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Trade and resources: Welfare effects of the Lake Victoria fisheries boom

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ABSTRACT

We examine the welfare implications of the Tanzanian fisheries boom resulting from Lake Victoria Nile perch exports during 1993–2008. In the literature, there are two opposing views on the effect of fish trade: some argue that fish trade can act as an engine of growth, while others contend that trade in fish negatively affects food security, local economies and incomes of the poor. We apply a micro level perspective using data from two years, the first from a 1993 World Bank household survey and the second, our own study from 2008, both covering about 520 households in the two regions, Mwanza and Mara, by Lake Victoria. Our results indicate increasing average income and a reduction in the share of household expenditure on food, both of which are positive indicators of welfare. For the poorest part of the population, urban areas had a substantial reduction in the fraction below the basic needs level, while the change in the rural areas was insignificant. However, growth in both areas was modest and inequality seems to have increased during the period. We conclude that there is more support in our data for a positive than a negative effect of the fish boom on the well-being of those residing in Mwanza and Mara.

1. Introduction

Fish is the main source of animal protein for 20% of the world's population. More than 40% of global fish production is traded internationally. The net exports of fishery commodities by developing countries, i.e., deducting their imports from the total value of their exports, increased to $27.7 billion in 2010. That figure exceeds the sum of total net exports of other important agricultural commodities for developing countries, such as coffee, cocoa, bananas and rubber (FAO, 2012). Tanzanian Nile perch exports amounted to $150 million in 2008, primarily to Europe. This was about 5% of Tanzania's total exports (NBS, 2011). In this paper, we assess the welfare implications of the Tanzanian fisheries boom following from the increase in quantities and prices of Nile perch exports from the Lake Victoria region since the early 1990s.

Economic theory in general supports trade liberalization. Countries can combine their resources in an optimal way to produce goods and services, and trade offers an opportunity to achieve higher levels of consumption compared to autarky. Hence, trade liberalization has been promoted with the idea that developing countries will be better off if rich countries lower their tariffs and allow imports to increase. However, trade liberalization combined with open access to a natural resource may imply welfare reductions for a country (Brander and Taylor, 1997).

Other contributions contend that trade in fish negatively affects food security, local economies and incomes of the poor. The dramatic increases in many of the important world food commodity prices in 2007–2008 reinforced concerns about whether trade liberalization may lead to reduced food security. A recent study notes that countries with low undernourishment are net importers of seafood from regions with high undernourishment, but argue that it is advantageous to generate surplus value from export than rather consuming it domestically (Smith et al., 2010). Particular concern is given to the poorest part of the world, i.e., Sub-Saharan Africa, where some hold that liberalizing fish trade has a pro-poor effect (Geheb et al., 2008), while others believe that it leads to negative effects on local populations' food security and welfare development (Abila, 2003; Bokea and Ikiara, 2000; Jansen, 1997). In particular, the view that the Lake Victoria Nile perch export has hurt the local

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economy has become widespread outside the scientific community, due in part to the documentary "Darwin's Nightmare" (for a critical analysis of the film, see Molony et al., 2007). On the other hand, Geheb et al. (2008), while noting the high frequency of malnutrition among the population in the lake regions of all three countries surrounding Lake Victoria, strongly reject the claim that there is a direct linear relationship between local malnutrition and Nile perch exports.

By looking at different indicators of welfare, that is, mean income, percentage of the population below the poverty line and the Gini[1] coefficient, we hope to shed more light on the pro- and anti-fish trade arguments. We also examine to what extent the theory of trade in natural resources, in particular Brander and Taylor (1997), can help explain the Lake Victoria case. The Lake Victoria fisheries are poorly managed and may be characterized as open access. Thus, according to Brander and Taylor (1997), we may find that trade liberalization has led to declining harvests and, all other things equal, a potential decline in welfare levels. On the other hand, imperfect capital markets and informal rules may work as an entry barrier to the fishery, which would postpone the movement to the new, long-run open access equilibrium. If trade liberalization leads to an increased exploitation of a relatively virgin stock, there may be economic rents through the transitional stage when effort and landings increase. In the transition phase, welfare may temporarily increase, at least for those directly being involved in the fishery. Potentially, the rents can be re-invested in other parts of the economy.

There is no reason to doubt that the Lake Victoria fisheries have provided Tanzania with high export revenues. According to the "trickle down" theory, this should also improve livelihood for the poor (e.g., Aghion and Bolton, 1997). However, the anti-fish trade literature distrusts the "trickle down" effect, and contends that trade in food such as fish primarily leads to increasing fish prices, while too little of the growing income ends up with the poor in order to offset the increasing prices, leading to declining welfare levels for the poor (see, e.g., Jansen, 1997). Hence, we look at the welfare levels of all the residents in the Lake Victoria regions.

Béné et al. (2010) carry out a macro level study of the effect of liberalizing fish trade on economic growth and look at all sub-Saharan countries. In their econometric study, they do not find any significant relationship between trade and negative impact on food security, nor a positive pro-poor outcome, but point at the potential of investigating these issues on a more micro oriented level. In this study, we apply a micro level perspective. Our point of departure is a 1993 World Bank household survey of Tanzania, including the lake side regions (HRDS, 1996).[2] We use the data collected for the two regions, Mwanza and Mara, and compare them with our own household survey data, which were collected for a random sample in the same regions during October–November in 2008 using a questionnaire identical to the 1993 survey. Hence, we can quantitatively estimate changes from the beginning to the end of the period and assess the welfare effects in terms of both level and distributional impact.

[1] The Gini coefficient is a commonly used measure of inequality from 0 to 1 based on the Lorenz curve. The higher the Gini, the more unequal the society. World Bank 1995 data report Gini coefficients of 0.26 for Sweden, 0.37 for the UK, and 0.57 for South Africa.

[2] The 1993 data used in this paper come from a nationally representative survey of 5000 households in Tanzania. The survey was a joint effort undertaken by the Department of Economics of the University of Dar es Salaam, the Government of Tanzania, and the World Bank, and was funded by the World Bank, the Government of Japan, and the British Overseas Development Agency. The World Bank is not responsible for the estimations reported.

2. The artisanal Lake Victoria fisheries

Lake Victoria is the largest tropical lake in the world (68,000 square kilometers), with its waters shared by three countries: Tanzania, 49%, Uganda, 45%, and Kenya, 6%. In 1998, about one-third of the total population or about 30 million people were supported by the lake basin in Kenya, Tanzania and Uganda (LVFO, 1999). Commercial fishing has been carried out for a long time but the economic importance of fishing has increased dramatically since the late 1980s. In the 1950s and 1960s, the non-indigenous species Nile perch (*Lates niloticus*) and Nile tilapia (*Oreochromis niloticus*) were introduced to compensate for the depletion of commercial fisheries by converting from low-value small fish to more easily caught higher-value species. This had minor impact for many years, but during the 1980s landed quantities were radically amplified and even more so in terms of value. Fishers called Nile perch the *mkombozi*, savior in Kiswahili (Reynolds et al., 1995). Since then, a growing share of the Nile perch catch has been exported, primarily to Europe. However, the rapid growth of Nile perch came at the expense of a severe reduction of the available number of species. Lake Victoria was known for more than 600 endemic species of *Haplochromis* cichlids. About 40% of these species disappeared and the Nile perch seems to have been a key contributor to this mass extinction, with contributions from environmental changes (Balirwa et al., 2003). Today the fisheries mainly consist of three commercially important species: Nile perch, the sardine-like dagaa (*Rastrineobola argentea*) and the Nile tilapia. In 2006, Nile perch, dagaa and Nile tilapia contributed 24%, 54%, and 7%, respectively, of total Lake Victoria landings (LVFO, 2012). Fishers in Lake Victoria use open wood vessels, which sometimes have outboard motors, but most commonly are operated by sail or paddle. The total crew ranges from two to six persons (Eggert and Lokina, 2010).

In principle, entry into the Lake Victoria fisheries is open to anyone with enough capital and the necessary skills. However, getting the capital and acquiring the skills may take some time. There is no catch limit, so participating fishers can catch as much as they can, given the stock level and their vessels' capacity. Fishing requires an annual license fee that approximately equals the gross revenues from two days of fishing, which function as a friction to free entry (Eggert and Lokina, 2010).

3. Open-access fisheries and trade: potential welfare effects

Chichilnisky (1994) brought attention to the potential problem of combining trade liberalization with open-access natural resources. Brander and Taylor (1997) provided formal proofs that trade and open access may lead to welfare reductions. Since then, a rich literature has developed; for recent surveys, see, e.g., Bulte and Barbier (2005) and Fischer (2010). The Lake Victoria fisheries could provide a case to test the theory of trade in natural resources. In order to do that, we briefly review the Brander and Taylor (1997) model, and examine the potential empirical links between their model and the real world example of Tanzanian Nile perch exports from the Lake Victoria fisheries. Their model and their assumptions yield the following results: when an autarkic country starts to trade an open-access natural resource, labor shifts from manufacturing to harvesting of the natural resource, and harvests jump up to an unsustainable level. Then, as the stock of the natural resource is being depleted, harvests decline until a new, long run open-access equilibrium is reached. In the new long run equilibrium, the stock is reduced and yearly catches are lower than in the autarky equilibrium. Trade liberalization thus leads to a *de facto* inward shift of the production possibilities frontier, and, consequently, welfare for the country stabilizes at an inferior level. Although the transition stage

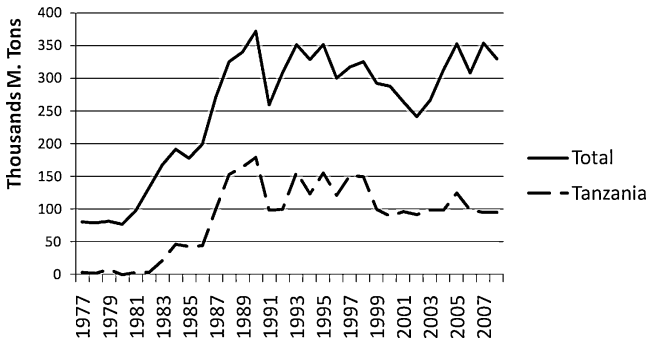

Fig. 1. Nile perch landings in Lake Victoria 1977–2008. FAO FishStat (2010).

is beneficial for the exporting country, a not-too- high discount rate implies that trade leads to an overall reduction in long run welfare.

There are several reasons why the predictions of Brander and Taylor (1997) may not hold in the Lake Victoria case. In order to detect welfare effects in the population around the lake as a whole, the natural resource sector must constitute a significant part of the regional economy. Further, as shown by Hannesson (2000), the results of Brander and Taylor depend on constant returns to scale in the manufacturing sector. If the sector competing for labor is, for instance, agriculture with decreasing returns to scale, trade may benefit welfare in the long run, even with open access. Finally, in a real world economy, shifting labor from one sector to the other takes time. Thus, in the Lake Victoria case, we may still be observing the transition to the new long run equilibrium. In this transition phase, welfare is likely to increase. When looking into the development in catches and effort in the Tanzanian Lake Victoria fisheries, it is not clear whether we have reached a new, long run open access equilibrium.

When landings of Nile perch took off during the mid-1980s, companies in all three countries established filet processing industries by the lake. The export nowadays contributes a substantial share of the foreign currency earnings in each country. For example, as discussed above, Tanzanian Nile perch exports amounted to about 5% of total Tanzanian exports in 2008 (NBS, 2011). Roughly 70% of the Tanzanian catch is landed in Mwanza and Mara, which in 2008 had a total population of about 5 million, i.e., about 12% of Tanzania's population.[3] Hence, the economic importance of the fishery to these two regions is non-negligible.

Despite signs that the stock has been reduced (LVFO, 2012), landings of Nile perch have been maintained at an annual level of about 300,000 tons since the early 1990s. Focusing on Tanzania, we see a decline from about 120,000 tons in the 1990s to 100,000 tons for most of the years during the new millennium (see Fig. 1). The current levels are fairly stable, but from 2007 total landings have been reduced by 11% to 300,000 tons in 2012 (Globefish, 2014).

In the frictionless model of Brander and Taylor (1997), trade liberalization and a higher world market price than the autarchy price rapidly shift the workforce to fishing. Harvest exceeds the net surplus production, the stock is reduced, and, after some time, a new, steady state, open-access equilibrium emerges, with harvests below the autarchy level. Fig. 1 gives the impression that landings of Nile perch have stabilized, and that potentially a new open-access equilibrium has been reached, i.e., landings are equal to net surplus growth and total value of landings are equal to total costs of fishing. However, when we look at development of fishing effort and total landings of fish, including the two other major types, dagaa and tilapia, it is hard to find support for equilibria from either an economic or a biological perspective. Since 1985, effort, measured as number of boats fishing in the lake, has increased dramatically (Fig. 2). Furthermore, the number of fishermen has more than tripled from 1985 to 2006. Even if the average crew size was reduced from five to three from 1985 to 2005, the number of fishermen has increased from 60,000 fishers in 1985 to about 200,000 in 2006, of whom 40% or approximately 80,000 are Tanzanian fishers (LVFO, 2012). Hence, fishing income remains higher than other alternatives available to many in the area.

Catch per unit effort (CPUE), here measured as annual catch per boat, increased until 1989, but then started to decline dramatically, and in 2006 CPUE was only 40% of the average during the peak years 1989–1990, as shown in Fig. 2.[4] This does not, however, imply that total harvests have declined as predicted by Brander and Taylor (1997). Due to increased landings of dagaa, total landings in Lake Victoria, measured in kilos, have in fact increased since 2002.[5] Real income development for fishers is less clear. While the crude CPUE measure in Fig. 2 indicates major reductions in income per fisher from 1989 to 2000, at least two other changes are counteracting that change. First, real prices for Nile perch exports have increased substantially. In 2008, Tanzanian landings were about 100,000 and the export value was $150 million, while landings in 1994 were 159,000 tons and the export value was $55 million in 2008 US dollars (Megapesca, 1997). Second, as average crew size has diminished over the years, reduction in catch per crew member is less dramatic (Eggert and Lokina, 2010). From fishing in the 1980s with almost no motorized vessels, 2012 figures report about 20,000 vessels with motor (LVFO, 2012).

Concerning the biological development of the stock, the reduction in our rough CPUE measure indicates a reduction of the Nile perch stock. Hydro-acoustic assessments indicate a reduction in the mean standing stock of Nile perch from 1.29 million tons in 1999/2001 to 0.82 million tons in 2005/2006 (LVFO, 2012). A number of biological studies have predicted a collapse if the increase in exploitation pressure is not halted (Pitcher and Brundy, 1995; Mkumbo et al., 2002; Balirwa et al., 2003; Njiru et al., 2007). On the other hand, the collapse has still not happened, and we conclude that it is unlikely that the Lake Victoria fisheries have reached a new steady state. Whether overall welfare has increased in Mwanza and Mara can thus not be predicted from theory, and the same applies for the distributional impact. We address these two issues in the remainder of this article.

4. Measuring welfare changes in Mwanza and Mara 1993–2008

In order to shed more light on the pro- and anti-fish trade arguments, we measure the welfare changes among the Tanzanian population by the lake from early 1990s until 2008 by using several indicators of welfare: education levels, mean income, fraction of budget used on food, share of population below the poverty line and the Gini coefficient. To be able to compare the indicators in a robust statistical way, we would ideally have panel household data collected at several points in time, including the beginning and the

[3] The area, like the country, has a rapid population growth of about 3% annually (http://www.mwanzacity.go.tz/Population.php).

[4] We assume a uniform distribution of Nile perch, implying the standard Schaefer production function, $h = qEX$. If harvest/effort is reduced for a constant catchability coefficient q, it indicates a reduction in stock, X. An open-access equilibrium may have a large standing stock, but, if marginal costs for fishing are reduced, an equilibrium is likely, implying a small standing stock.

[5] The average number of gill nets per vessel increased by 20% and the share of vessels with an outboard motor increased from 10% to 20% from year 2000 to 2006. In addition, landings of the low value dagaa have increased dramatically since 1994. Hence, the reduction in value per unit effort (VPUE), expressed as Tanzania shillings (Tsh) landed per boat and year, is larger than the CPUE reduction shown in Fig. 2.

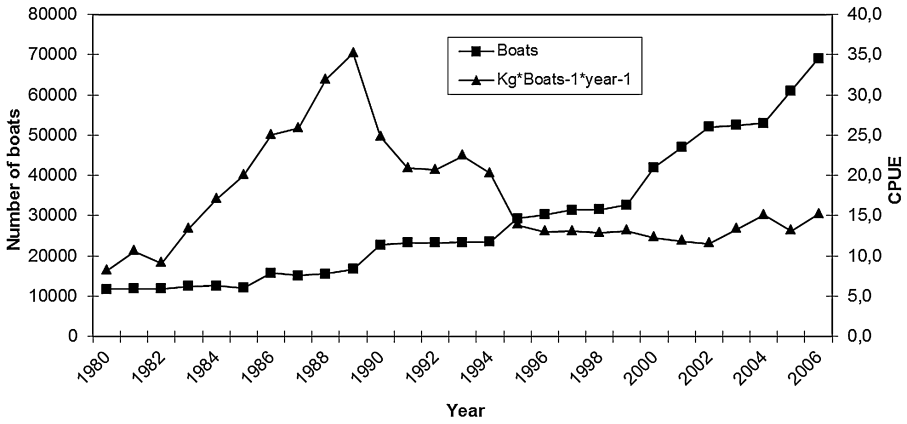

Fig. 2. Annual catch per boat (effort) and number of boats in Lake Victoria 1975–2006.
Authors' calculation using data from LVFO (2004), Warui (2007) and Geheb et al. (2008).

end of the period. To our knowledge, such data does not exist. A second alternative would have been to collect household data and ask respondents to also provide recall data of conditions 5, 10, and 15 years earlier. However, such a long time frame would add substantial uncertainty, which is hard to control for. Deaton (2001) discusses problems with too long recall periods and refers to studies where modest changes in recall period had dramatic impact on the final results. As an alternative, we found the World Bank data (HRDS, 1996). In 1993, the Population and Human Resources Division of the East Africa Department of World Bank carried out a household survey for Tanzania. That study included 516 households from the regions Mwanza and Mara by the lake (another 200 were also sampled in Kagera, the third lakeside region, but it was excluded due to limited funds for our survey). The 1993 data had only a handful of households directly relying on fisheries, and, given our aim of comparing the two surveys and the limited number of households that we could survey, we used a random sampling strategy.

In order to minimize the deviations due to differences in context and methods, we used the questionnaire from the 1993 survey to design a questionnaire where the recall periods were equally long for each type of expenditure, i.e., annually, monthly and weekly. In line with recommendations (Deaton, 2001), income was measured as total expenditures, where respondents were asked to state the value in Tanzanian shillings (Tsh) of consumed quantities, which were either bought, produced, received in kind, or given as a gift, loan or compensation. The sampling procedure in 1993 used a two-stage cluster sampling approach, which implies that the village weights should be used in the final analysis.[6] For the 2008 sample, we applied proportionate probability sampling, meaning that no further adjustment is needed in the final analysis of the data (for details on the methods, see Deaton, 1997). The two years of data is, of course, less than what is preferred, particularly as the global economy was hit by a recession by the end of 2008. However, given the lack of detailed micro level data from the area, we find them useful for our study.

In addition, we wanted to know whether development by the lake had been similar to or different than the rest of the country. In order to carry out such comparisons, we also used the existing household budget surveys (HBS) carried out by the National Bureau of Statistics (NBS) in Tanzania in 1991/92, 2000/01 and 2007 (NBS, 2011).

Table 1
Distribution of household sizes in the Mwanza and Mara regions in the 1993 and 2008 surveys.

Household size	Rural		Urban	
	1993	2008	1993	2008
1	0.3	0.8	2.0	2.3
2	3.4	2.7	5.1	3.8
3–4	20.3	14.3	27.8	22.6
5–6	28.0	24.0	26.7	30.3
7–8	22.2	27.0	16.1	27.2
9+	25.7	31.0	22.4	13.8
Mean Hh size	7.1	6.9	6.2	5.9
Sampled Hhs	261	258	255	261

4.1. The 1993 and 2008 household surveys

Table 1 shows the distribution of household sizes in rural and urban areas for the two regions at the two points in time, where household is defined as the persons who normally live in the dwelling and eat meals together. During the study period, we note a minor increase in the fraction of large households (five or more in a household), but at the same time the average household size has slightly decreased in both rural and urban areas.

4.2. Comparing welfare levels in 1993 and in 2008

First, we have to note that educational levels were increasing during the study period. Dercon and Krishnan (1998) found that, for Ethiopian farmers, increased educational level of the household head implied lower poverty levels, reduced fluctuations in poverty over seasons and increased the chances of getting better off over time. In 1964, by the time of independence, Tanzania had an extremely poorly educated population. Sarris and Tinios (1995) found increases in the educational level from 1976 to 1991 where, for instance, the fraction of those with no education went from 54/39% (rural/urban) to 29/16% for the whole country. Our data confirm a continued improvement in terms of education, which is reported in Table 2.

Note that the fraction of the population with *No education* is down from 21.9/14.5% in 1993 to 5.8/3.4% in 2008 and *Some or complete secondary* has increased from 5.4/16.9% in 1993 to 6.2/22.6% in 2008.

We then turn to measures of income on the household level. In order to adjust for differences in household sizes, we use the

[6] Two-stage cluster sample design is commonly used. In rural areas, they are often villages. If clusters are randomly selected with probability not proportional to the number of households they contain, they should be re-balanced with weights to ensure that each group of households is properly represented (see further Deaton, 1997).

Table 2
Education levels of heads of hh in Mwanza and Mara 1993 and 2008.

	Rural		Urban	
	1993	2008	1993	2008
No education	21.9	5.8	14.5	3.4
Some or complete primary	69.6	81.1	61.2	62.8
Some or complete secondary	5.4	6.2	16.9	22.6
Post-secondary	0.3	0.0	2.0	5.0
Adult education and other	1.5	4.2	1.2	4.2
Nonstated or missing	1.1	1.9	4.3	1.5

Table 3
Comparing welfare levels in Mwanza and Mara.

		1993	2008	t-stat
Weighted mean	Rural	740,000	770,000	−5.1
Exp. per adult equiv. in 2008 Tsh	Urban	1,040,000	1,160,000	−12.2
Average food share of total consumption per hh		75.9%	65.6%	−15.3

[a]USD 1 = Tsh 1200, 2008.

calorie-based equivalence scales developed by WHO (Dercon and Krishnan, 1998), where individuals are divided into females and males and into 13 different age classes and given weights in the range of 0.33–1.14. Finally, adjusting for inflation is another requisite for comparison. We used the IFS data base CPI (IMF, 2012), which is available on both a monthly and an annual basis for our period of interest.

In Table 3, we report the weighted mean income, measured as total expenditures per adult equivalent scaled, in 2008 Tsh. Mean rural average income per adult equivalent in 1993, expressed as 2008 Tsh, was 740,000, or roughly USD 620 with the average exchange rate for USD/Tsh in 2008 (see footnote a in Table 3). The corresponding figure for 2008 was Tsh 770,000, a small but significant increase. Similar development was recorded for average urban income, from Tsh 1,040,000 to Tsh 1,160,000, a small but significant increase.

From Table 3 we also see that, on average, there was a substantial improvement with respect to the food share[7] of total consumption over the period. The average food share of total consumption was 75.9% in 1993, while the corresponding figure for 2008 was 65.6%.

The average annual growth in weighted mean expenditure for the households over the period is modest, with 0.3% and 0.7% per year for rural and urban areas, respectively. The corresponding figures based on the HBSs for Tanzania in 1991/92, 2000/01 and 2007 are 1.5% from 1991/92 to 2001, and 1.9% from 2001 to 2007. Hence, if a comparison between different surveys is meaningful (we discuss this particular issue later on), these figures indicate that average growth rates in mean expenditures from 1991 to 2008 were lower in Mwanza and Mara than for the country on average, and splitting the latter figures into rural and urban does not alter the result.

In order to say something about the poorer fraction of the population, we need additional measures. The HBS provides figures of 'basic needs' poverty lines, expressed in Tsh for 91/92 and 2007, respectively.[8] We used these figures and inflated them by the IFS CPI (IMF, 2012) to get the corresponding 1993 and 2008 poverty lines. We could then calculate the fractions below the poverty lines for our samples.

Table 4
Comparing basic need levels in Mwanza and Mara.

		1993	2008	t-stat
Basic needs based on HBS 1991/2007	Rural areas	15.0%	14.0%	1.2
	Urban areas	17.9%	8.1%	17.7

Table 5
Comparing basic need levels in the rest of Tanzania.

		1991/92	2007
Fraction below basic needs levels (based on deflated levels from HBS)	Dar es Salaam	28.1%	16.4%
	Rural areas	40.8%	37.6%
	Other urban areas	28.7%	24.1%
	Mainland Tanzania	38.6%	33.6%

In Table 4, we report the fraction of households in our samples that earned less than the 'basic needs' poverty line. We see that in *rural areas* there is a reduction in poverty but it is small and not statistically significant. However, for the *urban areas* of Mwanza and Mara we find a substantial and statistically significant reduction in the fraction of poor below the basic needs level, from 17.9 to 8.1%.

In Table 5 we provide comparative figures for Tanzania computed by the HBS:

Notably, our 1993 and 2008 samples have substantially lower fractions of population below basic needs levels compared to what is reported for the HBSs from corresponding years. In addition, urban poverty in Mwanza and Mara was substantially more reduced compared to urban poverty in Tanzania as a whole, excluding Dar es Salaam. Still, the results reinforce the impression of the difficulty of comparing various household budget surveys. Eele et al. (2000) reported the problems of comparing seven different household surveys carried out in Tanzania during 1983 and 1999, where methodologies, definitions and populations covered differed. The overall impression from comparing our 2008 data and the 1993 World Bank data with the HBS surveys in Tanzania is that *rural areas* in Mara and Mwanza have had a development on a par with *rural areas* in the rest of Tanzania during 1993–2008, while *other urban areas* in Mwanza and Mara have had a substantially better development compared to the average *other urban areas* in Tanzania. The level of improvement seems to be even better or at least

[7] Originally studied by Ernst Engel (1857), who found what is now referred to as Engel's law, which states that the poorer a family is, the larger the budget share it spends on nourishment.

[8] In the 2000/01 survey, the HBS calculated a 'basic needs' poverty line based on the minimum adult calorific requirement with a food consumption pattern typical of the poorest 50% of the population and then adjusted for non-food share of expenditures of the poorest 25% of the population. To get adjusted 'basic need' poverty lines for the 91/92 and 2007 surveys, they adjusted for price changes by using a Fisher price index.

Table 6
Main fish species in Mara and Mwanza household meals in 2008, 1998, and 1988.

Main species (%)	Tilapia	Dagaa	Nile perch – whole fish	Nile perch – fish frames	Other fish	Obs
2008	21	46	21	11	2	519
1998	41	14	33	11	1	516
1988	49	2	32	16	1	512

on a par with the development pace of the metropolitan area of the biggest city in the country, Dar es Salaam.[9]

Sarris and Tinios (1995) showed how sensitive comparisons are, particularly regarding adjustments for inflation, when assessing welfare development in Tanzania. According to the official consumer price index of Tanzania CPI (IMF, 2012), the average annual price increases were 12.4% from 1993 to 2008. However, if we look at the basic need levels in Tsh from the HBS, these have increased by 8.7% on average in the period from 1993 to 2008. Of course, this could indicate that other prices have increased more than food prices. On the other hand, the official consumer price index of Tanzania may overstate the inflation, which then would explain our low growth figures for mean expenditure, reported in Table 3.

To get additional information about inequality of income, we also calculated the Gini coefficients for Mara and Mwanza in 1993 and 2008. The results indicate that inequality of income has increased from 0.356 in 1993 to 0.500 in 2008. Moreover, the change is significant, in that we calculate the standard deviation of the Gini to be slightly less than 0.03.

The HBS for Tanzania found a stable Gini of about 0.35 for Tanzania as a whole, as well as for urban and for rural areas, from 1991/92 to 2007. This figure may be too low. Using all 5000 observations for Tanzania from the 1993 World Bank study gives a Gini of 0.45, i.e., substantially higher than the 1991/92 HBS result of 0.34. Again, this illustrates the problem of comparing figures from different studies.

Finally, we are interested in the extent to which the populations of Mara and Mwanza have changed their consumption pattern with respect to fish types. As expected, the consumption of Nile perch has declined, while the consumption of dagaa has increased. In the 2008 survey, respondents were asked which type of fish they would primarily eat today, ten years ago and twenty years ago. In Table 6, we report the results. In 1988, Tilapia and Nile perch were the main fish type for almost all households. Presumably poorer households would buy the cheapest fish protein available at the time: fish frames of Nile perch, which are the carcasses and head of the Nile perch after the filets have been removed. From 1988 to 2006, the landings of the small sardine-like fish dagaa increased from less than 100,000 tons to almost 600,000 tons (Geheb et al., 2008; LVFO, 2012), and, whether fresh or dried, likely provided the cheapest source of fish protein in 2008. At the same time, real prices of Tilapia and Nile perch increased, which is reflected in reduced consumption shares of these species in 2008.

Brown et al. (2005a) showed the biological interrelationship between dagaa and Nile perch, implying that fishing down the Nile perch stock may increase the abundance of dagaa, which in turn implies changing fishing patterns. Mkumbo et al. (2002) confirm recovery of *Haplochromis* and other prey species as the Nile perch stock has been reduced.

4.3. An alternative method of comparing welfare

Another approach to measure welfare development, sometimes referred to as poverty mapping, has been developed in recent years (Hentschel et al., 2000; Minot, 2000; Elbers et al., 2003). Based on combining data from household surveys and census data, the idea is to use the household survey to estimate the relationship between poverty and a set of household characteristics – for example, education level of the household head – and then apply this relationship to the same household characteristics in the census data. Based on the assumption that the explanatory variable coefficients are constant over the time period studied, health surveys where data on the household characteristics are collected can then be transformed into welfare estimates. This approach does not imply any improvement in analyzing our data per se, as we have income data collected for both occasions, but we can investigate to what extent our data confirms our findings so far. In order to do that, we ran ordinary least squares (OLS) regressions on the two data sets, including occupation in fishing as an explanatory variable. For the 2008 data, we also have distance measures from the sample sites to Lake Victoria, which we use to construct two alternative dummy variables indicating whether the sampled households are within either 2 or 10 km of the beach of the lake. For the 2008 sample, we note that 64% of the households are situated 10 km or less from the lake. In Table 7, we report the summary statistics of the variables used in the regression (adjustment or inflation, see footnote a in Table 7). Heads having fishing as the main income are less than a handful in each sample. 'Paid employee' includes government, parastatal and private, which is a group that has been significantly reduced when comparing the samples, a development off-set by the increase in those self-employed.

In Table 8, we report the results of the regressions where the dependent variable is log of expenditures per adult equivalent. First, note that, for the 2008 data, there are clear indications that households closer to the lake are better off than those far away from the lake. Geheb et al. (2008) found similar results, with substantially lower rates of child malnutrition in households within 25 km of the lake compared to those in the range of 25–35 km from the lake.

Moreover, in 1993, the handful of household heads working as fishers made substantially more money than the reference alternative, farm work, but such a difference does not occur for the 2008 sample. Employees working for government, parastatal or private companies made significantly more than those doing farm work in 1993, but such differences had also vanished in 2008, potentially explaining the reduction of paid employees. Similarly, the self-employed made substantially more than those doing farm work in 1993, but the significant difference remains in 2008, indicating why the fraction of self-employed has increased so much during the period.

Finally, when we look at educational level for the 1993 data, we find that those with some or completed secondary education as well as those with post-secondary education have significantly higher income than the reference group, i.e., those, with some or completed primary education. For the 2008 sample, the picture is even clearer; income increases monotonically with education from the group of heads with no education to those with post-secondary education, which is in line with results of Minot (2007). Because education level significantly explains income, the fact that educational level has increased from 1993 to 2008 indicate larger assets in terms of human capital and renders some support to the finding that average income has increased over the period.

[9] The HBS results for Dar es Salaam were 28.1/17.6/16.4% from 91/92, 00/01 and 2007, respectively, indicating a similar magnitude in reduction of fractions below the basic needs level.

Table 7
Summary statistics of 1993 and 2008 sample used for income regression.

	2008		1993	
	Mean	Std dev	Mean	Std dev
Household count adult equivalent	5.22	2.07	5.35	3.01
Household count adult equivalent squared	31.5	21.9	37.6	54.1
Head age	44.3	14.2	43.6	13.2
Head female	0.16		0.15	
Head activity farmwork	0.46		0.51	
Head activity looking for work	0		0.002	
Head activity fishing	0.006		0.004	
Head activity paid employee	0.12		0.26	
Head activity self employed	0.30		0.17	
Head activity other	0.07		0.04	
Head activity missing	0.02		0.02	
Head education none	0.05		0.18	
Head education primary	0.72		0.65	
Head education secondary	0.14		0.11	
Head education Postsecondary	0.03		0.01	
Head education adult	0		0.01	
Head education other	0.04		0	
Head education missing	0.02		0.03	
Village lake 10 km	0.64			
Village lake 2 km	0.31			

[a] 1993 price variables adjusted for inflation using IFS series 73864ZF CPI urban areas all families (IMF, 2012) from the date of the survey to October 2008.

Table 8
OLS regression on income measured as log expenditure per adult equivalent.

	2008		1993
	Model 1	Model 2	Weighted
Household count adult equiv.	−0.350***	−0.326***	−0.162***
Household count adult equiv. sq.	0.022***	0.020***	0.006***
Head age	0.023	0.003	−0.001
Head gender	−0.055	−0.070	−0.074
Head activity farmwork	*Reference alternative*		
Head activity looking for work	Dropped	Dropped	0.296
Head activity fishing	0.340	0.335	0.874**
Head activity paid employee	0.168	0.184	0.275***
Head activity self employed	0.195**	0.217***	0.459***
Head activity missing	Dropped	Dropped	0.129
Head educ none	−0.451***	−0.466***	−0.040
Head educ primary	*Reference alternative*		
Head educ secondary	0.739***	0.753***	0.425***
Head educ postsecondary	0.800***	0.813***	0.395*
Head educ adult	Dropped	Dropped	−0.196
Head educ other	−0.323*	−0.289*	Dropped
Head educ missing	Dropped	Dropped	0.621***
Village lake 10 km	0.157**		
Village lake 2 km		0.190**	
Intercept	14.11***	14.06***	14.10***
N	502	502	515
Adj. R^2	0.270	0.273	0.317

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

5. Discussion and conclusions

This paper aims at assessing the development in welfare in Mwanza and Mara, the two Tanzanian regions by Lake Victoria that experienced a major upsurge in fishing and fisheries export during 1993–2008. Our point of the departure is the pro- and anti-fish trade arguments, which both have a foundation in economic theory. Our results indicate that average income in 2008 Tsh has increased in both rural and urban areas, with an average expenditure share for food substantially decreasing from 1993 to 2008. Looking at the poorest part of the population, we found that the fraction of those below a basic needs level in *rural* areas was only modestly and non-significantly reduced between 1993 and 2008, which is in line with the general trend from national HBS in Tanzania carried out during the period. For *urban* areas, we found a substantial reduction in the fraction below basic needs, indicating that the poorest in the urban areas of the two regions have had better development on average than Tanzanian *other urban areas* and at least as good as in Dar es Salaam. Concerning human capital, measured as education for the household head, we found substantial improvements in educational level, and a simple regression model indicates the significant impact of education on household income. We also found that households on average are better off when situated close to the lake.

On the other hand, the average growth in real income over the period is modest and there is a substantial increase in inequality when comparing the Gini coefficients for the sample in 1993 with the 2008 sample. Hence, growth in real income seems to have primarily accrued to the wealthier part of the population, while the middle income likely has experienced a minor change. Nile

perch landings have been quite stable in the latter part of our study period. Despite repeated warnings from biologists, we cannot say for sure that catches will decline in the future, which might lead to a reduction in welfare.

Putting all our findings together, we conclude that they do not indicate that fishing and fisheries exports during 1993–2008 have led to a decline in welfare, although this may eventually occur due to over-harvesting resulting from trade liberalization. This conclusion is in line with Geheb et al. (2008), who strongly reject the claim that there is a direct linear relationship between Nile perch exports and the high frequency of malnutrition among the population in the lake regions of all three countries surrounding the lake.

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