USING GENDER DISPARITIES IN LITERACY TO PREDICT FERTILITY IN DEVELOPING COUNTRIES: A PANEL REGRESSION STUDY

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Abstract

This paper presents an empirical analysis of fertility in the developing world, demonstrating that fertility reductions can be attributed to a number of important explanatory variables, particularly those related to health status, gender inequalities in literacy, and household income. The paper adds to the expansive literature on fertility by exploring whether differing levels of success in effecting the demographic transition can be attributed to these explanatory variables. The data used are from 57 developing nations and cover the time period 1975-2014.

KEYWORDS: (Fertility, literacy, gender inequality, demographic transition)

ON MY HONOR, I HAVE NEITHER GIVEN NOR RECEIVED
UNAUTHORIZED AID ON THIS THESIS

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Introduction

There has been a great deal of investigation into the demographic transition – the transition from a state of high fertility, high mortality and low levels of capital per worker, to low fertility and mortality and high levels of capitalization. The consensus among scholars that the fertility transition has been completed in most if not all of the developing world is reflected in most recent research (e.g. Bongaarts 2002). Among developing nations, however, the same is not true. Most regions in the developing world seem to be languishing in a pre-transition or incomplete transition stage – although there have been great advances in healthcare, contraception provision, and awareness in many regions of the developing world, fertility and mortality remain high on average, while their economies tend to remain under-capitalized. This paper aims to investigate the impact on improvements in health status, income and gender equality in educational attainment on effecting the demographic transition in developing countries. We find that the gender inequalities in literacy, as well as longevity, are both highly significant determinants of fertility.

Indeed, recent empirical research identifies major gaps within Sub-Saharan African nations with regards to successfully completing the demographic transition. Bongaarts (2010) demonstrates the existence of large differentials in fertility and mortality, as well as the associated determinants such as education, contraceptive availability, etc. between nations in Southern and Eastern Africa (more successful in transitioning) and those in the Western part of the continent. The effect that fertility has on economic growth has been demonstrated to be a

negative one (Becker and Barro 1994), and several channels through which this effect may occur – e.g. reducing the per capita level of capital – have been investigated.

Other theoretical approaches, particularly the hypothesis of 'old age support' forwarded by Morand (1995) and the hypothesis of fertility being a function of the relative wage (Galor and Weil 1996) will be explored in greater detail in the next section and the latter theory forms the foundation of this empirical study.

Furthermore, many developing nations have experienced rapid population growth in the latter half of the 20th century and the issues they are experiencing as a result of this growth deserve mention. One of the regions that have experienced the greatest sustained surges of rapid population growth is South Asia. India, in particular, has seen its population balloon from approximately 320 million in 1947 to approximately 1.28 billion in 2013 – a quadrupling of the population in roughly 65 years. Combined with the phenomenon of increasing urbanization, India today experiences issues such as food inflation, an overburdened urban infrastructure, a lack of labor in rural areas and high unemployment in urban areas. Due to the demerits of unchecked population growth, as well as its demonstrated adverse growth effects, it is important to understand why some countries continue to lag behind in completing the demographic transition.

This study aims to explore the relative importance of health status, household income and the relative wage available to men and women as determinants of fertility in developing countries using a panel regression analysis. We will fit a basic linear model in which fertility is expressed as a function of our proxies for health, income and relative wage to data taken from

57 developing nations spanning the period from 1975-2014. The goal of our exercise is to determine to what extent improvements in health status, income and relative wages can be given credit for fertility reductions in the developing world. On the other hand this would also give us the ability to explore the reasons why certain countries or regions have not experienced a significant demographic transition.

Theoretical & Empirical Background

This section is organized in three parts: the first outlines the three leading approaches seen in the theoretical literature concerning endogenous fertility literature. These are the intergenerational altruism hypothesis (Becker and Barro 1989), the need for old-age support (Morand 1995) and finally the relative wage hypothesis (Galor and Weil 1996). The second part of this section focuses on the literature, both empirical and theoretical, in it is demonstrated that demographic (especially fertility) trends are markedly different in developed and developing regions of the world. The discussion of the literature in this section informs our decision to focus on developing nations only. The third and final section covers a number of empirical investigations into the determinants of fertility. The papers reviewed in this section outline the effects of educational attainment (Barro and Lee 1994), the growth effects of fertility and of gender imbalances in educational attainment (Klasen 2002), as well as explore the effect of longevity (Zhang and Zhang 2005) on fertility. Additionally, this section covers a study in which different forms of female educational attainment are shown to be important factors in fertility differences among countries in Sub-Saharan Africa (Bongaarts 2010).

I. Theories of endogenous fertility

This sub-section outlines three leading theories that attempt to explain the fertility decision as a function of various explanatory variables, e.g. the degree of intergenerational altruism. While all three theories provide important insights into the fertility decision, one of these

(fertility as a function of the relative wage) forms the theoretical framework in which our regression analysis will take place.

Although a number of empirical growth analyses had been conducted during the latter part of the 20th century, these invariably treated fertility as an exogenous variable and attempted to ascertain its growth effects. It was not until the late 1980s and 1990s that theoretical models of endogenous fertility were developed. The first of these is the model based on the idea of intergenerational altruism – the idea that the utility function of the parents is affected by both the number and the wellbeing of their offspring (Becker and Barro 1989). In this paper, the authors develop a model in which the parents simultaneously determine their consumption and fertility levels. The optimization problem facing parents involves maximizing a utility function dependent on their own consumption, the number of offspring and the utility of each child. Based on this model, the following conclusions are offered: the rate of population growth is positively related to the degree of intergenerational altruism, and negatively related to the rate of growth in per capita consumption between generations. The authors argue that technological progress drives increases in per capita consumption, and that this channel explains the fall in fertility that is associated with economic development. Another feature of the model is that a permanent increase in the cost of children lowers the steady-state level of population growth and increases the steady-state level of capital per worker. This is an important result in the context of our study as increases in the relative wage available to women are effectively increases in the cost of children (assuming women continue to perform the majority of childbearing activities in the developing world as they do today).

Another important theoretical approach to modelling endogenous fertility involves the hypothesis that as countries in the developing world are often lacking in social safety nets, the fertility decision of a couple is influenced primarily by their perceived need for support in their old age (Morand 1995). As such, each child and the costs associated with it can be seen as a form of savings (where the goal is to have a retirement or old-age income). In Morand's paper, an overlapping generations model with endogenous fertility is developed in which income inequality affects economic growth through the transmission of human capital between successive generations. There is no assumption of altruism from either the parents or the children, and there are externalities associated with human capital accumulation (i.e. benefits for the next generation). The relationship between the level parental human capital and fertility is a negative one, presumably because individuals with high levels of human capital earn higher incomes and require less support in old age from their children. This allows the author to advance an alternative explanation of the demographic transition: "the economy is either locked in a poverty trap in which agents only invest in the quantity of children, or it evolves on a path of persistent growth along with fertility decline." What path a country will take is determined, in this model, by whether the initial level of average human capital is over a certain threshold. An exogenous increase in the returns on investments in human capital can also propel a country onto a growth path.

The primary theoretical underpinning of the empirical analysis conducted in this paper, however, comes from a growth model in which fertility is dependent on the relative wages of men and women, which are endogenously determined by their respective levels of human capital (Galor and Weil 1996). The purpose of this paper was primarily to test the 'relative wage

hypothesis' of fertility, in which the level of a household's fertility/labor-supply (as child-bearing is considered a rival activity to workforce participation) is based on the relative wages available to women and women in the labor market. While there has been much theoretical investigation into the various determinants of fertility and their relative importance, the relative wage hypothesis advanced by Galor and Weil is relatively simple to test empirically, especially compared to some of the other leading theories, e.g. Intergenerational altruism (Becker and Barro, 1989) or the need to fund old age and retirement (Morand 1995). The theoretical model proposed by Galor and Weil is based on two reasonable assumptions: i) that while men have more brawn (physical productivity) than women, both sexes possess the same level of brains (mental productivity) and ii) higher wages for women raise the opportunity cost of children relatively more than they raise household income. Thus, it follows that the level of capital per worker in the economy determines the actual market value of women's productive capabilities relative to those of men – a higher level of capital per worker allows the women who can supply mental assets ("brains") to earn a wage that is closer to the wage available to men (in a capital intensive economy being able to supply brawns is less important, whereas being able to supply brains increases in importance). The authors base these assumptions on previous empirical literature that establishes the negative effect that fertility has on both the level and growth rates of income (e.g. Mankiw et al, 1992) as well as the positive effect that increasing capital intensity in an economy has on the relative wages of women (Goldin, 1990). This paper proposes to test this hypothesis empirically using the gender disparity in literacy (defined as the difference between the percentage of adult males and adult females that are literate) as a signal of the relative wage available to women. As literacy is the most basic form

of educational attainment (or human capital), a positive value for this figure reflects a situation in which many more men than women are literate, or in other words, where the average human capital among male workers is higher than among their female counterparts. As gender disparities in literacy are such a strong signal for inequalities in relative wages available to men and women, the initial hypothesis advanced by Galor and Weil would be validated by a regression analysis that ascribes a statistically significant and positive effect on fertility to the gender disparity in literacy.

II. Developing vs. developed nations

This sub-section briefly outlines two papers that informed the decision to focus specifically on developing nations. Bongaarts (2002) argues that the groundwork for the demographic transition in the developed world had already been laid by the early 1950s (the best data available is unfortunately from the latter half of the century) while Bratti (2003) provides evidence that the fertility effects of educational attainment are dramatically different in women from developed countries.

Recent scholarship in the field of population studies agrees that the demographic transition has been completed in the developed world (Bongaarts 2002). As far as fertility reductions go, a post-transition fertility rate is seen in developing countries that have adopted strict measures of population control (e.g. China), however the developing world cannot be said to have completed a demographic transition as a whole. The paper challenges the long-held assumption that the post-transition societies reproduce at the replacement rate (i.e. a value of 2.1 births per woman) by asserting that fertility levels will instead remain permanently below

the replacement level. The author also outlines the fact that most of the underlying mechanisms through which the demographic transition was achieved in developed countries – such as improvements in healthcare and access to education - were already in place by the early 1950s. By characterizing developed nations as post-transition and developing ones as still transitioning, we should be able to apprehend the demographic transition as it occurs in the developing world, by matching improvements in healthcare, income and educational attainment to reductions in fertility. It is therefore worthwhile to focus entirely on the demographic transition that *is occurring* in the developing world rather than the one that already has occurred in the developed world.

An empirical study conducted among Italian women (Bratti 2003) questions the assumption that the effect of educational attainment on fertility is uniform across countries and regions. Bratti finds that among Italian women, all levels of education are positively co-related with labor force participation. However, primary and secondary education was found to *increase* fertility among the Italian women surveyed. It was only among women with post-secondary educations that a drop in fertility is observed, sharply contradicting the results of various empirical investigations that demonstrate a uniformly negative effect of female educational attainment on fertility (e.g. Klasen 2002, Barro and Lee 1994). Furthermore, empirical studies conducted in developing regions (such as Bongaarts 2010) clearly demonstrate the negative effect on fertility that female educational attainment has at all levels. The only reasonable conclusion is that significantly diverse demographic trends prevail in developed and developing regions – that while basic education may allow a woman in a developing country to enter the market for labor and significantly affect her fertility preferences, women in the developed

world usually have access to basic education and the labor market by default– possibly a result of greater capital availability – and educational attainment does not cause dramatic changes in fertility preferences for women in developed countries unless said attainment dramatically changes their potential income (i.e. post-secondary education). As a result we choose to focus entirely on developing countries for this exercise.

III. Empirical investigations into fertility

This sub-section outlines a few of the most important papers in the expansive empirical literature on fertility, educational attainment and economic growth. This paper builds on the literature by incorporating factors that have previously been demonstrated to be important factors in the fertility decision. Particularly, the effects of educational attainment on fertility (Barro and Lee 1994) informed the decision to focus on the gender disparity in literacy, while longevity (Zhang and Zhang 2005) was incorporated into the regression equation as it has been shown to exert significant influence.

Sources of Economic Growth (Barro and Lee 1994) is an empirical analysis conducted with the goal of ascribing differences in growth rates between countries to a set of quantifiable explanatory variables. Although this study is primarily concerned with the question of convergence in growth rates, as well as the effect of market distortions such as revolutions on growth, a number of important early findings relating to the determinants of fertility are discussed. The authors describe that schooling has significant impacts on the quantity and quality of children. In particular, female educational attainment relates inversely to fertility, and both male and female educational attainments are negatively related to infant mortality and

positively to life expectancy. Moreover, male and female educational attainment both relate positively to secondary enrollment. The authors maintain that through these channels, educational attainment (particularly among females) should exert a positive influence on economic growth.

A World Bank study (Klasen 2002) identifies various forms of gender inequality in educational attainment and explores their effects on economic growth, attempting to identify whether growth rate differentials between countries are a result of gender inequalities in schooling. A number of possible channels, once again focusing on increased capitalization through fertility reduction, are discussed as means through which this growth effect may occur. The results presented in this paper include the finding that gender inequality in education undermines economic growth directly by lowering average human capital, and indirectly through its impacts on investment and population growth. Furthermore, a significant portion of growth differentials in the 20th century can be ascribed to gender inequalities in education and its subsequent effects. The author makes the case for increasing gender equality in education, both as a goal in itself and as a means of achieving faster economic growth and development.

Another important variable, namely longevity or life expectancy, has been shown to exert a significant effect on fertility (Zhang and Zhang 2005). The authors begin by constructing a simple model in which rising longevity reduces fertility but increases saving, years of schooling, and the growth rate (but at a diminishing rate). This is based on the intuition that an individual expecting to survive past retirement saves more to provide for old age consumption. The paper then presents a cross-section analysis that demonstrates that life expectancy has significant

positive effects on the savings rate, the secondary school enrollment, and the growth rate of per capita income, but a significant negative effect on fertility. Since longevity is demonstrated to be an important determinant of fertility, we will include it in our analysis of the fertility effects of gender disparity in literacy to avoid an omitted variable bias.

A recent study (Bongaarts 2010) explores fertility differentials within Sub-Saharan Africa, motivated by the fact that significant fertility declines have occurred in eastern and southern Africa, while fertility remains at pre-transitional levels in most of western and central Africa. Using household survey data from countries across Africa, the author demonstrates that educational attainment in women is positively associated with demand for and use of contraception, and negatively associated with fertility and desired family size. This finding supports the intuition that educational attainment in women lowers fertility both directly – by raising the opportunity cost of child-rearing – and indirectly, by influencing contraceptive use and desired family size.

Methodology & Data

Our goal for this regression analysis is to explore the significance of three values that have been found to exert an important influence on fertility – namely health status, household income, and the relative wage of men and women, represented by our proxies namely life expectancy, per capita GNI, and the gender disparity in literacy. A basic linear model, in which fertility is expressed as a function of our proxies for health status and household income as well as gender disparity in literacy, will be used for this panel regression. Other variations on the functional form, such as those incorporating exponents and logarithmic functions, were tested but none performed better than the simple linear model – i.e., the basic linear model had the highest R-squared value associated with it.

$$Fertility = c + \beta_1 Ave.Life\ Expectancy_{it} + \beta_2 Ave.Lit.Disparity_{it} + \beta_3 GNI\ per\ capita_{it} + \varepsilon^1$$

Before proceeding with the regression, it is prudent to make sure our model is optimally specified. Conducting the Hausman test on our data set reveals that a random effects model is not the most efficient approach. Therefore a fixed effects panel regression may be the most appropriate methodology to adopt, if we wish to generate the most accurate model possible for fertility as a function of health status (Average Life Expectancy), household income (Per Capita GNI) and the gender disparity in literacy (Average Literacy Disparity - a signal of the relative wages available to men and women). Furthermore, since there is evidence of heteroskedasticity in the data set, we will also use robust standard errors in an effort to improve efficiency. The standard errors are robust as well as clustered around the identity

[1] Where c is the constant term and ε is the error term

variable ‘Country’ so as to reduce variation by grouping the residuals. We expect any intrinsic factors contributing to variations in fertility to operate on a national level, making a fixed effects model with robust errors clustered around country likely to be the best fit.

The data on literacy among male and female adults, as well as the data on fertility, was taken from the World Bank’s World Development Indicator Tables on Gender. The literacy rate is measured in percentage of adult males or females that are literate and is used to generate the Gender Disparity in Literacy by taking a difference of the values for men and women. The fertility variable is expressed in terms of births per adult (15+) woman. The data on life expectancy at birth was taken from the World Bank’s World Development Indicator Tables on Health and is measured in years. The data on per capita GNI was taken from the World Bank’s World Development Indicator Tables on Poverty and is measured in 2011 U.S. dollars. The data used covers the time period 1975-2014 and represents the following countries: Armenia, Bangladesh, Benin, Bolivia, Botswana, Bahrain, Brunei, Burkina Faso, Cameroon, Cape Verde, Central African Republic, Chad, Chile, Costa Rica, Cote d’Ivoire, Cyprus, Dominican Republic, Ecuador, Egypt, Ethiopia, Guatemala, Gabon, Haiti, India, Indonesia, Iran, Jordan, Kazakhstan, Kuwait, Libya, Macedonia, Malawi, Mali, Malaysia, Mozambique, Myanmar, Morocco, Namibia, Nepal, Nigeria, Panama, Pakistan, Paraguay, Peru, Philippines, Qatar, Rwanda, Saudi Arabia, Senegal, Sri Lanka, Swaziland, Syria, Tanzania, Thailand, Tunisia, Uganda, Vietnam, Yemen.

Under ideal circumstances, we would have liked to include data on other variables that have hitherto been considered determinants of fertility, e.g. access to contraceptives and the Gini co-efficient (to explore the effects of income inequality). Unfortunately, these data are

unavailable at the national level, especially for developing countries, during the time period in which we are interested.

Table 1: Descriptive statistics

Variable	**Global Average**	**Sample Average**
Fertility in 1960	4.9	N/A (data unavailable)
Fertility in 2011	2.4	3.41
Fertility during 1975-1984	3.6	5.57
Gender disparity in literacy (1991)	12.63	14.8

Fertility trends have shifted dramatically during the 20th century in both developing and developed nations. Driven by innovations in medicine, administration and social trends such as women entering the workforce in large numbers, the global fertility rate has fallen from 4.9 in 1960 to 2.4 in 2011. Over the same period of time, average life expectancy rose from 52.6 to 69.9. In many developed countries the fertility rate has fallen below the replacement level. The same cannot be said, however, of the developing world. While the global average for fertility during the period 1975-1984 was 3.6, for the developing countries that comprise our data set for the analysis in the next chapter, it was at 5.57. For the most recent block – 2005-2014 – the global average is 2.49, while the average fertility among our sample remains significantly higher at 3.41.

Global gender disparity in literacy was 12.63 in 1991, while the countries in the data set have an average value of 14.8 during the same period. The data set for our panel regression contains countries that exhibit large gender disparities in literacy, as well as those as exhibit small or even negative ones (representing situations in which more women than men are literate) so it is no surprise that the average within our sample is only slightly higher than the

global average. At first glance, high fertility and large gender differentials in literacy seem to occur in the some of the same places. It will be instructive to test statistically whether the association is in fact significant.

There is much reason to believe that the fertility effects of educational attainment are markedly different among women in developing and developed nations (Bratti 2003 and Bongaarts 2002). As a result developed countries have been excluded entirely from this exercise and we will be focusing on a data set comprising of observations from 57 developing nations in Asia, Africa, Latin America & the Caribbean. A handful of countries had to be dropped from the data set because of major gaps in reporting. The data covers the time period between 1975 and 2013, and is arranged in 'blocks' of 10 years (the first is 1975-1984). Although the scope of the study was initially wider, the poor availability of data for the period 1960-1975 forced a narrowing of the time frame.

Any study that attempts to investigate social phenomena in developing nations is likely to encounter the problem of a paucity of data, and this investigation faced the same difficulties. While the available data on fertility and life expectancy are comprehensive, the same cannot be said for the data on literacy rates and per capita GNI. In particular, the literacy data appear to have been collated from national census data, and have been recorded at different points in time for different countries. The data set also suffered from an imbalance as data reporting was significantly more thorough in some regions than in others. In order to overcome this problem, the data set was transformed from point observations to decade values: by treating a literacy data point from a particular decade's census as the **decade value** for that time period, and

taking an average of all data points for life expectancy and fertility over that same time period, the data set was transformed into a collection of ‘block values’ for fertility, literacy, life expectancy and per capita GNI. Transforming the data in this way allows us to compensate for the paucity of data and assemble a panel spanning both regional and temporal variation.

Results

The results of this regression are encouraging and support our initial hypotheses. The highly significant t-statistic and large negative co-efficient associated with Average Life Expectancy should be no surprise – it merely confirms the work done by economists such as Zhang and Zhang (2005) in which life expectancy is shown to be a significant determinant of fertility, with a negative effect. The authors of that study posit that longer lives may be associated with an increased propensity to save, and a reduced willingness to spend (including on child-rearing expenses). Average Literacy Disparity is significant at all levels, and has a smaller but positive co-efficient associated with it.

Table 2: Regression results

Variable	Coefficient
Average Life Expectancy	-0.1214316*** (0.0291597)
Average Literacy Disparity	0.0921481*** (0.0232546)
Per Capita GNI	-0.0000386** (0.0000188)
Constant Term	10.72768*** (2.036468)
$R^2 = 0.6756$ **No. of observations = 184**	**F-statistic: 105.64** **Prob > F = 0.000**

** indicates significance at α = 0.05 *** indicates significance at α = 0.01
(numbers in parentheses indicate robust clustered standard errors)

Our initial hypothesis was that that a positive gender disparity in literacy represents conditions where the average wage available to women relative to men is low (since more women than men lack literacy, the most basic of educational attainments) and that this creates the ideal conditions for sustained high fertility (by keeping the opportunity cost of each

additional child low). The fact that our variable is both significant and positive provides support for this theory. In comparison with our proxies for health status and relative wage, the per capita GNI variable does not appear to have as much influence on fertility. Household income has hitherto been considered an important determinant of fertility in both the empirical and theoretical literatures, and the consensus seems to be that it exhibits a negative effect on fertility. While the results of this study do not discredit such notions (and indeed uphold the theory that income has a negative effect on fertility), they certainly suggest that household consumption is not nearly as important a determinant of fertility as health status or the relative wage.

Gender disparities in literacy prevent women from entering the workforce in high numbers, since a lack of literacy limits women in developing countries to low-wage positions such as agricultural labor or domestic help. Since the relative wage available to women is quite low in such situations, it is no surprise that among developing countries there is a strong association between gender disparities in literacy and high fertility. A number of developing countries already suffer from overpopulation and low levels of capitalization – both difficulties arising from high fertility (Klasen 2002). The literature concerning capital availability and relative wages of women supports the hypothesis that increases in literacy and other forms of educational attainment in women should create a positive feedback loop in which through reduced fertility, the level of capital per worker would rise, increasing relative wages for women and the incentive for them both to educate themselves and to work (Galor and Weil 1996). The next generation would experience more educational attainment among females since the returns on education would be improved. Future generations should be able to

benefit from a higher level of capital per worker, as well as higher levels of human capital in the economy overall. It is easy to see that a similar phenomenon has occurred in the developed countries in the 20th century and is a major component of the demographic transition (Bongaarts 2002). Furthermore, the well-documented and adverse growth effects of high fertility should motivate policy-makers in the developing world to explore the methods in which gender disparities in literacy can be addressed.

Conclusion

This paper adds to the expansive literature on fertility and the demographic transition, by analyzing fertility differentials across a wide swathe of developing countries and explaining them in terms of a number of important explanatory variables, namely longevity, per capita income, and gender differentials in literacy rates. The initial hypothesis was that those countries that have achieved some measure of success in completing the demographic transition have done so primarily through the channels of improved healthcare, rising incomes and increased educational attainment for women (i.e. reductions in gender inequality in education). We are able to report that each of our variables of interest – most importantly, the gender disparity in literacy – is a significant determinant of fertility in developing nations. This is consistent both with previous regressions using global cross-country data (e.g. Barro and Lee 1994) as well as more focused studies that analyze fertility differentials within a developing region of the world (Bongaarts 2010).

The primary drawbacks from which this study suffers is a lack of data on contraceptive demand and use, as well as income inequality, at the national level for the developing countries in our sample. Since the empirical literature (Bongaarts 2010) indicates strongly that contraceptive use is an important determinant of fertility, and as the theoretical literature (Morand 1995) suggests that inequalities in income are an important factor in the fertility decision, incorporation of these variables in our analysis would have led to a stronger, more robust analysis of fertility. Further studies in this field should attempt to incorporate data on

income inequality as well as contraceptive demand and use, in order that their significance in effecting the fertility transition in developing countries can be gauged.

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