

UNIVERSITY OF HOHENHEIM

FACULTY OF BUSINESS, ECONOMICS AND SOCIAL SCIENCES



HOHENHEIM DISCUSSION PAPERS
IN BUSINESS, ECONOMICS AND SOCIAL SCIENCES

Institute of Economics

DISCUSSION PAPER 11-2016

THE CONTRIBUTION OF FEMALE HEALTH
TO ECONOMIC DEVELOPMENT

David E. Bloom

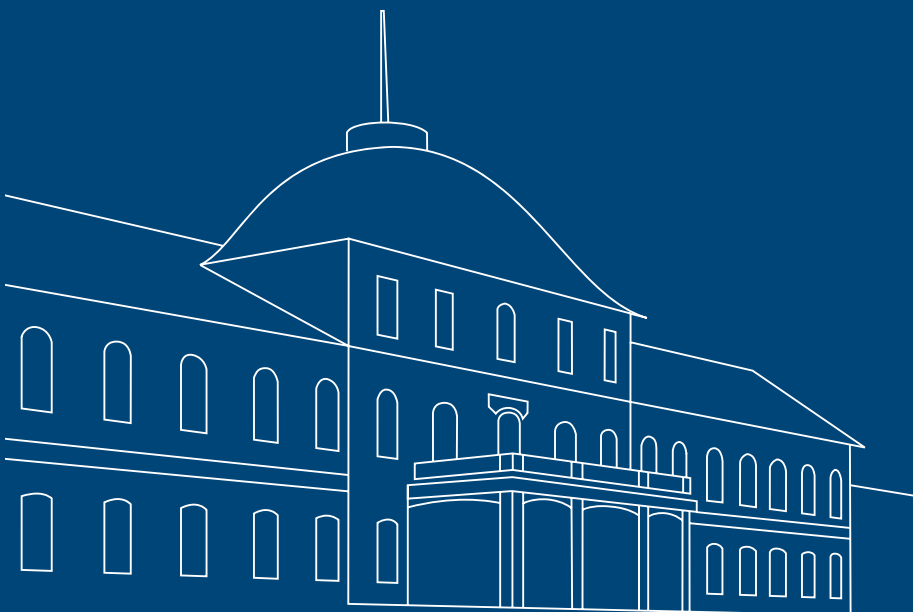
Harvard T. H. Chan School of Public Health

Michael Kuhny

Wittgenstein Centre, Vienna Institute of Demography

Klaus Prettner

University of Hohenheim



www.wiso.uni-hohenheim.de

Discussion Paper 11-2016

The contribution of female health to economic development.

David E. Bloom, Michael Kuhn, Klaus Prettnner

Download this Discussion Paper from our homepage:

<https://wiso.uni-hohenheim.de/papers>

ISSN 2364-2076 (Printausgabe)
ISSN 2364-2084 (Internetausgabe)

Die Hohenheim Discussion Papers in Business, Economics and Social Sciences dienen der schnellen Verbreitung von Forschungsarbeiten der Fakultät Wirtschafts- und Sozialwissenschaften. Die Beiträge liegen in alleiniger Verantwortung der Autoren und stellen nicht notwendigerweise die Meinung der Fakultät Wirtschafts- und Sozialwissenschaften dar.

Hohenheim Discussion Papers in Business, Economics and Social Sciences are intended to make results of the Faculty of Business, Economics and Social Sciences research available to the public in order to encourage scientific discussion and suggestions for revisions. The authors are solely responsible for the contents which do not necessarily represent the opinion of the Faculty of Business, Economics and Social Sciences.

The contribution of female health to economic development

David E. Bloom,^{*} Michael Kuhn,[†] and Klaus Prettnner[‡]

August 2016

Abstract

We analyze the economic consequences for less developed countries of investing in female health. We do this through developing and calibrating a novel micro-founded dynamic general equilibrium model in which parents trade off the number of children against investments in their education and in which we allow for health-related gender differences in productivity. We show that better female health speeds up the demographic transition and thereby the take-off toward sustained economic growth. By contrast, male health improvements delay the transition and take-off because *ceteris paribus* they raise fertility. Investing in female health is therefore a potent lever for promoting development.

JEL classification: O11, I15, I25, J13, J16.

Keywords: economic development, educational transition, female health, fertility transition, quality-quantity trade-off.

^{*}Harvard T. H. Chan School of Public Health, Department of Global Health and Population, 665 Huntington Avenue, Boston, Massachusetts 02115, USA; email: dbloom@hsph.harvard.edu.

[†]Wittgenstein Centre (IIASA, VID/ÖAW, WU), Vienna Institute of Demography, Wohllebengasse 12-14, A-1040, Vienna, Austria; email: michael.kuhn@oeaw.ac.at.

[‡]University of Hohenheim, Institute of Economics, Schloss, Osthof-West, 70593 Stuttgart, Germany; email: klaus.prettnner@uni-hohenheim.de.

1 Introduction

The interplay between gender (in)equality and economic development has received considerable attention in recent literature.¹ However, a key aspect of gender inequality has to do with health, and this has not yet been thoroughly examined.² Generally, four channels appear to matter: (i) Healthy women are more able to participate productively in the labor market with direct consequences for effective labor supply and hence the level and growth of economic output (Albanesi and Olivetti, 2016). (ii) Better health increases the returns to educational investments: This occurs both through lower morbidity, allowing for greater labor market participation at the intensive margin, and lower mortality, affecting labor market participation at the extensive margin (Jayachandran and Lleras-Muney, 2009; Albanesi and Olivetti, 2014). (iii) Better health of mothers directly affects the health of children through *in utero* effects and the mothers' ability to breastfeed and nourish their children in other ways (Field et al., 2009; Bhalotra and Rawlings, 2011). Female health thereby improves development prospects over the long run through direct intergenerational transmission of human capital (cf. Case and Ardington, 2006; Bloom et al., 2014a). (iv) Better female health may lower fertility and thus youth dependency with a knock-on effect on female labor participation and educational investments (Bloom et al., 2009). Lower fertility may arise as a direct consequence of improved reproductive health through availability of contraceptives (Bailey, 2006), but it is also triggered indirectly as a response to changes in the female opportunity costs of child rearing and changes in the returns to education. The consequence is a swing in the quality-quantity trade-off toward the quality of children (e.g. Galor and Weil, 2000; Soares and Falcão, 2008; de la Croix and Vander Donckt, 2010).

In this paper we develop a micro-founded dynamic general equilibrium model that examines some of the mechanisms by which improvements in female health can stimulate economic development. Overlapping generations of families choose consumption, numbers of children, and educational investments in their children. Education in turn translates into the stock of human capital of the next generation. We integrate decision-making at the household level into a two-sector economy, in which effective labor is either combined with a fixed factor in the production

¹See for example Galor and Weil (1996), Knowles et al. (2002), Lagerlöf (2003, 2005), Abu-Ghaida and Klasen (2004), Iyigun and Walsh (2007), Soares and Falcão (2008), Doepke and Tertilt (2009, 2014), Kimura and Yasui (2010), Schober and Winter-Ebmer (2011), Rees and Riezman (2012), Diebolt and Perrin (2013a,b), Hiller (2014), and Prettnner and Strulik (2016) for the role and evolution of gender inequality in economic development.

²See Stenberg et al. (2014) for the potential effects of female health on economic development. An extensive systematic review of the economic and noneconomic literature on female health and its role for development is presented in Iversen et al. (2014).

of goods or employed within an education sector. We solve for the dynamic general equilibrium and study the macroeconomic repercussions of individual choices, and thereby the conditions under which the economy switches from a low-growth regime that corresponds to a poverty trap with high fertility and no educational investments into a modern sustained growth regime with declining fertility and increasing educational investments. Note that we do not analyze the historical take-off to sustained long-run growth that is associated with the industrial revolution in currently industrialized countries. Rather we focus on contemporaneously poor countries that can benefit from technological spillovers from the rest of the world (for an appropriate description of the historical evolution from stagnation to growth see Galor and Weil, 2000).³

Our particular focus is on the role of female health, which affects female labor productivity and female labor force participation for any given level of education. Two findings motivate this focus: First, health is a crucial element of human capital and, as such, represents a central determinant of individual productivity (cf. Bloom et al., 2004; Bloom and Canning, 2005; Prettner et al., 2013). Second, while women face a longer life span than men, they experience higher productivity losses due to greater morbidity during their working lives (cf. Bonilla and Rodriguez, 1993; Vos et al., 2012).

We examine how household choices vary with the level of female health and what the implications are for macroeconomic outcomes. Specifically, we seek to understand whether better female health contributes to higher rates of economic growth and an earlier transition from stagnation to sustained economic growth. As healthier females have better access to the labor market (and higher earnings), raising children incurs a higher opportunity cost even within the high-fertility regime. This tends to enhance economic growth from technology adoption although the distinction may be insubstantial until the take-off. More importantly, better female health facilitates the economic transition in that it lowers the earnings threshold at which educational investments in children become profitable. These investments then trigger both the educational and demographic transition that underlie economic development. While this suggests a decidedly positive role for female health in economic development, an offsetting tendency exists. This is because greater participation of healthy women in the labor market raises aggregate labor supply, which in turn depresses earnings in the low-growth regime and, thereby,

³The article by Galor and Weil (2000) laid the foundations of Unified Growth Theory. For other contributions and extensive overviews see e.g. Kögel and Prskawetz (2001), Jones (2001), Hansen and Prescott (2002), Galor and Moav (2002, 2004, 2006), Doepke (2004), Galor (2005, 2011), Cervellati and Sunde (2005), Strulik and Weisdorf (2008), and Strulik et al. (2013).

the incentive for households to undertake investments in education. However, we show both analytically and numerically that despite this offsetting effect, female health unambiguously speeds up the economic transition.

We contrast these findings with the impact of improvements in male health alone, as well as with equiproportional improvements in the health of both sexes. By a pure income effect, male health improvements tend to increase fertility and, thereby, slow down economic growth and the progress toward economic transition. For equiproportional health improvements for both sexes, we find that economic growth during the low-growth regime remains unaffected, while it rises in the sustained growth regime. Strikingly, this finding mirrors the empirical results of Cervellati and Sunde (2011), who find that health improvements foster growth of per capita income after the demographic transition but not prior to it. Furthermore, we find that equiproportional health investments promote the transition from low growth to sustained growth, although not to the same extent as female health investments alone do.

Taken as a whole, our findings suggest a distinct role for development policies targeted at female health improvements. Potential policies might include the reduction of iodine deficiency, which, during pregnancy, has a more severe negative effect on the cognitive abilities of female children than of male children (cf. Field et al., 2009), and vaccination against human papilloma virus to prevent cervical cancer, which is the second deadliest cancer among women in the developing world (cf. Luca et al., 2014). While such policies may be based on female disadvantage regarding access to health care to begin with,⁴ our analysis suggests an additional rationale on development grounds: targeting female health tends to lead economies out of poverty traps or at least to significantly accelerate progress towards an economic take-off. Furthermore, female health tends to foster long-run growth prospects as well. However, targeting female rather than male health comes at a lower instantaneous utility gain to the household. This highlights a conflict between the short-term interests of utility-maximizing households and long-run development goals (cf. Duflo, 2012).

While we understand health and differences in health across genders to be exogenous for much of our analysis, we show in subsection 6.2 that our results are robust when allowing for endogenous and gender-specific investments in health. Notably, we show that men may be

⁴See e.g. Deaton (2008) and Molini et al. (2010) for evidence that the distribution of height and BMI is biased against women, Bhalotra (2010) and Baird et al. (2011) for disproportionate mortality of girls in the presence of economic crisis, and Bloom et al. (2001) and Self and Grabowski (2012) for evidence on difficulties for women to access health care when they lack autonomy.

advantaged in terms of health investments and health outcomes as a consequence of households seeking to maximize their net income. This result is notable insofar as we do not have to resort to tastes or social norms to explain discrimination against women in terms of health and health care. Adding elements of taste-based discrimination would only strengthen our findings.

Unlike previous work that has focused on partial equilibrium or stable growth paths, we are able to characterize the impact of gender-specific health on the full process of economic development. This allows us to highlight the role of general equilibrium repercussions and to explicitly calculate the timing of the economic transition. By emphasizing the role of female health in economic development, our model bears some resemblance to the theoretical analyses in Jayachandran and Lleras-Muney (2009), Albanesi and Olivetti (2014, 2016), de la Croix and Vander Donckt (2010), and Agénor et al. (2010). The first two of these articles examine how fertility and educational choices at the household level depend on maternal mortality but do not extend the analyses into a macroeconomic framework. Albanesi and Olivetti (2016) consider the role of improvements of maternal health on female labor supply with exogenous fertility and again within a partial equilibrium framework. de la Croix and Vander Donckt (2010) consider the impact of female health, modeled as more years lived in good health, on fertility and gender-specific educational investments in a collective household model with Nash bargaining. While they can conclude that female health contributes to a transition to a low-fertility regime with educational investments in both male and female children, de la Croix and Vander Donckt's macroeconomic environment is limited to an exogenous increase in wages over time. While our framework features a simpler model of the household (although one that gives rise to similar mechanics), its general equilibrium formulation allows a complete analysis of the general equilibrium effects that modulate the transition. Furthermore, our framework allows us to explicitly calculate how gender-specific health investments affect the timing of the economic transition.⁵ Finally, Agénor et al. (2010) consider a complex household model within a general equilibrium framework. Their work highlights the role of public infrastructure for accessing health care, thus giving the analysis a somewhat different focus. Furthermore, they concentrate on balanced growth paths, whereas we are particularly interested in the transition process.

The remainder of the paper is organized as follows. Section 2 introduces the model, solves for

⁵While not analyzing explicitly the role of female health but rather the effects of a general increase in longevity, Soares and Falcão (2008) nevertheless highlight several similar channels through which health improvements foster the economic-demographic transition by altering female labor supply and fertility. Similar to de la Croix and Vander Donckt (2010), their model, too, remains a partial equilibrium/household level analysis.

optimal choices at the household level, and sets out the market equilibrium. Section 3 is devoted to the dynamics of the model and develops our main result regarding the impact of female and male health on the economic transition, while Section 4 considers policy implications. Section 5 numerically characterizes the impact of gender-specific health on the development process. Section 6 shows that our results are robust with respect to collective household decision making, endogenous health, and the inclusion of physical capital, and Section 7 concludes.

2 The model

In this section we develop a simple analytically tractable dynamic general equilibrium model of economic development, featuring differences in male and female health. Time evolves discretely, and in generation t the economy is populated by $N_t/2$ couples formed out of a pool of N_t individuals. We assume that males and females pair randomly after coming of age. Each couple jointly decides on consumption, the number of children, and the educational investments in each child. The last two decisions determine the population growth rate and the individual human capital level, respectively, which then jointly determine the available aggregate human capital stock of the economy in the next generation $t + 1$.

The aggregate human capital stock net of the time that is spent on child rearing can be employed in two sectors: goods production and education. Educational investments of parents determine employment in the education sector, while aggregate consumption determines employment in final goods production. The only input in the education sector is teachers $L_{t,E}$, while final goods are produced by using workers $L_{t,Y}$, natural resources of fixed supply X , and the technologies available to generation t , denoted by A_t (see Galor and Weil, 2000). It is assumed that less developed countries have no research sector for the development of new technologies, but rather adopt technologies developed in more advanced countries. For a justification of this assumption see Jones (2002), Keller (2002), and Ha and Howitt (2007), who show that the largest industrialized countries almost exclusively drive the technological frontier of the world. Following Benhabib and Spiegel (2005), p. 941, we model the speed of technology adoption as being positively influenced by the technological gap between the less developed countries and the technology leaders and negatively influenced by the gap in human capital. The former can be justified by the notion that the adoption of new technologies is more likely to pay off when the incremental outputs that can be produced by using them are larger (cf.

Howitt, 2000; Acemoglu et al., 2006), while the latter can be justified by the notion that accessing new technology and adapting it to local conditions requires a certain level and mix of skills (cf. Nelson and Phelps, 1966).

2.1 Household choices

Consider a less developed economy populated by male-female couples whose preferences are captured by the following utility function:

$$u = \log(c_t) + \gamma \log(n_t) + \delta \log(\bar{e} + e_t), \quad (1)$$

where c_t denotes joint adult consumption, n_t refers to the number of children, e_t denotes investment in the education of the offspring, and \bar{e} represents the education level that children have without any educational investments by their parents (cf. Strulik et al., 2013). The rationale for $\bar{e} > 0$ is that children acquire knowledge during childhood by observing parents and peers. The parameters γ and δ measure the utility weight of the number of children and their education, respectively. Note that we follow a short-cut formulation in which education enters the utility function directly. The notion that individuals experience a “warm glow” from providing their children with a certain level of education justifies this short-cut (cf. Andreoni, 1989). It is well known that the results of utility maximization are similar to a formulation in which children’s *income* raises parental utility⁶ (the latter formulation is used e.g. by Galor and Weil, 2000; Galor, 2005, 2011). The budget constraint of the couple is given by

$$\xi_m \widehat{w}_t + \xi_f \widehat{w}_t (1 - \psi n_t) = c_t + e_t n_t, \quad (2)$$

where $\widehat{w}_t = w_t h_t$ refers to the wage rate per unit of time, depending on the human capital of adults, h_t , and the wage rate per unit of human capital, w_t .⁷ The parameter ξ_j , in which $j = \{m, f\}$, measures the extent to which gender-specific health allows an individual to work productively, while the parameter ψ refers to the fraction of time required for giving birth to and caring for one child. We impose the restriction $\psi > 0$ to ensure that fertility is finite and utility is

⁶This is evident by noting that $\log(w_{t+1} h_{t+1}) = \log(w_{t+1}) + \log(h_{t+1})$, where w_{t+1} and h_{t+1} denote the wage rate and human capital, respectively, in period $t + 1$. The first term is exogenous to the household, and so it drops out of the optimization problem, while the second term is determined by education.

⁷Note that we abstract from politically, socially, and institutionally motivated gender-specific wage discrimination. Incorporating such an analysis would not change our central results as long as discrimination was not too severe such that women were prohibited from labor market participation. However, it would come at a substantial reduction in expositional clarity.

bounded and $\psi < 1$ such that one child does not require the whole available time of the mother. Altogether, household income on the left-hand side of the equation comprises the husband's and the wife's earnings, both not only increasing in the (common) level of human capital but also in gender-specific productivity as determined by gender-specific health. Because, particularly in developing countries, time use patterns show that the contribution of mothers to child care dwarfs the contribution of fathers (according to Berniell and Sánchez-Páramo, 2011; Duflo, 2012, women spend 70% more time on child care than men in Sweden; the difference in Iraq is by a much larger factor of 10), we set the male contribution to zero and assume that women shoulder the full burden of child care. Thus, female earnings are lowered by the (full) amount of time ψn_t required for bearing and rearing n_t children. This means that quality-independent child costs are represented by foregone female earnings. By contrast, quality-dependent child costs are represented by total educational expenditure $e_t n_t$ on the right-hand side of Equation (2).

The impact of health on productivity and therefore on earnings can be understood in two ways: First, ξ_m and ξ_f may represent health-dependent labor participation in the sense that only healthy time can be used for productive employment. According to WHO data (WHO, 2016), we obtain $\xi_f = 0.8692$ and $\xi_m = 0.88337$. Furthermore, case-study evidence indicates that the economic burden of disease (in terms of labor lost) at the household level primarily falls on women (cf. Bonilla and Rodriguez, 1993). We make the additional assumptions that child care has to be provided and that this can be done regardless of the parental health status.⁸ Given that child care is provided unconditionally, this implies that the available working time is $1 - \psi n_t$, of which a share ξ_f is used effectively, whereas a share $1 - \xi_f$ is lost.⁹

Second, ξ_m and ξ_f may represent productivity at the work place, implying that (effective) wage rates are now given by $\xi_j \hat{w}_t$, whereas male and female participation are given by 1 and $1 - \psi n_t$, respectively. Indeed, ample evidence shows that individual productivity increases with health.¹⁰ While our analysis does not rely on *a priori* assumptions about the ordering

⁸This, obviously, rules out from our consideration very severe diseases. While we recognize that some acute infectious diseases may, indeed, debilitate women to the extent they cannot provide child care, several important chronic conditions (anemia, nonfatal malaria, cataract) are such that they are likely to depress female labor supply but not their ability to provide (at least basic) child care.

⁹One could argue that the provision of child care has negative utility for a woman who is sick. It can be checked that adding a term $-\phi(1 - \xi_f)\psi n_t$ for $\phi \geq 0$ to the utility function does not change our results qualitatively if ϕ is not too large.

¹⁰See for example Strauss and Thomas (1998), Schultz (2002, 2005), Shastry and Weil (2003), Bleakley (2007, 2010, 2011), Weil (2007), and Fink and Masiye (2012). The effects also include health impacts during childhood that reflect on adult productivity. Recent work by Bleakley (2007, 2010) identifies strong direct effects on adult productivity from childhood exposure to hookworms and malaria, respectively. Notably, productivity increases

of ξ_m and ξ_f , the literature on the male-female health gap suggests that $\xi_m \geq \xi_f$. Lower female productivity may arise, for instance, due to iodine deficiency, a problem encountered in many developing countries, in particular in Sub-Saharan Africa. As Field et al. (2009) find from microeconomic evidence, insufficient iodine intake during pregnancy lowers children's cognitive ability and subsequent educational attainment, in particular for girls. Notably this is true even when girls and boys receive the same amount of schooling. In this context, $\xi_m - \xi_f > 0$ could be interpreted as the extent to which maternal iodine deficiency impairs female productivity for a given quantity of education h_t (as would arise from educational spending e_t).

For fertility to be nonnegative and not to exceed the amount that would induce females to spend more time on child care than their available time budget allows, we assume that $\gamma \in (\delta, \xi_f/\xi_m)$ holds. Solving the couple's utility maximization problem then yields optimal consumption

$$c_t = \frac{(\xi_m + \xi_f)\widehat{w}_t}{1 + \gamma}, \quad (3)$$

while optimal fertility and optimal human capital investments are given by

$$n_t = \begin{cases} \frac{\gamma(\xi_m + \xi_f)}{\xi_f\psi(1+\gamma)} & \text{for } \widehat{w}_t \leq \frac{\gamma\bar{e}}{\delta\xi_f\psi}, \\ \frac{(\gamma-\delta)(\xi_m + \xi_f)\widehat{w}_t}{(1+\gamma)(\xi_f\psi\widehat{w}_t - \bar{e})} & \text{otherwise,} \end{cases} \quad (4)$$

$$e_t = \begin{cases} 0 & \text{for } \widehat{w}_t \leq \frac{\gamma\bar{e}}{\delta\xi_f\psi}, \\ \frac{\delta\xi_f\psi\widehat{w}_t - \gamma\bar{e}}{\gamma - \delta} & \text{otherwise.} \end{cases} \quad (5)$$

At low levels of wages, $\widehat{w}_t \leq \gamma\bar{e}/(\delta\xi_f\psi)$, the couple divides household income between consumption c_t and fertility n_t alone, while educational investments e_t are zero. The reason is that parents prefer a corner solution in which children only learn incidentally because income is so low that the marginal utility from consumption and fertility outweighs the marginal benefit from educational investments over and above the basic level. However, once wages surpass the threshold $\widehat{w}_t = \gamma\bar{e}/(\delta\xi_f\psi)$, investing in their children's education such that e_t turns positive becomes optimal for parents (cf. Strulik et al., 2013). Notably, the threshold depends on female health alone. By raising the opportunity cost of child care, improved female health tends to skew the quality-quantity trade-off toward educational investments rather than the number of

even for a given level of schooling. As Bleakley (2011) argues, better child health tends to raise, as a first-order effect, the quality of a given quantity of education, whereas ensuing (optimal) changes to the quantity of education only give rise to second-order effects.

children.

For increasing income and human capital, the model replicates a transition from high to low fertility, that is, fertility converges from above to

$$\lim_{\widehat{w}_t \rightarrow \infty} n_t = \frac{(\gamma - \delta)(\xi_m + \xi_f)}{(1 + \gamma)\xi_f^\psi} < \frac{\gamma(\xi_m + \xi_f)}{\xi_f^\psi(1 + \gamma)}, \quad (6)$$

where the right-hand side represents fertility in the low-growth regime. Furthermore, as inspecting Equation (5) shows, once the income threshold for positive educational investments is surpassed, these investments rise with income, paving the way for mass education (cf. Galor, 2005, 2011; Strulik et al., 2013). With regard to the impact of gender-specific health on the household allocation we can now state the following¹¹:

Proposition 1. *Given the level of earnings, \widehat{w}_t ,*

- (i) consumption increases (symmetrically) with male (ξ_m) and female (ξ_f) health;*
- (ii) fertility increases (decreases) with male (female) health both in the low-growth and in the modern growth regime and in the long-run limit; and*
- (iii) educational investments in the modern growth regime increase with female health and are unaffected by male health.*

Proof. Immediate from differentiation of (4), (5), and (6) with respect to ξ_f and ξ_m .

Improvements in male health yield an income effect that unambiguously leads to an expansion of both consumption and the number of children. By contrast, female health improvements yield both an income and a substitution effect. The income effect leads again to an unambiguous expansion of consumption, but this is no longer true with regard to the number of children. Here, the substitution effect, driven by the greater opportunity cost of children, leads to a reduction in the number of children. While this is true even in the low-growth regime, in the modern growth regime the reduction in fertility comes with greater educational investments. The effect that rising male income leads to higher fertility, while rising female income leads to lower fertility is well established empirically (cf. Butz and Ward, 1979; Schultz, 1985; Heckman and Walker, 1990; Bloom et al., 2009). Furthermore, Bratti and Mendola (2014) provide evidence that a

¹¹Note that we operate under the assumption that the costs of health interventions are borne by foreign governments or development agencies and that no cost differentials exist between male and female health interventions. See Subsection 6.2 for an extension in which the household undertakes health investments.

negative health shock to the mother reduces the educational enrollment of children, whereas a negative health shock to the father does not. Note that i) spillover effects of female health on the human capital levels of other household members would only strengthen our results and that ii) all our subsequent derivations hold true irrespective of whether the chosen fertility level is above or below the replacement rate.

2.2 Population development and labor force participation

Because each couple gives birth to n_t children at time t , the replacement rate of fertility is given by $n_t = 2$ and the adult population evolves according to

$$N_{t+1} = \frac{n_t}{2} N_t. \quad (7)$$

As far as labor market participation is concerned, we abstract from leisure and assume that individuals inelastically supply their available time net of child rearing. While interpreting ξ_m and ξ_f as health-dependent participation or as health-dependent productivity does not make any difference to the household analysis and will not make a difference to the key macroeconomic relationships summarized in the system of Equations (22)-(29), the subsequent intermediate analysis of employment in terms of workers (L_t) is based on the interpretation of ξ_m and ξ_f as health-dependent labor participation. Note that for this case human capital h_t is homogeneous across gender so that the wage rate, \widehat{w}_t , is gender neutral, while labor supply

$$L_t = \frac{N_t}{2} [\xi_m + \xi_f (1 - \psi n_t)] \quad (8)$$

depends on health in addition to the time that women allocate to child care.

Remark 1. *The productivity interpretation of ξ_m and ξ_f implies that the level of human capital $\xi_j h_t$ is gender specific. Hence, (i) the wage rate $\xi_j \widehat{w}_t$ is now gender specific, and (ii) labor demand and employment in terms of workers (L_t) will now depend on the gender composition, whereas (iii) labor supply in terms of workers is no longer health dependent. In this case, one would have to write out Equations (8), (10), (11), (14)-(16), and (18) in terms of aggregate human capital (H_t). Doing so, one can easily derive wages and earnings as (19) and (20) and the dynamic system (22)-(29), all of which apply regardless of the particular interpretation of ξ_m and ξ_f .*

2.3 Education sector

Once the income threshold for positive educational investments is surpassed, aggregate spending on formal education is given by education expenditures per couple ($e_t n_t$) multiplied by the number of couples ($N_t/2$), thus amounting to

$$e_t n_t \frac{N_t}{2} = \frac{\delta \xi_f \psi \widehat{w}_t - \gamma \bar{e}}{\xi_f \psi \widehat{w}_t - \bar{e}} \cdot \frac{(\xi_m + \xi_f) \widehat{w}_t}{1 + \gamma} \cdot \frac{N_t}{2}. \quad (9)$$

Aggregate education spending is then used to employ $L_{t,E}$ teachers whose aggregate wage bill is given by $\widehat{w}_t L_{t,E}$. Thus, we can derive the equilibrium number of teachers as

$$L_{t,E} = \frac{e_t n_t}{\widehat{w}_t} \cdot \frac{N_t}{2} = \frac{\delta \xi_f \psi \widehat{w}_t - \gamma \bar{e}}{\xi_f \psi \widehat{w}_t - \bar{e}} \cdot \frac{\xi_m + \xi_f}{1 + \gamma} \cdot \frac{N_t}{2}. \quad (10)$$

These teachers produce the human capital level of the next generation with a teaching productivity per unit of human capital of η . Because the human capital level of teachers is h_t and educational resources devoted to each child are given by $L_{t,E}/N_{t+1}$ with $N_{t+1} = n_t N_t/2$, we have the following equation of motion for individual human capital,

$$h_{t+1} = \begin{cases} \bar{e} & \text{for } \widehat{w}_t \leq \frac{\gamma \bar{e}}{\delta \xi_f \psi}, \\ \frac{\eta h_t L_{t,E}}{n_t N_t/2} + \bar{e} = \frac{\eta e_t}{w_t} + \bar{e} = \frac{\eta \delta \xi_f \psi \widehat{w}_t - \gamma \bar{e}}{(\gamma - \delta) w_t} + \bar{e} & \text{otherwise.} \end{cases} \quad (11)$$

In the infinite limit, the growth factor of human capital converges to

$$\lim_{h_t \rightarrow \infty} \frac{h_{t+1}}{h_t} = \frac{\eta \delta \xi_f \psi}{\gamma - \delta} \quad (12)$$

for rising levels of human capital.¹² The following result is immediate.

Proposition 2. *The long-run growth factor of human capital increases with female health but is unrelated to male health.*

The intuitive explanation is that for increasing male income the income and substitution effects with respect to fertility cancel out, while, for increasing female income the substitution effect dominates. This implies that rising male productivity due to improvements in health leave fertility and education investments unchanged, while rising female productivity due to

¹²Note from Equation (15) that $\lim_{h_t \rightarrow \infty} \widehat{w}_t = \infty$.

health improvements reduce fertility and raise education investments.¹³

2.4 Production sector

We follow Galor and Weil (2000) and assume that the production technology is given by

$$Y_t = H_{t,Y}^\alpha (A_t X)^{1-\alpha}, \quad (13)$$

where $H_{t,Y} = h_t L_{t,Y}$ refers to aggregate human capital employed in production, with $L_{t,Y}$ being the number of workers; $A_t \geq 1$ denoting the stock of technologies that a country has at its disposal; X denoting natural resources of fixed supply; and α denoting the elasticity of output with respect to human capital. This production function implies, *ceteris paribus*, that an increase in human capital employed in goods production and an increase in the technological sophistication of a country both raise output. Following Galor and Weil (2000) and assuming that no property rights are defined on the fixed resource X (such that its return is zero), gives the wage per unit of human capital as the average product of human capital, that is,

$$w_t = \frac{Y_t}{H_{t,Y}} = \left(\frac{A_t X}{h_t L_{t,Y}} \right)^{1-\alpha}. \quad (14)$$

The wage rate (per unit of time) is then given by

$$\hat{w}_t = h_t w_t = h_t^\alpha \left(\frac{A_t X}{L_{t,Y}} \right)^{1-\alpha}, \quad (15)$$

which declines with labor supply and increases with human capital. To summarize, effective labor has three dimensions in our setting: (i) productivity, which is determined by technology and captured by the variable A_t ; (ii) human capital, which is determined by the parental education decision and captured by the variable h_t ; and (iii) the available healthy time of men and women, which is given by the parameters ξ_m and ξ_f , respectively.

¹³Note that this effect would also be present if men spent time on childcare as long as they spend less on childcare than women.

2.5 Market clearing

Labor market clearing requires that labor is either employed in goods production or in the education sector such that $L_t = L_{t,E} + L_{t,Y}$, from which we obtain

$$L_{t,Y} = \frac{N_t}{2} \left[\xi_m + \xi_f (1 - \psi n_t) - \frac{e_t n_t}{\widehat{w}_t} \right], \quad (16)$$

where the second term in square brackets adjusts female labor supply for productivity and child rearing and the third term in square brackets refers to employment in the education sector. Following Walras' Law, we can also determine the amount of human capital employed in production by recognizing that production of final goods has to equal aggregate consumption, that is, goods markets are cleared. Hence, production per capita $y_t = Y_t/N_t$ has to equal consumption per capita such that

$$y_t = \frac{c_t}{2} = \frac{(\xi_m + \xi_f)\widehat{w}_t}{2(1 + \gamma)}. \quad (17)$$

Because $w_t = Y_t/H_{t,Y} = y_t/(H_{t,Y}/N_t)$, we obtain the following expressions for human capital and labor employment in final goods production

$$H_{t,Y} = \frac{(\xi_m + \xi_f)h_t}{2(1 + \gamma)}N_t \quad \Rightarrow \quad L_{t,Y} = \frac{\xi_m + \xi_f}{2(1 + \gamma)}N_t. \quad (18)$$

The expression for $L_{t,Y}$ can be verified by substituting the optimal values of e_t and n_t into Equation (16) and simplifying the expression. Using Equations (14) and (15), we can recalculate wages per unit of human capital and per unit of time as

$$w_t = \left[\frac{2(1 + \gamma)A_t X}{h_t(\xi_m + \xi_f)N_t} \right]^{1-\alpha}, \quad (19)$$

$$\Leftrightarrow \widehat{w}_t = h_t^\alpha \left[\frac{2(1 + \gamma)A_t X}{(\xi_m + \xi_f)N_t} \right]^{1-\alpha}. \quad (20)$$

2.6 International technology diffusion

In specifying the diffusion of technologies from countries that are advancing the world technological frontier we follow Benhabib and Spiegel (2005), p. 941, and assume that

$$A_{t+1} = \max \left\{ \frac{h_t}{\bar{h}_t} \left(\frac{\bar{A}_t}{A_t} - 1 \right) A_t + A_t, \bar{A}_t \right\}, \quad (21)$$

where \bar{A}_t and \bar{h}_t refer to the technological frontier and the human capital level in the most advanced countries, respectively. The larger the technological gap between more and less developed countries, the faster is the process of technology diffusion (cf. Howitt, 2000; Acemoglu et al., 2006). This can be justified by the notion that adopting new technologies is more likely to pay off the larger the additional amount of output that can be produced by using them. Furthermore, the gap between the average human capital of the less developed country and that of the technology leaders, h_t/\bar{h}_t , acts as a technology adoption barrier (cf. Nelson and Phelps, 1966; Parente and Prescott, 1994).¹⁴

3 Dynamic behavior of the economy in general equilibrium

Combining our building blocks, we obtain the following dynamic system that describes our model economy in the low-growth regime:

$$A_{t+1} = \frac{h_t}{\bar{h}_t} \left(\frac{\bar{A}_t}{A_t} - 1 \right) A_t + A_t, \quad (22)$$

$$h_{t+1} = \bar{e}, \quad (23)$$

$$N_{t+1} = \frac{\gamma(\xi_m + \xi_f)}{2\xi_f\psi(1+\gamma)} N_t, \quad (24)$$

$$w_{t+1} = \left[\frac{2(1+\gamma)A_{t+1}X}{(\xi_m + \xi_f)h_{t+1}N_{t+1}} \right]^{1-\alpha}, \quad (25)$$

while the modern growth regime is characterized by

$$A_{t+1} = \frac{h_t}{\bar{h}_t} \left(\frac{\bar{A}_t}{A_t} - 1 \right) A_t + A_t, \quad (26)$$

$$h_{t+1} = \frac{\eta\delta\xi_f\psi\hat{w}_t - \gamma\bar{e}}{(\gamma - \delta)w_t} + \bar{e}, \quad (27)$$

$$N_{t+1} = \frac{(\gamma - \delta)(\xi_m + \xi_f)\hat{w}_t}{2(1+\gamma)(\xi_f\psi\hat{w}_t - \bar{e})} N_t, \quad (28)$$

$$w_{t+1} = \left[\frac{2(1+\gamma)A_{t+1}X}{(\xi_m + \xi_f)h_{t+1}N_{t+1}} \right]^{1-\alpha}. \quad (29)$$

¹⁴In case that education levels converge between less developed and developed countries, technological levels would also converge. In this case the less developed country would also become a technology leader in the very long run.

Note that the low-growth regime represents a locally stable steady-state equilibrium in which an economy is caught and cannot escape without technological progress that it imports from the rest of the world. In this sense the latent state variable that eventually induces a take-off is the stock of technologies in rich countries (cf. Galor and Weil, 2000, where the latent state variable is the population size). Consider now the development of the economy from some time t_0 onward, assuming that at t_0 the economy is in the low-growth regime. Specifically, we then have

$$h_{t_0} = \bar{e}; \quad n_{t_0} = \frac{\gamma(\xi_m + \xi_f)}{\xi_f \psi (1 + \gamma)}; \quad e_{t_0} = 0; \quad w_{t_0} = \left[\frac{2(1 + \gamma)A_{t_0}X}{(\xi_m + \xi_f)\bar{e}N_{t_0}} \right]^{1-\alpha} < \frac{\gamma}{\delta \xi_f \psi},$$

where the inequality implies $\hat{w}_{t_0} < \gamma \bar{e} / (\delta \xi_f \psi)$ and thus fertility is high and no education investments are undertaken. One sufficient condition for sustained economic development is the ongoing growth of wages due to international knowledge diffusion. Using Equation (20) we can calculate the growth rate of wages as

$$g_t := \frac{\hat{w}_{t+1}}{\hat{w}_t} - 1 = \left(\frac{h_{t+1}}{h_t} \right)^\alpha \left(\frac{A_{t+1}/A_t}{n_t/2} \right)^{1-\alpha} - 1, \quad (30)$$

where $A_{t+1}/A_t = \max \{ h_t / \bar{h}_t (\bar{A}_t / A_t - 1) + 1, 1 \}$. It is sufficient for sustained wage growth ($g_t > 0$) that $h_{t+1}/h_t \geq 1$, i.e., human capital is nondecreasing, and $A_{t+1}/A_t \geq n_t/2$, i.e., technological progress does not fall short of population growth, implying that the wage rate is nondecreasing. We can then derive the following more specific sufficient conditions for a transition from low growth to modern growth and for sustained economic growth in the very long run.

Proposition 3. *The following holds for the occurrence of a transition and for its sustainability, respectively:*

(i) *A transition from low growth to modern growth arises if*

$$\frac{A_{t+1}}{A_t} > \frac{\gamma(\xi_m + \xi_f)}{2\xi_f \psi (1 + \gamma)}, \quad (31)$$

with $A_{t+1}/A_t = \max \{ \bar{e}_t / \bar{h}_t (\bar{A}_t / A_t - 1) + 1, 1 \}$ up until the point of transition.

(ii) Sustained economic development in the very long run arises if

$$\ln \left(\frac{\eta \delta \xi_f \psi}{\gamma - \delta} \right) \geq \frac{1 - \alpha}{\alpha} \ln \left[\frac{(\gamma - \delta)(\xi_m + \xi_f)}{2(1 + \gamma)\xi_f \psi} \right]. \quad (32)$$

Proof. See Appendix A.

Within the low-growth regime the wage rate can only increase through a rising “base-line” wage per unit of human capital. This requires that technological progress A_{t+1}/A_t outweighs population growth $n_t/2$ under high fertility. Given that, realistically, $n_t/2 > 1$ in these economies, this requires that technological growth is positive and sufficiently strong as by condition (31). Assuming that technological growth abates in the very long run, wages continue to increase unambiguously if human capital continues to outgrow the population by a sufficient amount. Thus, considering the long-run limits of human capital growth given in Equation (12) and fertility given in Equation (6), we find the sufficient condition (32) for sustained long-run growth.¹⁵

We can now identify the role of female health in sustained growth and in a transition to a modern growth regime. To this end, assume that the transition takes place at $\tau \geq t_0 + 1$ and that technology growth $A_{t+1}/A_t \simeq \hat{A}$ is roughly constant over the interval $[t_0, \tau]$. Defining $\hat{w}_\tau = \gamma \bar{e}/(\delta \xi_f \psi)$ as the wage level at which the transition occurs and combining this with the initial wage level

$$\hat{w}_{t_0} = \bar{e}^\alpha \left[\frac{2(1 + \gamma)A_{t_0}X}{(\xi_m + \xi_f)N_{t_0}} \right]^{1-\alpha} \quad (33)$$

and with the growth rate in the low-growth regime

$$g = \left[\frac{2\hat{A}(1 + \gamma)\xi_f \psi}{\gamma(\xi_m + \xi_f)} \right]^{1-\alpha} - 1, \quad (34)$$

we can use the relationship $\hat{w}_\tau = (1 + g)^{\tau - t_0} \hat{w}_{t_0}$ to solve for the time to transition as a function of ξ_f and ξ_m

$$\Delta = \tau - t_0 = \frac{\ln \hat{w}_\tau - \ln \hat{w}_{t_0}}{\ln(1 + g)}.$$

¹⁵For a precipitous exogenous fall in the rate of technological progress immediately after the transition to the sustained growth regime, a fall back to the low-growth regime cannot be entirely ruled out. A closer investigation of this rather unrealistic case is available from the authors upon request.

We then obtain

$$\frac{\partial \Delta}{\partial \xi_f} = \frac{1}{\xi_f \ln(1+g)} \left[-1 + (1-\alpha) \frac{\xi_f}{\xi_m + \xi_f} - (1-\alpha) \Delta \frac{\xi_m}{\xi_m + \xi_f} \right] < 0, \quad (35)$$

$$\frac{\partial \Delta}{\partial \xi_m} = \frac{(1-\alpha)(1+\Delta)}{(\xi_m + \xi_f) \ln(1+g)} > 0, \quad (36)$$

which allows us to state our main result.

Proposition 4. *Better female (male) health, that is, a higher ξ_f (ξ_m)*

(i) leads to faster (slower) wage growth in the low-growth regime and in the long-run limit and

(ii) speeds up (slows down) the transition to modern growth.

Proof. Part (i) follows immediately when inserting the low-growth and limiting values of n_t [cf. Equations (4) and (6)] and the limiting value of h_{t+1}/h_t [cf. Equation (12)] into (30) and taking the appropriate derivatives with respect to ξ_f and ξ_m . Part (ii) follows immediately from Equations (35) and (36).

Economies with better female health tend to experience faster wage growth during the low-growth regime and in the long-run limit. This is because they tend to exhibit less downward pressure on the wage rate for an expanding population and greater accumulation of human capital in the modern growth regime. While greater wage growth in the low-growth regime suggests that economic transition is taking place earlier, this is not a foregone conclusion. The reason is that while wages grow faster within economies with healthy females [the last term in (35)] and while these economies enter the transition at a lower wage level [the first term in brackets in (35)], they are also starting at a lower wage level [the second term in (35)]. This is because greater female labor participation (or productivity) initially tends to depress wages. As it turns out, the economy with a healthier (and more productive) female labor force experiences economic take-off at an earlier time. We note from (35) that the impact of female health on the speed to transition decreases with the growth rate on the path to transition and increases with the time to transition. Finally, we note that the reduction in the transition threshold is a crucial factor. This is because when the time to transition is short, the impact of lower fertility on the growth rate is insufficient to offset the initial reduction in the wage rate.

All of this contrasts with the impact of male health which, by raising fertility, tends to slow the pace economic development. This is consistent with the empirical evidence provided by Schultz (1985) and Heckman and Walker (1990), which both show that fertility increases with male income. Indeed, male health impedes economic transition by lowering both the initial level of wages and its growth rate.

We show in Section 6 that our results are robust to extensions of the model taking account of collective household preferences, endogenous health investments, and physical capital in the production process.

4 Policy applications

From a development policy perspective, our main result in Proposition 4 implies that efforts toward health improvements should be targeted at women. Indeed, the model suggests that redistributing health from men to women may be beneficial. The following result shows, however, that such a policy would create a conflict with the interests of the unitary household in the short run. This argument abstracts from the justification of the redistribution of healthcare opportunities to women based on an unequal distribution biased against women to begin with (cf. the literature referenced in the introduction).

Proposition 5. *Consider a redistribution of health from men to women such that $d\xi_f = -d\xi_m > 0$.*

- (i) *Such a policy unambiguously raises economic growth rates throughout and speeds up the economic transition, but*
- (ii) *for any given wage, \widehat{w}_t , it unambiguously lowers household utility, both in the low-growth and in the modern growth regime.*

Proof. See Appendix A.

Thus, while enhancing economic growth and hastening economic transition, a redistribution of health also lowers household utility. This is true even when such a policy fosters educational investments in the modern growth regime or induces a transition. Indeed, this follows from a revealed preference argument: Noting from the budget constraint in Equation (2) that redistribution unambiguously lowers family income, it must be true that the household with

better male health could always mimic the allocation chosen by a household with better female health and thereby do at least as well. Any deviation in the allocation (i.e., the choice of more children) must then be associated with even greater utility. We realize that this result depends on the assumption of unitary household decision making and may well change in the presence of collective decision-making. This notwithstanding, it highlights the scope for a conflict between the short-term interests of utility-maximizing households, which may favor male health improvements, and the long-term interests of development policies that favor female health improvements.

In many instances, health policies are not targeted at particular individuals within the household. One may wonder then what the implications are for the pace of economic development if women and men both benefit equally from a particular health policy.

Proposition 6. *Consider an increase in the health of both sexes by a common factor $\lambda > 1$. Such a policy*

- (i) leaves the growth rate unaffected in the low-growth regime and raises the growth rate in the long-run limit and*
- (ii) speeds up the economic transition.*

Proof. See Appendix A.

Given the opposing effects of male and female health on growth and development it is unclear *a priori* whether health improvements that affect both sexes alike promote development. Indeed, to some extent this depends on the economic regime itself. While a proportional increase in the health of both males and females promotes growth by lowering fertility and raising education in the modern growth regime, this is not true in the low-growth regime. In the absence of educational investments, proportional health improvements do not reduce fertility and thereby leave the growth rate unaffected. This result echoes the finding of Cervellati and Sunde (2011) that the impact of health on economic growth depends on whether the demographic transition has occurred or not. According to their analysis, health improvements, as measured by increases in life expectancy, tend to reduce fertility after the demographic transition to the extent that population growth slows down and per capita income growth increases. Before the transition, however, health improvements raise life expectancy but do not reduce fertility, which may even increase slightly. Consequently, population growth increases,

which in turn compromises per capita income growth. Although the health effects in our model work through morbidity/productivity rather than mortality/life expectancy, the impact is very similar: In the presence of a quality-quantity trade-off, female health improvements raise educational investments, and the ensuing increase in the cost of child care is enough to offset the positive income effect of male health on fertility, which is unambiguously reduced. By contrast, before the transition, the income effect, calling for an increase in fertility, exactly cancels the effect from greater female opportunity cost. Whether fertility increases or decreases ultimately depends on the distribution of health gains in the household. Thus, it is easy to conceive that if males benefit to a larger extent, fertility does, indeed, increase. What our analysis also shows is that health improvements common to men and women do, however, facilitate a take-off toward sustained economic development, albeit more slowly.

5 Numerical analysis

We now illustrate the analytical results with a numerical example based on a parametrization for Sub-Saharan Africa (year 2012), as given in Table 1. Specifically, we consider two exercises: First, we examine the impact of gender-specific health on the time to transition, seeking to assess the size of the effect; second, we solve the dynamic system as given by Equations (22) to (29) numerically, seeking to assess the impact of gender-specific health on the overall development process.

To proxy the impact of health on labor participation, we use data from WHO (2016) on the years of healthy life lost due to disability (YLD) for Sub-Saharan Africa. Assuming that the life-span in which women face a trade-off between participating in the labor force and child-rearing stretches from age 15 to age 50,¹⁶ we employ the age-gender specific values $YLD_{f,15-29} = 0.10545$, $YLD_{f,30-49} = 0.149821$, $YLD_{m,15-29} = 0.093425$, and $YLD_{m,30-49} = 0.134035$ to calculate

$$\xi_j = \frac{15 \times (1 - YLD_{j,15-29}) + 20 \times (1 - YLD_{j,30-49})}{35}$$

for $j = f, m$. We then obtain $\xi_f = 0.8692$ and $\xi_m = 0.88337$ as the gender-specific shares of the 35 year's life-span between ages 15 and 50 that individuals spend in good health. The parameters δ , γ , and ψ , capturing preferences for education, the number of children, and the

¹⁶This reflects the notion that women give birth approximately during the age-interval 15-35 years and that children require care up to age 15.

time cost of children, respectively, have been chosen to match the total fertility rate [Equation (4)], female labor force participation, $\xi_f (1 - \psi n_t)$, for Sub-Saharan Africa in the year 2012, and an asymptotic fertility rate [Equation (6)] at the replacement level of 2 (reflecting a balanced sex ratio at birth and the absence of mortality). Using the calibrated values, we then set the parameter η so as to induce the long-run stationarity of human capital according to Equation (12). Finally, we set $\alpha = 2/3$ such that the long-run share of national income going to the production factor labor is roughly in line with the data and we normalize $\bar{e} = 1$. Consistent with the data on which we base our numerical example, we assume a period length of 35 years. Regarding the levels and growth rates of foreign human capital and technology we assume values that guarantee a takeoff toward the modern growth regime in the late 20th Century.

We use these values for the baseline scenario and then assess the impact of a 5 percent increase in female health, as measured by the share of healthy time, in Scenario 1. Similarly, we consider a 5 percent increase in male health in Scenario 2, and a 5 percent increase in the health of both sexes in Scenario 3. Note that a 5 percent increase in female health amounts to a reduction of the (average) time of 48 days per year spent in disability by some 16 days.

Table 1: Parameter values for simulation

Parameter	Value	Parameter	Value
δ	0.08715	α	2/3
γ	0.14322	g_h (foreign)	0.00% p.a.
ψ	0.04945	g_A (foreign)	3.67% p.a.
ξ_f	0.86920	ξ_m	0.88337
\bar{e}	1.000	η	14.9700
period length t	35 yrs.		

Table 2 presents for the baseline case and the three scenarios the pretransition outcomes in terms of fertility, female labor force participation, economic growth, and the time to transition. According to World Bank (2016) data for Sub-Saharan Africa in 2012, fertility is around 5.1 children per household, and female labor force participation amounts to 0.64964. Annual growth (averaged over the time span 1961 to 2012) is on the order of 0.789% and amounts to an almost stagnating economy.¹⁷ We assign a stock of land X such that the baseline economy reaches transition after 75 years, corresponding to the third model period.

¹⁷We assume for this experiment constant technology adoption of about 5.2% per year. In our subsequent numerical experiment, technology adoption is specified according to the flexible form of Equation (21), giving rise to an average on the same order.

The five percent improvement in female health (Scenario 1) leads to a reduction in fertility of 2.4 percent and to an increase in female labor participation of about 5.9 percent. As a consequence, the time to transition is reduced by 7 years and 2 months, which is enough to trigger a transition after two rather than three periods as in the baseline. By contrast, a five percent increase in male health (Scenario 2) raises the time to transition by 3 years and 5 months. Given our assumption of a period length of 35 years, this does not have a bearing on the simulated transition process (see below). Finally, a five percent improvement in the health of both sexes reduces the time to transition by 4 years and 2 months, which again is not enough to induce an earlier transition in the numerical example.

A period length of 35 years leads to rather extreme impacts of changes in health on the transition process as it is modeled. Relatively small differences in the latent time to transition (as for example the 3 years difference when comparing Scenarios 1 and 3) may either trigger no effect (as for Scenario 3) or a change in the timing of transition by 35 years (as for Scenario 1). In that regard, changes in the latent time to transition are a more realistic measure of the likely impact of health on the transition process. Moreover, a long period length is associated with a second problem: whether or not a health improvement advances or delays economic transition (by a generation) is very sensitive to the level of the initial wage \hat{w}_{t_0} and therefore depends crucially on the assumptions about the initial state of the economy.

In light of these concerns we can arrive at a more robust statement about the role of health for economic take-off by considering the following stochastic setting. Suppose the initial conditions of the economy $\{A_{t_0}, N_{t_0}, X\}$ are randomly drawn from a set of values G so that they generate an initial wage $\hat{w}_{t_0}^b \in [\underline{w}^b, \bar{w}^b]$ for which transition arises after three periods (and three periods only) in the baseline scenario (b).¹⁸ Clearly, the range of initial wages $[\underline{w}^1, \bar{w}^1]$ for which transition arises after 3 periods in Scenario 1 satisfies $\underline{w}^1 < \underline{w}^b$ and $\bar{w}^1 < \bar{w}^b$ (i.e., the range is shifted “downward”). Intuitively this is due to the fact that better female health reduces the threshold wage for economic take-off.

Furthermore, for any given $\{A_{t_0}, N_{t_0}, X\} \in G$, the initial wage in Scenario 1 will satisfy $\hat{w}_{t_0}^1 \in [(\hat{w}_{t_0}^1/\hat{w}_{t_0}^b)\underline{w}^b, (\hat{w}_{t_0}^1/\hat{w}_{t_0}^b)\bar{w}^b]$ with $\hat{w}_{t_0}^1/\hat{w}_{t_0}^b < 1$. This is because of the greater effective labor supply associated with better female health in Scenario 1. Nevertheless, an interval

¹⁸More specifically, $\underline{w}^b := \gamma\bar{e}/[\delta\psi\xi_f^b(1+g^b)^3]$ and $\bar{w}^b := \gamma\bar{e}/[\delta\psi\xi_f^b(1+g^b)^2]$ with g^b as defined by Equation (34). Thus, the lower (upper) bound corresponds to the baseline threshold wage discounted by the growth over three (two) periods. If $\hat{w}_{t_0}^b < \underline{w}^b$, the transition would occur after four periods; if $\hat{w}_{t_0}^b > \bar{w}^b$, the transition would occur after two periods.

exists $[\bar{w}^1, (\hat{w}_{t_0}^1/\hat{w}_{t_0}^b) \bar{w}^b]$ such that a draw $\hat{w}_{t_0}^1 \in [\bar{w}^1, (\hat{w}_{t_0}^1/\hat{w}_{t_0}^b) \bar{w}^b]$ will induce a transition after three periods in the baseline case but a transition after two periods in Scenario 1. The probability of such a draw, $\pi_{b1} = [(\hat{w}_{t_0}^1/\hat{w}_{t_0}^b) \bar{w}^b - \bar{w}^1] [(\hat{w}_{t_0}^1/\hat{w}_{t_0}^b) (\bar{w}^b - \underline{w}^b)]^{-1}$, can now be read as the probability that the improvement in female health in Scenario 1 advances the economic transition by one period (i.e., by 35 years). For our numerical example we obtain $\pi_{b1} = 0.188$, which is of sizable magnitude.¹⁹

Table 2: Impact of health on pretransition outcomes and time to take-off

	Baseline	Scenario 1	Scenario 2	Scenario 3
Health parameters				
ξ_f	0.86920	0.91266	0.86920	0.91266
ξ_m	0.88337	0.88337	0.92754	0.92754
Pretransition outcomes				
Fertility n	5.1081	4.9855	5.2369	5.1081
Participation $\xi_f (1 - \psi n)$	0.64964	0.68766	0.64411	0.68212
yearly growth rate g	0.00789	0.00812	0.00765	0.00789
Time to transition (yrs.)	75	67.834	78.421	70.861
Yrs. gained on baseline	—	7.166	−3.421	4.139

In our second exercise, we graph the development paths for human capital, population, and income, embracing both pre- and post-transition periods. The impact of female health improvements is shown in Figure 1. The solid blue line refers to the baseline case, whereas the dashed red line refers to Scenario 1, i.e., an economy that experienced at the initial time (1900) a 5 percent increase in female healthy time.

Both economies start with the same population size, the same state of technology, and the same land endowment. They follow the same path until around the year 1970 when they are still in a low-growth regime without the accumulation of human capital [see panel b)] and very sluggish income growth [see panel f)]. The sole reason that wages grow at all is that the technological frontier in the rest of the world grows at a constant rate such that the distance to the frontier increases, leading to more intense technology adoption (cf. Howitt, 2000; Acemoglu et al., 2006). At the point of take-off (for the baseline scenario this is the year 2005 and for

¹⁹Similarly, we obtain $\pi_{b3} = 0.116$ as the probability that an equiproportional increase of health for both genders advances economic take-off by one generation, and (in an analogous way) we obtain $\pi_{b2} = 0.114$ as the probability that an improvement in male health delays take-off by one generation.

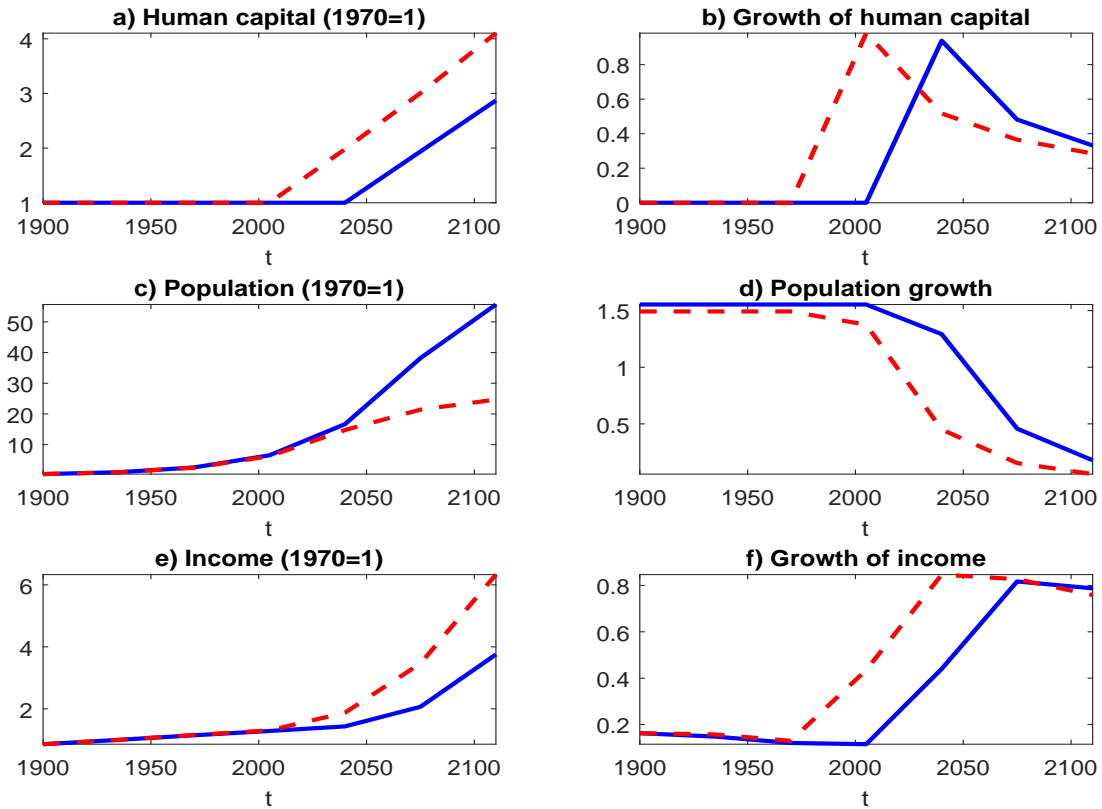


Figure 1: Illustration of the differential take-off in Scenario 1. The baseline simulation is reflected by the solid blue line. The dashed red line refers to a simulation with similar parameter values except that female health increases by 5 percent as compared with the baseline simulation.

Scenario 1 this is the year 1970), per capita income surpasses the value at which it becomes optimal for individuals to invest in the education of their offspring. From then on parents choose to have fewer children but to educate them better. Consequently, a fertility transition sets in and the rate of population growth declines [see panel d)]. The resulting increase in human capital helps to close the gap between the human capital level of the country under consideration and the rest of the world. This in turn leads to faster technology adoption and an increase of per capita income growth [see panels e) and f)].

In comparison with the baseline scenario we see that the benefits from female health improvements materialize only over time, but then in an accelerating way. This is due to diverging growth rates of human capital and income in the modern growth regime, implying that an initial advantage is magnified. Interestingly, little perceivable difference exists between the two economies in the “immediate” aftermath of the early transition (i.e., over the years 1970–2005). Thus, female health improvements appear to create only a small initial advantage in terms of slightly higher growth rates at a slightly earlier point in time, but this effect is vastly magnified

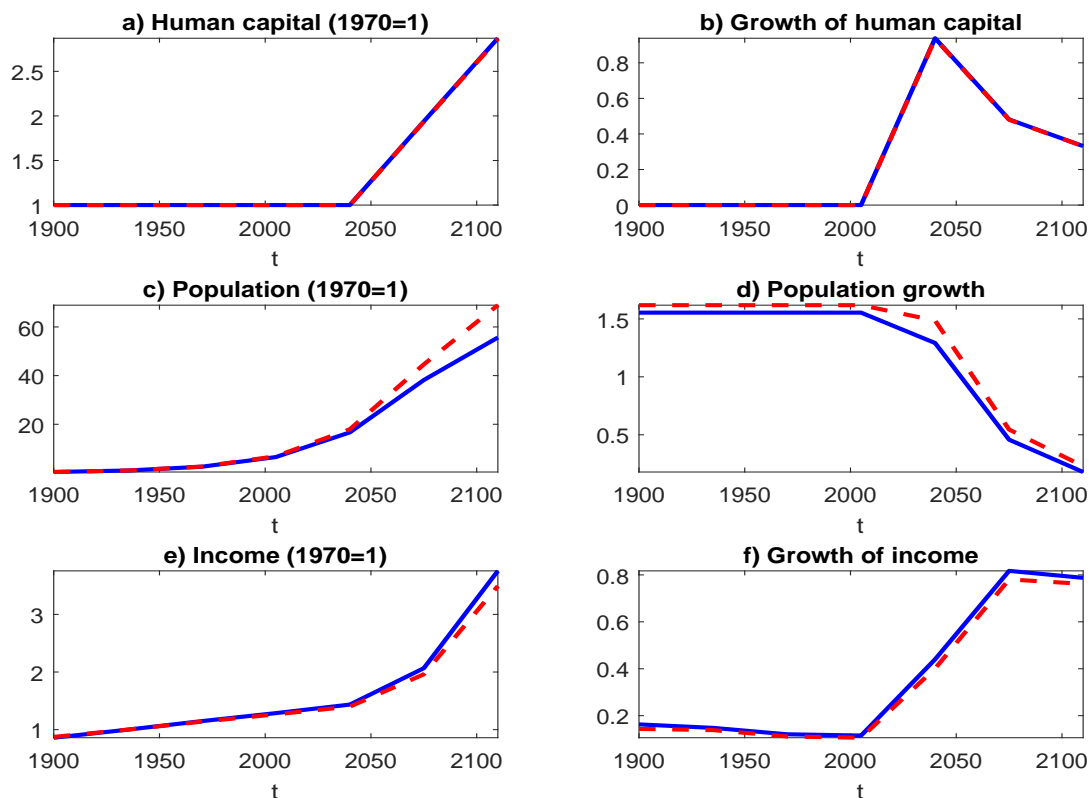


Figure 2: Illustration of the differential take-off in Scenario 2. The baseline simulation is reflected by the solid blue line. The dashed red line refers to a simulation with similar parameter values except that male health increases by 5 percent point as compared with the baseline simulation.

over the subsequent 70 years.

In Figure 2 we hold female health constant and simulate an increase in male health by 5 percent (Scenario 2). In this case, both economies take off in the year 2005. Nevertheless, even under the modern growth regime, the higher fertility level in Scenario 2 places a drag on income growth and the growth of human capital, causing these economies to also diverge (slightly). Finally, in Figure 3, we present the results of an equiproportional increase in health of both sexes (Scenario 3). Both economies experience the take-off in the year 2005 and the difference in post-transition growth rates is rather limited. This implies that these economies do not follow dramatically divergent development paths.

We should mention that the path of development is not invariant to the sequencing of events. If female health is improved earlier (later) than male health, the economy ends up on a higher (lower) income trajectory. This suggests that targeted health interventions for women are more effective for economic development the earlier they occur, conferring substantial cumulative

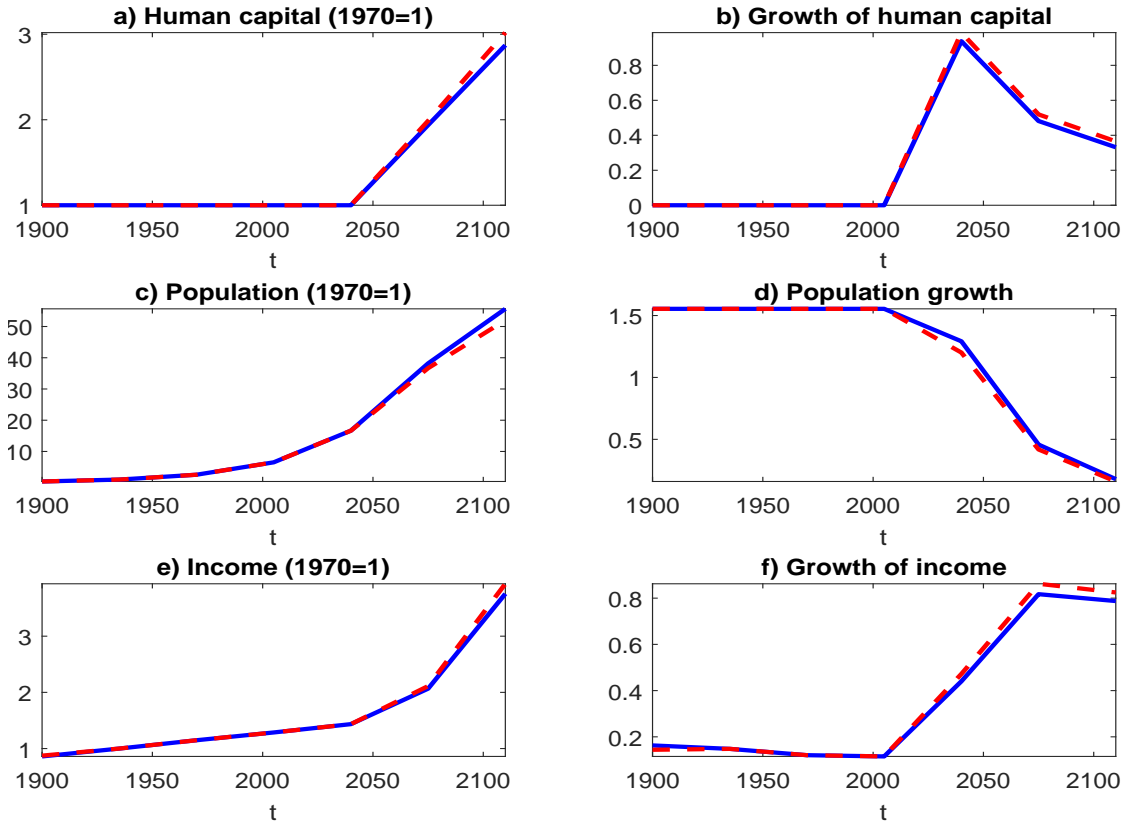


Figure 3: Illustration of the differential take-off in Scenario 3. The baseline simulation is reflected by the solid blue line. The dashed red line refers to a simulation with similar parameter values except that health increases equiproportionally by 5 percent point for males and females as compared with the baseline simulation.

benefits that would not be realized if intervention was delayed.

6 Extensions and robustness of the results

In this section we investigate three extensions of the model and analyze whether our results are robust to these alternative specifications. Subsection 6.1 relaxes the assumption of unitary household preferences in favor of collective preferences, Subsection 6.2 analyzes the implications of endogenous investments in health, and Subsection 6.3 sheds light on the effects of physical capital accumulation and foreign direct investment (FDI).

6.1 Collective household preferences

Frequent arguments hold that household allocations are (empirically) better represented by models of collective rather than unitary preferences.²⁰ To illustrate the robustness of our main results, this section derives the allocation under collective household preferences and sketches out the implications of (female) health improvements. Thus, consider collective preferences of the form

$$u = \widehat{\theta} [\log(c_t^m) + \gamma_m \log(n_t) + \delta_m \log(\bar{e} + e_t)] + (1 - \widehat{\theta}) \left[\log(c_t^f) + \gamma_f \log(n_t) + \delta_f \log(\bar{e} + e_t) \right], \quad (37)$$

according to which each partner $j = m, f$ derives utility from private consumption c_t^j and from the number of children and their education, the latter two being public goods within the household. The distribution function of bargaining power $\widehat{\theta} = \theta(\xi_m, \xi_f)$ is assumed to depend on the distribution of health. This can be viewed as a reduced form of the more common representation, in which $\widehat{\theta}$ depends on the income distribution within the household. Naturally, we have $\partial\theta/\partial\xi_m = \theta_m \geq 0 \geq \theta_f = \partial\theta/\partial\xi_f$, implying that better female (male) health tends to increase (decrease) women's bargaining power. We allow that partners differ in their preferences over children and their education. Similar to Rees and Riezman (2012) we follow empirical evidence that men tend to have a stronger preference for private consumption and the number of children as opposed to education (see e.g. Schultz, 1990; Thomas, 1990) such that we assume $\delta_m < \delta_f \leq \gamma_f \leq \gamma_m$. Solving the utility maximization problem subject to the original budget constraint in Equation (2) we obtain

$$c_t^m = \frac{\widehat{\theta}(\xi_m + \xi_f)\widehat{w}_t}{1 + \widehat{\gamma}}; \quad c_t^f = \frac{(1 - \widehat{\theta})(\xi_m + \xi_f)\widehat{w}_t}{1 + \widehat{\gamma}} \quad (38)$$

²⁰See Browning and Chiappori (1998) for a general characterization and de la Croix and Vander Donckt (2010), Rees and Riezman (2012), and Prettnner and Strulik (2016) for applications to the economic-demographic transition.

for male and female consumption and

$$n_t = \begin{cases} \frac{\widehat{\gamma}(\xi_m + \xi_f)}{\xi_f \psi (1 + \widehat{\gamma})} & \text{for } \widehat{w}_t \leq \frac{\widehat{\gamma} \bar{e}}{\delta \xi_f \psi}, \\ \frac{(\widehat{\gamma} - \widehat{\delta})(\xi_m + \xi_f) \widehat{w}_t}{(1 + \widehat{\gamma})(\xi_f \psi \widehat{w}_t - \bar{e})} & \text{otherwise,} \end{cases} \quad (39)$$

$$e_t = \begin{cases} 0 & \text{for } \widehat{w}_t \leq \frac{\widehat{\gamma} \bar{e}}{\delta \xi_f \psi}, \\ \frac{\delta \xi_f \psi \widehat{w}_t - \widehat{\gamma} \bar{e}}{\widehat{\gamma} - \widehat{\delta}} & \text{otherwise,} \end{cases} \quad (40)$$

for fertility and education with $\widehat{\gamma} = \widehat{\theta} \gamma_m + (1 - \widehat{\theta}) \gamma_f$ and $\widehat{\delta} = \widehat{\theta} \delta_m + (1 - \widehat{\theta}) \delta_f$, respectively. Thus, the allocation follows the same principles as for the unitary household, the only differences being that (i) aggregate household consumption c_t is now split according to the distribution rule and (ii) fertility and education as household public goods now depend on the weighted sums $\widehat{\gamma}$ and $\widehat{\delta}$ of individual preferences. Noting that $\text{sgn}(\partial \widehat{\gamma} / \partial \xi_j) = \text{sgn}[(\gamma_m - \gamma_f) \theta_j] = \text{sgn}(\theta_j)$ and $\text{sgn}(\partial \widehat{\delta} / \partial \xi_j) = [(\delta_m - \delta_f) \theta_j] = -\text{sgn}(\theta_j)$, deriving the following result is straightforward.

Proposition 7. *Given the wage rate \widehat{w}_t ,*

- (i) *aggregate consumption at the household level increases with female health (ξ_f), but responds ambiguously to male health (ξ_m);*
- (ii) *fertility increases (decreases) with male (female) health both in the low-growth and in the modern growth regime and in the long-run limit;*
- (iii) *educational investments in the modern growth regime increase (decrease) with female (male) health;*
- (iv) *the transition threshold decreases (increases) with female (male) health.*

The direct impact of health on the household's choices is now modified by the impact of health on the household distribution of bargaining power. For female (male) health improvements this implies that the preference weight on the number of children is reduced (increased), whereas the weight on education is increased (reduced). In most cases this simply leads to a reinforcement of the effects found for the unitary household model. In particular, female health improvements tend to lower fertility and raise education (in the modern regime) both directly and through the greater emphasis on education rather than the number of children in household decision making. But two notable changes occur: First, male health improvements now have

an ambiguous impact on household consumption. This is because the positive income effect is offset by a greater emphasis on fertility. Second, in the modern growth regime, male health now has a negative impact on education, because of the lower weight on education in household decision making.

The implications for the process of economic development follow in a straightforward way. Note first that the threshold for economic development $[\widehat{\gamma}\bar{e}/(\widehat{\delta}\xi_f\psi)]$ unambiguously decreases with female health. This occurs both directly and indirectly through the shift in household preferences toward the quality rather than the quantity of children. Furthermore, the economic growth rates both in the low-growth and modern growth regimes increase with female health due to the reduction in fertility. The converse applies to male health, where the transition threshold itself now increases with male health. It then follows by analogy to Proposition 4 that improvements in female (male) health unambiguously hasten (slow) the process of economic take-off.²¹

6.2 Endogenous health

Consider a setting in which male and female health depend on gender-specific investments in health improvements. We conceptualize this by modifying the budget constraint to

$$\xi_{m,t}\widehat{w}_t + \xi_{f,t}\widehat{w}_t(1 - \psi n_t) = c_t + e_t n_t - (i_m + i_f), \quad (41)$$

where health-dependent participation $\xi_{j,t} = \bar{\xi}_j + \widehat{\xi}_j(i_{j,t})$ for $j = f, m$ is now composed of an exogenous part $\bar{\xi}_j$ and a part $\widehat{\xi}_j(i_{j,t})$ that is amenable to health investments $i_{j,t}$. We also assume $\widehat{\xi}'_j(i_{j,t}) \geq 0$ and $\widehat{\xi}''_j(i_{j,t}) \leq 0$ for $j = f, m$.²² Maximizing utility as given by the original utility function (1) subject to the budget constraint (41) we obtain household consumption as

$$c_t = \frac{(\xi_{m,t} + \xi_{f,t})\widehat{w}_t - i_{m,t} - i_{f,t}}{1 + \gamma}, \quad (42)$$

²¹A proof is available from the authors on request.

²²Obviously, we need to impose $\bar{\xi}_j + \widehat{\xi}_j(i_{j,t}) \in [0, 1]$ for all $\bar{\xi}_j$ and $i_{j,t}$. This is satisfied, for instance, for the function $\widehat{\xi}_j(i_{j,t}) = z_j i_{j,t} / (1 + i_{j,t})$ with $\bar{\xi}_j, z_j \geq 0$ and $\bar{\xi}_j + z_j \leq 1$.

and fertility and education as, respectively,

$$n_t = \begin{cases} \frac{\gamma(\xi_{m,t} + \xi_{f,t})\widehat{w}_t - i_{m,t} - i_{f,t}}{\xi_{f,t}\widehat{w}_t\psi(1+\gamma)} & \text{for } \widehat{w}_t \leq \frac{\gamma\bar{e}}{\delta\xi_{f,t}\psi}, \\ \frac{(\gamma-\delta)(\xi_{m,t} + \xi_{f,t})\widehat{w}_t - i_{m,t} - i_{f,t}}{(1+\gamma)(\xi_{f,t}\psi\widehat{w}_t - \bar{e})} & \text{otherwise,} \end{cases} \quad (43)$$

$$e_t = \begin{cases} 0 & \text{for } \widehat{w}_t \leq \frac{\gamma\bar{e}}{\delta\xi_{f,t}\psi}, \\ \frac{\delta\xi_{f,t}\psi\widehat{w}_t - \gamma\bar{e}}{\gamma-\delta} & \text{otherwise.} \end{cases} \quad (44)$$

In addition, we find the optimal health investments described by $\widehat{\xi}_m'(i_{m,t})\widehat{w}_t = 1$ and $\widehat{\xi}_f'(i_{f,t})\widehat{w}_t(1 - \psi n_t) = 1$, according to which the marginal return in terms of greater earnings is equilibrated with the marginal unit of investment ($=1$). From the first-order conditions we obtain the following result.

Proposition 8. *For a gender-neutral health production function $\widehat{\xi}_m(i) = \widehat{\xi}_f(i)$, it is optimal for the household to invest more in male health if $n_t > 0$.*

The result follows in a straightforward way as the returns to health investments in terms of additional household earnings are greater for men than they are for women due to their lower rate of labor participation. Notably, this finding provides a productivity-based explanation for why women are discriminated against in terms of health investments (cf. the references in footnote 4), i.e., it does not rely on a preference bias against women.

Consumption and fertility now depend on the optimal health investments in men and women, while education depends on the optimal health investments in women. This additional channel implies that, in contrast to the baseline model, the fertility rate now depends on the wage rate. The same applies to the transition threshold, which depends on the wage rate through changes in female health investments. The following can be shown:²³

Lemma 1. *(i) Male health investments increase with the wage rate, $\partial i_{m,t}/\partial \widehat{w}_t > 0$. (ii) Ceteris paribus, female health investments decrease with fertility, $\partial i_{f,t}/\partial n_t < 0$, and increase with the wage rate, $\partial i_{f,t}/\partial \widehat{w}_t > 0$. (iii) If $\gamma < \xi_{f,t}/\xi_{m,t}$, female health investments increase with the wage rate when taking into account the optimal fertility response, $di_{f,t}/d\widehat{w}_t = \partial i_{f,t}/\partial \widehat{w}_t + (\partial i_{f,t}/\partial n_t)(dn_t/d\widehat{w}_t) > 0$.*

While the positive impact of the wage rate on the incentive to invest in male health is readily apparent, for women this is not entirely clear, because fertility itself now responds to

²³Proofs of Lemma 1 and the subsequent Proposition 9 are available from the authors on request.

wages and may, indeed, increase with the wage rate. This notwithstanding, it can be shown that as long as women participate in the labor market (as is implied by $\gamma < \xi_{f,t}/\xi_{m,t}$), female health investments respond positively to an increase in the wage rate.²⁴

With these dependencies settled, it is straightforward to see that exogenous changes to health essentially have the same impact on the household allocation and the process of economic development as in the model without endogenous health investments. Consider an exogenous increase in female health. While this has no impact on male health investments, the reduction in fertility triggers complementary female health investments, $di_{f,t}/d\bar{\xi}_f > 0$. Overall, this magnifies the impact of female health on economic growth and the speed toward economic take-off. However, by raising fertility, an exogenous increase in male health depresses female health investments, $di_{f,t}/d\bar{\xi}_m < 0$, implying even lower wage growth and a greater delay in reaching transition.

We conclude this extension by noting that endogenous health investments tend to accelerate or dampen the process toward economic transition. Thus, considering an economy that at time t_0 has not yet reached the point of economic take-off, i.e., $\hat{w}_{t_0} < \gamma\bar{e}/(\delta\xi_{f,t_0}\psi)$, and defining $\varepsilon_t = \varepsilon(\xi_{f,t}, i_{f,t}) \times \varepsilon(i_{f,t}, \hat{w}_t)$ as the product of the elasticity of female health with respect to health investments, $\varepsilon(\xi_{f,t}, i_{f,t}) = \hat{\xi}'_f i_{f,t}/\xi_{f,t}$, and the (partial) elasticity of female health investments with respect to the wage rate $\varepsilon(i_{f,t}, \hat{w}_t) = (\partial i_{f,t}/\partial \hat{w}_t)(\hat{w}_t/i_{f,t})$, we propose the following.

Proposition 9. *The following holds for the low-growth (pretransition) regime $t \in [t_0, \tau]$:*

- (i) *Fertility decreases with the wage rate if $\varepsilon_t \geq (i_{m,t} + i_{f,t})/c_t$ holds for $t \in [t_0, \tau]$.*
- (ii) *If this is true, then for any given $\hat{A} = A_{t+1}/A_t > n_{t_0}/2$, the economy accelerates toward an earlier transition.*

We only provide the intuition here (a formal proof is available upon request). According to (i), the impact of a wage increase on fertility is ambiguous. This is unsurprising because both male and female health investments increase with the wage rate. While the former drives up fertility, the latter tends to depress it. If, and only if, the impact of the wage increase on female health, as measured by the compound elasticity ε_t , is sufficiently strong, does fertility

²⁴Note that the equilibrium wage is now only implicitly defined by $\hat{w}_t = h_t^\alpha \{2(1 + \gamma)\hat{w}_t A_t X/N_t [(\xi_{m,t} + \xi_{f,t})\hat{w}_t - (i_{m,t} + i_{f,t})]\}^{1-\alpha}$. Verifying that this equation has a unique solution at $\hat{w}_t \in (0, 1)$ is straightforward.

decrease with the wage rate. This is more likely the lower aggregate health investments are in relation to consumption. An underdeveloped economy for which technology growth exceeds initial population growth such that wages grow at $g_t > 0$ [cf. Equation (30)] will then accelerate toward the point of take-off, τ . This is because health improvements (for males and females) along the development path ultimately work toward a reduction in fertility, which in turn boosts wage growth. In addition, the improvement in female health over time continues to lower the transition threshold, implying a further advance of the time of take-off. Conversely, if female health responds poorly to the wage rate, health improvements along the development path may increase fertility and, thereby, slow the transition process.

It is worth mentioning at this point that this extension can be rewritten to cover gender-specific educational investments instead of gender-specific health investments. In this case the basic argument would not change.

It is often argued that utility itself depends on health (see for example Grossman, 1972; Ehrlich and Chuma, 1990; Hall and Jones, 2007; Bloom et al., 2014b; Dalgaard and Strulik, 2014; Kuhn et al., 2015). We could capture some aspects of the utility-enhancing effect of health investments by adding a term to the utility function that increases with the gender-specific health levels. In the absence of cross-effects with the marginal utility of consumption, fertility, and/or educational investments, this would have no impact on our results. The presence of cross-effects in the utility function would, however, certainly complicate the interactions between health investments and the other endogenous variables. While there is no reason to think that it would change our central results, the explicit modeling of this would be complicated beyond the point of analytical tractability.

6.3 Physical capital and FDI

We follow Galor and Weil (2000) in disregarding physical capital as an input in production [cf. Equation (13)]. Indeed, we believe the assumption that most households do not hold substantial amounts of wealth is reasonable for developing countries. While capital may play a role in the production process, such capital is then predominantly owned either by a small class of capitalists within the country or by foreign investors. Focusing on the latter, however, shows an interesting relationship between (productivity-related) health improvements within a developing economy and FDI.²⁵

²⁵Considering a fully-fledged multi-country open economy framework that allows for a detailed analysis of capital and trade flows would complicate the model considerably. For the sake of clarity, we therefore restrict

We can examine this in a straightforward way by considering a production function

$$Y_t = H_{t,Y}^\alpha (A_t X_t)^{1-\alpha},$$

where X_t is now the supply of physical capital in period t .²⁶ Assuming that the price of capital is equal to the world-market interest rate, r , and that inputs are paid according to their marginal product, we then obtain immediately

$$X_t = \left[\frac{(1-\alpha) A_t^{1-\alpha}}{r} \right]^{\frac{1}{\alpha}} H_{t,Y} = \left[\frac{(1-\alpha) A_t^{1-\alpha}}{r} \right]^{\frac{1}{\alpha}} h_t [\xi_m + \xi_f (1 - \psi n_t)] \frac{N_t}{2}$$

as the stock of physical capital. Assuming for the sake of simplicity that capital does not depreciate, we obtain a growth rate of capital equal to

$$g_t^X = \frac{X_{t+1}}{X_t} - 1 = \hat{A}^{\frac{1-\alpha}{\alpha}} \frac{h_{t+1}}{h_t} \cdot \frac{n_t}{2} \cdot \frac{\xi_m + \xi_f (1 - \psi n_{t+1})}{\xi_m + \xi_f (1 - \psi n_t)} - 1.$$

For the case of pretransition growth, where $h_{t+1} = h_t = \bar{e}$ and $n_{t+1} = n_t$, these expressions simplify to

$$X_t = \left[\frac{(1-\alpha) A_t^{1-\alpha}}{r} \right]^{\frac{1}{\alpha}} \frac{\gamma(\xi_m + \xi_f) N_t}{1 + \gamma} \frac{1}{2},$$

$$g_t^X = \hat{A}^{\frac{1-\alpha}{\alpha}} \frac{n_t}{2} = \hat{A}^{\frac{1-\alpha}{\alpha}} \frac{\gamma(\xi_m + \xi_f)}{2\xi_f\psi(1 + \gamma)}.$$

The following is then easily verified.²⁷

Proposition 10. *For the low-growth (pretransition) regime $t \in [t_0, \tau]$, it holds that*

- (i) *the level of capital (FDI) in each period increases with both female health (ξ_f) and male health (ξ_m);*
- (ii) *the growth rate of capital (the growth rate of FDI), increases with male health, but decreases with female health.*

By increasing effective labor supply, better health, regardless of whether it is enjoyed by

ourselves to sketching out the main channels by which health might affect FDI flows in this section.

²⁶We realize that this interpretation of our production function implies that technical change A_t is capital augmenting. However, for our purposes this is not a crucial assumption. In fact, any specification $Y_t = A_t^\beta H_{t,Y}^\alpha X_t^{1-\alpha}$ with $\beta > 0$ would lead to a similar outcome.

²⁷Note that a low-growth regime obtains if the wage rate reported in Equation (45) is sufficiently low. This is always true for A_t being sufficiently low.

females or males, raises the marginal product of capital and, therefore, triggers a greater investment level. This result is consistent with the empirical findings of Alsan et al. (2006). Before the transition, the growth rate of the capital stock is determined by the rate of technological progress within a developing country and the rate of population growth. Thus, unsurprisingly, the absolute rate of capital growth increases with male health but decreases with female health. Given $\widehat{A} > 1$, the same holds for the per capita rate of capital growth. Thus, in contrast to many of our earlier findings, female health improvements compromise capital accumulation in the pre-transition regime.

In a world in which the returns to capital do not contribute to the income of the population under study (because they accrue abroad or to a population of negligible size) the measure to focus on is the full wage rate, which in the model with capital is given by

$$\widehat{w}_t = h_t w_t = h_t \alpha \left[\frac{(1 - \alpha) A_t^{1-\alpha}}{r} \right]^{\frac{1-\alpha}{\alpha}}. \quad (45)$$

Accordingly, wage growth follows as

$$g_t^w = \frac{\widehat{w}_{t+1}}{\widehat{w}_t} - 1 = \frac{h_{t+1}}{h_t} \widehat{A}^{\frac{(1-\alpha)^2}{\alpha}}.$$

Noting that $h_{t+1} = h_t = \bar{e}$ before the transition and recalling Equation (12), the following is then easy to verify.

Proposition 11. *As long as households do not receive capital income,*

- (i) *male health (ξ_m) has no impact on the growth and level of wages both before the transition and in the long-run limit;*
- (ii) *female health (ξ_f) has no impact on the growth and level of wages before the transition but enhances them in the long-run limit; furthermore, it speeds up the economic transition.*

Thus, in the presence of externally held capital, male health loses its role in the development process up to the economic transition. This result may come as a surprise, given that health has an impact on the process of capital accumulation. With the wage rate now determined exclusively by the state of technology and the international interest rate, it does not affect the development process as long as most households do not participate in the growing returns to capital. After the transition, male health improvements slow the process of wage growth by

stifling human capital growth although this effect vanishes in the long-run limit. Similarly, female health has no impact on the level and growth of wages before the transition takes place. Nevertheless, by lowering the transition threshold, it still contributes to acceleration of the economic take-off. By increasing the accumulation of human capital after the transition, female health continues to contribute to economic growth even in the long-run.²⁸

7 Discussion and conclusions

We have studied the impact of productivity- and earnings-enhancing female versus male health investments within a dynamic general equilibrium model of economic development with endogenous consumption, education, and fertility. We solved the model and studied the conditions under which the economy switches from a low-growth regime with high fertility and no educational investments to a modern growth regime with declining fertility and increasing educational investments. By raising female labor participation/productivity and thus the opportunity cost of children, greater female health has a direct negative impact on fertility. While this moderately enhances earnings growth during the low-growth phase, which is otherwise driven by technology adoption, it also has important level effects: on the one hand, it lowers the earnings threshold that must be met to initiate educational and demographic transitions; on the other hand, it lowers the wage level by increasing aggregate labor supply. As it turns out, however, starting from the same initial condition, an economy with better female health will always take off at an earlier date. In contrast, by raising income at the household level, male health improvements tend to increase fertility and thereby slow growth, the progress toward demographic and economic transition, and the resulting economic take-off. These analytical results are reflected in our numerical analysis as well.

From a development policy perspective, a case exists for health improvements to be targeted at women (e.g., by reducing iodine deficiency or vaccinating against the human papilloma virus). While this may also be justified on intra-household equity grounds, male health improvements are more effective in promoting household utility in the short run. This is because in societies in which males supply a greater share of their time to the labor market, household income increases by more if men rather than women benefit from a health-related increase in their earnings. Thus, a conflict may exist between the short-term interests of the household with a

²⁸We should caution, of course, that at some point after the transition, households would participate in the accumulation of capital, implying a change in the mechanics of growth before the long-run limit.

stronger emphasis on male health and long-term development goals with a stronger emphasis on female health. When health improvements benefit both sexes alike, growth is only promoted when an economic-demographic transition has already taken place. Only then will the increase in educational investments associated with better female health lead to an increase in the cost of children that overcompensates for the positive income effect on fertility. Nevertheless, economic take-off is still sped up as long as health improvements are not disproportionately enjoyed by men. Our main conclusion, that female health is more conducive to economic development than male health, is robust with respect to the introduction of collective rather than unitary household preferences, the endogeneity of health investments within the household, and the inclusion of physical capital in the production function (FDI).

To keep the model analytically tractable and for the sake of clarity, we abstracted from several issues that would increase the realism of the model. Apart from collective household preferences, endogenous health investments, and FDI, for which we showed that our results are robust with respect to their inclusion, additional extensions may take into account that i) utility itself depends on health; ii) reductions in fertility bring about endogenous increases in maternal health; iii) politically, socially, and institutionally motivated gender-specific discrimination may exist; iv) better male and female health comes with positive spillover effects on other household members, contemporaneously and over time; v) in the long run, the quality versus quantity preferences might be endogenous to economic development; vi) health interventions do not only reduce morbidity but also mortality; and vii) educational investments may differ according to gender. However, we have no reason to believe that relaxing the model's assumptions to incorporate those aspects would invalidate any of our results. Additional utility from health would raise the benefits of health investments on top of their effect on economic development, while maternal health improvements due to reductions in fertility would reinforce our results. We do not consider discrimination against women in the labor market or within the household but find that discrimination against women in terms of health may result from the maximization of net household income. We do not wish to imply that we perceive such an outcome to be desirable, or that preference-based discrimination against women is not an issue. But taking into account additional sources of discrimination would only strengthen our arguments unless it is so severe that it prevents female labor force participation altogether. Positive spillover effects of gender-specific health on other household members would change the results only if the spillover effects of male health were greater than the spillover effects of female health,

which is unlikely. Considering an endogenous evolution of preferences toward a higher quality of children as opposed to higher quantity would speed up the transition and reinforce the mechanisms outlined above. Finally, even if undertaken by parents, gender-specific investments in education can be shown to follow a similar trade-off as the gender-specific health investments we examined in section 6.2. In particular, investments in female education tend to increase in female health and decline in male health. As we have shown in Proposition 9, such a mechanism would strengthen our results.

One last limitation of our model is that it only examines the impact on labor participation, productivity, and economic growth of variations in morbidity (as opposed to mortality). While such a channel has been identified as empirically relevant (e.g., Field et al., 2009), it is by no means the only one. As Jayachandran and Lleras-Muney (2009) and Albanesi and Olivetti (2014) show, reductions in maternal mortality also serve as a trigger for economic development by fostering investments in female education, which ultimately translate into greater labor participation and lower fertility. An examination of this channel would call for an extension of our model to incorporate gender-specific educational investments. While such modeling may provide further insights, we speculate that this would not alter dramatically the mechanics or the results. To some extent, the sole effect of reductions in maternal mortality is to alter the sequence of events: In this case, investments in female education increase before female labor participation increases. By contrast, in our case, reductions in morbidity trigger greater female participation before they trigger greater educational investments. In both cases, however, the joint increase in education and participation comes with a reduction in fertility, which sets off the virtuous cycle of development. That said, reductions in male mortality may also turn out to be conducive to economic development. As Soares and Falcão (2008) show, greater educational investments in children with higher life expectancy, regardless of their gender, trigger a fertility decline. However, this does not contradict our finding that by raising the opportunity cost of children, female health improvements exert additional leverage on economic development.

Altogether, we believe that our theoretical framework could provide guidance on household-level empirical analyses with respect to the relations between female health and development and between female health and household income. This offers a promising avenue for further research.

Acknowledgments

We would like to thank Hendrik Jürges, Alyssa Lubet, Elizabeth Mitgang, Alexia Prskawetz, Christa Simon, Harald Uhlig, Katharina Werner, Joshua Wilde, and Maria Winkler-Dworak for valuable comments and suggestions. We are grateful to the Norwegian Agency for Development Cooperation for funding this study under grant number QZA-0408-QZA-12/0628.

Appendix A

Proof of Proposition 3. Part (i): Because $h_{t+1} = h_t = \bar{e}$ in the low-growth regime, Equation (30) simplifies to

$$g_t = \left(\frac{A_{t+1}/A_t}{n_t/2} \right)^{1-\alpha} - 1.$$

A transition from low growth to modern growth occurs if $g_t > 0$ for all $t \geq t_0$. As is readily checked, this holds if and only if $A_{t+1}/A_t > n_t/2$. Substituting from Equation (4), the low-growth level of fertility gives the condition in Equation (31). Part (ii): Assume that $A_{t+1}/A_t = 1$ in the very long run, where the economy has reached the technological boundary. Substituting the limit values from Equations (12) and (6) into the condition $g_t \geq 0$ and taking logarithms gives the condition in Equation (32).

Proof of Proposition 5. Part (i) follows immediately from Proposition 4.

Part (ii): As is readily verified from Equations (3)-(5), the redistribution $d\xi_f = -d\xi_m = z > 0$ leaves optimal consumption c_t unaffected. Referring by $\{u_t, n_t, e_t\}$ and $\{u'_t, n'_t, e'_t\}$ to pre- and postredistribution levels of utility, fertility, and education, respectively, we then obtain from Equation (1) that

$$u_t > u'_t \Leftrightarrow \gamma [\log(n_t) - \log(n'_t)] + \delta [\log(\bar{e} + e_t) - \log(\bar{e} + e'_t)] > 0. \quad (\text{A.1})$$

Consider now in turn the three cases, where (a) the low-growth regime arises both pre- and postreform, i.e., the case where $\hat{w}_t = h_t w_t < \gamma \bar{e} / \delta \xi_f \psi$; (b) the modern growth regime arises both pre- and postreform, i.e., the case where $\hat{w}_t > \gamma \bar{e} / \delta \xi_f \psi$; and (c) the case in which for $\hat{w}_t \in [\gamma \bar{e} / [\delta (\xi_f + z) \psi], \gamma \bar{e} / \delta \xi_f \psi]$ the regime switches from low growth to modern growth.

Case (a): As is readily checked from Equations (4) and (5), we have $n_t > n'_t = \gamma(\xi_m + \xi_f) / [(1 + \gamma)(\xi_f + z) \psi]$ and $e_t = e'_t = 0$, implying immediately that the second equality in

Equation (A.1) holds.

Case (b): Substituting from Equations (4) and (5) the modern growth values n_t and e_t together with

$$n'_t = \frac{(\gamma - \delta)(\xi_m + \xi_f)\widehat{w}_t}{(1 + \gamma)[(\xi_f + z)\psi\widehat{w}_t - \bar{e}]} \quad (\text{A.2})$$

$$e'_t = \frac{\delta(\xi_f + z)\psi\widehat{w}_t - \gamma\bar{e}}{\gamma - \delta}, \quad (\text{A.3})$$

we can rewrite the second inequality in Equation (A.1) as

$$(\gamma - \delta) \{ \log [(\xi_f + z)\psi\widehat{w}_t - \bar{e}] - \log (\xi_f\psi\widehat{w}_t - \bar{e}) \} > 0,$$

which holds because the term in curly braces is positive and $\gamma > \delta$ by assumption.

Case (c): Substituting from Equations (4) and (5) the value n_t from the low-growth regime and $e_t = 0$ together with n'_t and e'_t as from Equations (A.2) and (A.3), we can rewrite the second inequality in (A.1) as

$$G(\widehat{w}_t) = \left\langle \begin{array}{l} \gamma \{ \log (\gamma/\xi_f\psi) - \log (\gamma - \delta) + \log [(\xi_f + z)\psi - \bar{e}/\widehat{w}_t] \} \\ + \delta \{ \log (\bar{e}/\delta) - \log [(\xi_f + z)\psi\widehat{w}_t - \bar{e}] + \log (\gamma - \delta) \} \end{array} \right\rangle > 0.$$

$G_{\widehat{w}_t} < 0$ for $\widehat{w}_t \in [\gamma\bar{e}/[\delta(\xi_f + z)\psi], \gamma\bar{e}/\delta\xi_f\psi]$ can be verified, implying that

$$\begin{aligned} G(\widehat{w}_t) &\geq G(\gamma\bar{e}/\delta\xi_f\psi) \\ &= \left\langle \begin{array}{l} \gamma \{ \log (\gamma/\xi_f\psi) - \log (\gamma - \delta) + \log \{ (\psi/\gamma) [\gamma z + (\gamma - \delta)\xi_f] \} \} \\ + \delta \{ \log (\bar{e}/\delta) - \log \{ (\bar{e}/\delta\xi_f) [\gamma z + (\gamma - \delta)\xi_f] \} + \log (\gamma - \delta) \} \end{array} \right\rangle \\ &= (\gamma - \delta) \{ \log [\gamma z + (\gamma - \delta)\xi_f] - \log (\gamma - \delta) - \log (\xi_f) \} \\ &> (\gamma - \delta) \{ \log [(\gamma - \delta)\xi_f] - \log (\gamma - \delta) - \log (\xi_f) \} = 0, \end{aligned}$$

where the second inequality follows for $z > 0$. Hence, $u_t > u'_t$ for $\widehat{w}_t \in [\gamma\bar{e}/[\delta(\xi_f + z)\psi], \gamma\bar{e}/\delta\xi_f\psi]$, which completes the proof.

Proof of Proposition 6. Part (i) follows immediately when recalling from Equation (30) that the growth rate declines with n_t in all regimes and increases with e_t in the long-run limit and then noting from Equations (4), (6), and (12) that n_t is independent of λ , whereas $\lim_{w_t h_t \rightarrow \infty} h_{t+1}/h_t$

increases with λ . Part (ii) follows in analogy to Part (ii) of the proof of Proposition 4 with the time to transition given by

$$\Delta = \frac{\ln(\widehat{w}_\tau/\lambda) - \ln(\widehat{w}_{t_0}/\lambda^{1-\alpha})}{\ln(1+g)}$$

with $\widehat{w}_\tau = \gamma\bar{e}/\delta\xi_f\psi$, and \widehat{w}_{t_0} and g as defined in Equations (33) and (34), respectively. We then have $\partial\Delta/\partial\lambda = -\alpha\lambda^{-1}[\ln(1+g)]^{-1} < 0$.

References

- Abu-Ghaida, D. and Klasen, S. (2004). The costs of missing the Millennium Development Goal on gender equity. *World Development*, Vol. 32(No. 7):1075–1107.
- Acemoglu, D., Aghion, P., and Zilibotti, F. (2006). Distance to frontier, selection, and economic growth. *Journal of the European Economic Association*, Vol. 4(No. 1):37–74.
- Agénor, P.-R., Canuto, O., and da Silva, L. P. (2010). On gender and growth: the role of intergenerational health externalities and women’s occupational constraints. Policy Research Working Paper 5492. The World Bank, Washington, D.C.
- Albanesi, S. and Olivetti, C. (2014). Maternal health and the baby boom. *Quantitative Economics*, Vol. 5(No. 2):225–269.
- Albanesi, S. and Olivetti, C. (2016). Gender roles and medical progress. *Journal of Political Economy*, Vol. 124(No. 3):650–695.
- Alsan M., Bloom D. E., and Canning D. (2006) The effect of population health on foreign direct investment inflows to low- and middle-income countries. *World Development*, Vol. 34(No. 4):613-630.
- Andreoni, J. (1989). Giving with impure altruism: Applications to charity and Ricardian equivalence. *Journal of Political Economy*, Vol. 97(No. 6):1447-1458.
- Bailey, M. J. (2006). More power to the pill: the impact of contraceptive freedom on women’s life cycle labor supply. *The Quarterly Journal of Economics*, Vol. 121(No. 1):289–320.
- Baird, S., Friedman, J., and Shady, N. (2011). Aggregate income shocks and infant mortality in the developing world. *Review of Economics and Statistics*, Vol. 93(No. 3):847–856.

- Benhabib, J. and Spiegel, M. M. (2005). Human capital and technology diffusion. In *Handbook of Economic Growth, Volume 1A*, Elsevier, Amsterdam, 935–966.
- Berniell, M. and Sánchez-Páramo C. (2011). Overview of time use data used for the analysis of gender differences in time use patterns. Background paper for the *World Development Report 2012*.
- Bhalotra, S. (2010). Fatal fluctuations? Cyclicity in infant mortality in India. *Journal of Development Economics*, Vol. 93:7–19.
- Bhalotra, S. and Rawlings, S. B. (2011). Intergenerational persistence in health in developing countries: The penalty of gender inequality? *Journal of Public Economics*, Vol. 95:286–299.
- Bleakley, H. (2007). Disease and development: evidence from hookworm eradication in the American south. *Quarterly Journal of Economics*, Vol. 122(No. 1):73–117.
- Bleakley, H. (2010). Malaria eradication in the Americas: a retrospective analysis of childhood exposure. *American Economic Journal: Applied Economics*, Vol. 2(No. 2):1–45.
- Bleakley, H. (2011). Health, human capital, and development. *Annual Review of Economics*, Vol. 2:280–310.
- Bloom, D. E. and Canning, D. (2005). Health and economic growth: reconciling the micro and macro evidence. Center on Democracy, Development and the Rule of Law Working Papers.
- Bloom, D. E., Canning, D., and Fink, G. (2014a). Disease and development revisited. *Journal of Political Economy*, Vol. 122(No. 6):1355–1365.
- Bloom, D. E., Canning, D., Fink, G., and Finlay, J. E. (2009). Fertility, female labor force participation, and the demographic dividend. *Journal of Economic Growth*, Vol. 14(No. 2):79–101.
- Bloom, D. E., Canning, D., and Moore, M. (2014b). Optimal retirement with increasing longevity. *Scandinavian Journal of Economics*, Vol. 116(No. 3):838–858.
- Bloom, D. E., Canning, D., and Sevilla, J. (2004). The effect of health on economic growth: a production function approach. *World Development*, Vol. 32(No. 1):1–13.

- Bloom, S. S., Wypij, D., and Gupta, M. D. (2001). Dimensions of women's autonomy and the influence on maternal health care utilization in a north Indian city. *Demography*, Vol. 38(No. 1):67–78.
- Bonilla, E. and Rodriguez, A. (1993). Determining malaria effects in rural Colombia. *Social Science and Medicine*, Vol. 37(No. 9):1109-1114.
- Bratti, M. and Mendola, M. (2014). Parental health and child schooling. *Journal of Health Economics*, Vol. 35:94-108.
- Browning, M. and Chiappori, P.-A. (1998). Efficient intra-household allocations: a general characterization and empirical tests. *Econometrica*, Vol. 96(No. 6):1241–1278.
- Butz, W. P. and Ward, M. P. (1979). The emergence of countercyclical U.S. fertility. *The American Economic Review*, Vol. 69(No. 3): 318–328.
- Case, A. and Ardington, C. (2006). The impact of parental death on school outcomes: longitudinal evidence from South Africa. *Demography*, Vol. 43(No. 3):401–429.
- Cervellati, M. and Sunde, U. (2005). Human capital formation, life expectancy, and the process of development. *American Economic Review*, Vol. 95(No. 5):1653–1672.
- Cervellati, M. and Sunde, U. (2011). Life expectancy and economic growth: the role of the demographic transition. *Journal of Economic Growth*, Vol. 16(No. 2):99–133.
- Dalgaard, C.-J. and Strulik, H. (2014). Optimal aging and death: understanding the Preston curve. *Journal of the European Economic Association*, Vol. 12(No. 3):672–701.
- Deaton, A. (2008). Height, health, and inequality: the distribution of adult heights in India. *American Economic Review*, Vol. 98(No. 2):468–474.
- de la Croix, D. and Vander Donckt, M. (2010). Would empowering women initiate the demographic transition in least developed countries? *Journal of Human Capital*, Vol. 4(No. 2):85–129.
- Diebolt, C. and Perrin, F. (2013a). From stagnation to sustained growth: the role of female empowerment. *American Economic Review*, Vol. 103(No. 3):545–549.

- Diebolt, C. and Perrin, F. (2013b). From stagnation to sustained growth: the role of female empowerment. Association Française de Cliométrie (AFC) Working Paper 4, Restinclières, France.
- Doepke, M. (2004). Accounting for fertility decline during the transition to growth. *Journal of Economic Growth*, Vol. 9(No. 3):347–383.
- Doepke, M. and Tertilt, M. (2009). Women’s liberation: What’s in it for men? *Quarterly Journal of Economics*, Vol. 124(No. 4):1541–1591.
- Doepke, M. and Tertilt, M. (2014). Does female empowerment promote economic development? NBER Working Paper 19888, Cambridge, Massachusetts.
- Dufo, E. (2012). Women empowerment and economic development. *Journal of Economic Literature*, Vol. 50(No. 4):1051–1079.
- Ehrlich, I. and Chuma, H. (1990). A model of the demand for longevity and the value of life extension. *Journal of Political Economy*, Vol. 98(No. 4):761–82.
- Field, E., Robles, O., and Torero, M. (2009). Iodine deficiency and schooling attainment in Tanzania. *American Economic Journal: Applied Economics*, Vol. 1(No. 4):140–169.
- Fink, G. and Masiye, F. (2012). Assessing the impact of scaling-up bednet coverage through agricultural loan programmes: evidence from a cluster-randomized controlled trial in Katete District, Zambia. *Transactions of the Royal Society of Tropical Medicine & Hygiene*, Vol. 106(No. 11):660–667.
- Galor, O. (2005). From stagnation to growth: Unified Growth Theory. *Handbook of Economic Growth*, Elsevier, Amsterdam, 171–293.
- Galor, O. (2011). *Unified Growth Theory*. Princeton University Press, Princeton, New Jersey.
- Galor, O. and Moav, O. (2002). Natural selection and the origin of economic growth. *Quarterly Journal of Economics*, Vol. 117(No. 4):1133–1191.
- Galor, O. and Moav, O. (2004). From Physical to Human Capital Accumulation: Inequality and the Process of Development *The Review of Economic Studies*, Vol. 71(No. 4): 1001-1026.
- Galor, O. and Moav, O. (2006). Das Human-Kapital: a theory of the demise of the class structure. *The Review of Economic Studies*, Vol. 73(No. 1):85–117.

- Galor, O. and Weil, D. N. (1996). The gender gap, fertility, and growth. *The American Economic Review*, Vol. 86(No. 3):374–387.
- Galor, O. and Weil, D. (2000). Population, technology, and growth: from Malthusian stagnation to the demographic transition and beyond. *The American Economic Review*, Vol. 90(No. 4):806–828.
- Grossman, M. (1972). On the concept of health capital and the demand for health. *Journal of Political Economy*, Vol. 80(No. 2):223–255.
- Ha, J. and Howitt P. (2007). Accounting for trends in productivity and R&D: a Schumpeterian critique of semi-endogenous growth theory. *Journal of Money, Credit and Banking*, Vol. 39(No. 4):733–774.
- Hall, R. E. and Jones, C. I. (2007). The value of life and the rise in health spending. *Quarterly Journal of Economics*, Vol. 122(No. 1):39–72.
- Hansen, G. D. and Prescott, E. C. (2002). Malthus to Solow. *American Economic Review*, Vol. 92(No. 4):1205–1217.
- Heckman, J. J. and Walker, J. R. (1990). The Relationship Between Wages and Income and the Timing and Spacing of Births: Evidence from Swedish Longitudinal Data. *Econometrica*, Vol. 58(No. 6):1411–1441.
- Hiller, V. (2014). Gender inequality, endogenous cultural norms, and economic development. *Scandinavian Journal of Economics*, Vol. 116(No. 2):455–481.
- Howitt, P. (2000). Endogenous growth and cross-country income differences. *American Economic Review*, Vol. 92(No. 4):502–526.
- Institute for Health Metrics and Evaluation (2013). Global Burden of Disease Study 2010. India Global Burden of Disease Study 2010 (GBD 2010) Results 1990-2010, Institute for Health Metrics and Evaluation, 2013: Seattle.
- Iversen, J. H., Onarheim, K. H., and Bloom D. E. (2015). Economic benefits of investing in womens' health: A systematic review. Working Paper, Boston Massachusetts.
- Iyigun, M. and Walsh, R. P. (2007). Endogenous gender power, household labor supply, and the demographic transition. *Journal of Development Economics*, Vol. 82(No. 1):138–155.

- Jayachandran, S. and Lleras-Muney, A. (2009). Life expectancy and human capital investments: evidence from maternal mortality declines. *The Quarterly Journal of Economics*, Vol. 124(No. 1):349–397.
- Jones, C. I. (2001). Was an industrial revolution inevitable? Economic growth over the very long run. *Advances in Macroeconomics*, Vol. 1(No. 2):1–43.
- Jones, C. I. (2002). Sources of U.S. economic growth in a world of ideas. *American Economic Review*, Vol. 92(No. 1):220–239.
- Keller, W. (2002). Geographic localization of international technology diffusion. *The American Economic Review*, Vol. 92(No. 1):120–142.
- Kimura, M. and Yasui, D. (2010). The Galor–Weil gender-gap model revisited: from home to market. *Journal of Economic Growth*, Vol. 15(No. 4):323–351.
- Knowles, S., Lorgelly, P. K., and Owen, P. D. (2002). Are educational gender gaps a brake on economic development? Some cross-country empirical evidence. *Oxford Economic Papers*, Vol. 54(No. 1):118–149.
- Kögel, T. and Prskawetz, A. (2001). Agricultural productivity growth and escape from the Malthusian trap. *Journal of Economic Growth*, Vol. 6(No. 4):337–357.
- Kuhn, M., Wrzaczek, S., Prskawetz, A., and Feichtinger, G. (2015). Optimal choice of health and retirement in a life-cycle model. *Journal of Economic Theory*, Vol. 158:186–212.
- Lagerlöf, N.-P. (2003). Gender equality and long-run growth. *Journal of Economic Growth*, Vol. 8(No. 4):403–426.
- Lagerlöf, N.-P. (2005). Sex, equality, and growth. *The Canadian Journal of Economics*, Vol. 38(No. 3):807–831.
- Luca D. L., Iversen J. H., Lubet A. S., Mitgang E., Onarheim K. H., Prettner K., and Bloom D. E. (2014). Benefits and costs of the women’s health targets for the post-2015 development agenda. Copenhagen Consensus Center Working Paper.
- Molini, V., Nube, M., and den Boom, B. V. (2010). Adult BMI as a health and nutritional inequality measure: applications at macro and micro levels. *World Development*, Vol. 38(No. 7):1012–1023.

- Nelson, R. and Phelps, E. (1966). Investment in humans, technological diffusion, and economic growth. *American Economic Review*, Vol. 61(No. 1/2):69–75.
- Parente, S. T. and Prescott, E. C. (1994). Barriers to technology adoption and development. *The Journal of Political Economy*, Vol. 102(No. 2):298–321.
- Prettner, K., Bloom, D. E., and Strulik, H. (2013). Declining fertility and economic well-being: do education and health ride to the rescue? *Labour Economics*, Vol. 22(June 2013):70–79.
- Prettner, K. and Strulik, H. (2016). Gender equity and the escape from poverty. *Oxford Economic Papers* (forthcoming).
- Rees, R. and Riezman, R. (2012). Globalization, gender, and growth. *Review of Income and Wealth*, Vol. 58(No. 1):107–117.
- Schober, T. and Winter-Ebmer, R. (2011). Gender wage inequality and economic growth: is there really a puzzle?—a comment. *World Development*, Vol. 39(No. 8):1476–1484.
- Schultz, T. P. (1985). Changing World Prices, Women’s Wages, and the Fertility Transition: Sweden, 1860-1910. *Journal of Political Economy*, Vol. 93(No. 6):1126–1154.
- Schultz, T. P. (1990). Testing the neoclassical model of family labour supply and fertility. *Journal of Human Resources*, Vol. 25(No. 4):599–634.
- Schultz, T. P. (2002). Wage gains associated with height from health human capital. *American Economic Review*, Vol. 92(No. 2):349–353.
- Schultz, T. P. (2005). Productive benefits of health: evidence from low-income countries. In G. López-Casasnovas, B. Rivera, and L. Currais (Eds.), *Health and Economic Growth: Findings and Policy Implications*, (257–286), Cambridge, MA: Massachusetts Institute of Technology.
- Self, S. and Grabowski, R. (2012). Female autonomy and health care in developing countries. *Review of Development Economics*, Vol. 16(No. 1):185–198.
- Shastri, G. K. and Weil, D. N. (2003). How much of cross-country income variation is explained by health? *Journal of the European Economic Association*, Vol. 1(No. 3-4):387–396.
- Soares, R. R. and Falcão, B. L. S. (2008). The demographic transition and the sexual division of labor. *Journal of Political Economy*, Vol. 116(No. 6):1058–1104.

- Stenberg, K. et al. (2014). Advancing social and economic development by investing in women's and children's health: a new Global Investment Framework. *The Lancet*, Vol. 383(No. 9925):1333–54.
- Strauss, J. and Thomas, D. (1998). Health, nutrition, and economic development. *Journal of Economic Literature*, Vol. 36(No. 2):766–817.
- Strulik, H., Prettner, K., and Prskawetz, A. (2013). The past and future of knowledge-based growth. *Journal of Economic Growth*, Vol. 18(No. 4):411–437.
- Strulik, H. and Weisdorf, J. (2008). Population, food, and knowledge: a simple unified growth theory. *Journal of Economic Growth*, Vol. 13(No. 3):195–216.
- Thomas, D. (1990). Intra-household resource allocation: an inferential approach. *Journal of Human Resources*, Vol 25(No. 4):635–664.
- Vos, T. et al. (2012). Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet*, Vol. 380(No. 9859):2163–2196.
- Weil, D. (2007). Accounting for the effect of health on economic growth. *The Quarterly Journal of Economics*, Vol. 122(No. 3):1265–1306.
- World Bank (2016). The World Development Indicators. Available at <http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators> [Accessed: August 1, 2016].
- WHO (2016). Health statistics and information systems. Estimates for 2000-2012. Available at http://www.who.int/healthinfo/global_burden_disease/estimates/en/index2.html [Accessed: August 1, 2016].

Hohenheim Discussion Papers in Business, Economics and Social Sciences

The Faculty of Business, Economics and Social Sciences continues since 2015 the established "FZID Discussion Paper Series" of the "Centre for Research on Innovation and Services (FZID)" under the name "Hohenheim Discussion Papers in Business, Economics and Social Sciences".

Institutes

- 510 Institute of Financial Management
- 520 Institute of Economics
- 530 Institute of Health Care & Public Management
- 540 Institute of Communication Science
- 550 Institute of Law and Social Sciences
- 560 Institute of Economic and Business Education
- 570 Institute of Marketing & Management
- 580 Institute of Interorganisational Management & Performance

Download Hohenheim Discussion Papers in Business, Economics and Social Sciences from our homepage: <https://wiso.uni-hohenheim.de/papers>

Nr.	Autor	Titel	Inst.
01-2015	Thomas Beissinger, Philipp Baudy	THE IMPACT OF TEMPORARY AGENCY WORK ON TRADE UNION WAGE SETTING: A Theoretical Analysis	520
02-2015	Fabian Wahl	PARTICIPATIVE POLITICAL INSTITUTIONS AND CITY DEVELOPMENT 800-1800	520
03-2015	Tommaso Proietti, Martyna Marczak, Gianluigi Mazzi	EUROMIND-D: A DENSITY ESTIMATE OF MONTHLY GROSS DOMESTIC PRODUCT FOR THE EURO AREA	520
04-2015	Thomas Beissinger, Nathalie Chusseau, Joël Hellier	OFFSHORING AND LABOUR MARKET REFORMS: MODELLING THE GERMAN EXPERIENCE	520
05-2015	Matthias Mueller, Kristina Bogner, Tobias Buchmann, Muhamed Kudic	SIMULATING KNOWLEDGE DIFFUSION IN FOUR STRUCTURALLY DISTINCT NETWORKS – AN AGENT-BASED SIMULATION MODEL	520
06-2015	Martyna Marczak, Thomas Beissinger	BIDIRECTIONAL RELATIONSHIP BETWEEN INVESTOR SENTIMENT AND EXCESS RETURNS: NEW EVIDENCE FROM THE WAVELET PERSPECTIVE	520
07-2015	Peng Nie, Galit Nimrod, Alfonso Sousa-Poza	INTERNET USE AND SUBJECTIVE WELL-BEING IN CHINA	530
08-2015	Fabian Wahl	THE LONG SHADOW OF HISTORY ROMAN LEGACY AND ECONOMIC DEVELOPMENT – EVIDENCE FROM THE GERMAN LIMES	520
09-2015	Peng Nie, Alfonso Sousa-Poza	COMMUTE TIME AND SUBJECTIVE WELL-BEING IN URBAN CHINA	530

Nr.	Autor	Titel	Inst.
10-2015	Kristina Bogner	THE EFFECT OF PROJECT FUNDING ON INNOVATIVE PERFORMANCE AN AGENT-BASED SIMULATION MODEL	520
11-2015	Bogang Jun, Tai-Yoo Kim	A NEO-SCHUMPETERIAN PERSPECTIVE ON THE ANALYTICAL MACROECONOMIC FRAMEWORK: THE EXPANDED REPRODUCTION SYSTEM	520
12-2015	Volker Grossmann Aderonke Osikominu Marius Osterfeld	ARE SOCIOCULTURAL FACTORS IMPORTANT FOR STUDYING A SCIENCE UNIVERSITY MAJOR?	520
13-2015	Martyna Marczak Tommaso Proietti Stefano Grassi	A DATA-CLEANING AUGMENTED KALMAN FILTER FOR ROBUST ESTIMATION OF STATE SPACE MODELS	520
14-2015	Carolina Castagnetti Luisa Rosti Marina Töpfer	THE REVERSAL OF THE GENDER PAY GAP AMONG PUBLIC-CONTEST SELECTED YOUNG EMPLOYEES	520
15-2015	Alexander Opitz	DEMOCRATIC PROSPECTS IN IMPERIAL RUSSIA: THE REVOLUTION OF 1905 AND THE POLITICAL STOCK MARKET	520
01-2016	Michael Ahlheim, Jan Neidhardt	NON-TRADING BEHAVIOUR IN CHOICE EXPERIMENTS	520
02-2016	Bogang Jun, Alexander Gerybadze, Tai-Yoo Kim	THE LEGACY OF FRIEDRICH LIST: THE EXPANSIVE REPRODUCTION SYSTEM AND THE KOREAN HISTORY OF INDUSTRIALIZATION	520
03-2016	Peng Nie, Alfonso Sousa-Poza	FOOD INSECURITY AMONG OLDER EUROPEANS: EVIDENCE FROM THE SURVEY OF HEALTH, AGEING, AND RETIREMENT IN EUROPE	530
04-2016	Peter Spahn	POPULATION GROWTH, SAVING, INTEREST RATES AND STAGNATION. DISCUSSING THE EGGERTSSON-MEHROTRA-MODEL	520
05-2016	Vincent Dekker, Kristina Strohmaier, Nicole Bosch	A DATA-DRIVEN PROCEDURE TO DETERMINE THE BUNCHING WINDOW – AN APPLICATION TO THE NETHERLANDS	520
06-2016	Philipp Baudy, Dario Cords	DEREGULATION OF TEMPORARY AGENCY EMPLOYMENT IN A UNIONIZED ECONOMY: DOES THIS REALLY LEAD TO A SUBSTITUTION OF REGULAR EMPLOYMENT?	520
07-2016	Robin Jessen, Davud Rostam-Afschar, Sebastian Schmitz	HOW IMPORTANT IS PRECAUTIONARY LABOR SUPPLY?	520
08-2016	Peng Nie, Alfonso Sousa-Poza, Jianhong Xue	FUEL FOR LIFE: DOMESTIC COOKING FUELS AND WOMEN'S HEALTH IN RURAL CHINA	530

Nr.	Autor	Titel	Inst.
09-2016	Bogang Jun, Seung Kyu-Yi, Tobias Buchmann, Matthias Müller	THE CO-EVOLUTION OF INNOVATION NETWORKS: COLLABORATION BETWEEN WEST AND EAST GERMANY FROM 1972 TO 2014	520
10-2016	Vladan Ivanovic, Vadim Kufenko, Boris Begovic Nenad Stanasic, Vincent Geloso	CONTINUITY UNDER A DIFFERENT NAME. THE OUTCOME OF PRIVATISATION IN SERBIA	520
11-2016	David E. Bloom Michael Kuhn Klaus Prettner	THE CONTRIBUTION OF FEMALE HEALTH TO ECONOMIC DEVELOPMENT	520

FZID Discussion Papers

(published 2009-2014)

Competence Centers

IK	Innovation and Knowledge
ICT	Information Systems and Communication Systems
CRFM	Corporate Finance and Risk Management
HCM	Health Care Management
CM	Communication Management
MM	Marketing Management
ECO	Economics

Download FZID Discussion Papers from our homepage: https://wiso.uni-hohenheim.de/archiv_fzid_papers

Nr.	Autor	Titel	CC
01-2009	Julian P. Christ	NEW ECONOMIC GEOGRAPHY RELOADED: Localized Knowledge Spillovers and the Geography of Innovation	IK
02-2009	André P. Slowak	MARKET FIELD STRUCTURE & DYNAMICS IN INDUSTRIAL AUTOMATION	IK
03-2009	Pier Paolo Saviotti, Andreas Pyka	GENERALIZED BARRIERS TO ENTRY AND ECONOMIC DEVELOPMENT	IK
04-2009	Uwe Focht, Andreas Richter and Jörg Schiller	INTERMEDIATION AND MATCHING IN INSURANCE MARKETS	HCM
05-2009	Julian P. Christ, André P. Slowak	WHY BLU-RAY VS. HD-DVD IS NOT VHS VS. BETAMAX: THE CO-EVOLUTION OF STANDARD-SETTING CONSORTIA	IK
06-2009	Gabriel Felbermayr, Mario Larch and Wolfgang Lechthaler	UNEMPLOYMENT IN AN INTERDEPENDENT WORLD	ECO
07-2009	Steffen Otterbach	MISMATCHES BETWEEN ACTUAL AND PREFERRED WORK TIME: Empirical Evidence of Hours Constraints in 21 Countries	HCM
08-2009	Sven Wydra	PRODUCTION AND EMPLOYMENT IMPACTS OF NEW TECHNOLOGIES – ANALYSIS FOR BIOTECHNOLOGY	IK
09-2009	Ralf Richter, Jochen Streb	CATCHING-UP AND FALLING BEHIND KNOWLEDGE SPILLOVER FROM AMERICAN TO GERMAN MACHINE TOOL MAKERS	IK

Nr.	Autor	Titel	CC
10-2010	Rahel Aichele, Gabriel Felbermayr	KYOTO AND THE CARBON CONTENT OF TRADE	ECO
11-2010	David E. Bloom, Alfonso Sousa-Poza	ECONOMIC CONSEQUENCES OF LOW FERTILITY IN EUROPE	HCM
12-2010	Michael Ahlheim, Oliver Frör	DRINKING AND PROTECTING – A MARKET APPROACH TO THE PRESERVATION OF CORK OAK LANDSCAPES	ECO
13-2010	Michael Ahlheim, Oliver Frör, Antonia Heinke, Nguyen Minh Duc, and Pham Van Dinh	LABOUR AS A UTILITY MEASURE IN CONTINGENT VALUATION STUDIES – HOW GOOD IS IT REALLY?	ECO
14-2010	Julian P. Christ	THE GEOGRAPHY AND CO-LOCATION OF EUROPEAN TECHNOLOGY-SPECIFIC CO-INVENTORSHIP NETWORKS	IK
15-2010	Harald Degner	WINDOWS OF TECHNOLOGICAL OPPORTUNITY DO TECHNOLOGICAL BOOMS INFLUENCE THE RELATIONSHIP BETWEEN FIRM SIZE AND INNOVATIVENESS?	IK
16-2010	Tobias A. Jopp	THE WELFARE STATE EVOLVES: GERMAN KNAPPSCHAFTEN, 1854-1923	HCM
17-2010	Stefan Kirn (Ed.)	PROCESS OF CHANGE IN ORGANISATIONS THROUGH eHEALTH	ICT
18-2010	Jörg Schiller	ÖKONOMISCHE ASPEKTE DER ENTLOHNUNG UND REGULIERUNG UNABHÄNGIGER VERSICHERUNGSVERMITTLER	HCM
19-2010	Frauke Lammers, Jörg Schiller	CONTRACT DESIGN AND INSURANCE FRAUD: AN EXPERIMENTAL INVESTIGATION	HCM
20-2010	Martyna Marczak, Thomas Beissinger	REAL WAGES AND THE BUSINESS CYCLE IN GERMANY	ECO
21-2010	Harald Degner, Jochen Streb	FOREIGN PATENTING IN GERMANY, 1877-1932	IK
22-2010	Heiko Stüber, Thomas Beissinger	DOES DOWNWARD NOMINAL WAGE RIGIDITY DAMPEN WAGE INCREASES?	ECO
23-2010	Mark Spoerer, Jochen Streb	GUNS AND BUTTER – BUT NO MARGARINE: THE IMPACT OF NAZI ECONOMIC POLICIES ON GERMAN FOOD CONSUMPTION, 1933-38	ECO

Nr.	Autor	Titel	CC
24-2011	Dhammika Dharmapala, Nadine Riedel	EARNINGS SHOCKS AND TAX-MOTIVATED INCOME-SHIFTING: EVIDENCE FROM EUROPEAN MULTINATIONALS	ECO
25-2011	Michael Schuele, Stefan Kirn	QUALITATIVES, RÄUMLICHES SCHLIEßEN ZUR KOLLISIONSERKENNUNG UND KOLLISIONSVERMEIDUNG AUTONOMER BDI-AGENTEN	ICT
26-2011	Marcus Müller, Guillaume Stern, Ansgar Jacob and Stefan Kirn	VERHALTENSMODELLE FÜR SOFTWAREAGENTEN IM PUBLIC GOODS GAME	ICT
27-2011	Monnet Benoit, Patrick Gbakoua and Alfonso Sousa-Poza	ENGEL CURVES, SPATIAL VARIATION IN PRICES AND DEMAND FOR COMMODITIES IN CÔTE D'IVOIRE	ECO
28-2011	Nadine Riedel, Hannah Schildberg-Hörisch	ASYMMETRIC OBLIGATIONS	ECO
29-2011	Nicole Waidlein	CAUSES OF PERSISTENT PRODUCTIVITY DIFFERENCES IN THE WEST GERMAN STATES IN THE PERIOD FROM 1950 TO 1990	IK
30-2011	Dominik Hartmann, Atilio Arata	MEASURING SOCIAL CAPITAL AND INNOVATION IN POOR AGRICULTURAL COMMUNITIES. THE CASE OF CHÁPARRA - PERU	IK
31-2011	Peter Spahn	DIE WÄHRUNGSKRISEUNION DIE EURO-VERSCHULDUNG DER NATIONALSTAATEN ALS SCHWACHSTELLE DER EWU	ECO
32-2011	Fabian Wahl	DIE ENTWICKLUNG DES LEBENSSTANDARDS IM DRITTEN REICH – EINE GLÜCKSÖKONOMISCHE PERSPEKTIVE	ECO
33-2011	Giorgio Triulzi, Ramon Scholz and Andreas Pyka	R&D AND KNOWLEDGE DYNAMICS IN UNIVERSITY-INDUSTRY RELATIONSHIPS IN BIOTECH AND PHARMACEUTICALS: AN AGENT-BASED MODEL	IK
34-2011	Claus D. Müller-Hengstenberg, Stefan Kirn	ANWENDUNG DES ÖFFENTLICHEN VERGABERECHTS AUF MODERNE IT SOFTWAREENTWICKLUNGSVERFAHREN	ICT
35-2011	Andreas Pyka	AVOIDING EVOLUTIONARY INEFFICIENCIES IN INNOVATION NETWORKS	IK
36-2011	David Bell, Steffen Otterbach and Alfonso Sousa-Poza	WORK HOURS CONSTRAINTS AND HEALTH	HCM
37-2011	Lukas Scheffknecht, Felix Geiger	A BEHAVIORAL MACROECONOMIC MODEL WITH ENDOGENOUS BOOM-BUST CYCLES AND LEVERAGE DYNAMICS	ECO
38-2011	Yin Krogmann, Ulrich Schwalbe	INTER-FIRM R&D NETWORKS IN THE GLOBAL PHARMACEUTICAL BIOTECHNOLOGY INDUSTRY DURING 1985–1998: A CONCEPTUAL AND EMPIRICAL ANALYSIS	IK

Nr.	Autor	Titel	CC
39-2011	Michael Ahlheim, Tobias Börger and Oliver Frör	RESPONDENT INCENTIVES IN CONTINGENT VALUATION: THE ROLE OF RECIPROCITY	ECO
40-2011	Tobias Börger	A DIRECT TEST OF SOCIALLY DESIRABLE RESPONDING IN CONTINGENT VALUATION INTERVIEWS	ECO
41-2011	Ralf Rukwid, Julian P. Christ	QUANTITATIVE CLUSTERIDENTIFIKATION AUF EBENE DER DEUTSCHEN STADT- UND LANDKREISE (1999-2008)	IK

Nr.	Autor	Titel	CC
42-2012	Benjamin Schön, Andreas Pyka	A TAXONOMY OF INNOVATION NETWORKS	IK
43-2012	Dirk Foremny, Nadine Riedel	BUSINESS TAXES AND THE ELECTORAL CYCLE	ECO
44-2012	Gisela Di Meglio, Andreas Pyka and Luis Rubalcaba	VARIETIES OF SERVICE ECONOMIES IN EUROPE	IK
45-2012	Ralf Rukwid, Julian P. Christ	INNOVATIONSPOTENTIALE IN BADEN-WÜRTTEMBERG: PRODUKTIONSCLUSTER IM BEREICH „METALL, ELEKTRO, IKT“ UND REGIONALE VERFÜGBARKEIT AKADEMISCHER FACHKRÄFTE IN DEN MINT-FÄCHERN	IK
46-2012	Julian P. Christ, Ralf Rukwid	INNOVATIONSPOTENTIALE IN BADEN-WÜRTTEMBERG: BRANCHENSPEZIFISCHE FORSCHUNGS- UND ENTWICKLUNGSAKTIVITÄT, REGIONALES PATENTAUFKOMMEN UND BESCHÄFTIGUNGSSTRUKTUR	IK
47-2012	Oliver Sauter	ASSESSING UNCERTAINTY IN EUROPE AND THE US - IS THERE A COMMON FACTOR?	ECO
48-2012	Dominik Hartmann	SEN MEETS SCHUMPETER. INTRODUCING STRUCTURAL AND DYNAMIC ELEMENTS INTO THE HUMAN CAPABILITY APPROACH	IK
49-2012	Harold Paredes- Frigolett, Andreas Pyka	DISTAL EMBEDDING AS A TECHNOLOGY INNOVATION NETWORK FORMATION STRATEGY	IK
50-2012	Martyna Marczak, Víctor Gómez	CYCLICALITY OF REAL WAGES IN THE USA AND GERMANY: NEW INSIGHTS FROM WAVELET ANALYSIS	ECO
51-2012	André P. Slowak	DIE DURCHSETZUNG VON SCHNITTSTELLEN IN DER STANDARDSETZUNG: FALLBEISPIEL LADESYSTEM ELEKTROMOBILITÄT	IK
52-2012	Fabian Wahl	WHY IT MATTERS WHAT PEOPLE THINK - BELIEFS, LEGAL ORIGINS AND THE DEEP ROOTS OF TRUST	ECO
53-2012	Dominik Hartmann, Micha Kaiser	STATISTISCHER ÜBERBLICK DER TÜRKISCHEN MIGRATION IN BADEN-WÜRTTEMBERG UND DEUTSCHLAND	IK
54-2012	Dominik Hartmann, Andreas Pyka, Seda Aydin, Lena Klauß, Fabian Stahl, Ali Santircioglu, Silvia Oberegelsbacher, Sheida Rashidi, Gaye Onan and Suna Erginkoç	IDENTIFIZIERUNG UND ANALYSE DEUTSCH-TÜRKISCHER INNOVATIONSNETZWERKE. ERSTE ERGEBNISSE DES TGIN- PROJEKTES	IK
55-2012	Michael Ahlheim, Tobias Börger and Oliver Frör	THE ECOLOGICAL PRICE OF GETTING RICH IN A GREEN DESERT: A CONTINGENT VALUATION STUDY IN RURAL SOUTHWEST CHINA	ECO

Nr.	Autor	Titel	CC
56-2012	Matthias Strifler Thomas Beissinger	FAIRNESS CONSIDERATIONS IN LABOR UNION WAGE SETTING – A THEORETICAL ANALYSIS	ECO
57-2012	Peter Spahn	INTEGRATION DURCH WÄHRUNGSUNION? DER FALL DER EURO-ZONE	ECO
58-2012	Sibylle H. Lehmann	TAKING FIRMS TO THE STOCK MARKET: IPOS AND THE IMPORTANCE OF LARGE BANKS IN IMPERIAL GERMANY 1896-1913	ECO
59-2012	Sibylle H. Lehmann, Philipp Hauber and Alexander Opitz	POLITICAL RIGHTS, TAXATION, AND FIRM VALUATION – EVIDENCE FROM SAXONY AROUND 1900	ECO
60-2012	Martyna Marczak, Víctor Gómez	SPECTRAN, A SET OF MATLAB PROGRAMS FOR SPECTRAL ANALYSIS	ECO
61-2012	Theresa Lohse, Nadine Riedel	THE IMPACT OF TRANSFER PRICING REGULATIONS ON PROFIT SHIFTING WITHIN EUROPEAN MULTINATIONALS	ECO

Nr.	Autor	Titel	CC
62-2013	Heiko Stüber	REAL WAGE CYCLICALITY OF NEWLY HIRED WORKERS	ECO
63-2013	David E. Bloom, Alfonso Sousa-Poza	AGEING AND PRODUCTIVITY	HCM
64-2013	Martyna Marczak, V́ctor G3mez	MONTHLY US BUSINESS CYCLE INDICATORS: A NEW MULTIVARIATE APPROACH BASED ON A BAND-PASS FILTER	ECO
65-2013	Dominik Hartmann, Andreas Pyka	INNOVATION, ECONOMIC DIVERSIFICATION AND HUMAN DEVELOPMENT	IK
66-2013	Christof Ernst, Katharina Richter and Nadine Riedel	CORPORATE TAXATION AND THE QUALITY OF RESEARCH AND DEVELOPMENT	ECO
67-2013	Michael Ahlheim, Oliver Fr3r, Jiang Tong, Luo Jing and Sonna Pelz	NONUSE VALUES OF CLIMATE POLICY - AN EMPIRICAL STUDY IN XINJIANG AND BEIJING	ECO
68-2013	Michael Ahlheim, Friedrich Schneider	CONSIDERING HOUSEHOLD SIZE IN CONTINGENT VALUATION STUDIES	ECO
69-2013	Fabio Bertoni, Tereza Tykvov3	WHICH FORM OF VENTURE CAPITAL IS MOST SUPPORTIVE OF INNOVATION? EVIDENCE FROM EUROPEAN BIOTECHNOLOGY COMPANIES	CFRM
70-2013	Tobias Buchmann, Andreas Pyka	THE EVOLUTION OF INNOVATION NETWORKS: THE CASE OF A GERMAN AUTOMOTIVE NETWORK	IK
71-2013	B. Vermeulen, A. Pyka, J. A. La Poutr3 and A. G. de Kok	CAPABILITY-BASED GOVERNANCE PATTERNS OVER THE PRODUCT LIFE-CYCLE	IK
72-2013	Beatriz Fabiola L3pez Ulloa, Valerie M3ller and Alfonso Sousa- Poza	HOW DOES SUBJECTIVE WELL-BEING EVOLVE WITH AGE? A LITERATURE REVIEW	HCM
73-2013	Wencke Gwozdz, Alfonso Sousa-Poza, Lucia A. Reisch, Wolfgang Ahrens, Stefaan De Henauw, Gabriele Eiben, Juan M. Fern3ndez-Alvira, Charalampos Hadjigeorgiou, Eva Kov3cs, Fabio Lauria, Toomas Veidebaum, Garrath Williams, Karin Bammann	MATERNAL EMPLOYMENT AND CHILDHOOD OBESITY – A EUROPEAN PERSPECTIVE	HCM

Nr.	Autor	Titel	CC
74-2013	Andreas Haas, Annette Hofmann	RISIKEN AUS CLOUD-COMPUTING-SERVICES: FRAGEN DES RISIKOMANAGEMENTS UND ASPEKTE DER VERSICHERBARKEIT	HCM
75-2013	Yin Krogmann, Nadine Riedel and Ulrich Schwalbe	INTER-FIRM R&D NETWORKS IN PHARMACEUTICAL BIOTECHNOLOGY: WHAT DETERMINES FIRM'S CENTRALITY-BASED PARTNERING CAPABILITY?	ECO, IK
76-2013	Peter Spahn	MACROECONOMIC STABILISATION AND BANK LENDING: A SIMPLE WORKHORSE MODEL	ECO
77-2013	Sheida Rashidi, Andreas Pyka	MIGRATION AND INNOVATION – A SURVEY	IK
78-2013	Benjamin Schön, Andreas Pyka	THE SUCCESS FACTORS OF TECHNOLOGY-SOURCING THROUGH MERGERS & ACQUISITIONS – AN INTUITIVE META- ANALYSIS	IK
79-2013	Irene Prostoplow, Andreas Pyka and Barbara Heller-Schuh	TURKISH-GERMAN INNOVATION NETWORKS IN THE EUROPEAN RESEARCH LANDSCAPE	IK
80-2013	Eva Schlenker, Kai D. Schmid	CAPITAL INCOME SHARES AND INCOME INEQUALITY IN THE EUROPEAN UNION	ECO
81-2013	Michael Ahlheim, Tobias Börger and Oliver Frör	THE INFLUENCE OF ETHNICITY AND CULTURE ON THE VALUATION OF ENVIRONMENTAL IMPROVEMENTS – RESULTS FROM A CVM STUDY IN SOUTHWEST CHINA –	ECO
82-2013	Fabian Wahl	DOES MEDIEVAL TRADE STILL MATTER? HISTORICAL TRADE CENTERS, AGGLOMERATION AND CONTEMPORARY ECONOMIC DEVELOPMENT	ECO
83-2013	Peter Spahn	SUBPRIME AND EURO CRISIS: SHOULD WE BLAME THE ECONOMISTS?	ECO
84-2013	Daniel Guffarth, Michael J. Barber	THE EUROPEAN AEROSPACE R&D COLLABORATION NETWORK	IK
85-2013	Athanasios Saitis	KARTELLBEKÄMPFUNG UND INTERNE KARTELLSTRUKTUREN: EIN NETZWERKTHEORETISCHER ANSATZ	IK

Nr.	Autor	Titel	CC
86-2014	Stefan Kirn, Claus D. Müller-Hengstenberg	INTELLIGENTE (SOFTWARE-)AGENTEN: EINE NEUE HERAUSFORDERUNG FÜR DIE GESELLSCHAFT UND UNSER RECHTSSYSTEM?	ICT
87-2014	Peng Nie, Alfonso Sousa-Poza	MATERNAL EMPLOYMENT AND CHILDHOOD OBESITY IN CHINA: EVIDENCE FROM THE CHINA HEALTH AND NUTRITION SURVEY	HCM
88-2014	Steffen Otterbach, Alfonso Sousa-Poza	JOB INSECURITY, EMPLOYABILITY, AND HEALTH: AN ANALYSIS FOR GERMANY ACROSS GENERATIONS	HCM
89-2014	Carsten Burhop, Sibylle H. Lehmann-Hasemeyer	THE GEOGRAPHY OF STOCK EXCHANGES IN IMPERIAL GERMANY	ECO
90-2014	Martyna Marczak, Tommaso Proietti	OUTLIER DETECTION IN STRUCTURAL TIME SERIES MODELS: THE INDICATOR SATURATION APPROACH	ECO
91-2014	Sophie Urmetzer, Andreas Pyka	VARIETIES OF KNOWLEDGE-BASED BIOECONOMIES	IK
92-2014	Bogang Jun, Joongho Lee	THE TRADEOFF BETWEEN FERTILITY AND EDUCATION: EVIDENCE FROM THE KOREAN DEVELOPMENT PATH	IK
93-2014	Bogang Jun, Tai-Yoo Kim	NON-FINANCIAL HURDLES FOR HUMAN CAPITAL ACCUMULATION: LANDOWNERSHIP IN KOREA UNDER JAPANESE RULE	IK
94-2014	Michael Ahlheim, Oliver Frör, Gerhard Langenberger and Sonna Pelz	CHINESE URBANITES AND THE PRESERVATION OF RARE SPECIES IN REMOTE PARTS OF THE COUNTRY – THE EXAMPLE OF EAGLEWOOD	ECO
95-2014	Harold Paredes-Frigolett, Andreas Pyka, Javier Pereira and Luiz Flávio Autran Monteiro Gomes	RANKING THE PERFORMANCE OF NATIONAL INNOVATION SYSTEMS IN THE IBERIAN PENINSULA AND LATIN AMERICA FROM A NEO-SCHUMPETERIAN ECONOMICS PERSPECTIVE	IK
96-2014	Daniel Guffarth, Michael J. Barber	NETWORK EVOLUTION, SUCCESS, AND REGIONAL DEVELOPMENT IN THE EUROPEAN AEROSPACE INDUSTRY	IK

IMPRINT

University of Hohenheim
Dean's Office of the Faculty of Business, Economics and Social Sciences
Palace Hohenheim 1 B
70593 Stuttgart | Germany
Fon +49 (0)711 459 22488
Fax +49 (0)711 459 22785
E-mail wiso@uni-hohenheim.de
Web www.wiso.uni-hohenheim.de