FERTILITY AND STRUCTURAL CHANGE IN DEVELOPING COUNTRIES

Dissertation

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BRICs	....	Country Group: Brazil, Russia, India, China
CME	....	Child Mortality Estimates
DHS	....	Demographic and Health Survey
FE	....	Fixed Effects
GDP	....	Gross Domestic Product
GLS	....	Generalized Least Squares
GM	....	Galor and Mountford (2008)
GMM	....	Generalized Method of Moments
GNI	....	Gross National Income
ICRG	....	International Country Risk Guide
LSDV	....	Least Squares Dummy Variable
OECD	....	Organization of Economic Cooperation and Development
OLS	....	Ordinary Least Squares
PWT	....	Penn World Tables
SITC	....	Standard International Trade Classification
TFR	....	Total Fertility Rate
UGT	....	Unified Growth Theory
WDI	....	World Development Indicators
WHO	....	World Health Organization
WTO	....	World Trade Organization

"I believe that the emphasis on curbing population growth diverts attention from the more vital issue of pursuing policies that allow the population to take care of itself." Mohammad Yunus

Chapter 1

Introduction

There is little doubt that the world population will grow. The most recent United Nation's report on the development of the global population, the world population prospects (UN 2015), reveals that even in the most restrictive estimation trajectory population numbers worldwide will rise for at least another 35 years. However more likely, they will rise far beyond 2050 as predicted by the medium variant which sees the peak not to occur before 2100. Even though one may question the precision of century-spanning estimates, two things about the presented population development are remarkable and worth to note. The first is concerned about *where* additional people are located and the next are the *defining bounds* of future trajectories as published by the United Nations.

In the medium variant, the latest revision projects an additional 2.2 billion people in the world by 2050. However, even the simplest division into developed and developing economies shows that almost all people will be added in developing countries. The population of developed countries is projected to maintain fairly stable at 1.3 billion. Thus, the increase of people is located in those countries at the lower end of the development ladder, a situation that will certainly put pressure on societal and economic development in these countries.

However, while the location of additional people is easily and (most likely correctly) established - at least within the mentioned general division of country groups- the precise amount is by far harder to predict. The United Nation's world population prospects

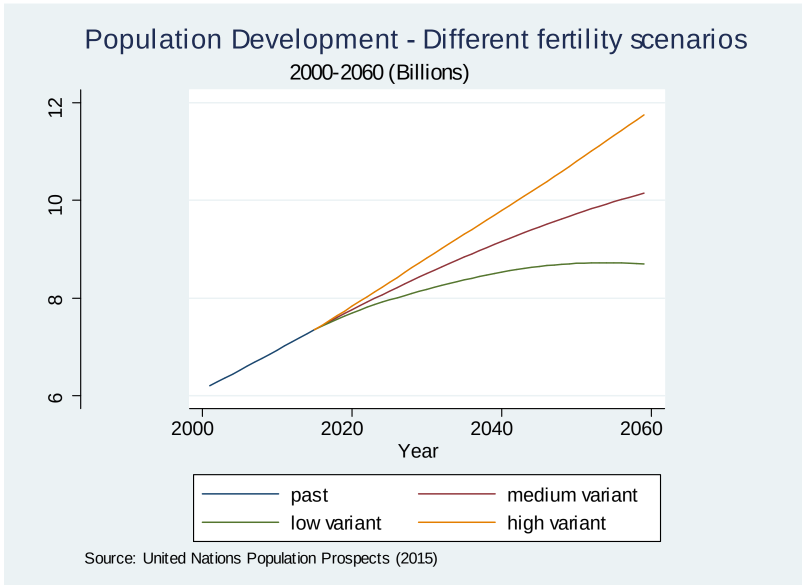

Figure 1·1: World population development for different fertility scenarios, 2000-2060

therefore present next to the medium also a high and a low variant. Figure 1·1 presents a replication of the different variants based on data from the report for the years 2000 - 2060. The difference projected between the high and the low variant within five years (by 2020) amounts already to 350 Million people, or the current population of the United States. A bit further down the road, by mid-century, this difference already amounts to 2.6 billion people (10.9 vs 8.3), a number that has vast impacts on resources, the environment and human development. Even though there is no doubt that numbers of additional people in the presented dimensions do affect human and environmental development and the pressure to understand their driving forces are high, it remains largely difficult to map future population developments with precision. The major reason is uncertainty about the decline in *fertility rates*.

The variants presented in figure 1·1 are based on future expected developments of

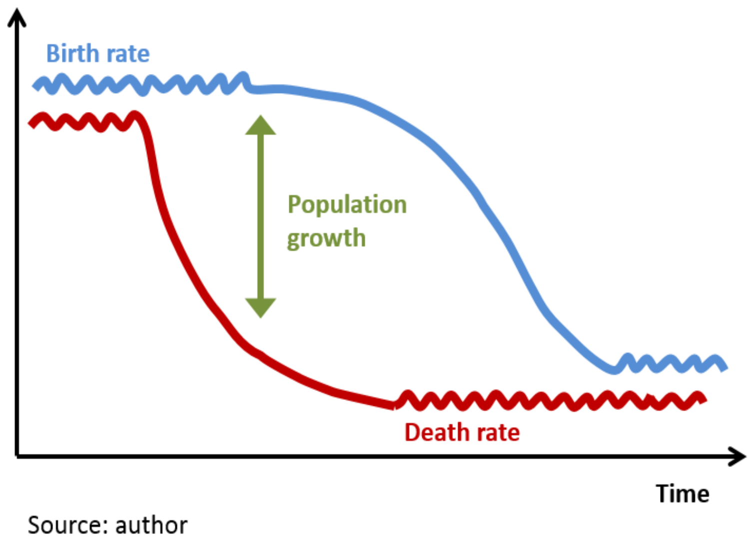

Figure 1·2: Demographic transition scheme

fertility (medium variant), with a margin of half a child more (high variant) or less (low variant) per woman. This rather flexible trajectory is sensible and mirrors the literature that debates about fertility decline. An answer to the question why fertility is the key can be retrieved when we look at the demographic transition model. A look at this model reveals why it is necessary to get fertility rates correctly predicted to make reliable estimates on population growth. A classic demographic transition occurs in several steps. It is characterized by (in principle) three phases (Coale 1984).

Naturally population growth occurs (mostly) from a difference in birth and death rates as depicted in figure 1·2. Now, looking at both factors in the time continuum (figure 1·2), the initial stage of the demographic transition is characterized by both, high birth and high death rates. As time passes the death rate (red line) starts to fall, which is the entry into the second stage. The arising difference between continuously high birth rates and falling death rates increases population growth. Eventually, when the birth rate starts to fall as well, population growth decreases again. The whole transition enters the final stage when birth and death rates have reached a lower level that keeps population growth again constant (just like at the beginning of the transition at both high and low birth and death rates). Explanations for a decline in mortality rates are generally easier at hand than for a decline in birth rates. As Bloom (2011) notes, "mortality decline is conventionally understood to be reflective of some combination of medical advances (...); dietary improvements; and public health measures focused on sanitation, safe drinking water, and vector control." (p. 564) Therein also lies an explanation why mortality rates are more easily predicted and forecasted: factors that affect a decline in mortality are potentially spread internationally conducive to international integration. Medical knowledge and technology for example is easily transferred to different nations once developed. In other words, as "leading" countries (e.g. industrialized countries) have already passed the stages and benefitted from the development of medical advances, these may be utilized by "late-comers" in the transition. In contrast to mortality, the underlying causes of the *decline in fertility* are not yet comprehensively understood, even more, they are subject to an intense debate (Shenk et al. 2013).

A closer look at the economic structure of countries reveals that those that have a higher birth rate are also those that are predominantly engaged in traditional, i.e. agricultural or primary, activities. The simple correlation is plotted in figure 1·3. Thus, as emphasized in the economic literature, which is one strand that explains fertility development (see below), modernization is potentially an important driver of fertility development. The relationship shown in figure 1·3 is one indication for an interdependence between economic development and modern economic structures. Another one, however, is the historic experience of already industrialized countries. When factories emerged and industries grew during industrialization, societal change took place. And this change also entailed a decline of birth rates during the era. However, while the onset of industrialization, its drivers

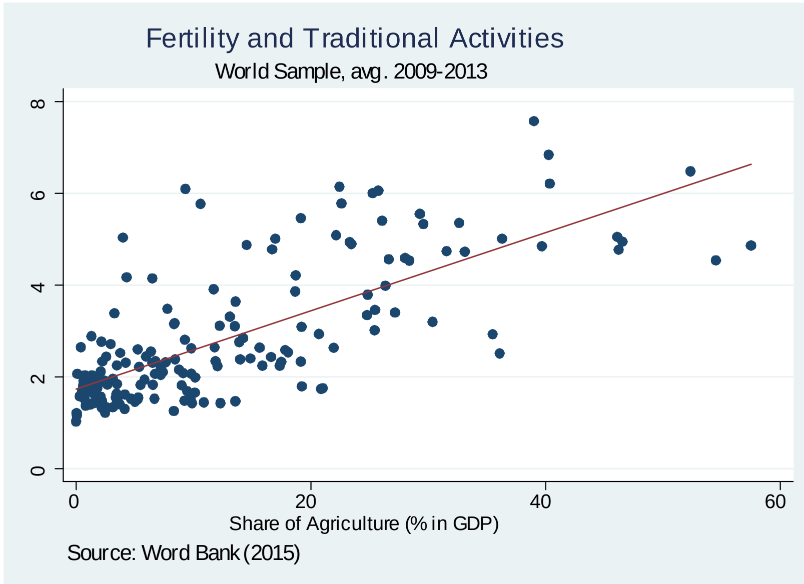

Figure 1·3: Fertility levels and engagement in agricultural production

and determinants for developed economies may be pinned down, at least in retrospective, there remains much discussion about modernization in the development economics literature on what may bring about economic growth and modernization in *today's* developing economies. Though, in connection with the hypothesized connection between fertility and modernization, an understanding of modernization's drivers would potentially directly feed into understanding population development. This thesis sets out to contribute to an understanding of the interrelation between fertility development and modernization, which entails structural change in the economic sense and which is an important interrelation in development trajectories.

1.1 Fertility decline and its drivers

The main disciplines rivalling about the theories of fertility decline and advocating their relative importance are economics, evolutionary anthropology and, perhaps obviously, demography. Theoretical statements about fertility decline are usually classified into three categories (Schellekens and van Poppel 2012). A mortality focussed strand, a cultural transmission strand and an economic/investment strand. Since the first rests fundamentally on the idea that fertility declines *after* infant mortality has declined, it is also called the classic demographic transition theory (see figure 1·2) dating back to Notestein (1945) and Davis (1945). The key factor that triggers fertility decline is infant mortality (Cleland 2001, Reher and Sanz-Gimeno 2007). To match increasing child survival rates parents will adjust (in this case lower) their fertility. Because this process is induced with a lag, population growth rises during the adjustment period. Similarly, though stressing the relative importance of mortality *risk*, Quinlan (2007) also predicts decreasing fertility rates in connection with lower infant mortality. In addition to a focus on child survival, also general mortality has been connected with fertility decisions. Unified growth theory (UGT), for example, finds that increased lifespans, as a consequence of lower mortality, allow not only greater payoffs to one's own education, but also to that of children (Cervellati and Sunde 2005).

The second set of theories about fertility decline circles around the idea of the diffusion of modern cultural norms within populations (Cleland and Wilson 1987). If these modern cultural norms are associated with fewer children their diffusion will bring about an ideational change that leads to a reduction of children born. Several mechanisms have been proposed that spread cultural norms (Shenk et al. 2013). Broader social classes adopt reproductive behavior or attitudes towards reproduction of an elite via mass media or directly through social contact (Basu 1993). A similar imitating mechanism is proposed for example by Richerson and Boyd (2005). Here the adoption of fertility norms takes place because people seek prestige and are inclined to follow the habits and behavior of people with (thought of) higher prestige. Also the influence of social networks (Kohler et al. 2001) and kinship (Newson et al. 2007) has been associated with the diffusion of low fertility norms. While contact with kin fosters existing sets of norms an increasing interaction with non-kin might also diffuse non-kin (potentially lower fertility) ideals. Social networks are similarly associated with the transmission of behavior or information affecting fertility norms. That is, people are more likely to adopt accepted reproductive behavior within their social network.

The third set of theories about fertility decline are economic and investment models. These models are mainly concerned with economic explanations for fertility decline and associate a change in socioeconomic conditions with changing fertility behavior. Having children is often associated with costs and benefits, and investing in them (and one self) is then connected with the decision of their quantity. Caldwell's (1982) wealth flows approach posits that depending on the economy, a child either consumes wealth (modern economy) or provides wealth through engaging in the labor market or working at home (traditional economy). More precisely, in traditional economies the wealth flow, the intergenerational transfer, goes from children to their parents. As societal changes occur, and the economy modernizes, this set up starts to lose its standing. The flow increasingly starts to reverse as parents increase investment in their children's education and leave larger bequests. Alongside may also occur a reduction in the willingness to pay for the elderly while increased educational levels enable people to save and invest in their offspring's education. Thus, depending on the economic environment, there are incentives either to have many or few children. A focus on human capital and reproduction has been pioneered by Becker (1960). His connection of rational choice theory with fertility decisions has since then been a major theoretical ground for economic explanations of fertility decline. In the basic framework families optimize a utility function that incorporates both, child quantity and quality along with other consumption. The quality of a child is usually associated with its health and/or educational level. In a subsequent framework of overlapping generations Becker (1992) introduces parents' investments in child education as a means of increasing the payoffs over their children's lifetime. This effect is strengthened with increasing returns to education that are brought about by modern labor markets. These same markets also work on the opportunity costs a family faces when raising children. As raising a child consumes time, parents will face increasing opportunity costs depending on their own level of education and position in the modern labour market. Therefore rising education (at the parental level) in combination with a modern labor market is also expected to induce couples to have fewer children.

In another strand of literature, clearly related to the economic and investment type models, the evolution of fertility has also taken an important role. In quest to explain poverty traps this strand of the economic development literature has turned to fertility and population growth as potential candidates (among many others) for the explanation of these development traps. The development or poverty trap is generally perceived as a stable, self-reinforcing situation that maintains poor living conditions. Oldest and well known is the trap formulated by Thomas Malthus; it dates back to the end of the 18th century (Malthus 1798). The therein described mechanism proposes mankind to be "trapped" in terms of economic development at around subsistence levels. Two core ingredients are necessary for the proposition. First, the standard of living is related positively to the growth of the population and second, one factor of production, in this case land, is fixed in supply implying decreasing returns to the other factors, such as labor. The prediction is that a small population may enjoy a larger standard of living while the opposite holds true for the reverse. That is either a "preventive check", i.e. the large population preventively reduces fertility or a "positive check", which is the reduction in births and increasing death rates due to malnutrition, disease or famine occurs on the population size. As carefully outlined in Galor and Weil (2000) this proposition used to be very much in line with the experience of humankind throughout most of its history. Accordingly the standard of living did not change much in Europe for centuries and even more, in China it is estimated that the real wage was even higher at the beginning of the first century than at the end of the 18th century (Kao Chang 1986). Similarly, population growth did hardly occur for long periods of time. Livi-Bacci (1997) estimates this rate to be 0.064 % annually between year 1 and 1750 for the world. However, and ironically as Galor and Weil (2000) also note, the situation changed right after the time of Malthus and population figures rose but still were outpaced by output growth implying growth of per capita output throughout most of the western countries.

The idea that population development may be related to the emergence of poverty traps, however, remains popular also after Malthus. Nelson (1956) presents a neo-Malthusian version essentially implying the same trap at work. However, during the 1950s this model was designed to specifically explain prolonged underdevelopment in least developed countries, especially in Africa. It assumes income generating production that depends on investments through savings. Further, at low income levels - in this case around subsistence - the relationship between small income gains and population growth is assumed positive. This is due to a inverse relation between income and mortality. A decrease in mortality will thus spur population development and thus dilute any potential increases in the income level making savings and investments impossible. The poor economy therefore remains trapped in this so called low-level equilibrium. Besides the savings and investment channel to increase physical capital, that in the above mechanism may not be tapped to improve growth, another channel has been proposed in relation to population development: investments in human capital. It may be that they also follow nonconvexities and require a certain threshold after which increasing returns take over (Azariadis and Drazen 1990).

Both, the look at the original Malthusian ideas as well as the neo-Malthusian specific focus on least developed countries shows that rising income initially boosts population growth. However, at higher levels of income (i.e. the experience of advanced economies) the opposite appears to hold. The relationship between income and fertility behavior is thus not straight forward. Explaining both, the Malthusian stagnation and the modern take off phase is at the core of unified growth models. Unified growth theory has made use of the quantity-quality trade-off and the modernization aspect to explain fertility decline in several ways. In e.g. Soares (2005) or Galor and Weil (1999) mortality impacts on the cost of educating children, while in, e.g., Galor and Weil (2000) technological progress raises returns to education.

Further, more recently, globalization has been proposed as a determinant of fertility levels. Or, as Do et al. (2014:1) argue, "in an era of ever-increasing integration of world markets, the role of globalization in determining fertility can no longer be ignored". Most prominently Galor and Mountford (2008) present a model where international trade, determined by Ricardian comparative advantages, leads to changes in fertility levels. The model shows a mechanism where globalization may be a drag to the decline of developing countries' fertility rates. Theoretically international integration has also been connected to population outcomes via slightly different channels, that, however, point to the same underlying quantity-quality mechanism. Rees and Riezman (2012) argue that globalization that creates market opportunities for women has an effect on human capital creation, in the way that it increases schooling among children. Contrarily, created market opportunities for men do not lead to this development. Similarly, Do et al. (2014) present a model that comes to similar conclusions. However, they pronounce the importance of female labor-intensive comparative advantages. In countries that have a comparative advantage in female labor-intensive goods, the relative wage, and therefore the opportunity costs for women, is higher. This, in connection with the Becker-type mechanism, generates lower fertility. To sum up, to the degree that female labor-intensive goods (Do et al. 2014) and human capital intensive goods (Galor and Mountford 2008) are similar and globalization creates market opportunities for women (Rees and Riezman 2012) these theories may also empirically be picked up with more detailed trade data.

The empirical literature on fertility's determinants has also produced ample, though sometimes mixed, evidence for influencing factors. Classic demographic transition theory emphasizes the role of mortality and, especially, infant mortality. The main mechanisms put forward are a hoarding and a replacement effect. While the latter describes that parents will try to replace a lost child, the former stresses that in anticipation of a mortality risk more children will be born than generally desired. This strategy insures against eventual losses. Existing studies could well establish a decline in total fertility in relation to a decline in infant mortality. Palloni and Rafalimanana (1999) present evidence from both, country- and individual-level data, for Latin America based on Demographic and Health Survey (DHS) data. The effect of infant mortality on fertility in pooled cross-sectional time-series data is positive with coefficients between .1 and .5. More recently the link between infant mortality and total fertility has also been established at the country level in, e.g., Lorentzen et al. (2008). By analyzing a cross-section it is shown that infant mortality is among the important predictors of total fertility. The latter result could also be replicated at the country level in Angeles (2010). The similar effect of infant mortality on total fertility holds in a large cross-country sample of around 110 countries. However, while the effect on total fertility is straight forward and rather clearly established, the effect on net fertility remains ambiguous (Canning et al. 2013, Doepke 2005). That is, if infant mortality decreases total fertility with an estimated marginal impact of anywhere between 0 and 1 net fertility would at most remain unchanged. More likely, net fertility and thus population growth would go up. Existing empirical evidence on the impact of infant mortality on net fertility is unclear. While Angeles (2010) also presents estimates of a positive relation between infant mortality and net births, Canning et al. (2013), in a micro-level study, find no net effects. Moreover, in their study the missing, and thus population growth neutral, impact of infant mortality on net births can only be established once interdependent preferences are incorporated. These are preferences where an individual's fertility choice affect that of others and consequently may magnify or increase the effect compared to the previous situation without interdependent preferences. Doepke (2005) puts forth that even though net fertility declined alongside infant or child mortality other factors are responsible for the observed large reductions in net fertility rates. So, while the role of mortality on net reproduction is rather contested, its role in reducing total fertility is clearly established.

Another factor, besides infant mortality, is, as presented in Doepke (2005), education. According to the theory, education may influence fertility decisions in several ways. Most often found in economic and investment models is the role of female education. Female education may serve as a proxy for the shadow value of time and therefore be a testable determinant for the presence of Becker's quantity-quality trade-off. Angeles et al. (2005), in a micro-study of Indonesian women between 1960 and 1993, find that indeed female education has a negative impact on fertility rates, also after controlling for potential endogeneity. Similarly, Murtin (2013) reports a negative effect of schooling on birth rates for a sample of 70 countries between 1870 and 2000. The results maintain significance in a number of sub-samples that use different starting dates of the time series. Especially developing countries start a lot later than 1870. Further, Murtin (2013) reports a dominant effect of primary education on birth rates in the cross-country analysis. For the region of Sub-Sahara Africa (SSA) Bongaarts (2010) presents significant negative partial relationships between education and fertility. Based on descriptions of DHS data it is shown that with rising educational attainment a) the use of contraceptives increases, b) desired family size decreases and c) (unsurprisingly) fertility decreases. Additional country-study evidence is presented in Osili and Long (2008). Based on national DHS data they find that an additional year of schooling reduces fertility by .26 births. Conversely, Geruso and Royer (2014) find that additional schooling in the UK contributed to less teenage pregnancy, however, it could not reduce completed fertility. The connection between education and social empowerment and fertility is also presented in Skirbekk and Samir (2012). However, in this study (female) educational attainment is less interpreted as a shadow value of time but rather as a proxy for a change of (women's) social status and therefore a diffusion of modern norms. All in all it appears, that especially in developing countries studies could establish the link between female education and fertility robustly (Duflo et al. 2014).[1]

Since the theoretical underpinning in the Becker-type model trades off child quantity (numbers) against child quality (their health and education), there have also been attempts to more directly establish this empirically with the help of school enrollment rates and birth rates. Historic data from around the European fertility transition has been often employed. Dribe (2009), for example, finds a negative relation between the number of teachers and fertility rates in Sweden between 1880 and 1930. Becker et al. (2010) make use of Prussian historic census data and present evidence that the quantity-quality trade-off existed at that time. The dataset is compelling because a (not strictly enforced) law enabled parents to send their children to school without punishing them when they decided not to. In a similar vein Bleakley and Lange (2009) made use of an presumably exogenous shock to the price of child education (i.e. child-quality). The eradication of the Hookworm disease dramatically increased school attendance and was accompanied by a decline in fertility rates.

While female education is clearly established as an impact factor on fertility levels, there is also evidence that the quantity-quality trade-off has played a role (at least) in the historic experience of developed countries.

Income is another factor that may well determine fertility outcomes. The socioeconomic

[1] However, for an account of the impact of female eduaction on fertility in developed economies during (or even pre-) transition time see, e.g., Becker et al. (2013) for Prussia or Murphy (2010) for France.

idea that connects income with fertility rests to a large degree on the ideas of Becker (1960, 1992). However, in the Becker setting rising income in fact induces both, demand for more quality as well as more quantity. So declining fertility can only be achieved with relative elasticities favoring quality demand. But rising income may theoretically also lead to an increase of fertility. A different approach, though stressing the same point (i.e. that income may not have a clear impact on fertility) is found in Docquier (2004). With a focus on inequality it is argued that at the macro-level it may well depend on the distribution of income whether fertility declines or rises. Cross-sectionally, with different income levels there may be confounding effects of income on fertility. In many cross-country empirical studies the level of income is controlled for, however without disentangling the precise mechanisms.[2] Thus, empirical studies could mostly not establish universal impacts. Murtin (2013), in a cross-country analysis, found that at low levels, income may be positively related while not having much of an impact afterwards. Amarante (2014) presents opposing findings for a sample of Latin American countries. The level of income measured by GDP per capita is negatively associated with fertility rates. Another recent study, Brückner and Schwandt (2014), finds that changes in per capita GDP are positively associated with changes in fertility, while Angeles (2010) finds the impact of GDP per capita on fertility is dependent on covariates and estimation method.

Female labor force participation has also been a well discussed factor in the discussion about the determinants of fertility. However, empirically it has mainly been analyzed in the context of developed countries and the consensus about its relationship appears to be that its impact is vastly influenced by modern countries' institutional settings (Ahn and Mira 2002). The institutional settings are related to child- or day-care opportunities as well as financial support to obtain these. Societal norms naturally may also influence the

[2] Income also interacts with already discussed factors. For example in the education-health relationship (e.g. Clark and Royer 2013) it is discussed as a mediator variable.

relationship between labor force participation and fertility. Further, as long as women are mainly concerned with child rearing, there is a direct interdependence between fertility and female labor force participation obscuring empirical findings. For developed countries Engelhardt et al. (2004) find impacts running in both directions. For developing or low income countries the relationship may depend upon the sector that is dominant in employing women. While employed in a modern sector, women may find it impossible to rear children. However, while employed in (self-sustaining) agriculture the rearing and supervision of children may not be as problematic.

More modern economic structures may also be approximated by female labor force participation and related to fertility as a determinant. Another way to measure modern structures, relating to either socioeconomic or diffusionist theoretical backing, or both, is to use urbanization as a proxy variable[3]. Historically western economies urbanized in a wave of structural transformation from agrarian to industrialized economies. A phenomenon that clearly impacted on reproductive behavior via both socioeconomic and ideational change. The change in economic opportunities that came along with industrialization is at the core of unified growth models[4] that explain a decline in birth rates (as a consequence of the changing structures in the economy and society) which eventually shifted resources towards the growth take-off that followed. In most models the emphasis is on technology, brought about by industrialization, that lead to an increase in the demand for education. This, by increasing the returns to education, induced parents to invest in their offsprings' schooling. However, due to the quantity-quality trade-off, a lower fertility rate was the result. The empirical assessment of the role of modernization in determining demographic outcomes has, as indicated, often taken the form of looking at urbanization. Urbaniza-

[3]The demographic literatures' reasoning to assess urbanization's impact on fertility is that it represents the spread of modern social norms.

[4]See for a seminal review Galor (2005).

tion, by reflecting both, modern norms and economic opportunities, has historically been an accompanying phenomenon of industrialization. And as industrialization has preceded the demographic transition in western economies (Clark and Cummins 2009), urbanization may serve as an approximation of modern aspects of an economy. Amarante (2014) has found that the share of rural population, which is the inverse of urbanization, is significantly positively related to fertility, or, in an instrumental approach, positively, but not significantly associated with fertility in a sample of Latin American countries. Similarly, Beine et al. (2013) find mostly significant negative effects of urbanization on fertility, however they also lose some significance once an instrumental approach is adopted or when the sample is constraint to developing countries. Throughout negative and significant effects of a control for urbanization are presented in Berrebi and Ostwald (2015), however the sample always contains the full set of countries in the world. Canning et al. (2013) present both possible effects of an urban indicator. Negative, at the individual level and positive at the country level. It appears that urbanization does not necessarily present a negative impact on fertility (Kalemli-Öczan 2012), nevertheless, if the sample is large enough and comprising of a (heterogeneous) world sample, a negative significant relationship becomes visible.

1.2 Fertility and trade

A very recent, and thus still small, theoretical literature proposes that there may well be an impact of globalization on fertility outcomes (Galor and Mountford 2008, Do et al. 2014, Rees and Riezman 2012) or fertility related outcomes (Sauré and Zoabi 2014).

Galor and Mountford (2008) present a formal theory of the effects of international integration on fertility outcomes across both, developed and developing countries. A differential effect between these country groups arises from a difference in the composition of trade of these countries. While the industrialized group of countries trades more in modern products, the developing economies trade more in traditional products. Comparative advantages will make both groups better off by trading and generate benefits. However, these two broad categories of tradables differ distinctly in their demand for skills (and thus human capital) in their production. While traditional products are more associated with the use of lower skilled labor, modern products require a higher degree of skills. Trade will therefore induce more demand of physical (lower skilled) labor in the countries that trade these products, while the opposite holds true for the group that trades in modern sectors. That is, the latter group is assumed to show more demand for skilled labor due to requirements of modern products' production processes. At this point the quality-quantity trade-off (Becker 1960, 1992) is introduced. Given the opportunities on the labor market, parents face the decision to either have more children that are less educated or fewer, but better educated ones. Since the demand for skills is not given equally across countries, there is a bigger incentive for parents to reduce the number of children only in those countries that show a greater demand for human capital. So essentially trading may affect the decisions to have children through the potential earnings channel of children which opens up through demand in human capital or educated workers. While this is most prominent exposition of a relationship between trade and fertility (and ultimately income) the idea also appears in Do et al. (2014) and Rees and Riezmann (2012). It leaves testable implications for determinants of fertility, namely the influence of trade flows. Indeed there do exist empirical expositions for the proposed relationship. Galor and Mountford (2008) themselves present evidence in support for the theoretically developed mechanism. A cross-country sample of 132 countries is used to regress trade openness upon fertility (and control for infant mortality and GDP). The factor content of trade (low vs high skilled) is implicitly introduced through a sample split according to OECD membership. OECD members are thus assumed to have a higher skill component in their trade than non–OECD members.

The five year sample between 1985 and 1990 indicates that the effect of trade on fertility is negative in OECD countries, while the opposite holds true for non-OECD countries. In the specification an important determinant, mortality (Doepke 2005, Angeles 2010), is controlled for. However, uncontrolled for, and important according to, among others, Becker et al. (2010), is the level of female education. It is considered particularly important as it not only approximates foregone income, but also the ability to oversee reproduction-related health outcomes. The latter is especially important in the context of developing economies (Osili and Long 2008, Duflo et al. 2014). Further, female labor force participation has also been identified in the empirical fertility literature as an important determinant (Bloom et al. 2009). Thus, to identify robust effects of the trade mechanism, it is also necessary to control for the impact of female labor force participation on fertility in the estimation.

Similar to Galor and Mountford (2008), Do et al. (2014) present a formal mechanism between fertility outcomes and global integration. And the empirical extension uses far more detailed trade data to support the theoretically developed channel. However, the robustness towards the established determinants of fertility is yet to be confirmed. More directly speaking the role of infant mortality (Lorentzen et al. 2008, Angeles 2010) is not comprehensively accounted for, while the same is true for education (identified in e.g. Becker et al. 2010). As the empirical acceptance of the theoretically proposed channels hinges on the degree to which it's relevance is tested within already existing knowledge, a comprehensive empirical specification accounting for existing determinants and newly proposed ones is necessary.

Chapter 2 of this thesis contributes to fill this gap in the literature and relates empirically trade patterns to population development. It is entitled *Trade and Fertility in the Developing World: The Effects of Trade and Trade Structure* and based on the identically entitled paper written jointly with Thomas Gries and published in 2014 in the *Journal of Population Economics*. Prior to publication it has been presented to the research community on several occasions. The chapter focusses on the role of international (trade) integration in determining fertility rates across the world and builds mostly upon the theoretical advances by Galor and Mountford (2008). It builds upon the theoretically developed idea that trade differentials, which are related to the human capital content of trade, impact on fertility rates. These theoretical advances are incorporated into a fully developed cross-country empirical estimation of fertility levels. Building on relatively detailed trade data, the chapter presents evidence that, along other (well established) determinants, differences in the human capital content of trade also impact on the local country-average fertility level. In more detail that is manufacturing exports are found to correlate negatively with fertility levels while the opposite holds true for primary exports. In other words, the more skill-intensive exports take place the more likely it is that fertility levels react to this negatively due to a presumed increase in demand for higher education. At the same time the analysis reveals in a more in depth analysis, that these effects vary across country groups and that the effects are comparatively small in relation to other determinants of fertility levels.

There are several contributions to the literature. The main contribution to the literature is that the theoretically developed linkages are empirically supported. By doing so, the empirical analysis expands and deepens existing knowledge. First, it challenges the hypothesis to hold within richer specified empirical fertility models. That is, acknowledged fertility determinants such as education (e.g. Azarnert 2008) or female labor force participation (e.g. Bloom et al. 2009 or Mishra and Smith 2010) are introduced into the specifications alongside the trade variables that are tested. Second, by looking at different country groups, it is possible to expand the empirical knowledge and suggest the theoretically hypothesized channel to vary in intensity. More precisely, it is found that the least developed countries do not face the same effects as more advanced countries. While the proposed negative impact holds within the complete sample, a split according to development levels reveals that least developed countries do not show the negative impact of manufacturing exports on fertility levels. Presumably - as suggested in the chapter - because the impact may simply not be measurable. Third, the contribution also expands the analysis from an econometric point of view. In a panel setting it is possible to account for a source of unobserved heterogeneity that may lead to an omitted variable bias. In the empirical fertility literature culture or religion are frequently named factors that are often not measured and accounted for. The panel set up in the chapter enables to control for this source of unobserved heterogeneity. And lastly, the use of an instrumental estimator is further strengthening the estimation results.

1.3 Fertility and modernization

Modernization, in a broader sense both, economic- and norms and values-wise, has, as the previous section also suggest, been crucial for and interrelated to fertility development. A traditional measure for modernization has long been the degree of urbanization.[5] The justification of this procedure rests to a large degree on the historical urbanization patterns of today's industrialized countries. That is, modern economic structures increased the degree of urbanization heavily. E.g. in England the spread of larger factories and the adoption of new production technologies (most prominently, for example, steam engines) during the 1850s were followed by a substantial increase in the concentration of people living at the same place. This trend towards densely populated areas was subsequently further manifested. While the labor force in manufacturing doubled in England between 1850 and 1880, the urban population also doubled during the same period (Kim 2005).

And because industrialization has preceded the demographic transition (Clark and

[5] Even further, the correlation between urbanization and income has been perceived that strong that urbanization has sometimes been used as an approximation for the level of development (Jedwab and Vollrath 2015).

Cummins 2009), modernization in the form of urbanization is regarded as an impacting driver of reproductive behavior. However, the impact may occur through both, socioeconomic and ideational change. An important aspect of socioeconomic change alongside industrialization is the change in job opportunities. With a change in production technologies and a concentration and centralization of production, urbanization goes along with the demand of better educated workers. Again, the quality-quantity trade-off may become apparent as parents restrict their number of offspring in order to enable them (the children) to benefit from better paying jobs (that require a certain degree of education) in the industrializing economy. Similarly, as emphasized in ideational change point of views, urbanization also enables the effective spread of modern social norms regarding reproductive behavior.

The use of urbanization as an indicator for modern structures has been a leading approach in cross-country empirical growth models (e.g. Acemoglu et al. 2002, 2005, Dittmar 2011) and, due to the aforementioned channels, also found its way to empirical studies seeking to explain fertility behavior. However, as noted in Kalemli-Özcan (2012), urbanization has not proven to be a consistent predictor in determining fertility levels. Amarante (2014) has used its inverse (the share of rural population) and finds a positive impact, significant, however, only when it is not instrumented for. The results are valid for Latin American countries, which also represent a rather homogeneous group. In Beine et al. (2013) the significant negative effect of urbanization is only maintained as long as the sample is not constraint to developing countries. Further, the notion that the effect of urbanization on fertility rests to a degree on the sample selected is supported by Berrebi and Oswald (2015) where significant negative effects of an urbanization control are maintained in a world sample. Another recent study reports similar mixed results for an urbanization control variable in the estimation of country-wide fertility levels. A sample of developing countries shows both negative and positive correlations in Canning et al. (2013). A possible explanation are different restrictions on the set of countries.

Even though the idea that modernization brings about a change in reproductive behavior persists, the empirical implementation of urbanization as its indicator has led to mixed results as indicated above. A reconciliation may be, however, a recently proposed refined view about the causes of urbanization especially in the context of developing countries.[6] The proposition has profound implications for urbanization's interpretation as a modernization proxy in developing countries. It is those countries, however, that, as presented in the introduction, would gain most from understanding the mechanisms of fertility decline. Therefore, the connection of the recent notion of underlying causes of urbanization with fertility in this country group appears sensible.

Gollin et al. (2014) show that urbanization does not necessarily follow from a concentration of productive facilities. It may also be an outcome of unevenly distributed rents contrary to (more) evenly distributed payments for labor's productivity. Both scenarios imply stark, opposing implications for reproductive behavior. While "productive cities", which is the coined term for urbanization with roots in growing productive and labor intensive capacity, may generate the mechanism that leads to an on average decline in fertility, "consumption cities", where income opportunities are kept highly unequal, may not generate the mechanisms that drives down fertility. At the same time both situations may be described with an equal degree of urbanization.

Chapter 3, entitled *Fertility and Modernization: The Role of Urbanization in Developing Countries*, brings together cross-country fertility estimation with this recently proposed aspect of urbanization in developing countries and fills the literature gap by introducing the refined view into the modernization and fertility relationship. It is also based on joint work with Thomas Gries and has been published under the same title in the *Journal of*

[6] The notion of urbanization without growth during the end of the 20th century in develping countries (and especially in Africa) has earlier also been described in Fay and Opal (2000).

International Development in 2015. While chapter two focusses on a very specific, though theoretically well developed channel, this chapter focusses on the general relation between modernization and fertility in developing countries. Even more, it introduces the currently developed view of urbanization as a modernization proxy in developing countries into cross-country fertility analysis.

In chapter three, a distinction is made to account for this differing notion urbanization's quality on the background of Gollin et al. (2014)'s findings. Gollin et al. (2014) argue that urbanization may be the outcome of two different processes. Either labor flows from agriculture to the industrial sector, i.e. "production cities" arise, or rents from e.g. resource extraction demand urban services and lead to "consumption cities". With regard to the mechanisms of fertility decline the incentive structure to reduce fertility may look differently in both types - consumption cities vs production cities - of economic structures.

It contributes to the literature in several respects. First, it is a comprehensive empirical cross-sectional country study of aggregate fertility behavior in developing countries with a focus on modernization. However, it not only allows for socioeconomic (demand) theory on fertility change, but also ideational change ideas that are advocated by many demographers. A basic idea of ideational change models is that modern social norms diffuse most in agglomerations where people are living in greater density. An ideational change towards low fertility norms may therefore be detected. Moreover, there need to be supportive structures for these ideas to spread. The latter may well depend - as the chapter argues - on the agglomeration's characteristics. Second, it incorporates recent findings in development research on the causes of urbanization into population research. And third, it introduces interaction modelling in fixed-effects panel estimations to trade-off sample availability and informational content. The empirical analysis reveals that urbanization may indeed be of a different quality with regard to its capacity to induce fertility decline. While urbanization that is characterized by higher slum incidence, presumably the type neither supplying enough higher paying manufacturing jobs nor having the supportive structure for ideational change, does not lower fertility, the opposite is true for 'better quality' urbanization, i.e. of the type with lower slum incidence.

1.4 Modern sector development with trade and institutions

In socioeconomic models the mechanisms that lead to changes in fertility are closely connected with economic modernization and industrialization as will be presented in chapters two and three. Further, not only the connection is well accepted but it also seems that modernization has a profound impact on fertility. Naturally this implies that once countries change their economic structure and industrialize, people will be employed in jobs with a higher productivity and benefit from income gains. This process may trigger a change in reproductive behavior and channel resources to educate fewer children better. A reinforcing positive loop may occur. If this process of declining fertility may be triggered by a modern sector expansion, the question is how? What is necessary for the industrial sector, the modern sector in developing countries to develop?

A look at the literature confirms that the importance of a modern sector for countries to develop has widely been acknowledged. This includes empirical contributions (e.g. Szirmai 2012, De Vries et al. 2012, Peneder 2003) but as well analytical ones (e.g. Duarte and Restuccia 2010 or Dekle and Vandenbrouke 2012). Szirmai (2012) analyses the importance of manufacturing growth for overall development in a long time-series sample of developing and developed countries. The findings indicate that industrialization has played an enormously important role in recent growth stories up to the present and supports the *engine of growth* hypothesis for the industrial sector. Similarly, De Vries et al. (2012) find beneficial aggregate growth effects of sectoral shifts for the BRICs, however with the restriction that a distinction between formal and informal activities within sectors has to be made. That is, the positive effect is found when resources (i.e. labor) are shifted towards formal activities that are associated with higher productivity. By focussing on developed countries Peneder (2003) finds in panel estimations a positive effect of structural variables on aggregate growth in the 1990s. Even though he does not explicitly link the modern sector to aggregate growth, Rodrik (2013) also underlines its importance. In a study of convergence it is found that labor productivity in the industry sector does converge in a cross-section sample of countries from the complete range of incomes.

A next set of related literature describes the characteristics of the industrial sector. Typically - and regarded as central in the production process - the modern manufacturing sector enables the accumulation of capital (Szirmai 2012). Especially during the initial stages of development the possibility to accumulate capital within the dominating primary sector is scarce. The higher (average) capital intensity in industry therefore allows for this shortcoming of the agricultural sector to be ameliorated. Possibly connected to the aforementioned accumulation of capital is another characteristic of the modern sector. It is generally assumed to be possible to generate higher productivity increases than the traditional sector. This effect has been coined as the structural change bonus (e.g. Rodrik 2009). Further characteristics include opportunities of economies of scale and linkage and spillover effects (Szirmai 2012). Especially the latter are frequently assumed to present positive externalities of investments in knowledge and technology that occur both within and across sectors.

The importance of linkages and spillovers is also presented in the literature that connects modern sector trade with (overall-) growth. Herzer et al. (2006) argue that knowledge spillovers and diffusion within the sector will take place when companies start to engage in trade and export their products to the international market. Similarly, it is found that when modern sector companies start to compete internationally and export, their productivity may increase (Van Biesebroek 2005). In his study Van Biesebroek (2005) finds that higher productivity exists in companies that export. While this can still be explained with self-selection, the subsequent finding that productivity increases after exporting has commenced, is evidence that exporting is beneficial for productivity enhancement (e.g. also in Melitz 2003 or Dogan et al. 2011). Besides supporting the sector's own development, exporting manufacturing products also alleviates price instabilities resulting from primary products (Hesse 2008). Primary products' prices fluctuate a lot more than secondary products' prices at the global scale. Based on the modern sector's characteristic of special capital needs, or - put more positively - special investment opportunities, it is also sensible to look at the literature that posits institutions to be of major importance for that sector's development. Acemoglu et al. (2001) focus on the risk of expropriation, which, as part of the institution of property rights enforcement, may be important for development. Empirically this has also found some support in the firm-level literature. Johnson et al. (2002) find that weak property rights weaken the investment environment and lead companies to not invest into their businesses.

While the necessity for developing countries to develop a modern sector has been widely acknowledged, and several aspects, such as trading and sound institutions, have been widely discussed in the general growth context, their introduction as direct determinants of modern sector development has not yet been studied.

In chapter four, *Crucial for Modern Sector Development? The Role of Exports and Institutions in Developing Countries*, this lack of evidence is picked up. The chapter is also related to the theme of modernization in developing countries, similar to the previous ones. It has been presented to the research community on several occasions and is based on a jointly written paper with Thomas Gries. While chapters two and three empirically connect the degree of modernization as a determinant of fertility levels, chapter four shall focus on the drivers of modernization itself, or, operationally defined, on the emergence of a modern (industrial) sector. What are the specific drivers for modern sector development?

Based on the finding that a formal industrial sector exhibits benefits for further general development the chapter empirically explores its potential determinants. The necessary theoretical underpinning is taken from the general and broad economic development literature that argues for the relative importance of different determinants. A first major focus is placed on trade, and especially manufacturing exports. Manufacturing exports are positively associated with a country's overall development for predominantly two reasons. First they take volatility from a primary products trading economy and second they induces productivity gains and spillover-effects within the sector. Another focus is placed on institutional development. Also from the broader growth literature (e.g. Acemoglu et al. 2005, Rodrik 2002) it can be derived that especially having secure property rights has potentially large impacts on capital accumulating behavior and investments within the sector. Other discussed aspects such as the role of natural resources or aid are also picked up in the empirical analysis of developing countries.

The chapter contributes to and enhances the literature in three ways. First, it establishes that the two well discussed factors of per capita growth are key determinants of modern (manufacturing) sector development in developing countries. In a cross-country sample of over 70 countries and a lengthy time span of over 30 years not only the recently introduced cross-country convergence (Rodrik 2013) is supported but also extended with knowledge about key drivers. Second, it uses an up-to-date empirical estimation strategy to control for possible endogeneity in a dynamic panel setting. The major results of a positive impact of exports on the manufacturing sector and the driving role of sound institutions on that sector hold across various specifications and estimation strategies. And third, it derives more nuanced results across the large sample of 75 developing economies according to their development level. Especially for exports there appears to exist a nonlinearity within the level of development of the countries in the sample. A simple division according to the World Bank's income categories reveals that exporting does support the manufacturing sector's development only for the richer two country groups according to the World Bank classification.

Chapter 2

Trade and Fertility in the Developing World: The Impact of Trade and Trade Structure

This chapter is based on joint work with Thomas Gries and published with slight differences in the Journal of Population Economics (2014), 27(4):1165-1186.

2.1 Introduction

Both trade and fertility are important issues in the development economics debate. How does international trade affect a country's development? What are the causes and effects of fertility in the development process? An important recent contribution by Galor and Mountford (2008, 2006) proposes that these two factors, trade and population development, are interrelated. The authors suggest that international trade between developed and developing countries asymmetrically affects the demand for human capital in these countries. High trade-induced human capital demand in developed countries contributes to a decrease in fertility rates while the opposite, i.e., a lack of human capital demand, leads to an increase in fertility rates in developing countries. In the tradition of unified growth theory (e.g., Galor et al., 2009, Galor and Weil 2000, McDermott 2002, Doepke 2004 or Galor 2011) they analyze both developing and developed countries and argue that world trade intensification asymmetrically affects the pace of demographic transition across countries. Naturally, demographic transition is characterized by an initial decline in mortality rates followed by a corresponding decline in fertility rates.[1] However, as its onset and evolvement is neither a simultaneous nor uniform process and its implications for income distributions are great, understanding it is vital. Accordingly, especially in the light of ongoing vast trade intensification (WTO 2006, 2011) over the past decades it appears to be an important theory that connects trade and demographic development and contributes to an understanding of the immense differences in per-capita incomes across countries.

In a stylized two-economy model Galor and Mountford (2008) propose a mechanism that explains the current distribution of the world population and the "Great Divergence" in income per capita across countries. While the controversy about the divergence in income levels and its explanations[2] include differences in institutions, geographic locations, human capital formation, and colonialism, their proposition rests on the role of international trade and increasing globalization patterns.[3] In brief, they propose that international trade affects economies differently due to their different trade composition. While in industrialized economies the gains from trade will be directed towards investment in human capital formation, in developing economies they will be directed towards population growth. Specifically, they assume different levels of technology within an agrarian and a manufacturing sector. These sectors differ in relevance and size in industrialized and developing economies. While industrialized economies rely on strong technology-intensive sectors, developing countries rely on the opposite, which are less skill- but more labor-intensive sectors. Resting on the presumptions of comparative advantage, international trade deepens developed countries'

[1] For a detailed account of the demographic transition, theory, and trends see recently e.g., Galor (2012), or earlier, Bloom et al. (2003) or Lee (2003). See Strulik and Vollmer (2013) for an evolutinary account of cross-country fertility dispersion.

[2] Galor and Mountford (2008) provide a brief overview of the most important papers in the respective areas.

[3] Other theoretical contributions that connect world trade with fertility decisions are Lehmijoki and Palokangas (2009) and Sauré and Zoaby (2011). While the former focus on wage and income effects induced by international trade, the latter concentrate on the development of female labor force participation in connection with international trade and the resulting fertility and growth effects.

specialization in skill-intensive, industrial and technologically advanced goods, while countries that focus on less skill-intensive and more labor-intensive goods specialize in those sectors. The result is that gains from trade are channeled into the demand for human capital in developed economies, while in developing economies the demand for unskilled labor could rise. This leads to a gradual investment in the quality of the labor force in the former group of countries, while the latter group may invest more in increasing the size of the labor force. Now from a household's point of view, this means that in an industrialized, skill-intensive economy there is an incentive to have smaller families and provide one's children with better education. Parents optimize their own consumption and the potential income of their offspring. Naturally, skilled workers have greater income potential. Assuming that it is more resource-intensive for parents to raise skilled than unskilled offspring, they decide on the number of children and the amount of time they want to devote to raising them. This is essentially a decision on whether to raise skilled or unskilled children. As raising skilled children requires more time and money, they will restrict themselves to having fewer children. However, if there is demand for human capital these children later have a greater potential income (a significant return on human capital) which is an incentive for parents to invest in their children's education. From the macro perspective this is an aspect of demographic transition, namely a decline in fertility rates. According to theory, in an economy with intensive use of unskilled labor this driver of demographic transition is absent, which leads first to a divergence in countries' fertility levels and eventually to a divergence of per capita income levels. All in all, we learn from the model that the structure of the export sector is significant in determining the impact of international trade on fertility (and income). If the theory holds, one could ask whether the development of advanced economies adversely affects the development of less-developed countries (Galor and Mountford 2008), the answer to which contributes a more nuanced aspect to the debate on whether trade encourages income growth.

Galor and Mountford (2008) also provide empirical evidence for the proposed relationship. In a conventional cross-country sample of 132 countries fertility is regressed upon trade openness, while in another sample of 97 countries the average years of schooling are regressed on openness. The chosen period is 1985 to 1990. Since theory requires a division of the sample according to the factor content of trade (human capital intensive vs. unskilled labor intensive) the sample is split into OECD and non-OECD countries, assuming that the former export on average more human capital intensive goods. The results support the hypothesis. The trade share in GDP affects the average fertility rate negatively in OECD countries, i.e., countries with an assumed high share of human capital-intensive goods in their exports. The opposite holds true for non-OECD countries. The authors also find a negative effect of the trade share on education in non-OECD countries but a positive effect in OECD countries. Finally, the results are strengthened by the use of the Frankel-Romer instrumentation (Frankel and Romer 1999) for trade share in GDP.

While the empirical section nicely underlines the broad mechanism developed in the theory, the specification leaves room for a more in-depth analysis. The main point is whether the proposition holds in richer specified empirical fertility models. By incorporating additional regressors and employing opulent specifications we strengthen the link between the theory and this strand of population literature and make the proposition comparable with existing fertility estimations. For instance, the inclusion of education as a determinant of fertility is particularly important (e.g., Becker et al. 2010 or Azarnert 2008), as is accounting for the relationship between fertility and female labor force participation (e.g., Bloom et al. 2009, Galor and Weil 1996 or Mishra and Smyth 2010). Further, we expand the empirical knowledge by dividing the panel into subpanels of different income levels. This enables us to provide more evidence for the interaction channel that possibly varies in intensity. From an econometric point of view we also expand the analysis along the following lines. First, instead of relying on one trade indicator (trade share in GDP) and to differentiate between factor contents by splitting the sample in OECD vs. non-OECD, we use two trade indicators in two sectors. Our assumption is that on average, the human capital content in manufactures is higher than in primary exports.[4] Also, we use this trade indicator in per capita terms in order to relate it more directly to fertility decisions. Second, and in line with the literature, we assume fertility decisions to be affected also by factors such as culture or religion. Thus, to control for such unobserved heterogeneity at the country level we expand the analysis to include a panel setting. Third, the use of a system GMM estimator enables us to account for potential endogeneity problems that are inherent in many conventional (cross-country) regressions. The use of the estimator is especially important as fertility regressions are well-known for complicated cause and effect situations, as noted by Schultz (2007), for example.

We are primarily interested in exploring whether international trade impacts on fertility decisions across countries. The implications of a positive finding would be a long-run change in a country's comparative advantages, population development, and also growth patterns as predicted by GM. However, as we do not directly test the relationship between trade and growth we do not elaborate on this vast literature.[5]

Our empirical findings generally support the theory. They show that (i) international trade affects fertility significantly, especially in less developed countries, and (ii) the type of exports (i.e., their skill intensity) is particularly important for the direction of impact on fertility. In our analysis we find evidence that while manufacturing exports affect fertility negatively, primary exports affect fertility positively.

The remainder of this paper is structured as follows. We introduce our data and

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[4] As Galor and Mountford (2008) note, there is little authoritative data on the factor content of trade. Even though there may be sections of the manufacturing sector that operate with very little human capital intensity and parts of the primary sector that operate with a high degree of human capital, we would expect our results to be further strengthened if we had more differentiated data.

[5] A good literature overview and a critical account of related problematic issues can be found in, e.g., Winters (2004).

methodology in detail in the next section and continue with the estimation results. The last section summarizes our major findings and concludes the paper.

2.2 Empirical Analysis

The goal of this section is to determine the effects of different export sectors on fertility. Based on the theoretical model we expect high-skill industrial high-industrial exports to impact differently on fertility than low-skill industrial low-industrial or primary exports. Our estimation strategy involves using a panel, today a common practice in cross-country empirical estimations. Further, we divide our sample into sub-samples and use different estimators for a robustness analysis. The main part of our analysis circles around a panel estimation with the GMM systems estimator which has several advantages but so far has not frequently been applied to fertility estimations.

We propose a straightforward panel regression model in which we regress a fertility proxy on trade measures with a capable GMM estimator. Because the estimator needs to be used with caution (Roodman 2009) we provide more details on its application and strength below. In the estimation we control for other potential impacts on fertility as drawn from the existing fertility literature. Using five databases (World Development Indicators, Comtrade, Child Mortality Database, Penn World Tables, and Barro and Lee's dataset on educational attainment), we create a panel of around 100 countries (N) and 38 years (T) between 1970 and 2007. We limit our complete sample to this time frame and country choice, since for many countries there is not enough data for the period before 1970 to create a reliable dataset. Depending on the specification we alter the panel and, as in our main analysis, create a balanced panel of five 5-year averages. However, we provide precise information about the number of countries and observations for each individual estimation in the tables, and indicate a sample change to yearly data in the robustness analysis section.

2.2.1 Model and Methodology

The balanced panel that is analyzed in the main section consists of 68 countries and includes five non-overlapping 5-year periods from 1980 to 2005. The limitation in observations stems from data availability. In the robustness section we allow for unbalanced panels and estimate with more observations. According to our goal of estimating the effect of export sectors on fertility we estimate the model:

$$F_{it} = \alpha + \beta T_{it} + \gamma X_{it} + \xi_t + \eta_i + \varepsilon_{it} \tag{2.1}$$

where the subscripts i and t denote country and time. F is our measure of fertility, T are two trade variables of interest, and X is a set of control variables. We include both time- and country-specific unobserved effects, ξ and η. For the time effect we allow for a linear trend to pick up on the general trend of declining fertility and to retrieve results relative to this trend. α is a common intercept and ε is an i.i.d. error term. The inclusion of a country-specific effect guarantees that country-specific time-invariant characteristics are modeled properly. In the context of fertility this seems relevant as, for example, cultural differences may affect fertility rates. However, the inclusion of η produces estimation problems for the conventional OLS cross-section estimator. For consistency the country-specific effects would have to be orthogonal to other regressors (Caselli et al. 1996). We cannot rule this out from a theoretical perspective. Consistent estimators thus start by eliminating the country-specific term by either taking deviations from period averages (fixed-effects estimator) or by using period averages right away (between estimator) (DeJong and Ripoll 2006). This strategy deals successfully with estimation inconsistencies resulting from non-orthogonality between regressors and country-specific effects but, as Caselli et al. (1996)

note, inconsistencies remain unless all regressors are strictly exogenous. In our case this is especially important to note as some of our control variables (e.g., female labor force participation) are a potential source of this endogeneity bias.

To cope with both problems we use the system GMM estimator proposed by Arellano and Bover (1995) and Blundell and Bond (1998). The system GMM estimator is similar to the difference GMM estimator proposed by Arellano and Bond (1991). Both estimators use a differenced version

$$F_{it}-F_{i(t-1)} = \beta(T_{it}-T_{i(t-1)})+\gamma(X_{it}-X_{i(t-1)})+(\xi_t-\xi_{(t-1)})+(\eta_i-\eta_i)+(\varepsilon_{it}-\varepsilon_{i(t-1)}) \quad (2.2)$$

of equation (2.1) to eliminate the country-fixed effect η_i. Endogeneity concerns are countered with within-instruments, i.e. the use of lagged level data as instruments in the differenced equation (equation (2.2)) (the difference estimator) or the use of first differences as instruments in the level equation (equation (2.1)), which is part of the system estimator. In the presentation of our main results we focus on the system GMM estimator[6] since the difference estimator is said to have shortcomings. Easterly and Levine (2001) specifically note that the lagged levels of persistent regressors may prove to be weak instruments that could bias the estimation. Also, the use of differences alone leaves information about the level relationship unused (DeJong and Ripoll 2006) and further reduces the time dimension of the sample.

Even though the GMM system estimator appears to control for many caveats in panel data estimation, it rests on critical assumptions. Therefore we follow Roodman (2006) and

[6] Estimations with the difference estimator do not qualitatively alter our key findings.

report among regression coefficients and sample-size important test statistics to validate the identifying assumptions. The first is the Hansen-J test for over-identification (Hansen 1982). The null hypothesis of instrument exogeneity should not be rejected. The Hansen-J test may be weakened by instrument proliferation (Roodman, 2009), thus we limit the number of instruments and report their count. Further, we report the m_1- and m_2- tests for autocorrelation in the differenced errors ($\varepsilon_{it} - \varepsilon_{i(t-1)}$) after Arellano and Bond (1991). The presence of second-order serial correlation may mean that some lags are invalid instruments. Therefore we should not reject the null of no serial correlation in the m_2- test. To deal with heteroscedasticity and arbitrary correlation patterns within countries we use the two-step estimator and the finite-sample Windmeijer correction.

To obtain generally valid results we run several specifications with differing sets of control variables, ensuring that we proceed in accordance with the fertility literature. A core proposition of the theory by Galor and Mountford is the differential effect of trade on fertility. This effect is primarily modeled by using two different trade variables.

In an extension we make robustness checks and exchange our estimator for an even more common fixed-effects estimator. Even though we cannot control for endogeneity (but can leave out the most critical variable, female labor force participation) we are still capable of controlling a bias resulting from unobserved heterogeneity (e.g., the above mentioned cultural differences across countries). Also, our chosen GLS estimator is capable of correcting serial correlation problems and group-wise heteroscedasticity.[7] However, most importantly, it performs well in an unbalanced panel so we can return to a yearly panel with more variation and more countries. The panel dimensions almost double in terms of the number of countries and increase seven times in terms of t. We estimate the same model as in equation (2.1). Increasing the sample size also allows us to split the panel

[7] A test after Greene (2003) indicates heteroscedasticity within groups. Our test for serial correlation (after Wooldridge 2002) also rejects the null hypothesis of no serial correlation.

and estimate the model in different income groups without reducing the sub-samples to a small number of observations. This will provide an impression of how well-behaved the proposition of impact is across income groups.[8]

2.2.2 Data and variables

Dependent Variable

We estimate *fertility* with the total fertility rate (TFR). The TFR is a composite measure containing all age-specific fertility rates. Therefore, it comprises the number of children a imaginary woman would give birth to if she were to move fast-forward through her life (and her childbearing years). The great advantage of this is that the TFR is not influenced by age composition. The indicator is taken from the World Bank's development indicators (WDI) and lets us focus directly on reproductive behavior. Since the theory states that trade impacts on fertility levels, we use this indicator in levels. For a more detailed description and potential drawbacks of the TFR see, e.g., Weil (2005).

Independent variable

Trade variables are a) *manufacturing exports per capita* and b) *primary exports per capita.* Using exports per capita seem more appropriate than using trade shares or a structure-indicating ratio, since exports per capita cover potential effects for an average person and hence point more directly towards the fertility decision of an household. We include both variables in one regression to identify an differential effect.[9] Primary exports per capita refers to the value of exports (to the world) in categories 0-4 according to standard

[8] We follow the World Bank's income groups classification: High-income countries, Upper middle-income countries, Lower middle-income countries, Low-income countries with 2009 GNI per capita of more than US$12 195, US$3 946-US$12 195, US$996–US$3 945 and less than US$996, respectively.

[9] Tests with separate estimations for both variables do not alter our findings.

international trade classifications (SITC) divided by population. Manufacturing exports per capita refers to the values of exports (to the world) in SITC categories 5-8, also divided by total population. Data on trade statistics is drawn from the trade division of the United Nations (Comtrade 2011), while data on population figures is drawn from the Penn World Tables (Heston et al. 2011). The variable is used in levels to approximate the demand for human capital according to the theory. Exports per capita are stated in current US dollars.

Control variables

GDP per capita, the first control variable, is our proxy for income. The role of income as a determinant of fertility is not straightforward and the subject of an long-standing debate.[10] The impact of income on fertility strongly rises and falls depending on whether children are perceived as a productive asset or a consumption good (Drèze and Murthi 2001). If children are regarded as a consumption good the focus is on costs and the quality-quantity trade-off. This means that rising income makes children more affordable, hence we have a positive relationship. At the same time one may observe that when parents' income increases, their opportunity costs rise as well, showing a possible negative effect. Alternatively, if parents substitute quality for quantity the effect would also be negative. Particularly in developing countries, children are more likely to be regarded as a productive asset, i.e., an inexpensive source of additional labor and old-age security. What may further confuse the relationship is the type of (additional) income. While wage increases raise opportunity costs, an increase in productive assets, e.g., land, could raise demand for children (Drèze and Murthi 2001). Due to these complications we do not expect a particular sign for this control variable. Our data source is the Penn World Tables (Heston et al. 2009), while

[10] As early as in 1798 Malthus proposed that income increases above subsistence levels are capable of spurring population growth (Malthus 1798).

GDP per capita is used in levels to account for the mentioned possible interactions. It is stated in constant 2005 US dollars.

We also control for *infant mortality* as it directly affects fertility decisions.[11] To obtain a desired family size in the presence of rising child mortality, parents are forced to have more children. We therefore expect a strong positive relationship between infant mortality and fertility. It is suggested that especially in developing countries, infant mortality may not be exogenous to fertility. Due to hygiene and health issues high fertility can lead to higher child mortality (Drèze and Murthi 2001). We will account for this by using instruments. The data is taken from the CME Info portal, a UN inter-agency group (Unicef, UN Population Division, World Bank, WHO) that produces child mortality estimates (CME, 2010). Further, general mortality is also said to influence fertility decisions (e.g., Angeles 2010), however general mortality correlates strongly with child mortality and is thus not included separately.

We also control for *female labor force participation* in our analysis. Especially if women are mainly occupied with child-rearing, their participation in the labor force affects the number of children they have. However, in less developed agricultural economies family duties and labor participation may be more easily combined than in middle-income, more industrialized societies. We therefore do not expect a uniform impact. Further, it is generally acknowledged that female labor force participation can lead to an endogeneity problem, as fertility can also be a determinant of labor force participation (Bloom et al. 2009). We use data from the World Development Indicators (World Bank 2011) that is stated as the ratio of economically active women to the total number of women aged 15 and older. "Economically active" means that they participate in the production of goods and services.

[11] See e.g. Doepke (2005) on the relationship between fertility and child mortality in the Becker-type quantity-quality model.

Female education. The role of education is said to have different effects on fertility. Higher education can lead to higher income and thus increase the opportunity costs of having children. It may also be the case that more educated women, especially in developing countries, leave the agrarian sector and bear fewer children. Female education is also said to affect a woman's ability to have the desired number of children (see, e.g., Kim 2010). We also control for education since Galor and Mountford's conclusion that trade in industrial goods induces investments in human capital can be interpreted in two ways. The first is the modeled channel of induced investments in one's offspring's education, while the second is investment in one's own education. By including female education we control for the second effect. The level of education is approximated by the average years of schooling, with data taken from Barro and Lee (2013). The original data is provided in the shape of 5-year averages. To obtain the yearly time series for the robustness estimations we interpolate between the values because the series seem to follow strong trends and do not vary greatly.

Urbanization. In the analysis, urbanization can impact fertility decisions because in urban settings children are less likely to be seen as a productive asset. Also, children are more difficult to supervise in urban environments (Drèze and Murthi 2001). Finally, a rapid spread of modern social norms is attributed to urban settings. We use data from the World Development Indicators on the share of population living in urban areas (World Bank 2011). We also interpolate the original 5-year averages to obtain yearly time series that we use in the robustness section for the same reasons as our education variable.

In the main analysis we use half-decade averages data from 1980 to 2005. Even though it causes us to lose information, we create this balanced panel as it is preferably used by our estimator. Summary statistics are given in Table A2.1 for both the main (averaged) panel and the robustness/extension panel with yearly data from 1970 to 2008. Detailed information on data and its source is given in the appendix (Table A2.2).

2.3 Estimation Results

Table 2.1 shows the estimation results for the complete sample of all 68 countries in the balanced panel. The columns present the estimations of different model specifications. On the left-hand side we start with less detailed specifications and increase the level of specification (in accordance with existing fertility studies) towards the right. Throughout all estimations we control for country-specific effects (e.g., religion or culture) and in most cases also for a linear time trend. The latter is supposed to control for a general trend of declining fertility and to enable us to make statements about impacting factors relative to this trend. We are mainly interested in the behavior of the two export sector variables, manufacturing (Man. Exp. p.c.) and primary (Prim. Exp. p.c.) exports per capita. Looking at the complete sample of all income groups, we find a negative and significant impact of manufacturing exports on fertility, while primary exports per capita exert a positive significant impact on fertility. This finding provides empirical evidence for a differential effect of different trade sectors on fertility. The hypothesis from Galor and Mountford (and their theoretical model) is supported. A growing manufacturing export sector seems to impact on the average household fertility decision. According to the theory, the availability of jobs in the manufacturing export sector increases demand for education and in turn, lowers fertility. Also, looking at the control variables we find many of the expected signs, the majority of which are significant. We see a non-significant positive impact of income on fertility. Given the debate, we would have expected it to be at least negative. However, it may be the case that since the majority of countries are in the developing group, the theory favoring this direction of impact is supported. As acknowledged in the literature, child mortality appears to be positively (and throughout, significantly) related to fertility. Another strong negative relationship is established for female schooling while female labor force participation is, as expected, negatively related to fertility, however not significantly.

Table 2.1: Trade and Fertility (Main Sample - GMM Estimates)

Dependent: TFR	**All Countries**				
Model:	(1)	(2)	(3)	(4)	(5)
Man. Exp. p.c.	-0.145***	-0.090***	-0.093***	-0.092***	-0.095**
	(0.022)	(0.027)	(0.024)	(0.036)	(0.040)
Prim. Exp. p.c.	0.061***	0.070***	0.062***	0.067***	0.063*
	(0.022)	(0.019)	(0.020)	(0.033)	(0.033)
lnfant Mortality		0.168**	0.145**	0.288***	0.304***
		(0.072)	(0.067)	(0.080)	(0.097)
GDP p.c.				0.101	0.129
				(0.121)	(0.145)
Fem.Schooling	-0.359***	-0.344***	-0.324***	-0.250**	-0.248**
	(0.131)	(0.093)	(0.089)	(0.100)	(0.108)
Fem.Lab.For.Part.	-0.011	0.008	-0.014	-0.013	-0.006
	(0.196)	(0.144)	(0.130)	(0.150)	(0.155)
Urbanization				0.033	0.022
				(0.063)	(0.074)
Time-trend	yes	no	yes	no	yes
Observations	338	338	338	337	337
Countries	68	68	68	68	68
Hansen (p-value)	0.72	0.25	0.32	0.15	0.13
Instrument count	10	40	41	43	44
AR(1) (p-value)	0.01	0.00	0.00	0.00	0.00
AR(2) (p-value)	0.40	0.21	0.20	0.14	0.15

Notes: Dependent variable in all models is the total fertility rate (TFR). All variables are used in natural logarithms. *, ** and *** denote significance at the 10-,5- and 1% level, respectively. Windmeijer corrected S.E.s in parentheses. All models are estimated with a constant. Sample range is 1980 - 2005 in 5-year averaged non-overlapping periods

In Table 2.2 the two panels at the top and at the bottom divide the complete sample into high-income (top) and middle- and low-income countries (bottom). Of the initial 68 countries, 33 are in the World Bank's income categories 1 (high-income) and 2 (high-income non-OECD), while the remaining 35 are in categories 3 (upper middle-income), 4 (lower middle-income) and 5 (low-income).

The two subsamples differ slightly in their similarity to the overall results. First, even though still negative the effect of manufacturing exports on fertility is losing magnitude

Table 2.2: Trade and Fertility (High-/Low-Income Samples - GMM Estimates)

Dependent: TFR	**High-Income Countries (Groups 1 and 2)**				
Model:	(1)	(2)	(3)	(4)	(5)
Man. Exp. p.c.	-0.083**	-0.076	-0.086	-0.057*	-0.061*
	(0.035)	(0.072)	(0.056)	(0.030)	(0.033)
Prim. Exp. p.c.	0.095***	0.098*	0.098**	0.041	0.038
	(0.035)	(0.053)	(0.041)	(0.033)	(0.026)
Infant Mortality		-0.017	0.001	0.291**	0.264**
		(0.143)	(0.165)	(0.121)	(0.129)
GDP p.c.				0.321*	0.372**
				(0.175)	(0.162)
Fem.Schooling	-0.509	-0.895**	-0.415	-0.208	-0.082
	(0.333)	(0.410)	(0.439)	(0.520)	(0.573)
Fem.Lab.For.Part.	-0.024	-0.052	-0.120	0.010	-0.085
	(0.232)	(0.221)	(0.265)	(0.257)	(0.295)
Urbanization				0.123	0.092
				(0.085)	(0.122)
Time-trend	yes	no	yes	no	yes
Observations	164	164	164	163	163
Countries	33	33	33	33	33
Hansen (p-value)	0.23	0.44	0.12	0.22	0.17
Instrument count	22	24	25	30	30
AR(1) (p-value)	0.18	0.47	0.28	0.03	0.03
AR(2) (p-value)	0.42	0.41	0.48	0.12	0.14
Dependent: TFR	**Lower-Income Countries (Groups 3,4 and 5)**				
Model:	(1)	(2)	(3)	(4)	(5)
Man. Exp. p.c.	-0.066**	-0.059**	-0.046*	0.013	0.034
	(0.031)	(0.029)	(0.026)	(0.036)	(0.036)
Prim. Exp. p.c.	0.039	0.113***	0.074**	0.178***	0.135***
	(0.033)	(0.039)	(0.031)	(0.038)	(0.038)
Infant Mortality		0.445***	0.367***	0.496***	0.310**
		(0.117)	(0.118)	(0.119)	(0.121)
GDP p.c.				-0.266**	-0.427***
				(0.135)	(0.162)
Fem.Schooling	-0.317***	-0.053	0.025	-0.014	-0.105
	(0.103)	(0.173)	(0.168)	(0.227)	(0.166)
Fem.Lab.For.Part.	-0.188	-0.269**	0.017	-0.160	0.013
	(0.148)	(0.127)	(0.220)	(0.125)	(0.149)
Urbanization				0.005	0.174
				(0.130)	(0.115)
Time-trend	yes	no	yes	no	yes
Observations	174	174	174	174	174
Countries	35	35	35	35	35
Hansen (p-value)	0.31	0.29	0.25	0.21	0.50
Instrument count	16	18	17	25	25
AR(1) (p-value)	0.02	0.04	0.03	0.03	0.01
AR(2) (p-value)	0.45	0.47	0.92	0.82	0.52

Notes: Dependent variable in all models is the total fertility rate (TFR). All variables are used in natural logarithms. *, ** and *** denote significance at the 10-,5- and 1% level, respectively. Windmeijer corrected S.E.s in parentheses. All models are estimated with a constant. Sample range is 1980 - 2005 in 5-year averaged non-overlapping periods and significance in the high-income sample. Further, the positive effect of primary exports is present and significant in three models ((1) - (3)). However, looking at the test statistics we clearly see that we should not rely confidently on these results. None of the three models show the expected autocorrelation pattern. We thus conclude that the effect for high-income countries is far less pronounced. Using the model's terminology, the parents' assessment of the payoff associated with their children's education does not include a higher payoff if they find employment in the manufacturing export sector. A possible explanation for the missing effect on the average household fertility decision is that the manufacturing sector in high-income countries does not necessarily call for additional schooling over and above the already high educational attainment of workers. This seems plausible because the general level of education in developed countries is sufficient for producing large shares of their manufacturing exports. Further, the 'quality versus quantity' decision with respect to children does not have as significant an impact on household's income as in less developed economies. In high-income countries, social conditions and job opportunities for women may point more towards the trade-off between labor market participation of women and the number of children than towards the trade-off between the number of children and education quality.

Second, in middle- and low-income countries (bottom panel) the situation appears different. On the one hand, the impact of manufacturing exports on fertility is still (mostly) negative, however it loses some significance. On the other hand, we obtain a fairly strong indication of a positive impact of primary exports on fertility. This supports Galor and Mountford's hypothesis[12] who predict that due to a limited incentive to invest in children's education in the primary sector, fertility levels are positively affected. The lack of skill

[12] In the empirical section of Galor and Mountford's paper this impact is not explicitly tested. However, the authors detect a positive influence of the general indicator 'trade/GDP' on fertility in non-OECD countries. Under the assumption that non-OECD countries trade mostly in little skill-intensive (primary) goods, this implicitly supports their theory.

intensity necessary for primary exports and consequently little human capital demand therefore does not induce a demographic change as the more skill-intensive manufacturing exports sector does. The finding that primary exports tend to positively affect fertility levels in lower-income countries is consistent with the conclusion of Weil and Wilde (2009), who argue that economic development in countries that depend heavily on agricultural production suffer from high population growth. Further, we observe that the direction of impact of our control variables does not change substantially over the subsamples, which lends credibility to the estimations.

Robustness and Extension The two subsamples described above indicate that the mechanism is more valid in developing economies. Therefore, to obtain an even more differentiated view for developing countries we proceed by running further sets of estimations for additional subsamples. Since dividing the sample used in the main analysis further would reduce the individual sample size to as few as 20 observations, we now use the complete sample with yearly data to obtain sufficient observations. In the now unbalanced panel we use a GLS estimator and still control for time and country effects. Table 2.3 gives the estimation results. The panels from top to bottom are for income groups 3, 4 and 5, respectively.

Table 2.3: Trade and Fertility (Middle- and Low-Income Countries - Fixed Effects Estimates)

Dependent: TFR	**Higher Middle Income (Group 3)**				
Model:	(1)	(2)	(3)	(4)	(5)
Man. Exp. p.c.	-0.004**	-0.005**	-0.004**	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Prim. Exp. p.c.	0.005*	0.006*	0.007**	0.006**	0.005
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Infant Mortality		0.046***	0.035**	0.034**	0.042***
		(0.018)	(0.018)	(0.016)	(0.016)
GDP p.c.		0.036***			0.040***
		(0.010)			(0.011)
Fem.Schooling				-0.280***	-0.259***
				(0.021)	(0.023)
Urbanization					-0.084
					(0.057)
Time trend (t)	-0.023***	-0.022***	-0.022***	-0.015***	-0.015***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	657	654	654	603	603
Countries (n)	22	22	22	19	19
Years (t)	38	38	38	38	38
Dependent: TFR	**Lower Middle Income (Group 4)**				
Model:	(1)	(2)	(3)	(4)	(5)
Man. Exp. p.c.	-0.002*	-0.002*	-0.002*	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Prim. Exp. p.c.	0.003*	0.002	0.003	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Infant Mortality		0.214***	0.214***	0.203***	0.186***
		(0.014)	(0.014)	(0.013)	(0.013)
GDP p.c.		0.002			0.002
		(0.007)			(0.006)
Fem.Schooling				0.092***	0.091***
				(0.012)	(0.011)
Urbanization					0.059**
					(0.024)
Time trend (t)	-0.019***	-0.013***	-0.013***	-0.017***	-0.018***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Observations	845	842	842	810	810
Countries (n)	28	28	28	26	26
Years (t)	38	38	38	38	38
Dependent: TFR	**Low Income (Group 5)**				
Model:	(1)	(2)	(3)	(4)	(5)
Man. Exp. p.c.	-0.001	-0.001	-0.001	0.000	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Prim. Exp. p.c.	0.006**	0.005	0.006**	0.008**	0.009***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Infant Mortality		0.279***	0.270***	0.180***	0.438***
		(0.032)	(0.031)	(0.033)	(0.050)
GDP p.c.		0.024**			0.028**
		(0.011)			(0.014)
Fem.Schooling				0.206***	0.147***
				(0.015)	(0.017)
Urbanization					0.322***
					(0.040)
Time trend (t)	-0.007***	-0.002***	-0.002***	-0.015***	-0.013***
	(0.00)	(0.000)	(0.001)	(0.001)	(0.001)
Observations	354	354	354	272	272
Countries (n)	15	15	15	12	12
Years (t)	38	38	35	35	35

Notes: Dependent variable in all models is the total fertility rate (TFR). All variables are used in natural logarithms. *, ** and *** denote significance at the 10-,5- and 1% level, respectively. Heteroscedasticity and Serial Correlation robust S.E.s in parentheses. Sample range is 1970 - 2007 (1973-2007 bottom panel) with yearly intervals.

Interestingly, we do not see the same negative impact of manufacturing exports across the subsamples. While in most higher and lower middle-income countries (top and middle panel) manufacturing exports negatively affect fertility, the subsample for low-income countries fails to show a single significant estimate. A possible explanation is that modern structures are too weakly developed and the role of manufacturing exports is marginal and unable to affect average fertility. Turning to the effect of primary exports on fertility we find the strongest and positive impact in the group of least developed countries and in four of our five models, even a significant impact. Even though the impact is positive in the panels for income groups 3 and 4, it is not significant in all cases. Besides these differentiated observations our split into subsamples further establishes the existence of a differential effect of manufacturing and primary exports on fertility levels.

In addition to our findings on the impact of trade in manufacturing and primary products on fertility in high-, middle and low-income countries, it is worth pointing out some of the results for the control variables. *Child mortality*, generally acknowledged as one of the main determinants of fertility, is - as expected - positively related to fertility, which is consistent with Doces (2011), Jeon and Shields (2005), Lehmijoki and Palokangas (2009), and Galor and Mountford (2008). In Table 2.2 we see that the impact is bigger in lower-income than in high-income countries. This result is further refined in Table 2.3 where the strength of impact varies considerably. While in least-developed countries the effect is strong, it decreases as the development level rises, with a very small impact in income group 3 (top panel of Table 2.3). Intuitively, this is explained by lower child mortality in more developed countries. This robust relationship yields an important result for policy-making. If birth rates are to be brought down in low-income countries, lowering child mortality is an important target. *Female education* also shows the expected sign across most estimations in Tables 2.1 and 2.2. There is a clear negative relationship between female education and fertility, a finding consistent with Becker et al. (2010) and Osili and Long (2008), for example. The *labor force participation rate of women* also affects fertility negatively, a result in line with existing empirical evidence (Pampel 1993 or Jeon and Shields 2005). However, our estimations are not significant. We have left out this particular variable in our estimations for income groups 3 to 5 due to clear endogeneity problems that are not addressed by the GLS estimator, so no further statements can be retrieved. The presence of insignificant results makes sense because there are differences in opportunities for economically active women to raise children. A factory worker will find it more difficult to take care of children than a woman working on a rural family-owned field, even though both women would count as economically active. We also control for *per capita income*. The effect of income on fertility (or population growth) is discussed extensively in the literature.[13] However, there are still supporters of a negative impact of income on fertility as well as supporters of the contrary, namely a positive impact of income on population growth. Our coefficient estimates reflect this controversy. We find both positive and negative relationships which can, however, indicate opposing underlying effects. Interestingly, in the estimations for income groups 3 to 5 we see a positive relationship in the top and bottom income groups. That is, in higher-income and low-income countries GDP per capita increases fertility levels while in between (group 4) we witness a less strong relation (small insignificant coefficient). A commonly hypothesized u-shaped relationship may be present that possibly depends on the substitution and income effect of children (Weil 2005).

To validate our estimations further we reestimate Tables 2.1 and 2.2 using the extended yearly dataset and the GLS estimator. The re-estimation results are given in the appendix in Table A2.3. The full sample consists of around 100 countries and 38 years. We have around 3 000 observations for the complete sample of all countries and 1 200 and 1 800 for

[13] For a comprehensive review see e.g., Kelley (1988).

the high-income and lower-income subsamples, respectively. All estimations support our main finding of the differential effect that manufacturing exports and primary exports exert on fertility. However, it is most visible in the lower-income sample (bottom panel). We find significant negative effects of manufacturing exports and significant positive effects of primary exports. The consistent positive impact of child mortality and its clear difference in magnitude between higher- and lower-income countries further strengthen the estimation.

2.4 Conclusion

Our contribution provides supporting empirical evidence for Galor and Mountford's (2008) hypothesis that international trade among developing and developed countries induces an asymmetry in their demand for human capital, to which fertility rates react. While they increase in developing countries, they decrease in developed countries. This is the case because skill intensity in the trading sectors differs and if it is beneficial to invest in human capital, fertility is driven down.

This contribution expands the existing empirical evidence given by Galor and Mountford in various ways. First, we directly address different export sectors as determinants of fertility and use exports per capita in two distinct sectors, primary exports and manufacturing exports. Second, we expand the analysis to include a panel setting and to control for unobserved characteristics that are certainly important for fertility estimations. Third, we include the most frequently suggested determinants of fertility as controls to make this study more comparable to existing fertility literature. Lastly, by using subsamples we can also point out different effects at different development levels. Our panel regression contains half-decade averages over the period 1980 to 2005 and covers around 70 countries.

In support of Galor and Mountford's (2008) theory we find that manufacturing exports lower fertility levels while primary exports have either a positive impact or none at all.

We find that this relation holds especially in developing countries, where education levels are generally lower. However, this effect is not present in the group of least developed countries. Our findings support the general proposition of Galor and Mountford's (2008) work that trade is a driver of demographic transition and a possible explanation for the great divergence in income levels across countries.

High fertility levels are often regarded as harmful to development. A recent survey by the United Nations (World Fertility Policies 2011) has found that many governments regard their fertility levels with concern. Hence, besides lowering infant mortality as our estimates also show that global trade integration can support the goal of lowering fertility levels in countries which export primarily skill-intensive manufacturing goods. However, as this also works in the other direction countries whose exports consist of little skill-intensive (primary) goods may face an aggregation of problems associated with high fertility levels. Further, a strategy of export-led growth via skill-intensive manufactures may provide additional benefits by lowering fertility rates and thus impacting on the demographic transition that can later pay off in the shape of a demographic dividend.

2.5 Appendix to Chapter 2

Table A2.1: Summary statistics

Variable (Main Sample 1980-2005)	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**	**n**
Fertility	2.81	1.40	1.08	7.34	340	68
Manufacturing exports per capita (US-$)	1841.63	3722.65	2.39	32676.04	340	68
Primary exports per capita (US-$)	824.60	1491.52	3.00	11537.62	338	68
GDP per capita (US-$)	13576.37	10446.71	878.83	43388.80	340	68
Infant mortality	28.71	27.99	2.36	142.68	340	68
Female labor force participation	44.85	14.59	11.82	84.52	340	68
Female schooling (years)	7.32	2.63	1.30	12.73	340	68
Urbanization	60.97	22.05	8.50	100.00	339	68
Variable (Rob./Ext. Sample 1970-2007)	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**	**n**
Fertility	3.83	1.90	1.08	8.08	3958	104
Manufacturing exports per capita (US-$)	1242.53	3324.64	0.03	50856.73	3429	104
Primary exports per capita (US-$)	873.48	2393.12	1.64	46256.85	3255	103
GDP per capita (US-$)	11438.89	12506.59	561.55	111730.40	3951	104
Infant mortality	46.59	40.89	1.90	193.00	3967	104
Female schooling (years)	5.99	3.05	0.12	12.73	3666	94
Urbanization	53.32	24.00	5.70	100.00	4056	104

Table A2.2: Data Sources and Description

Variable	Description	Time range	Source
Fertility	Fertility is measured as the Total Fertility Rate (TFR). This is a composite measure containing all age-specific fertility rates. It comprises the number of children an imaginary woman would give birth to if she were to move fast-forward through her life (and her childbearing years).	1970-2007	World Development Indicators (WDI)
Manufacutring exports per capita	Exports classified in groups SITC 5,6,7 and 8 in current USD divided by total population numbers.	1970-2007	United Nations Commodity Trade Database (2011)/Penn World Tables 7.0
Primary exports per capita	Exports classified in groups SITC 0,1,2,3 and 4 in current USD divided by total population numbers	1970-2007	United Nations Commodity Trade Database (2011)/Penn World Tables 7.0
GDP per capita	Gross domestic product per capita in constant USD	1970-2007	Penn World Tables 7.0
Infant mortality	Mortality rate per 1,000 live births	1970-2007	Child Mortality Database (2011)
Female labor force participation	The ratio of economically active women to all women aged 15 and older.	1980-2007	World Development Indicators (WDI)
Female schooling	Average years of schooling among women.	1970-2007	Barro and Lee (2010)
Urbanization	Share of total population living in urban areas.	1970-2007	World Development Indicators (WDI)

Table A2.3: Trade and Fertility (Complete Sample - Fixed Effects Estimates)

Dependent: TFR	**All Countries**				
Model:	(1)	(2)	(3)	(4)	(5)
Man. Exp. p.c.	-0.005***	-0.004***	-0.003***	-0.003***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Prim. Exp. p.c.	0.000	0.002	0.002	0.002	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Infant Mortality		0.211***	0.208***	0.183***	0.188***
		(0.009)	(0.009)	(0.010)	(0.010)
GDP p.c.		0.007			0.009*
		(0.005)			(0.005)
Fem.Schooling				0.058***	0.050***
				(0.010)	(0.011)
Urbanization					0.009
					(0.021)
Time trend (t)	-0.017***	-0.010***	-0.010***	-0.013***	-0.012***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	3150	3115	3116	2906	2905
Countries (n)	103	103	103	93	93
Years (t)	38	38	38	38	38
Dependent: TFR	**High Income Countries**				
Model:	(1)	(2)	(3)	(4)	(5)
Man. Exp. p.c.	-0.007**	-0.003	-0.001	0.001	-0.001
	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)
Prim. Exp. p.c.	0.000	-0.000	0.001	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Infant Mortality		0.164***	0.179***	0.068***	0.064***
		(0.024)	(0.024)	(0.027)	(0.029)
GDP p.c.		0.053***			0.027*
		(0.014)			(0.016)
Fem.Schooling				-0.454***	-0.438***
				(0.043)	(0.048)
Urbanization					0.074
					(0.088)
Time trend (t)	-0.016***	-0.009***	-0.008***	-0.005***	-0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	1294	1265	1266	1221	1220
Countries (n)	38	38	38	36	36
Years (t)	38	38	38	38	38
Dependent: TFR	**Low Income Countries**				
Model:	(1)	(2)	(3)	(4)	(5)
Man. Exp. p.c.	-0.006***	-0.004***	-0.004***	-0.002**	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Prim. Exp. p.c.	0.000	0.004**	0.004**	0.002*	0.002
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)
Infant Mortality		0.278***	0.271***	0.228***	0.226***
		(0.010)	(0.010)	(0.010)	(0.010)
GDP p.c.		-0.003			0.001
		(0.006)			(0.006)
Fem.Schooling				0.122***	0.111***
				(0.009)	(0.010)
Urbanization					0.074***
					(0.021)
Time trend (t)	-0.017***	-0.010***	-0.010***	-0.015***	-0.016***
	(0.00)	(0.000)	(0.000)	(0.000)	(0.001)
Observations	1856	1850	1850	1685	1685
Countries (n)	65	65	65	57	57
Years (t)	38	38	38	38	38

Notes: Dependent variable in all models is the total fertility rate (TFR). All variables are used in natural logarithms. *, ** and *** denote significance at the 10-,5- and 1% level, respectively. Heteroscedasticity and Serial Correlation robust S.E.s in parentheses. Sample range is 1970 - 2007 with yearly intervals.

Chapter 3

Fertility and Modernization: The Role of Urbanization in Developing Countries

This chapter is based on joint work with Thomas Gries. The underlying article, presented here slightly modified, has been published in the Journal of International Development (2015), forthcoming.

The chapter, just like the previous one, also contributes to the empirical fertility literature. However, while chapter two focusses on a very specific, though theoretically well developed channel - the trade nexus-, this chapter focusses on the general relation between modernization and fertility in developing countries. Even more, it introduces the currently developed view of urbanization as a modernization proxy in developing countries into cross-country fertility analysis. By doing so it uses most recent research in development economics and incorporates the findings into the fertility literature. Further it is closer in interpretation of various competing theories on fertility decline, namely the demographer's modernization theory. The findings indicate that the distinctions made are necessary and are capable of drawing conclusions for unusually large sample sizes.

3.1 Introduction

In many cases recent trends in fertility change in developing countries indicate a slowdown in the decline in fertility rates (Eastwood and Lipton 2011).[1] Unlike in advanced economies, this process is taking place in high-fertility settings that are not predicted in classic transition theory models. What is more, in some extreme cases the deceleration in decline has reversed and become a rise (see, e.g., Zambia, Figure 3·1) Following economic theory regarding fertility change, we propose a focus on distinct modern sector developments in an empirical cross-country setting to analyze fertility trends in developing countries. Exploring the fertility transition along the lines of modern urbanization characteristics, i.e., incorporating various urbanization qualities, we demonstrate the importance of a functioning modern sector for fertility development in these countries. It also provides insights into why fertility may respond differently in today's developing countries than in now advanced countries in their respective time of transition.

Figure 3·1 presents selected fertility rates from least developed countries. Even though we generally observe declining fertility trends, it is also obvious that the rate of decline is slowing and, what is more, even in the presence of unexpectedly high levels of fertility (between 5 and 6 births per woman).

The economic literature that describes the transition from high to low-fertility regimes rests fundamentally on the theory developed in Becker (1981) and Becker and Barro (1988). Their mechanism of a child quantity-quality trade-off faced by parents has become the primary tool for describing changes in fertility regimes. Parents derive their utility from both the number of children as well as their children's level of education and are constrained by both time and money. Two core channels impact on the trade-off. The first proposes that if economic development in the form of technological progress occurs, the returns on

[1] See also Shapiro & Gebreselassie (2008) on stalling fertility rates in Sub-Saharan Africa.

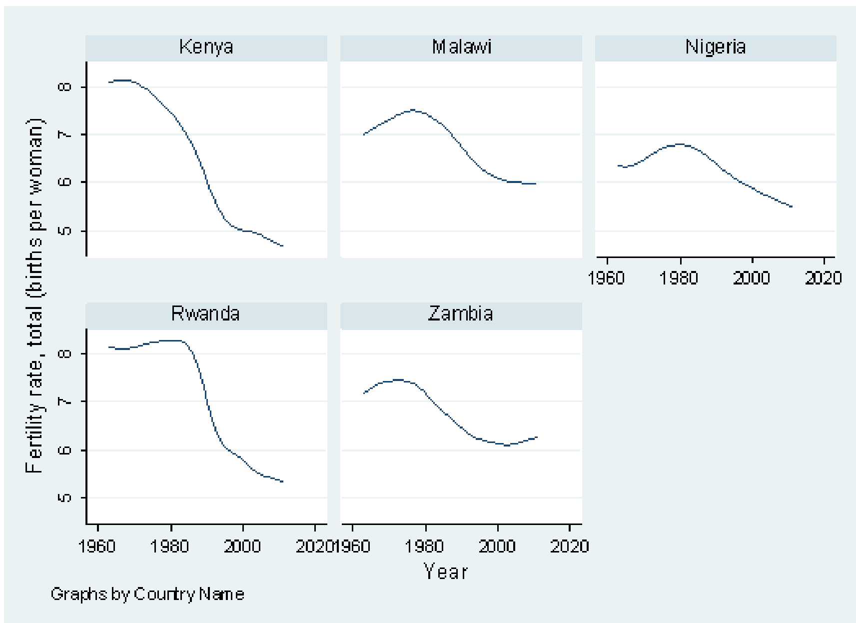

Figure 3·1: Fertility in selected countries, 1960 - 2012 (based on World Bank (2013) data).

children's education increase. On the one hand, this makes it more valuable to invest in children's education but on the other, it requires parents to have fewer children due to the aforementioned constraints. A version of this mechanism is found in, e.g., Galor and Weil (2000) or Kitaura and Yakita (2010). The second channel proposes that high mortality rates would trigger a reduction in the investment on children's education. High mortality rates reduce the returns on educational investment, thus making it more expensive to invest in child education. Therefore one would expect fertility rates not to react negatively to mortality increases. This side of the trade-off has been emphasized in one way or another for example in Kalemli-Oczan (2002, 2003) and Soares (2005). That the trade-off indeed existed in the past has been empirically tested for the case of Prussia. Becker et al. (2010) identifies it using pre-industrial revolution census data. A major application of the trade-off is found in unified growth models that describe theoretically the transition from stagnation to modern growth regimes (Galor and Weil 1996, 2000) and effectively explain the transition to industrialized economies during the industrial revolution.

Next, we establish why the modern sector is important for the aforementioned mechanism. The mechanism emphasizes the importance of education and predicts a decline in fertility levels if returns on education rise. However, a rise in returns on education is generally attributed to an emerging *modern* sector, meaning an expansion in jobs that require higher skills and consequently pay higher wages. This links modern sector development with population decline. The importance of a modern sector for fertility decline via returns on education is the core mechanism presented in Galor and Mountford (2008), who focus on differential international trade. A closely connected issue, the channel of modern sector trade, is empirically confirmed in Gries and Grundmann (2014). However, there are also models that do not focus on returns on education although they connect modern sector development with fertility. For example, Lehmijoki and Palokangas (2009) map an increase in women's relative wages via trade and their work's complementarity to capital.

This is then expected to lower the fertility rate. Sauré and Zoabi (2011) also focus on a rise in women's labor force participation induced by modern sector trade. Higher labor force participation is then associated with lower fertility levels. With or without an explicit increase in human capital returns, the modern sector appears to be of great importance in explaining the fertility transition in the economic literature.

The role of 'modernization' is also discussed in the demographic literature. According to classical transition theory, 'modernization' that leads to falling fertility rates comprises falling mortality rates, economic development, education, and urbanization (Angeles 2010). Urbanization is described as causing declining fertility rates in several frameworks. White et al. (2008) put forth why urbanization is expected to reduce fertility levels. Children in urban areas are less likely to contribute as early and as productively to family income as they would in rural (agricultural) areas. Therefore the net benefits of having more children are diminished. Also, housing (space) is more expensive and having more children would require parents to provide more space. Then, in urban areas access to modern birth control may be facilitated, along with potentially easier access to better health services in general. Finally, urban areas are also associated with ideational change in innovation-diffusion theories, leading to a dissipation of fertility-enhancing beliefs and attitudes (Reed et al. 1999).

From the economic and demographic literature we infer the importance of a modern sector that mostly emerges in urban agglomerations. Urbanization, measured as the proportion of the population that lives in urban agglomerations, has itself been widely used as an indicator of industrialization/modernization in empirical economic analyses (e.g., Acemoglu, Johnson and Robinson 2002, 2005).[2] We believe that this practice is particularly

[2] Urbanization (or urban/rural residence) is also used in fertility estimations (e.g., Kalemli-Öczan 2012 or Canning et al. 2013). However, the evidence on its impact at the national level is mixed, certainly in part due to the theme of this research.

useful in historical cross-country samples (as done in Acemoglu, Johnson and Robinson 2002) since it allows for large sample sizes due to an almost unmatched availability of the indicator. However, the indicator itself may fail to incorporate very recent research on urbanization in developing countries. Gollin et al. (2013) argue that urbanization in these countries can be of different quality and call for a differentiated treatment of so-called production vs. consumption cities. While the former emerge due to an influx of workers needed in production, the latter mostly provide (petty) services jobs for migrants. As outlined above the Q-Q trade-off arises (apart from changes in child mortality) from increasing returns on education. However, these increasing returns are mostly associated with the production type of city where urban agglomeration is driven by an enlargement of the industrial base. The interpretation of urbanization as a process that is not necessarily and purely driven by economic activity also lies at the heart of demographic research that explains urbanization with demographic change (Dyson 2011) or presents it as a historical process driven by institutional, technological, and population change (Fox 2012).

This research presents an analysis of the negative impact of modern sector development on aggregate fertility development as hypothesized in the literature. More specifically, we approximate modern sector development with the rate of urbanization and, based on recent research, incorporate the role of quality in urban sector development. The cross-developing-country results show how different urban developments impact on the change in country-level reproductive behavior.

Our results suggest that urbanization plays a role in determining the country-wide fertility level. In a sample of around 130 developing countries we find a negative, yet not always robust, influence of the degree of urbanization on the fertility level. While this can be interpreted as supporting the idea of approximating modernization with the urbanization indicator, it also demands caution. We hence further refine our measure of modern structures to show that concerns about recent trends in urbanization (Gollin et al. 2013) should not be neglected in the context of demographic change. Urbanization with either high slum prevalence or a narrow export sector base does not emerge as having a negative impact. Our results show that in this case, we are rather dealing with a fertility-enhancing situation in contrast to the main effect. The major policy implication of these findings is that developing countries could support their demographic transition by developing production cities that are characterized by less slum incidence and an industrial base that supplies jobs to the population.

The remainder of this paper presents the data and methodology in the next section, followed by the results. The last section concludes.

3.2 Data and Methodology

3.2.1 Data

Dependent variable: *Fertility.* We are interested in the behavior of the country-wide fertility rate, as this indicator is of major importance in the analysis of demographic change. More precisely, we use the total fertility rate (TFR), which is frequently used in cross-country studies on fertility behavior and is constructed as follows:

$$TFR = y * \sum_{a=1}^{b} \frac{births_a}{number\ of\ women_a} \tag{3.1}$$

In eq. 3.1 the age-specific (age or age-group a) fertility rate (births per woman) is simply summed up over all ages or age groups and multiplied by the number of years in each age group/cohort (y). The TFR is thus constructed using age-specific fertility rates proposing the fertility rate a woman at the beginning of her childbearing years would face over the course of her life. Because it is based on cohort/age-specific fertility rates it is insensitive to age distribution. In other words, it does not pick up on declines that result from a change in cohort size, as a different indicator (number of births) would certainly do. Further, even though the TFR registers whether a cohort delays fertility, it could be rather slow to do so on a yearly basis. However, as we are interested in longer time-horizons and the underlying structural settings, we average the data to ensure that we capture the longer run effects correctly. The data is taken from the World Bank's Word Development Indicators (WDI).

Independent variables: *Urbanization.* Urbanization is defined as the percentage of people living in urban agglomerations as given by national statistical offices. The data is also taken from the WDI. The use of the indicator in this plain definition may reflect the idea that the more urbanized a country, the more people are affected by modernized societal structures both in terms of behavioral and structural economic changes and therefore the lower the average fertility rate. However, as implied by research by Gollin et al. (2013) this indicator – although extensively used and widely available – may not fully capture modernization effects because recent increases in urbanization in developing countries have been identified as not being driven by industrialization. To relate urbanization more closely to the theoretical hypothesis we therefore augment it in the estimation with the two following qualifying indicators.[3]

Slum incidence. We assume urban agglomerations with a higher degree of slum incidence to remove the characteristics that allow for the theoretically developed channel for fertility to decline through modernization. From an ideational point of view this is the spread of modern social norms accompanying higher living standards or, from an economic perspective, the spread of higher-skilled labor activities across larger shares of the population. The slum population is mostly forced to either engage in subsistence farming or in

[3]For a further graphical motivation for the hypothesized relationship we provide plots of the association between urban fertility and the two 'quality indicators,' slum incidence and export diversification, in the appendix (figure 2 and 3).

collecting recyclables from waste, providing petty services, or even begging (UN-Habitat 2010). Moreover, we also assume the average provision of health and sanitation services to be worse. This presumably impacts overall health in general and child health in particular (Günther and Hartgen 2012). The United Nations Human Settlements Program provides estimates on slum incidence for many developing countries worldwide that comprise the percentage of the urban population that lives under slum conditions. Slum conditions are present if one or more of three conditions are not met for a household. From the information for slum incidence in 2005 we create a dummy variable indicating whether the country falls into the higher or lower slum incidence category.[4]

Degree of diversification in exports. We follow the idea of Fox (2014) and use this indicator to obtain information on urban economic conditions. We assume that a robust urban economy will induce the opportunity structures needed for the quantity-quality trade-off to work and that it is characterized by a broad income base and by diversified and extensive trade. The variable, interacted with urbanization, provides further evidence of the quality of the urbanization at hand. We use a diversification index from United Nations Conference on Trade and Development that ranges from 0 to 1 and create an additional dummy variable indicating whether a country has shown little (index > 0.7) mean diversification in the available period.[5]

Controls: We use *GDP per capita* to approximate the level of income, which is a generally acknowledged determinant of fertility. However, the precise impact may depend on the perception of children, i.e., whether they are perceived as a productive asset or a consumption good (Drèze and Murthi 2001). In the sample of developing countries the impact may be positive due to a dominant view of children as a form of old-age

[4] There is no convention on what exactly defines high slum incidence. We use a 50% threshold for higher slum incidence which is in line with reports of UN-Habitat. See, e.g., UN-Habitat (2008) chapter 2.5.

[5] The threshold is placed around the samples' mean (and median). A variation of the used threshold does not qualitatively alter our results.

security or an inexpensive source of additional labor. GDP per capita is used in levels and taken from the World Bank (WDI) in constant 2005 dollars. For a decrease in our next control variable, *infant mortality*, the theory rather strongly predicts a negative impact on children born.[6] To have a desired number of children parents have to have more children if infant mortality is high. However at the same time infant mortality may not be exogenous to fertility. Especially in developing countries with hygiene and health problems, high fertility may also be accompanied by high infant mortality. The data is taken from CME (2010). Next, we control for *female education.* Education may raise the opportunity costs of childbearing and would therefore reduce the number of children born. It may also be the case that especially in poorly developed regions, education enables women to have the desired number of children (Buyinza and Hisali 2014). Consequently, the effect on fertility is expected to be negative. Female education is approximated with the (gross) secondary school enrollment rate provided in the World Development Indicators (2013). In an extended specification we also follow recent research by Galor and Mountford (2008) and Gries and Grundmann (2014) and include *manufacturing exports* (as a proportion of merchandise exports) as a factor that impacts on fertility change, because a higher skill-content in trade (manufacturing vs. agriculture) gives rise to the Q-Q trade-off in the fertility decision.

The dataset comprises around 130 developing countries[7] and 10 five-year- averaged, non-overlapping points of data in time from 1962 to 2012. Table 3.1 shows the summary statistics.

[6] For a recent analysis of infant mortality on fertility see, e.g., Canning et al. (2013); for a theoretical approach in the Becker-type model, see, e.g., Doepke (2005).

[7] The included countries are listed in Table A3.1 in the appendix according to their level of slum incidence.

Table 3.1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
TFR	4.688	1.856	1.14	9.154	1358
GDP per capita	1909.556	1908.38	65.605	13223.427	1097
Female Schooling	46.016	33.326	0	152.318	925
Infant mortality	66.856	42.887	4.5	210.007	1170
Urbanization	39.732	20.676	2.211	93.260	1400
Manufacturing exports	26.069	25.229	0	97.408	902
Export diversification	0.714	0.11	0.376	0.907	536
Slum incidence	51.932	26.162	2	99	319

3.2.2 Model

Following the country-level estimations in Kalemli-Oczan (2012) and Canning et al. (2013) we set up a panel estimation model for the total fertility rate and include our independent variable, urbanization, in both its natural and its qualified version[8]:

$$TFR_{it} = \alpha + \beta * URB_{it} + \gamma * URB_{it} * D_i + \delta * \mathbf{X}'_{it} + \zeta_t + \eta_i + \varepsilon_{it} \tag{3.2}$$

where TFR_{it} is the total fertility rate, URB_{it} is the urbanization rate, D_i is a dummy that indicates whether there is high slum incidence or low export diversification or both (in different specifications), $\mathbf{X}'_{it}$ is a vector of control variables. ζ_t is a time-fixed effect and η_i represents the country-specific effect while ε_{it} represents an iid error term. The subscripts t and i identify the time and observational unit. Because most of our data is available in a cross-section time-series format we can benefit from controlling for η_i , the country-specific, time-constant term. While panel data generally increases sample size and allows for a higher level of detail, the possibility to control for the unobserved fixed effect is immensely valuable in the context of fertility estimation. Specifically, it enables us to

[8] A comparable use of dummy variable interactions in a cross-country panel-fixed effects model may also be found in, e.g., Rodrik (2008) or Arena (2008).

control for the underlying effect of cultural or social norms that do not vary (greatly) over time. If we do not control for this in the estimation, we would almost certainly obtain biased estimation results.

3.2.3 Estimation design

To acknowledge that ignoring the country-specific effect in 3.2 may lead to a biased estimation due to unobserved heterogeneity we first use a fixed effects estimator for the panel.[9] While our control variables are chosen to control for the commonly discussed factors that impact on country-wide fertility levels, we are, due to the panel structure, also able to control for time-invariant country intrinsic effects. In the case of fertility this frequently involves cultural and social characteristics that are not clearly measurable but nevertheless influence aggregate fertility decisions. Technically, the estimator subtracts the mean of the observation within groups and thus cancels out time-invariant effects. However, it also assumes covariates to not correlate with the error, that is, strict exogeneity. In this respect two of our included control variables may appear especially troublesome. Both child mortality and female schooling may be influenced by fertility. Even though it would be desirable to circumvent the problem with a suitable outside instrument, it is hard to find such an instrument in macro panels with a long time dimension. Therefore we rely in a second step on within-instrumentation of endogenous covariates, based on the work of Arellano and Bover (1995) and Blundell and Bond (1998). The estimators developed therein belong to the class of GMM estimators and rely on specific moment conditions. Broadly speaking, we use lagged-level data to instrument endogenous covariates in a first-differenced equation and lagged first differences in a level equation. We report diagnostics for the validity of the used instruments.

[9] We also estimate a pooled regression model with ols. It includes the time-fixed effects and clustered standard errors at the country level. However, the results do not change.

3.3 Results

In Table 3.2 we present the main estimations corresponding to the hypothesis. The first two columns show regression results from the same model, but they differ according to the estimation design in the estimators we use. Model (1) is the fixed-effects panel estimator and in model (2) we use the system GMM estimator where we instrument infant mortality, female schooling, and also GDP per capita. The model includes the modernization proxy urbanization on its own. Both estimators indicate a negative yet non-significant relationship with fertility. We can interpret this in two ways. First, the modernization aspect may have been picked up by the controls 'female schooling' and 'infant mortality,' both of which clearly indicate their relevance in the relationship with the hypothesized directions of impact. However, it is also possible that urbanization, based on the recent literature, does not fully represent what characterizes modernization. This is our main hypothesis and therefore the result is to be expected to the degree that urbanization does not necessarily capture the fertility-lowering effects assumed in the theoretical economic literature. Therefore, we insert a dummy for slum incidence to qualify the urbanization measure further in the next two columns. Again, we present both estimators for the same model. The model now includes the plain urbanization measure as well as urbanization interacted with the dummy for slum incidence. Since the dummy takes the value zero or one we may interpret the coefficient of the interaction as the difference to the effect when the dummy takes the value zero, i.e., solely the coefficient of the urbanization term. In other words, we differentiate the urbanization effect and interpret the interaction term as part of the urbanization impact in high slum-incidence countries. In columns (3) and (4) we observe that the change in effect is positive and significant for both our estimators. In line with the hypothesis that in less developed urban agglomerations (the ones with higher slum incidence) the effect on the aggregate fertility level is not negative becomes visible.

In the last two columns of Table 3.2 we follow, as mentioned above, the idea of Fox (2014) and create another qualifying dummy variable. It is created according to the degree of specialization in exports. Following the rationale that a broad industrial production base will most likely provide the agglomeration that can be associated with fertility lowering channels (investment in education), a lack of export diversification points towards a less developed urban agglomeration. We may interpret the interaction term in analogy to the ones before. In this case the fixed effects estimator (column (5)) does not indicate a positive deviation from the main effect, however the coefficient remains non-significant. By contrast, as seen in the last column there is again supportive evidence that the hypothesis is correct. The deviation of the main effect is significantly positive. Even though the main effect of urbanization is negative across the estimations, it is hardly ever significant. Where it is significant, as in column (3), we find a combined non-significant impact for countries with a deficit in the quality of their urbanization. This supports two main results. The first is that urbanization does not necessarily capture the modernization effects assumed in the theoretical model to lower fertility levels; the second is that urbanizing countries with a lack of quality in urbanization will certainly not benefit in terms of fertility decreases that may be associated with urbanization (as in column (3)).

In Table 3.3 we show extended and robustness estimations and again present both fixed-effects and GMM estimations. In columns (1) and (2) the previously separately inserted dummy variables jointly interact with urbanization. The interpretation remains the same, however in these cases the estimated deviation from the main effect stems from countries with both high slum incidence and high export concentration. In other words, the quality of urbanization is even more clearly identified than before. And, as expected, the results closely match the previous ones. In other words, urbanization qualified by both high

Table 3.2: Modernization and Fertility Change in Developing Countries I

Dependent: Total Fertility Rate						
Model:	(1)	(2)	(3)	(4)	(5)	(6)
	FE	GMM	FE	GMM	FE	GMM
Urbanization$_t$	-0.015	-0.000	-0.026**	-0.005	-0.014	-0.004
	(0.010)	(0.008)	(0.011)	(0.007)	(0.012)	(0.007)
Urban$_t$ x Slum inc.			0.020*	0.010**		
			(0.012)	(0.004)		
Urban$_t$ x Exp div					-0.001	0.007**
					(0.011)	(0.003)
(log) GDP pc$_t$	-0.064	-0.130	-0.035	-0.106	-0.069	-0.113
	(0.144)	(0.187)	(0.147)	(0.176)	(0.146)	(0.178)
Female schooling$_t$	-0.016***	-0.023***	-0.015***	-0.021***	-0.016***	-0.023***
	(0.004)	(0.007)	(0.004)	(0.007)	(0.004)	(0.008)
Infant mortality$_t$	0.014***	0.018***	0.014***	0.016***	0.014***	0.016***
	(0.003)	(0.006)	(0.003)	(0.006)	(0.003)	(0.005)
Observations	801	801	801	801	801	801
Countries	132	132	132	132	132	132
Hansen (P-Value)		0.22		0.30		0.27
Instruments		89		90		90
AR(1)P-Value		0.00		0.00		0.00
AR(2)P-Value		0.21		0.10		0.16

Notes: *, ** and *** denote significance at the 10-,5- and 1% level, respectively. S.E.s in parentheses: Windmeijer corrected (GMM) and Country-clustered (FE). Country- and time-fixed effects fixed effects are included in all models. Time-fixed effects are included in models (1) - (6). In (7) it is excluded and in (8) it is included, but set to be linear. Slum inc. and Exp div are dummy variables for slum incidence in 2005 and export diversification (the index is greater for less diversified countries). The sample range is 1962 - 2012 in 10 five-year non-overlapping periods.

slum-incidence and high export concentration increases the effect on fertility levels. The following two columns ((3) + (4)) are presented based on research by Jedwab (2013). In an analysis of Sub-Saharan countries he identifies that much urbanization in Sub-Saharan Africa (SSA) has taken place (and still is taking place) without industrialization (the fertility reducing factor). In our framework this is easily adopted by introducing a region dummy for SSA. We thus test the hypothesis that urban agglomerations especially in the least developed region in the world, i.e., SSA, have structural deficits in terms of incentive provision to reduce fertility. Indeed, the results strongly support this and even gain in size and significance.

Galor and Mountford (2008) and Gries and Grundmann (2014) provide evidence that the skilled-labor content of trade also plays a role in determining fertility levels. In order to account for this impact factor we include a variable of manufacturing exports in columns (5) and (6). This change in model specification does not alter our findings on the effect of qualified urbanization. Finally, we reestimate the model and change the constraints on the time parameter. In column (7) the time effect is altogether excluded and in column (8) is set to be linear. Both versions of the model maintain the effect previously found.

Interpreting the results from a less economic perspective leads us to conclude that the diffusion of modern social norms regarding fertility behavior does not *necessarily* and to an equal degree take place in urban agglomerations. We can assume that urban agglomerations characterized by a large proportion of the population living in slum conditions will be much less effective in spreading the norms that are required for a measurable decrease in aggregate fertility. Our results lend great support to (i) the hypothesis that the quality of urbanization varies and (ii) this needs to be regarded with care. (ii) is not only valid in cross-country economic development estimations, but - as our results underline - also

Table 3.3: Modernization and Fertility Change in Developing Countries II

Dependent: Total Fertility Rate								
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	FE	GMM	FE	GMM	FE	GMM	FE	FE
Urbanization	-0.028**	-0.004	-0.030**	-0.003	-0.018	-0.010	-0.042***	-0.027**
	(0.011)	(0.008)	(0.012)	(0.007)	(0.012)	(0.007)	(0.011)	(0.011)
Urban x Slum inc. x Exp div	0.024*	0.011**						
	(0.012)	(0.004)						
Urban x SSA			0.027**	0.012**				
			(0.012)	(0.005)				
Urban x Slum inc.					0.035***	0.013***	0.019*	0.020*
					(0.013)	(0.003)	(0.011)	(0.012)
Manuf. exports					-0.006**	-0.013***		
					(0.003)	(0.002)		
linear time-trend								-0.139***
								(0.032)
(log) GDP pc	-0.030	-0.091	-0.026	-0.220	0.290	-0.126	-0.006	0.0[illegible]4
	(0.149)	(0.176)	(0.149)	(0.190)	(0.211)	(0.229)	(0.134)	(0.145)
Female schooling	-0.014***	-0.022***	-0.014***	-0.021***	-0.015***	-0.016**	-0.019***	-0.014***
	(0.004)	(0.007)	(0.004)	(0.007)	(0.005)	(0.008)	(0.004)	(0.004)
Infant mortality	0.014***	0.016***	0.012***	0.012*	0.014***	0.011	0.021***	0.013***
	(0.003)	(0.006)	(0.003)	(0.006)	(0.004)	(0.007)	(0.003)	(0.003)
Observations	801	801	801	801	649	649	801	801
Countries	132	132	132	132	124	124	132	132
Hansen (P-Value)		0.29		0.23		0.13		
Instruments		90		90		91		
AR(1)P-Value		0.00		0.00		0.00		
AR(2)P-Value		0.11		0.19		0.29		

Notes: *, ** and *** denote significance at the 10-,5- and 1% level, respectively. S.E.s in parentheses: Windmeijer corrected (GMM) and Country-clustered (FE). Country-fixed effects are included in all models. Time-fixed effects are included in models (1) - (6). In (7) it is excluded and in (8) it is included, but set to be linear. Slum inc., SSA, Exp div are dummy variables for slum incidence, Sub-Saharan Africa and export diversification (the index is greater for less diversified countries). The sample range is 1962 - 2012 in 10 five-year non-overlapping periods.

in cross-country fertility estimations. This suggests that recent research into urbanization and its quality (Gollin et al. 2013) also contributes to the understanding of longer-run changes in population development.

3.4 Conclusion

In the context of demographic change, this contribution creates a link between the theoretical prediction that modernization supports demographic change and recently presented evidence concerning urbanization in developing countries. In theory, modernization ought to be accompanied by industrialization which provides jobs and incentives to invest in skills, a situation that has long been attributed to urban agglomerations. This, and its wide availability (and also its rather easy comparability), has lead urbanization to emerge as a frequently used indicator for modern structures. However, recent research indicates that urbanization may well take place without the modernization characteristics often attributed to it. The theory on the change in reproductive behavior points out necessary incentives to invest in skills, which is possible in more modern (urban) structures, hence we present a panel cross-country fertility estimation for developing countries with a refined view on urbanization.

On the one hand, we are able to assemble a large cross-developing country dataset with a time dimension of 50 years thanks to the wide availability of urbanization; on the other hand, we have to qualify the measure of urbanization. In this study we do so by interacting urbanization with slum incidence and export diversification. Further, by using urbanization we also account for social interaction effects identified in the demographic literature. The estimation of the large cross-developing country panel dataset, where we also take up reverse causality issues by adopting a GMM estimation approach, indicates that the presence of low-quality urbanization, i.e., an agglomeration without the economic (and social) structures to provide higher skilled jobs, impacts significantly more positively on fertility than higher-quality urbanization.

Against the background of a strong slowdown in fertility declines in least developed countries, an important implication of this finding is the necessity to create quality urbanization in order to eventually benefit from demographic change.

3.5 Appendix to Chapter 3

Table A3.1: Countries included by slum incidence

Higher slum incidence (>50% in 2005)
Afghanistan, Angola, Burundi, Benin, Burkina Faso, Bangladesh Belize, Bolivia, Bhutan, Botswana, Central African Republic, Cote d'Ivoire Congo (Dem. Rep.), Congo (Rep.), Comoros, Cape Verde, Ethiopia, Gabon Ghana, Guinea, Gambia, Guinea-Bissau, Haiti, Kenya, Cambodia, Lao PDR Lebanon, Liberia, Madagascar, Mali, Mongolia, Mozambique, Mauritania Malawi, Niger, Nigeria, Nicaragua, Nepal, Rwanda, Sudan, Senegal, Sierra Leone Somalia, Chad, Togo, Tanzania, Uganda, Yemen (Rep.), Zambia
Lower slum incidence (<50% in 2005)
Argentina, Brazil, Chile, China, Cameroon, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, Egypt, Grenada, Guatemala, Guyana, Honduras, Indonesia, India, Iran, Iraq, Jamaica, Jordan, Libya, St. Lucia, Sri Lanka, Lesotho, Morocco, Mexico, Myanmar, Namibia, Pakistan, Panama, Peru, Philippines, Paraguay, El Salvador, Suriname, Syrian Arab Republic, Thailand, Tunisia, Turkey, Uruguay, Venezuela, Vietnam, South Africa, Zimbabwe

The export diversification index provided by the Unctad has a greater value the less a country is diversified in its exports.

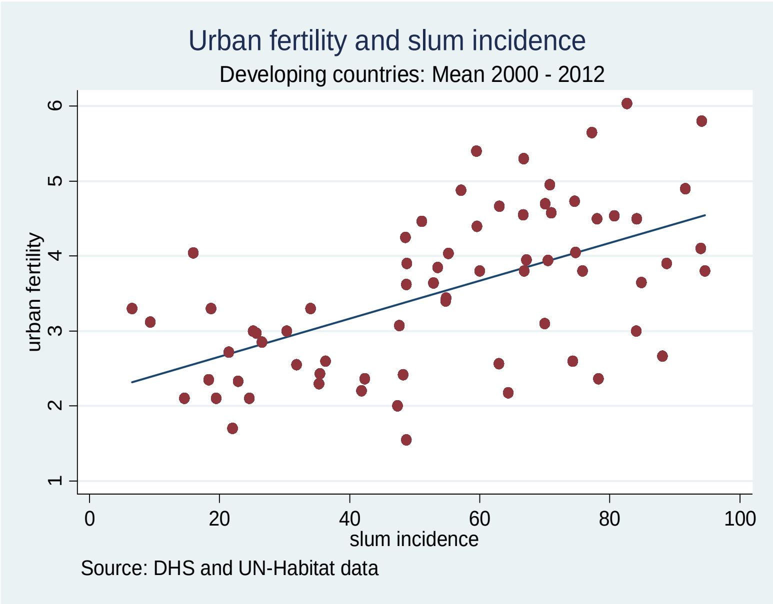

Figure A3·1: Urban fertility and slum incidence

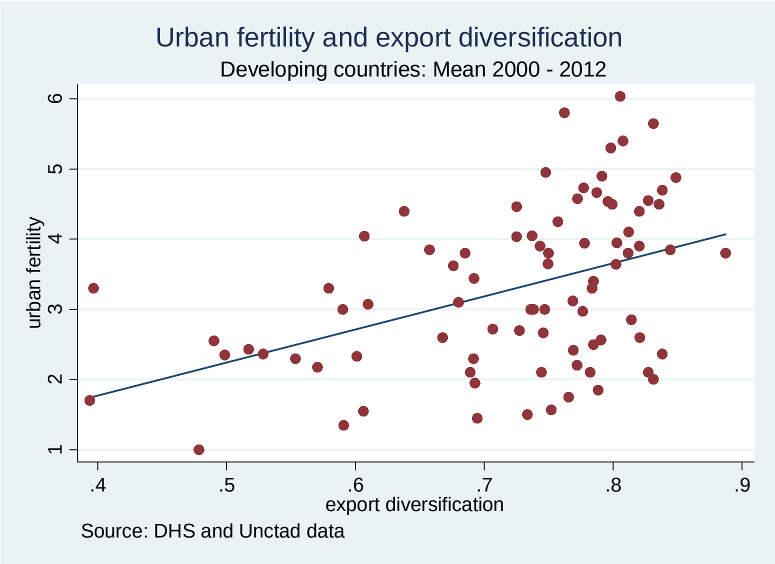

Figure A3·2: Urban fertility and export diversification

Chapter 4

Modern Sector Development - The Role of Exports and Institutions in Developing Countries

This chapter is based on joint work with Thomas Gries. The underlying article, differing slightly from this chapter, has been published in the conference paper series 2015 of the Verein für Socialpolitik as "Beiträge zur Jahrestagung des Vereins für Socialpolitik 2015: Theorie und Politik - Session: Trade, finance and institutions E08-V2". Similar to the previous ones, the chapter is also related to the theme of modernization in developing countries. While chapters two and three empirically connect the degree of modernization as a determinant of fertility levels, this chapter focusses on the drivers of modernization itself. In the line of argumentation that is, it picks up the previous results - broadly, that modernization drives fertility - and consequently draws the attention now to the determinants of modernization.

4.1 Introduction

A thriving modern sector is of major importance for a country's long-term and sustainable development. The historical experience of today's advanced economies suggests that the path to growth in these countries was accompanied by a structural shift towards a modern manufacturing sector. While western countries already industrialized as early as the mid 19th century, newly industrialized countries such as South Korea or Taiwan massively expanded their manufacturing sector in the mid to late 20th century. Moreover, recently we have been witnessing the emergence of a strong Chinese manufacturing sector that drives the overall economic performance of the whole country. In addition to such anecdotal evidence, recent research by Rodrik (2013) on labor productivity in manufacturing underlines the importance of understanding the mechanisms that drive development in the modern, respectively the manufacturing sector.[1]

In the literature a number of empirical and theoretical studies emphasize the importance of a modern sector for overall economic performance. While some contributions (e.g., Szirmai 2012, De Vries et al. 2012, Timmer and De Vries 2009, Rodrik 2009, Peneder 2003) document the positive impacts of modern sector dynamics on overall economic development empirically,[2] others suggest that there are links between sectoral and general productivity or development by using an analytical framework (e.g., Duarte and Restuccia 2010, Kuralbayeva and Stefanski 2013, Dekle and Vandenbrouke 2012).

Figure 4·1 illustrates the correlation between overall and sectoral growth using data from the sample examined in this study. We map growth rates of the manufacturing sector (upper panel) and growth rates of GDP, both in per capita terms, in developing countries over two time periods between 1980 and 2010. In comparison we map the association between the agricultural sector (lower panel) and growth rates of GDP. While both sectors appear to be positively correlated with per capita GDP growth, we see a clear relatively stronger association of the modern sector in these developing countries.[3] How important

[1] Throughout we focus on the whole manufacturing sector and term it 'modern' especially vis-à-vis a traditional agricultural sector in developing countries. A further refinement of sub-sectoral activity is not subject of this study and would greatly alter data requirements.

[2] This literature focuses on the impact of modern (manufacturing) sector growth on overall growth but (mostly) also acknowledges that e.g., a service sector can play an important role in development (see, e.g., Szirmai and Verspagen 2011). However, as documented in de Vries et al. (2015) service sector's productivity gains can mostly not match those of the manufacturing sector.

[3] Our sample includes 75 countries; see appendix for details.

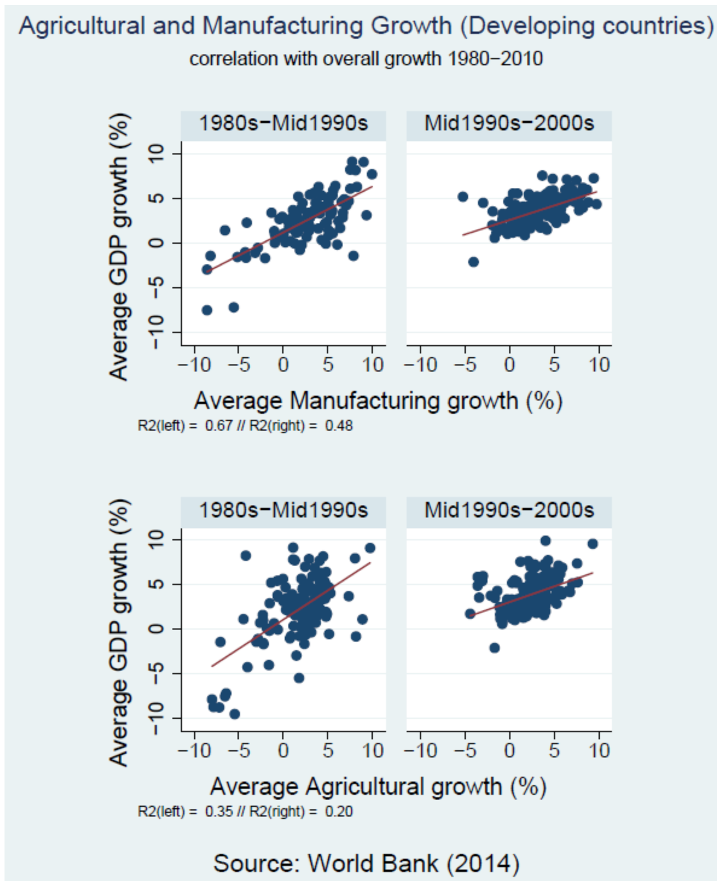

Figure 4·1: Association between sectoral and overall growth in developing countries, 1980 - 2010.

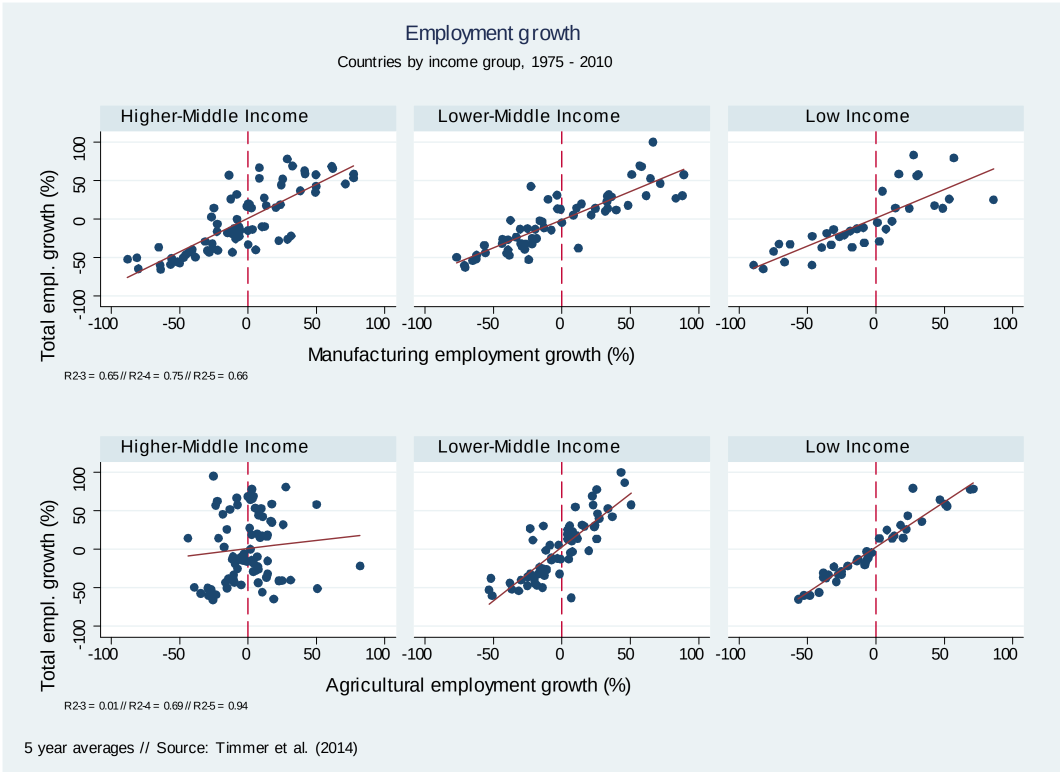

Figure 4·2: Employment growth: sectoral and overall, by income group.

a focus on the modern manufacturing sector is can also be derived from figure 4·2. By using data from the ten sector database we relate overall employment growth with sectoral employment growth by income group. Again the top panel shows figures for the manufacturing sector while the bottom panel shows figures for the agricultural sector. While the relation between manufacturing employment growth and overall employment growth maintains stable across income groups, this does not hold true for agricultural sector employment growth for the higher income group. In other words, the opportunity to further enjoy employment growth becomes more viable with the manufacturing sector than with the agricultural sector after reaching a certain level of income and development.

However, while the positive relationship between manufacturing activities and overall growth achieves consensus among economists- naturally the question arises of what exactly makes a country's (modern) manufacturing sector grow. What drives the economic dynamics in this important sector? Surprisingly, there is little evidence provided in the literature and to the best of our knowledge no comprehensive empirical estimation of a modern sector's development drivers. A possible reason may be that the literature about structural change received considerable attention lately and focussed on descriptions and benefits. For example Fagerberg (2000) shows that structural change occurs when within manufacturing economies focus on the technologically most progressive sub-sectors. This lets manufacturing sector's productivity grow faster. Similarly, Peneder (2003) shows that greater shares in high-tech industries positively influence income growth. And also explicitly for developing regions McMillan and Rodrik (2011) show that structural change is conducive to development if labor shifts to higher productivity sectors[4]. Our question of driving factors is connected to the literature that documents the importance of structural change, but is still distinctly different. While we take the sector's importance for long-run development[5] as given (as thoroughly argued), we ask what promotes this sector and thus what are the determinants to modernize the economy by manufacturing expansion. That is, we will explore direct growth determinants for this sector and do so along the lines of the existing (overall-)growth literature. Herrendorf et al. (2014) review a large body of mostly theoretical advances in the structural change literature and find that most times there is a consideration of exogenously given changes impacting on the process of structural transformation. Though we are not directly concerned with an economy's relative compo-

[4]Similarly, Gollin et al. (2014) document a striking difference in productivity between the agricultural and non-agricultural sector in developing countries. This may imply a misallocation of production factors that, if changed, bears great potential for development.

[5]Importance in the sense of important for development. It is well known that in relative size the manufacturing sector in developing countries often does not exceed 20% of output.

sitional structure, we depart from to suggestion of Herrendorf et al. (2014) and ask for the factors behind the modern sectors evolvement, the drivers. The structural change literature that incorporates internationalization is narrow, in particular more recent studies are not at all numerous. Matsuyama (2009) proposes an open economy model for structural change including a trade channel that may positively impact on the employment share of the manufacturing sector. More quantitatively this is supported in Uy et al. (2013) for the experience of South Korean manufacturing.

Therefore, in this paper we adopt a somewhat broader view. We take manufacturing sector growth as a broader indication for the economic modernization process in a developing country. We ask, to what extend does a developing country's society have access to modern sector income generation and what are the determinants of this economic modernizations process. That is, we are interested in the diffusion of modern sector production within the society. We indicate access to modern sector income generation by manufacturing sector value added per capita. As this measure describes modern production per capita it may be interpreted as an indicator for the spread of modern economic activities within a country's population. Our modern sector perspective shall capture its role in long-run development and the sector as a source to provide fundamental societal and economic change on a potential path towards higher stages of development and income. With interest in pinning down potential determinants of this modernization we focus on the role of exports and institutions for the development of this important sub-sector.

Why is the manufacturing sector expected to promote growth and in particular, eligible to be associated with trade and institutions? The answer, we argue, lies on the one hand in its special characteristics and on the other hand, in the mechanisms that connect trade and institutions with development in the general growth literature. Szirmai (2012) thoroughly reviews the key characteristics (that also make the sector especially relevant for overall growth). First, the sector is said to provide better opportunities for capital accumulation, which is a crucial factor for growth. Typically, capital intensity is higher and manufacturing is more concentrated than spatially dispersed agriculture. Second, the manufacturing sector evokes higher productivity increases, a mechanism that has also been referred to as the structural change bonus (Rodrik 2009, Temple and Woessmann 2006, Timmer and de Vries 2009). Apart from opportunities for economies of scale, linkage and spillover effects are important aspects of the modern manufacturing sector. The linkage effect refers to a situation where direct forward and backward interaction (linkages) between different (sub)sectors occur and present positive externalities to investment. Spillover effects are special externalities to investments in knowledge and technology and occur both within and across sectors.

Our proposition, namely that exports impact on modern sector development, is guided by the trade literature on the impacts of *manufacturing exports* on overall development (e.g., Herzer and Nowak-Lehmann 2006, Berg et al. 2012, Hesse 2008, Imbs and Wacziarg 2003, Ledermann and Maloney 2003, Herzer et al. 2006, and Naudé et al. 2010). While the literature on general trade and development remains rather inconclusive[6], the line of argumentation in the mentioned strand suggests that a vertical diversification of exports, i.e., manufacturing in addition to primary products, is beneficial (Herzer and Nowak-Lehman 2006, Berg et al. 2012) because it alleviates (export) price instabilities for primary products (Hesse 2008). This is also supported by Lederman and Maloney (2003), who find that an export sector that concentrates on natural resources has a rather negative impact on growth. Further, the benefits of exports of and diversification towards manufacturing products include i) (firm-level and industry-wide) productivity and efficiency gains (Herzer

[6] See, e.g., Sachs and Warner (1995), Dollar and Kraay (2003), Alesina et al. (2000), Frankel and Romer (1999) or Wacziarg (2001) for a positive account of the impact of trade on growth, and Rodriguez and Rodrik (2001) for a critical account. Further, Birdsall and Hamoudi (2002) focus on the inadequacy of the openness measure in the debate, while Greenaway et al. (2002) suggest an unfavorable time framing of the analysis. Very recent empirical studies also focus on trade liberalization in times of crisis (Falvey et al. 2012) and on cross-country heterogeneity in the trade-income relationship (Herzer 2013).

et al. 2006, Naudé et al. 2010, Melitz 2003, Dogan et al. 2011), ii) (knowledge) spillovers and diffusion (Herzer et al. 2006, Naudé et al. 2010), and iii) the loosening of a country's foreign exchange constraint (Naudé et al. 2010). We argue that the benefits of vertical diversification vis-à-vis traditional primary production[7] are channeled through the manufacturing sector with the special characteristics outlined above, and naturally most of these effects will primarily have an impact on the modern manufacturing sector. Some empirical evidence for the beneficial channel of trade is presented in Chandran and Munusamy (2009) for the case of Malaysian manufacturing.

Similarly to trade, or more precisely exports, institutions may well prove a determinant of manufacturing sector dynamics. The broad discussion of the impact of institutions on growth dates back to North (1990) and has spawned influential research that argues that it is relevant (e.g., Acemoglu et al. 2005, Rodrik 2002). Thus, if institutions matter in the hypothesized way to the aggregate economy, we would expect them to be all the more important to modern sector development. As the concept of institutions is highly complex, we highlight only some of the aspects. A much-discussed institution that is highly relevant to our analysis is property rights. Acemoglu et al. (2001) focus on expropriation risk as a dimension of property rights enforcement and find that this has a strong impact on per-capita income development. When it comes to the modern sector, we consider this important as the manufacturing sector is characterized by higher capital needs, so consequently uncertain property rights (in this case expropriation risk) can hamper investment. A second dimension of property rights that is presumably important to the modern sector is the availability of contractual enforcement institutions. Focusing on the firm environment, Johnson et al. (2002) find, without differentiating any further, that weak property

[7] Imbs and Wazciarg (2003) analyze the distribution and find u-shaped empirical evidence that countries are diversified according to their development level with low and high levels of development representing specialisation and in between higher diversification.

rights prevent firms from investing their profits.

In our panel analysis of a sample of 75 developing countries from 1970 until 2005 we find evidence of the importance of both manufacturing exports and institutional quality for manufacturing sector growth. These findings are robust across model specifications and different estimation strategies. While we are also able to underline the importance of secure property rights as an economic institution, we are unable to conclude that manufacturing exports are equally important across all income levels. The remainder of the paper is structured as follows. The next section contains our empirical analysis with an in-depth description of model, estimation strategy, and data, followed by a results section including tables. The last section concludes.

4.2 Empirical Analysis

In this section we map out the econometric model and explain our dataset. We are particularly interested in whether exports and institutions drive manufacturing sector development. Based on the literature referenced above, we are positive that it is possible to establish this link empirically. Our estimations are based on a GMM estimator that explicitly accounts for endogeneity among the regressors as well as country-specific effects. However, we also use several other estimators to review our primary results' robustness. In the following we motivate the model and the estimation technique, and discuss several of the estimators that are common in growth estimations.

4.2.1 Model and Methodology

We analyze a panel of 75 developing countries over the period 1970 to 2005, which is split into six non-overlapping five-year intervals. Since we wish to identify the drivers of manufacturing sector growth, we estimate the model as follows:

$$y_{it}^m - y_{i(t-1)}^m = gr_{it}^m = \alpha + \beta y_{i(t-1)}^m + \gamma Exp_{it}^m + \delta Inst_{it} + \theta Cont_{it} + \xi_t + \eta_i + \varepsilon_{it} \quad (4.1)$$

where the subscripts i and t denote country and time, respectively. y^m is manufacturing output in logarithmic form, $Exp^m$and $Inst$ represent the regressors of interest, exports in manufacturing and institutions while $Cont$ is a varying set of control variables. ξ and η are unobserved period- and country-specific effects, α is a common intercept and ε is an i.i.d. error term. In our half-decade panel we average most variables over the time period. This removes short cycles that are not of interest here, and therefore displays the relationship of the variables within five years. We hypothesize that the time frame is well chosen to capture the effects of our independent variables on our dependent one, that is we expect the effects to materialize within five years. However, even though commonly conducted and necessary averaging the variables comes at the cost of reducing sample size and losing variation. The lagged term of y^m captures the convergence present in manufacturing as found by Rodrik (2013) and is the beginning of period value of the dependent variable. For example, we regress the growth rate of manufacturing output between 1990 and 1995 on the control variables averaged over the same time period but also on the initial value of manufacturing output in 1990. The panel specification enables us to include η, a control for unobserved country-inherent and time-invariant effects. These may otherwise be a source of endogeneity from omitted variables. We are therefore able to control for characteristics including geographical and population features such as natural resources, colonial history, climate, and remoteness. Di Giovanni and Levchenko (2009) even argue that institutional quality and the political system can be captured. The time effects we control for (ξ) pick up shocks common to the whole system, e.g., world market fluctuations.

However, if rewritten, equation (4.1) represents a classic dynamic model with a lagged dependent variable

$$y^m_{it} = \alpha + (1+\beta) y^m_{i(t-1)} + \gamma Exp^m_{it} + \delta Inst_{it} + \theta Cont_{it} + \xi_t + \eta_i + \varepsilon_{it} \tag{4.2}$$

that introduces known estimation problems. The inclusion of η is especially problematic for the conventional OLS estimator. For consistency, the country-specific effects would have to be orthogonal to other regressors (Caselli et al. 1996), a feature that has to be ruled out due to the presence of a lagged dependent variable.

A prominent approach is to use a class of estimators which first start by eliminating the country-specific term by either taking deviations from period averages and focusing on within-country variation (fixed-effects or least squares dummy variable estimator, LSDV) or by using period averages right away (between estimator) (DeJong and Ripoll 2006). The former has been found to be consistent only for a large time dimension, a feature that most macroeconomic panels, including ours, lack. However, as the bias is well-known (Nickell 1981) bias-correcting estimators have been developed for small-T panels (e.g., Kiviet 1995, or for unbalanced panels, Bruno 2005). Even though the latter estimator already deals successfully with this bias it still requires, as does the fixed-effects estimator, strictly exogeneous regressors.[8] If this is not given, there is a lasting contemporaneous correlation between regressors and disturbances which aggravates the estimation (Caselli et al. 1996). We have to acknowledge that imposing the strict exogeneity restriction on our regressors would be highly critical because when it comes to our two variables of interest, exports and institutions, one can convincingly argue that they are not only causes but also effects of manufacturing development. For example the firm-level literature on exports often argues that there may be more productive companies selecting themselves into the

[8] The estimator is implemented in Stata in the routine xtlsdvc. We use the Blundell-Bond estimator for the initial estimates, apply a bias correction of order O(1/NT^2) and use 200 repetitions to bootstrap the variance-covariance matrix. However, estimates do not change when we change these settings.

export market, which would mean a reverse causality also in the aggregate case, or that exports enhance a company's productivity through exposition to international competition or economies of scale.[9] The latter is the channel explored in this research. However, as we only want to capture the channel from exports to sectoral growth we have to best avoid the potential source of the endogeneity bias.

An often-used solution for this problem is to use the system GMM estimator proposed by Arellano and Bover (1995) and Blundell and Bond (1998). The system GMM estimator is similar to the difference GMM estimator proposed by Arellano and Bond (1991). Both estimators use a differenced version of equation (4.1)

$$\begin{aligned} gr^m_{it} - gr^m_{i(t-1)} &= (\alpha - \alpha) + \beta(y^m_{i(t-1)} - y^m_{i(t-2)}) + \gamma(Exp^m_{it} - Exp^m_{i(t-1)}) \\ &\quad + \delta(Inst_{it} - Inst_{i(t-1)}) + \theta(Cont_{it} - Cont_{i(t-1)}) \\ &\quad + (\xi_t - \xi_{t-1}) + (\eta_i - \eta_i) + (\varepsilon_{it} - \varepsilon_{i(t-1)}) \end{aligned} \tag{4.3}$$

to eliminate the country-fixed effect η_i. Endogeneity concerns associated with the regressors are circumvented by using within-instruments. In our model it is particularly important to account for the potential endogeneity problem for two reasons. First, both variables of interest, institutions and exports, can be determined by manufacturing development. Second, the included control variables may flaw the estimation if they are not exogenous. The use of within-instruments, that is, the use of instruments from the available data, is an appealing approach since we would struggle to find convincing instruments from outside. Under two assumptions we may find internal instruments for the first-differenced equation: (a) the error ε_{it} is not serially correlated; and (b) the variables in levels are weakly exoge-

[9] Examples of both may be found in e.g. Greenaway and Kneller (2007) or Greenaway et al. (2007).

nous, i.e. potentially correlated with past (and current) disturbances but not with future errors. Under these conditions lagged levels may prove to be valid instruments for their first differences. However, Easterly and Levine (2001) note that lagged levels of persistent regressors may prove to be weak instruments in equation (4.3) and bias the estimation. Further, the sole use of differences leaves information about the level relationship unused (DeJong and Ripoll, 2006) and reduces the time dimension of the sample. Especially the latter fact is critical as our time dimension is already short ($T = 6$). In order to circumvent the arising problems the system GMM estimator has been introduced to combine the first-difference equation (4.3) with the level equation (4.1). In order to obtain lagged first-differences as valid instruments in the levels equation a further assumption has to be made: first-differences may not be correlated with the country-fixed effect.

Even though this estimator controls for many caveats in dynamic panel data estimation, it hinges on assumptions that need to be validated. We follow Roodman (2006) and report next to regression coefficients and sample-size important test statistics, which are designed to validate the identifying assumptions. These include the Hansen-J test for over-identification (Hansen, 1982) and Arellano and Bond's (1991) tests for autocorrelation. The Hansen test's null hypothesis is that the instruments are exogenous and thus should not be rejected. As this test may be weakened by instrument proliferation (Roodman 2009), we limit the number of instruments[10] and report their count. Next, we report the m_1- and m_2- tests for autocorrelation in the differenced errors ($\varepsilon_{it} - \varepsilon_{i(t-1)}$). The presence of second-order serial correlation (in differenced errors) implies first order serial correlation of the ε_{it} which violates our assumptions. Therefore we should not reject the null of no serial correlation in the m_2- test. Further, we explore not only the exogeneity of the complete

[10] We use all available lags and collapse the instrument matrix only for those potentially endogenous variables that are not at the core of the analysis. We do so to maintain a maximum of information in the estimation.

set of instruments but also for specific subsets. As noted in Roodman (2009) a specific subset of interest are the lagged differences as instruments for the lagged dependent variable (in the levels equation). We report a p-value for the difference-in-Hansen test of the null hypothesis of instrument exogeneity.[11] And lastly, we use the finite-sample Windmeijer (2005) correction and the two-step estimator to deal with heteroscedasticity and arbitrary correlation patterns within countries.

Our strategy involves running several specifications with a differing set of control variables and using several different estimators. However, as outlined above, we obtain most results from our preferred system GMM estimator.

4.2.2 Data and Variables

To obtain a large set of panel data with the regressors of interest and relevant controls, we combine several data sources. These include the World Bank's development indicators, Barro and Lee's educational attainment dataset, the comtrade dataset on exports by category, the Penn World Tables, the Fraser Institute's World Freedom Index, and the International Country Risk Guide (ICRG). The countries in the sample are selected solely based on data availability and the World Bank's income classification. We include developing countries that are associated with either income group three, four, or five.[12] Summary statistics are given in Table A1.

[11] As this is most crucial in system GMM estimation we report this diagnostic right within the estimation results. However, other subsets of our instruments all pass the difference-in-Hansen test of instrument exogeneity (available upon request).

[12] Upper middle-income countries, Lower middle-income countries, Low-income countries with 2011 per capita GNI of US$ 4 036-US$ 12 475, US$ 1 026-US$ 4 036 and less than US$ 1 025, respectively.

Dependent variable

Our dependent variable is the growth rate, averaged over five years, of per capita manufacturing output. In analogy to common empirical growth estimations we relate output to population, as this accounts for size effects between economies and enables us to interpret it as the population's penetration with modern sector production. Related measures are the relative share of a sector in GDP, or the sectoral labor force's productivity. While the former targets relative changes, the letter targets a specific growth channel. Even though our focus is on neither, we make sure that our results are not at square.[13] Manufacturing output is taken as value added in constant 2000 US$ from the World Bank's development indicators (World Bank 2012), while the population figures are from the Penn World Tables version 7.1 (Heston et al 2012).

Independent variables

Our subject of interest is the effect of exports and institutions on manufacturing sector dynamics. First, we use manufacturing exports from the United Nations Commodity Trade Statistics database (Comtrade 2012). Manufacturing comprises products in SITC categories 5 to 8. Again, we relate manufacturing exports to population figures to account for size effects and to achieve comparability across countries. Next, the Fraser Institute's Economic Freedom Index (Gwartney et al. 2012) serves as an approximation of institutional quality. It is scaled from 1 to 10, with 10 being the best developed institutions across several dimensions including size of government, legal structure and property rights, access to money, freedom to trade, and regulation of credit, labor, and business. The index is often used in the literature, not least because it provides a long series of data and is thus

[13] In (unreported) extensions we therefore also scale with GDP and see no contradictions with our core results. Similarly, when taking out scale parameters, the results are maintained. The use of the sectoral labor force's productivity greatly reduces the sample size and maintains results for exports.

suitable for the panel analysis we perform with a time dimension of over 30 years.

Control variables

We would expect the amount of human capital available to impact the growth of a more modern sector.[14] In developing countries, manufacturing activities (in comparison to, e.g., subsistence agriculture) generally require the use of more complex technology which in turn can only be put to productive use by an educated workforce. The absorption of better technology should thus be facilitated by a more highly educated workforce. To approximate the level of human capital we mainly use average years of schooling of both males and females. The data source is Barro and Lee's educational attainment dataset (2010). Another common determinant of growth is investments. Especially for a capital-intensive modern manufacturing sector investments appear invaluable. We also include investments in our regression to comply with standard empirical growth estimations (e.g., Mankiw et al. 1992). Next, foreign aid is also believed to impact especially on the manufacturing sector. Rajan and Subramanian (2011) conduct an empirical investigation of this. According to them, aid favors the domestic non-tradables sector over an export manufacturing sector in that it affects the real exchange rate. Empirically, they find that recipient countries perform worse in terms of their manufacturing sector's share in GDP. We control for the impact of aid on manufacturing in our estimations using aid data from the World Bank (World Bank 2012). We also use official per-capita information on development aid and assistance. Next, we include urbanization, which can be regarded as a driver of modern sector development in three ways. First, urban agglomerations provide easy access to a pool of labor that can be employed in manufacturing. Second, geographical closeness facilitates spillover effects. Third, urbanization can also be regarded as a measure of modernization

[14] For a general account of human capital and growth see e.g. Barro (2001).

in general (health, education, infrastructure). However, because urbanization can also be easily thought of as an effect rather than a cause, it is important to treat it as a potentially endogenous variable. And lastly, natural resource dependence may also influence modern sector development and is therefore included. Several channels are suggested in the related literature (see e.g. van der Ploeg 2011). First, resource availability may divert funds away from more beneficial activities, of which the modern sector is certainly one. Second, triggering conflicts over rents, resource dependence also increases uncertainty, which can affect real investments and human capital accumulation negatively. Third, a boom in natural resource exports can drive up the exchange rate and decrease competitiveness of the manufacturing sector. For these reasons, we let natural resource dependence enter our model. However, as the effects potentially dependent on the institutional environment we do not necessarily expect a strong impact in either direction. The data are drawn from the World Development Indicators (World Bank 2012) and represent resource rents as a share of GDP, and separately its subcomponents oil, gas, coal, mineral and forest rents as shares of GDP.

As mentioned in the introduction, recent research by Rodrik (2013) analyzes convergence in manufacturing sector labor productivity. He finds *unconditional* convergence for both two-digit categories and aggregate manufacturing activities, which leads us to also account for conditional convergence across countries. We take the proposition of convergence as a point of departure to derive additional driving mechanisms. Thus we set up a base case with conditional convergence and add our proposed influencing mechanisms, namely exports and institutions. Technically, that means we control for β-convergence by including the lagged level of the dependent variable as a regressor. In our estimation we include the beginning-of-period level of per capita manufacturing output as an explanatory variable for the growth rate.

4.3 Results

Exports and Institutions Table 4.1 shows our estimation result for the first set of estimations. This set employs the strategy of estimating *different* model specifications with the *same* estimator, our preferred system GMM estimator. Later we turn to alternative ways of estimation. Column (1) shows the basic estimations of the effects of our regressors of interest. Both variables, exports and institutions, display an impact on manufacturing sector growth, which is positive and significant alongside controls of convergence and time- and country specific effects. The next column includes controls for effects other than country, time, and convergence. We include a control for human capital and official development assistance (2), and also for urbanization and investments (3). In columns (4) and (5) we present the estimations with an included control for natural resource rents (4) and the subcomponent mineral rents (5)[15]. Even though the inclusion of further controls reduces the magnitude of the main effects they clearly remain significant at the 1% level. Further, including additional regressors forces us only slightly to reduce the sample for data availability reasons alone. However, we see that this reduction does not change our estimation results.

Given that the system GMM estimator rests on restrictive assumptions we discuss our instrument's validity based on common diagnostics. Almost all our estimations fulfill the required assumption about no serial correlation in the errors. According to the m_2- test we cannot reject the hypothesis of no second-order serial correlation (in the differenced errors). Further, as the consistency of the estimator critically hinges on the validity of the used instruments we conclude from the J-test confirmation that our set of instruments is valid in the estimation. That is, the null hypothesis of exogenous instruments cannot be

[15] For brevity we do not show the results for other subcomponents of natural resources. They are similar to the composite indicator in column (4). However mineral rents, which appear significant, are maintained throughout the following estimations.

Table 4.1: Manufacturing Growth in Developing Countries - System GMM Estimates

Dep. var.: Manuf. Growth	**All Countries**				
Model:	(1)	(2)	(3)	(4)	(5)
Initial Manufacturing$_{t-1}$	-0.298***	-0.243***	-0.221***	-0.218***	-0.201***
	(0.055)	(0.074)	(0.049)	(0.052)	(0.056)
Manuf. Exports$_t$	0.184***	0.127***	0.124***	0.114***	0.119***
	(0.041)	(0.035)	(0.039)	(0.039)	(0.039)
Institutions$_t$	0.111***	0.104***	0.085***	0.089***	0.079***
	(0.027)	(0.037)	(0.022)	(0.023)	(0.022)
Schooling$_t$		0.016	-0.023	-0.016	-0.016
		(0.025)	(0.022)	(0.022)	(0.018)
Urbanization$_t$			0.002	0.001	0.001
			(0.003)	(0.003)	(0.002)
Investments$_t$			0.085*	0.093*	0.069
			(0.049)	(0.053)	(0.051)
ODA$_t$		-0.064**	-0.040**	-0.047***	-0.035*
		(0.031)	(0.020)	(0.016)	(0.019)
Natural res. rents$_t$				0.003	
				(0.002)	
Mineral res. rents$_t$					-0.015***
					(0.004)
Implied λ	0.071	0.056	0.050	0.049	0.045
Observations	292	279	279	279	279
Countries	77	71	71	71	71
Hansen (p-value)	0.62	0.36	0.56	0.52	0.46
Diff-in-Hansen (p-value)	0.65	0.50	0.91	0.86	0.79
Instruments	54	56	68	69	69
AR(1) (p-value)	0.00	0.00	0.00	0.00	0.00
AR(2) (p-value)	0.35	0.28	0.32	0.32	0.40

Notes: Dependent variable in all models is per capita Manufacturing Growth. Initial Manufacturing, Manufacturing Exports, Investments and ODA are used in per capita terms and natural logarithms. Natural and mineral resource rents are shares of GDP. *, ** and *** denote significance at the 10-, 5- and 1% level, respectively. Windmeijer corrected S.E.s in parentheses. All models are estimated with constant, time- and country-fixed effects. Sample range is 1970 - 2005 in 5-year averaged non-overlappingperiods. Diff-in-Hansen test tests the instrument exogeneity of the first-differences in the system-GMM levels equation (see text).

rejected. Finally, we test for the validity of instrument subsets, that is, we test whether the instruments for each endogenous regressor qualify separately as valid. The results indicate that this is the case for almost all subsets.

Having established exports and institutions impact positively on the growth rate of manufacturing, with a presumably well qualified estimator for dynamic panel data models, we turn to estimating the full specification (i.e., specification (5) in Table 4.1) with alternative estimators. While column (1) in Table 4.2 replicates the estimated coefficients in Table 4.1, columns (2) to (5) represent the estimations with the difference GMM estimator (2), the LSDVC estimator (3), the fixed-effects estimator (4), and the cross-sectional OLS estimator (5).

The estimated coefficients for exports are positive and significant across the various estimators. Their magnitude is greatest among the GMM estimations, however significance is given at the 1% level across the board. The results for the institutions variable differ slightly. The obtained results are positive and significant (as the main estimation) in three of the five cases. The difference GMM estimator and the OLS estimator do not confirm a positive impact of institutions on modern sector development. The latter two results are also from the smallest samples. While the difference estimator reduces the sample to 61 countries the cross-section OLS sample consists of only 45 countries. However, the remaining significant results are of a similar magnitude.

Control variables From the broad (theoretical) literature we would expect *human capital* to enhance modern sector growth, for example as it facilitates the absorption of modern technology. However, looking at our estimations we find mixed evidence of a positive impact of the level of human capital on modern sector growth.[16] Even though it is

[16] In fact this finding is in line with work of e.g. Pritchett (2001) who notes that especially in macro estimations, as ours, the link may be weak.

Table 4.2: Manufacturing Growth in Developing Countries - Different Estimators

Dep. var.: Manuf. Growth	**All Countries**				
Estimator:	SysGMM	DiffGMM	LSDVC	FE	cs-OLS
Initial Manufacturing$_{t-1}$	-0.201***	-0.596***	0.763***	-0.422***	-0.116***
	(0.056)	(0.147)	(0.055)	(0.048)	(0.017)
Manuf. Exports$_t$	0.119***	0.198***	0.062***	0.092***	0.045***
	(0.039)	(0.071)	(0.021)	(0.028)	(0.010)
Institutions$_t$	0.079***	0.016	0.057***	0.043**	0.034
	(0.022)	(0.053)	(0.020)	(0.018)	(0.024)
Schooling$_t$	-0.016	0.042	-0.005	0.008	0.011
	(0.018)	(0.061)	(0.036)	(0.040)	(0.008)
Urbanization$_t$	0.001	-0.040***	-0.005	-0.003	0.001
	(0.002)	(0.014)	(0.005)	(0.004)	(0.001)
Investments$_t$	0.069	0.061	0.131**	0.195***	0.039**
	(0.051)	(0.170)	(0.053)	(0.048)	(0.015)
ODA$_t$	-0.035*	-0.007	0.012	0.012	-0.041***
	(0.019)	(0.032)	(0.026)	(0.027)	(0.009)
Mineral res. rents$_t$	-0.015***	-0.006	-0.010	-0.006	-0.012**
	(0.004)	(0.010)	(0.012)	(0.009)	(0.005)
Implied λ	0.045	0.181	0.054	0.110	0.025
Observations	279	201	279	279	45
Countries	71	61	71	71	
Hansen (p-value)	0.46	0.64			
Diff-in-Hansen (p-value)	0.79				
Instruments	69	37			
AR(1) (p-value)	0.00	0.20			
AR(2) (p-value)	0.40	0.81			

Notes: Dependent variable in all models is per capita Manufacturing Growth rate, except in the LSDVC estimation. The LSDVC model's dependent is per capita manufacturing output. Initial Manufacturing, Manufacturing Exports, Investments and ODA are used in per capita terms and natural logarithms. Mineral resource rents are a share of GDP. *, ** and *** denote significance at the 10-,5- and 1% level, respectively. Windmeijer corrected S.E.s in parentheses. All models are estimated with a constant, time- and country-fixed effects. Sample range is 1970 - 2005 in 5-year averaged non-overlapping periods. OLS estimates based on complete period averages. Diff-in-Hansen test tests the instrument exogeneity of the first-differences in the system-GMM levels equation (see text).

often times positive, in no estimation does the variable significantly support modern sector development. We measure human capital in average years of schooling. As summarized in Glewwe (2002) the link between schooling and productivity may not hold in all cases, especially not in Sub-Saharan Africa. That the links from schooling to skills to productivity are not adequately given may explain our results.[17] Next, we find that *investments* are positively related to manufacturing development. In most of our estimations we find a significant effect and thus support for the standard proposition that higher investment levels support growth. This is expected, as manufacturing is on average more capital-intensive than basic agricultural activities. By contrast, we do not find much evidence that *urbanization* significantly supports manufacturing growth. In other words, we can assume neither that there is a functioning link between a prospective labor pool and the sector's activity, nor that a more modern environment has a positive impact. The latter, however, may be due to the broad measure which urbanization is or that we may be dealing with different types of urbanization as proposed by Gollin et al. (2013). One fuels industrialization by supplying labor to the modern sector, while the other is based on the consumption of, e.g., resource rents where people engage in low-productivity petty services instead of high-productivity industry jobs. And next, we find evidence of a negative impact of *official development aid* on manufacturing growth. While the effect is smaller in magnitude than our main effects, trade and institutions, we can argue that official development aid is by no means a driver of structural change as it impedes modern sector development. The proposed link via the real exchange rate (Rajan and Subramanian 2011) may thus indeed put the manufacturing (tradable) sector at a disadvantage compared to other sectors. However, very likely may also be the case that aid, by flowing into other sectors (health, education), makes the modern one less competitive in comparison.

[17] The use of other approximations for human capital available (e.g., secondary schooling in the labor force, secondary schooling, primary schooling (all World Bank 2012) does not change our results.

In the last two columns of Table 4.1 we present the results of natural resources as a factor that impacts on modern sector development in our sample. The broad literature on natural resource dependence proposes several channels, which are in short outlined above.[18] In column (4) we include natural resource dependence in our model and note two aspects. First, our results hold, lending further credibility to our specification. And second, which is almost equally interesting and important, we see no significant impact of natural resources on modern sector development. However, from this estimation we can only infer that natural resources do not impede modern sector development controlling for institutions, exports and human capital. All of these are major channels of impact described in the natural resource literature. Another reason could be that natural resource subcomponents (i.e., gas, oil, coal, minerals, and forests) show different effects and hence lead to a non-significant overall effect. We consider this second explanation and report the most interesting result in column (5). For the minerals subcomponent we find a significant negative effect, even though we still control for the main channels of impact. We assume mineral extraction in developing countries to have comparatively higher labor intensity, especially in Sub-Saharan Africa. This may present a further constraint to modern sector development as the labor force may be absorbed by the mineral mines. Our results suggest that even though in general natural resources may not be problematic or even a curse, individual resources may differ in their impact on modern sector development, as the example of minerals shows in our estimation.

Convergence Our estimation results indicate that there is conditional convergence in aggregate per capita manufacturing output growth. Countries with a lower prior level of manufacturing output hence grow faster, as indicated by the negative coefficients on initial

[18] See, e.g., Gylfason and Zoega (2006) or van der Ploeg (2011) for a discussion of channels through which natural resources impact on growth.

manufacturing output in Tables 4.1 and 4.2. The convergence effect is significant across all estimations. Our estimation is thus in line with the proposition of Rodrik (2013) concerning the existence of convergence in manufacturing sector labor productivity, although in our case it is conditional upon the set of control variables and not restricted to the labor force. Nevertheless, our conditional convergence effects are even similar in magnitude to the one's estimated on labor productivity. To illustrate this, we report the implied λ which is the annualized rate of convergence derived from the coefficient for our lagged dependent variable. λ solves $1 + \beta = e^{-\lambda t}$, with β being the estimated coefficient and t the time in years between the current value and the lagged term, in this case $t = 5$.[19] The annualized rate of convergence in manufacturing is estimated at around 5% a year, while Rodrik's conditional estimations vary between 5 and 6%.[20] Finally, from an econometric point of view we gain confidence that we model and specify correctly by comparing estimates of the fixed effects, OLS and system GMM estimations. As argued by Bond (2002) the estimates of the cross-section OLS model and the fixed-effects model represent upwards and downwards biased estimates of the lagged dependent variable's coefficient. So the true value should lie in between. In our estimations this is clearly the case for the system GMM estimates.[21]

4.3.1 Extension

Having established the relevance of both institutions and trade for modern sector growth we extend the estimations to improve and strengthen the results along two lines, namely a differentiation of institutions and trade effects across income levels.

First, in the main analysis we use the broad measure of economic freedom from the

[19] For more details on convergence see, e.g., Barro and Sala-i-Martin (1992).

[20] See Rodrik (2013), p. 176, Table 1, even-numbered columns.

[21] The simple (in contrast to the reported time-averaged) OLS levels estimation with all observations produces an estimate of -0.14 for the lagged dependent variable, close to that reported in column (6).

Fraser Institute. As the index is also available in subcategories, namely size of government, legal structure and property rights, access to money, freedom to trade, and regulation of credit, labor, and business we can also use these to approximate the quality of economic institutions more precisely (assuming that the index components are obtained in an unbiased and comprehensive manner). First we exclude the subcomponent 'size of government' of the institutional quality index. We do so to avoid to rely on an indicator that is frequently criticized for being ideologically skewed. A bigger 'size of government' generally reduces the institutional quality score, a procedure that may be regarded as questionable (column 1). Next, we reduce the index to legal structure and property rights and regulation of credit, labor, and business (column (2)). Especially property rights are in this context expected to be important (Johnson et al. 2002). In columns (3) we reestimate (2) without investments, an important channel for institutional quality. And lastly in column (4) of Table 4.3 we look at an institutional quality indicator from the international country risk guide, namely socioeconomic conditions. First we see that our estimations remain robust to a change in the institutions index in column (1). This index excludes the size of government score which comprises, among others, tax rates. Next, by focusing on aspects of institutions promoting modern sector growth (column (2)), i.e., secure property rights and the regulation of credit, labor, and business, which are more direct from a theoretical perspective, we still estimate a significant coefficient as expected. However, this result is not strengthened when we leave out investments (column (3)). The latter result is somewhat surprising as especially property rights are associated with modern sector growth via enhancing the investment environment. A reconciling aspect might be that we capture the investment level with a very broad indicator. The last column (4) shows that the institutional quality indicator from the international country risk guide is similarly positively and significantly associated with modern sector growth. Further the effects of our included control variables (especially official development aid and mineral resource rents) do not change in this extension.

Next, we estimate our core model and interact our trade variable with dummies for different income levels in the countries under investigation. We propose and perform this exercise to evaluate whether our effects are robust across this dimension and whether policy implications can be generated across the board for different levels of income. We generate quintile dummies according to the income at the end of the sample. In Table 4.4 we see evidence that the impact of trade levels may well be connected to income group. While the interaction with higher income levels generates the previously found evidence of a positive impact, the first quintile does not suggest a significant impact of trade levels on modern sector growth. The quintile-specific results are derived from the joint validity of the two export coefficients. We get the strong impression that countries at the lower end of the income scale have not been able to boost modern sector growth through trading over the time frame studied. Because trade levels are comparatively low in the lowest income group we could argue that we are experiencing size effects, meaning that the volume of trade is not large enough to make an impact. Though this seems plausible when we look at the levels, there is another possible explanation. As prior literature has shown, diversification of exports (e.g., Berg et al. 2012) is beneficial as it insures against drawbacks in specific industries. We calculate the Herfindahl diversification index across income groups and find that the lowest income group is least diversified in its manufacturing exports. We may thus argue that the lack of diversification also plays a role in the relationship between trade levels and modern sector growth. (cf. Table A4.1)

4.4 Conclusion

In this contribution we study the determinants of modern sector development and contribute to the recently revived interest in modern sector development (e.g., Rodrik 2013).

Table 4.3: Manufacturing Growth in Developing Countries - Different Insitutions

Dep. var.: Manuf. Growth	Fraser			ICRG
Model:	No GS	PR & BR	PR & BR	Soc Econ
	(1)	(2)	(3)	(4)
Initial Manufacturing$_{t-1}$	-0.218***	-0.224***	-0.230***	-0.200***
	(0.067)	(0.061)	(0.065)	(0.072)
Manuf. Exports$_t$	0.095**	0.099***	0.138***	0.103*
	(0.042)	(0.033)	(0.038)	(0.057)
Institutions [2-5]$_t$	0.051**			
	(0.020)			
Institutions [2+5]$_t$		0.075***	0.062**	
		(0.028)	(0.028)	
Soc Econ$_t$				0.050**
				(0.021)
Schooling$_t$	0.009	-0.000	0.001	0.002
	(0.022)	(0.016)	(0.016)	(0.015)
Urbanization$_t$	0.000	0.001	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Investments$_t$	0.085*	0.089*		
	(0.048)	(0.053)		
ODA$_t$	-0.044**	-0.040*	-0.037*	-0.042**
	(0.022)	(0.021)	(0.023)	(0.017)
Mineral res. rents $_t$	-0.013***	-0.015***	-0.015***	-0.013**
	(0.003)	(0.004)	(0.005)	(0.007)
Implied λ	0.049	0.051	0.052	0.045
Observations	266	269	269	245
Countries	70	71	71	66
Hansen (p-value)	0.27	0.46	0.47	0.18
Diff-in-Hansen (p-value)	0.22	0.64	0.84	0.24
Instruments	69	69	63	52
AR(1) (p-value)	0.00	0.00	0.00	0.00
AR(2) (p-value)	0.33	0.37	0.33	0.22

Notes: Dependent variable in all models is per capita Manufacturing Growth. Initial Manufacturing, Manufacturing Exports, Investments and ODA are used in per capita terms and natural logarithms. Mineral resource rents are a share of GDP. *, ** and *** denote significance at the 10-,5- and 1% level, respectively. Windmeijer corrected S.E.s in parentheses. All models are estimated with constant,time- and country-fixed effects. Sample range is 1970 - 2005 in 5-year averaged non-overlapping periods. Diff-in-Hansen test tests the instrument exogeneity of the first-differences in the system-GMM levels equation (see text). Subcomponents of Institutions index: Governement Size (GS 1), Property Rights (PR 2), Access to money (3), Freedom to trade (4) and Business Regulation (BR 5).

Table 4.4: Manufacturing Growth in Developing Countries - Income Interactions by Quintile

Dep. var.: Manuf. Growth Model:	1st Quint.	2nd Quint.	3rd Quint.	4th Quintile	5th Quint.
Initial Manufacturing$_{t-1}$	-0.277***	-0.268***	-0.276***	-0.247***	-0.267***
	(0.056)	(0.068)	(0.076)	(0.057)	(0.066)
Manuf. Exports$_t$	0.122***	0.124***	0.104**	0.093**	0.105***
	(0.035)	(0.042)	(0.048)	(0.046)	(0.040)
Exports$_t$ x Inc1	-0.102***				
	(0.039)				
Exports$_t$ x Inc2		0.005			
		(0.017)			
Exports$_t$ x Inc3			-0.001		
			(0.009)		
Exports$_t$ x Inc4				0.013	
				(0.014)	
Exports$_t$ x Inc5					-0.002
					(0.014)
Institutions$_t$[All]	0.080***	0.077**	0.099***	0.105***	0.109***
	(0.030)	(0.032)	(0.026)	(0.026)	(0.032)
Schooling$_t$	-0.000	-0.007	0.000	-0.007	0.006
	(0.014)	(0.015)	(0.022)	(0.018)	(0.012)
Urbanization$_t$	0.002	0.002	0.002	0.001	0.001
	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)
Investments$_t$	0.060	0.098	0.102*	0.108*	0.097
	(0.047)	(0.060)	(0.060)	(0.056)	(0.062)
ODA$_t$	-0.039*	-0.043**	-0.047**	-0.050**	-0.054***
	(0.022)	(0.021)	(0.023)	(0.021)	(0.021)
Mineral res. rents $_t$	-0.013***	-0.016***	-0.013**	-0.013***	-0.014***
	(0.004)	(0.005)	(0.005)	(0.004)	(0.005)
Implied λ	0.065	0.062	0.065	0.057	0.062
Observations	279	279	279	279	279
Countries	71	71	71	71	71
Hansen (p-value)	0.50	0.51	0.43	0.52	0.53
Diff-in-Hansen (p-value)	0.65	1.00	0.74	0.52	0.68
Instruments	69	69	69	69	69
AR(1) (p-value)	0.00	0.00	0.00	0.00	0.00
AR(2) (p-value)	0.34	0.37	0.42	0.40	0.41

Notes: Dependent variable in all models is per capita Manufacturing Growth. Initial Manufacturing, Manufacturing Exports, Investments and ODA are used in per capita terms and natural logarithms. Mineral resource rents are shares of GDP. *, ** and *** denote significance at the 10-, 5- and 1% level, respectively. Windmeijer corrected S.E.s in parentheses. All models are estimated with constant, time- and country-fixed effects. Sample range is 1970 - 2005 in 5-year averaged non-overlapping periods. Diff-in-Hansen test tests the instrument exogeneity of the first-differences in the system-GMM levels equation (see text).

We take manufacturing sector growth as a broader indication for the economic modernization process in a developing country and ask for the determinants of this economic modernization process. What are the drivers for growth and diffusion of modern sector production within the developing society? Our modern sector perspective shall capture its role in long-run development and the sector as a source to provide fundamental societal and economic change on a potential path towards higher stages of development and income. Given the history of developed countries we technically focus on the drivers of manufacturing sector growth, namely trade and institutional quality. In a cross-section time-series analysis we use several model specifications as well as several panel estimators to obtain robust results and account for potential econometric drawbacks, especially endogeneity. In our sample of 75 developing countries from all developing regions of the world, we find that both exports and institutional quality impacted on manufacturing sector growth over the sample period 1970 to 2005.

Our results for manufacturing exports indicate that a the diffusion of a country's modern production capacity is positively driven by exporting to international markets. One possible reason is that developing countries can bridge domestic demand shortages for manufacturing products by selling to the large global market. However, productivity and spillover gains are also likely induced by exposure to international competition. Next, we find that the aforementioned positive impact is not uniform across income levels. The poorest countries in our sample do not benefit from trade, possibly due to their negligible trade volumes that have no measurable impacts on the entire sector. In addition to low export levels, these countries are also the least diversified.

Similarly, we find that the quality of overall institutions is beneficial for manufacturing sector development. Our measure of institutional quality comprises several dimensions, including secure property rights, a dimension hypothesized as being especially important for capital-intensive manufacturing. Looking at this dimension more in isolation, we find evidence that this aspect is important, too, to modern sector development.

Further, we find interesting results for our control variables. These include a negative impact of official development assistance on modern sector development. That said, natural resources generally do not seem to weaken a country's likelihood of developing a successful modern sector. However, this latter result is conditional on factors such as institutions or exports. Finally, our isolated analysis of mineral resources indicates that their presence has a negative impact on the modern sector, giving rise to the assumption that the mineral sector impacts via a different channel than other resources. We propose that it is a labor-intense sector which absorbs human capital that would be needed to form the manufacturing sector.

The implications of our results are twofold. First, even though trade in general may not be found to be unambiguously positive for overall growth, we provide evidence that when it comes to the modern sector, exports appear to be a largely important source of growth. Thus, to enlarge the modern sector there need to be adequate export opportunities for its products. And second, we also find that sound (economic) institutions, especially secure property rights, are vital to this sector. However, since we do not find that exports are relevant in countries with very low income levels, further research is required to gain insights into how to encourage manufacturing sector growth in least developed countries.

4.5 Appendix to Chapter 4

Table A4.1: Summary statistics

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
Manuf. Growth	0.08	0.276	-1.326	1.151	517
Manuf. Output pc	217.99	267.775	3.564	1699.99	651
Manuf. Exports pc	122.086	285.535	0.031	3544.31	479
Institutions	5.452	1.15	2	7.9	498
Schooling (Years)	5.28	2.531	0.088	10.982	672
ODA pc	120.911	308.743	-2.723	6869.789	863
Investment pc	915.185	1068.276	11.838	7547.74	882
Urbanization (%)	40.005	19.932	2.884	91.685	956
Mineral rents (% of GDP)	1.111	3.135	0	23.934	817
Manuf. Exports pc by group	**Mean**	**Std. Dev.**	**Min.**	**Max.**	
Inc group 1	7.272	16.61	0.031	83.917	
Inc group 2	27.241	35.938	0.439	212.646	
Inc group 3	67.957	85.466	0.398	394.425	
Inc group 4	175.436	271.405	1.173	1585.311	
Inc group 5	303.74	491.405	4.61	3544.31	
Export diversification by group	Herfindahl-Index for SITC 5 - 8				
Inc group 1	0.358	0.253	0.031	0.985	
Inc group 2	0.338	0.227	0.03	0.985	
Inc group 3	0.315	0.24	0.013	0.986	
Inc group 4	0.192	0.17	0.003	0.826	
Inc group 5	0.301	0.22	0.012	0.881	

Table A4.2: Countries included

Argentina, Armenia, Benin, Bangladesh, Bulgaria, Belize, Bolivia, Brazil, Botswana, Central African Republic, Chile China, Cote d'Ivoire, Cameroon, Colombia, Costa Rica, Dominican Republic, Algeria, Ecuador, Egypt, Fiji, Gabon, Guatemala Guyana, Honduras, Indonesia, India, Iran, Jamaica, Jordan, Kazakhstan, Kenya, Kyrgyz Republic, Sri Lanka, Lesotho, Lithuania, Morocco, Moldova, Mexico, Mali, Mongolia, Mozambique, Mauritius, Malawi, Malaysia, Namibia, Niger Nicaragua, Nepal, Pakistan, Panama, Peru, Philippines, Papua New Guinea, Paraguay, Rwanda, Senegal, El Salvador Togo, Thailand, Tunisia, Turkey, Tanzania, Uganda, Ukraine, Uruguay, Venezuela, Vietnam, South Africa, Zambia, Zimbabwe

Chapter 5

Concluding remarks

A reasonable assumption concerning the development of global population numbers is that they will rise well above the current level until mid century, and possibly also well further after that point. While global population growth itself may not be problematic, the trajectory expects the rise to be concentrated and thus large in mainly poorly developed regions. When excessive population growth numbers are negatively related to human and environmental well being and development, which is certainly the case, a sound understanding of their drivers is crucial and an important aspect of explaining economic and social development across poor regions in the world.

This thesis fills research gaps concerned with population development and its linkages to structural, economic change. It emphasizes on the determinants of fertility, which has been found to be the greater puzzle of the major two determinants of population growth - fertility and mortality. Of the explanations for declining fertility the economic demand theories are shown in this thesis to be of an integral part in determining future fertility developments. The analysis indicates that the economic transformation towards higher paying, human capital demanding job opportunities is a vital ingredient not only to increase the standards of living, but also to lead to a demographic transition.

In more detail, this thesis shows that the era of global economic integration, the globalization of trade and production processes, may also influence demographic transition trajectories in especially those countries that are located at the onset of the transition. A formalized theory proposes that the human capital content of trade may determine whether benefits from trade are materialized and channeled towards either an enlargement of the population or further education of the population. In a detailed cross-country estimation it is confirmed that while primary exports show none, or a positive impact on reproductive behavior the opposite is true for manufacturing exports. However, for this broad finding two qualifications have to be made. A split according to income shows that the least developed country group, which is the country group that potentially also faces the largest increases in population, does not show the negative impact of manufacturing trade on fertility. While this does not mean that the mechanism is absent, it may be the case that it is too small to impact upon the country average fertility rate. And second, compared to other factors the channel that is identified is relatively small compared to mortality and education.

Modernization, in both, the economic and norms and value sense, appears to be an important driver of population change. Chapter three in this thesis underlines the importance of sound, economic structural transformation to change a population's composition. The clear and optimistic implication is that economic transformation will also deeply impact on the population's composition and potentially receive a further boost from declining birth rates and enhanced education. The finding that demographic change is deeply rooted in and interacting with socioeconomic change, delegates policy advice also to the creation of a modern economy with higher productivity jobs. Chapter four of this thesis picks up the analysis of the determinants for development of a modern sector in developing countries. The findings underline that it is important for developing countries to obtain strong and reliable institutions to spur investment in a modern sector and to integrate into the world market in order to benefit from spillover effects within the sector that are related to competition and productivity gains. However, again the analysis reveals that the mechanisms may not be linear in the income group. Therefore, while policies that enhance institutional quality and support export orientation may be beneficial for countries beyond a certain level of income, there is no evidence that this is also true in the least developed group. It appears that the presented relationships are mostly relevant beyond a certain development level.

An important avenue for future empirical research in this realm is to obtain more detailed data and to establish relationships especially for the poorest countries. In the near future detailed fertility data with increasing reliability will surely be present. Future research may therefore benefit from taking the broader positions presented in this thesis to a close-up scenario. This may potentially also derive knowledge on least developed countries, a group whose changes may not (yet) be captured in the broad cross-country analysis presented here. While detailed (micro-) data may already be available for shorter periods of time, the benefits of long cross-section time-series data will be reclaimable in the near future for this category of data as well. Especially the quantity-quality trade-off, that has been tested for advanced economies with historical data, may become testable for developing economies more directly as well. This would certainly underline the relevance of economic forces in the determination of population development.

A main positive message from this thesis is that economic structural change will loosen population pressure in developing countries *once it occurs.* To relate to the introductory quote of Mohammad Yunus one may put forth that if taking care for itself as a society entails creating jobs in positions above the subsistence level, a crucial characteristic of structural change, curbing population growth directly and actively is no longer necessary.

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