people derive utility only from their own consumption, and from the quality and quantity of their children, then, in an efficient matching, either the husband and the wife have a low wage rate, or one spouse has a high and the other a low wage rate. In the second type of couple, the high-wage spouse specializes in income raising activities, and the low-wage one in domestic, essentially child raising activities. For this efficient NB equilibrium to be implementable, either the high-wage spouse's cash endowment must be large enough to compensate the low-wage spouse before the children are born, or there must be institutions that guarantee a later payment. As the legal system of a modern economy does not provide such guarantee for the reasons mentioned in section 2, an efficient matching is achieved only by the descendants of primeval plough users who have access to extra-legal means of enforcing pre-marital contracts. Having developed in a context where that innovation gave men a comparative advantage over women in agricultural production, however, the guarantee applies only if the high-wage spouse is the man. When subsequent technological innovations made education rather than gender the source of comparative advantage, efficiency continued to require that the high-wage spouse specialize in income raising, and the low-wage spouse in child raising activities, but the former was no longer necessarily the man. Given that the probability of getting a high wage rate conditional on education is the same for boys as for girls, all children should then get the same amount of education. Given the available contract enforcing facilities, however, girls will get no education above the compulsory minimum, and the low-wage spouse in a different-wage couple will consequently be the woman. This raises the question, what prevents the immigrants from country B, or their descen-

dants, from modifying their extra-legal contract enforcement institutions so that they apply not only when the high-wage spouse is the man, but also when it is the woman? The answer is that, so long as people do not care where their income comes from, and regard the time spent with their children as a cost, nobody has an incentive to change the rules.

This argument does not need to be strengthened by bringing in additional assumptions. If anything, it needs to be weakened because Alesina et al. (2013) do not find that the descendants of primeval plough users practice a rigid gender division of labour, but only that their gender attitudes are less egalitarian than those of others. As already pointed out in subsection 2.1, the specialization would be less than full if the mother and the father's attention were not perfect substitutes in the production of child quality. Furthermore, it must be recognized that our utility function – of common use in microeconomics, especially in the economics of the family – is strictly appropriate only to an economy where survival and reproduction are the overwhelming considerations. In a prosperous economy, where subsistence consumption is amply assured for most and infant mortality is negligible, some people may be willing to pay a price for personal career satisfaction, or to spend time with their children. We can think of these sources of gratification as luxury goods. A sufficiently rich couple descended from primeval plough users may then take advantage of traditional contract enforcement practices to specialize, but stop well short of total specialization in order to allow the woman to pursue a career, or the man to see more of his children. At some income level, they may even give up specialization altogether, but the evidence suggests that this is generally not yet the case.

5 References

Alesina, A., P. Giuliano and N. Nunn (2013), "On the origins of gender roles", *Quarterly Journal of Economics* 128, 469–530

Becker, G. S. (1957), *The Economics of Discrimination*, Chicago: The University of Chicago Press

Boserup, E. (1970), *Woman's Role in Economic Development*, London: George Allen and Unwin

Cigno, A. (2012), "Marriage as a commitment device", *Review of Economics of the Household* 10, 193–213

Diamond, J. (2005), *Guns, Germs, and Steel: The Fates of Human Societies*, New York: W. W. Norton

Folbre, N. (1994), "Children as public goods," *American Economic Review* 84, 86-90