

WELFARE EFFECTS OF FISHERIES BOOM IN LAKE VICTORIA¹

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ABSTRACT

In this paper we try to assess the welfare implications of the Tanzanian fisheries boom following from the increase in quantities and prices of the Lake Victoria Nile perch export primarily to Europe over the last twenty years. We have a micro level perspective using data from a 1993 World Bank household survey and our own study from 2008, both containing data from about 520 households in the two regions Mwanza and Mara by the lake. Our results indicate that average income has increased in both rural and urban areas. For the poorest part of the population, rural areas experienced only modestly and non-significantly reductions in the fraction below basic needs, while urban areas had a substantial reduction. Concerning human capital measured as education for the household head we found substantial improvements in educational level and a simple regression model confirmed the significant impact of education on household income. We also found that households on average are better off when situated close to the lake.

Keywords: International fish trade, Lake Victoria, Poverty reduction, Tanzania

Introduction

Fish is the main source of animal protein for 20 percent of the world's population. More than 40 percent of the 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, have increased to \$24.6 billion in 2006. That figure exceeds the total net exports of other important agricultural commodities for developing countries, such as coffee, rubber, cocoa, and meat (FAO, 2008). Liberalization of trade is generally advocated as a positive factor in improving the standards of living for a country's population. 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 for all involved parties, compared to autarky. Hence, trade

¹ Financial support from Environment and Trade in a World of Interdependence (Entwined), funded by the Foundation for Strategic Environmental Research (Mistra), Sweden, and Environment for Development, funded by Sida (Swedish International Development and Cooperation Agency), is acknowledged. Thanks to the World Bank for the 1993 HRDS (1996) survey data. Thanks to Mitch Adams for excellent research assistance. Thanks to Måns Söderbom and Entwined colleagues for their helpful comments. Financial support from Sida to the Environmental Economics Unit at University of Gothenburg is gratefully acknowledged

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. Similarly, foreign direct investment or joint venture projects in poor countries offer opportunities for technology diffusion and increased welfare (Bhagwati 2001).

On the other hand, more recent literature on trade and renewable resources has stressed potential problems. Trade in renewable resources is not necessarily beneficial for welfare, and may also be problematic for resource conservation. In fact, when property rights are completely absent, trade can be detrimental to stocks and may also reduce the welfare of resource-exporting countries (Chichilnisky, 1993; Brander and Taylor, 1997).

According to Brander and Taylor (1997) liberalization of trade in renewable resources will shift labour in developing countries from manufacturing to harvesting of the natural resource. The new open access equilibrium in the natural resource sector implies a lower yearly catch and a higher harvesting effort. Since manufacturing also has declined, developing country welfare stabilizes at a lower level. The Brander and Taylor story assumes among others full employment, free access to capital needed for harvesting and no regulation and/or social control of the renewable resource. Clearly, some or all of these assumptions may not hold for the Lake Victoria fisheries and the surrounding communities.

The dramatic increases in many of the important world food commodity prices 2007-2008 led to a reinforced concern about whether trade liberalization may lead to reduced food security. Particular worry is given to the poorest part of the world, i.e. Sub-Saharan Africa, where there is an ongoing debate about whether liberalizing fish trade has pro-poor effect or leads to negative effects on local populations' food security and welfare development (Geheb et al., 2008; Béné et al., 2010; Abila, 2003).

In this paper we try to assess the welfare implications of the Tanzanian fisheries boom following from the increase in quantities and prices of Nile perch export primarily to Europe over the last twenty years. There are certainly many relevant interrelationships on a macro level, but in this study our focus is on the micro level perspective. Our point of departure is a 1993 World Bank household survey of Tanzania including the lake side regions.² We use the data collected for the two regions Mwanza and Mara and compared them with our own household survey data, which were collected for the same regions during October-November in 2008. Hence, we can quantitatively estimate changes over time and assess the welfare effects both in terms of level and distributional impact.

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%. Approximately one-third of the population or about 30 million people are supported by the lake basin in Kenya, Tanzania and Uganda (LVFO, 1999). Commercial fishing has been carried out for a long time

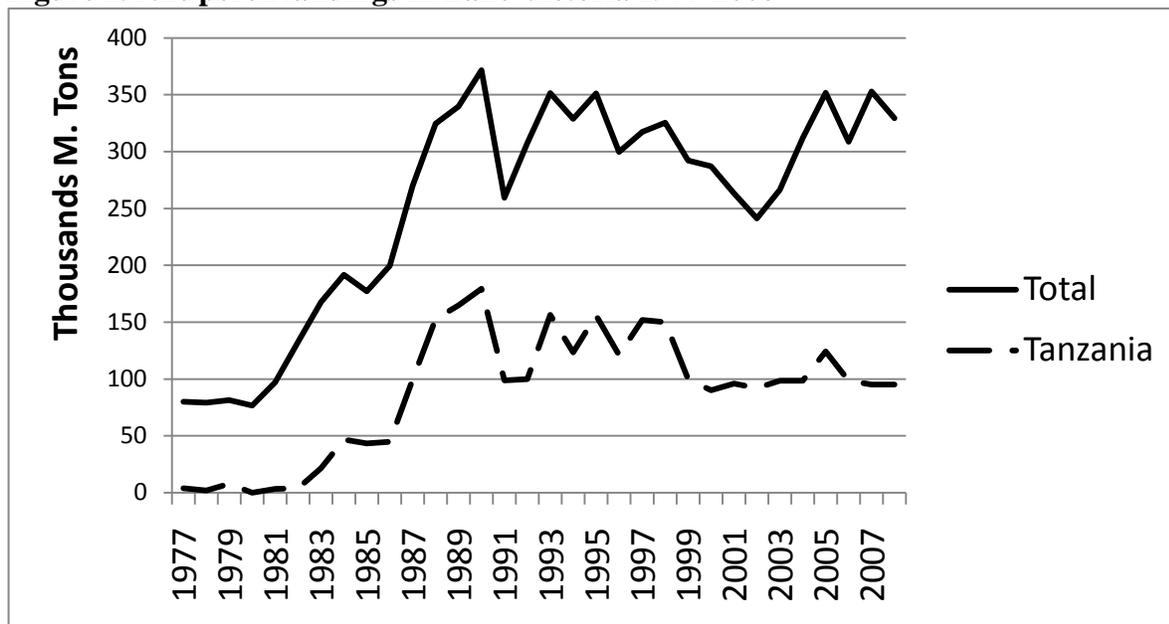
²The 1993 data used in this paper come from a nationally representative survey of 5,000 households in Tanzania. The survey was a joint effort undertaken by the Department of Economics of the University of Dar es Salaam, the Government of Tanzania, and the World Bank, and was funded by the World Bank, the Government of Japan, and the British Overseas Development Agency. The World Bank is not responsible for the estimations reported.

but the economic importance of fishing has increased dramatically over the last 25 years. In the 1950s and 1960s the non-indigenous species Nile perch (*Lates niloticus*) and Nile tilapia (*Oreochromis niloticus*) were introduced to compensate for depleting commercial fisheries by converting low-value small fish to more easily caught higher-value species. This had minor impact for many years, but during the 1980s landed quantities was radically amplified and even more so in terms of value. All three countries experienced the establishment of fillet processing industries by the lake and the export nowadays contributes with a substantial share of the foreign currency earnings in each country. Tanzanian Nile perch export amounted to \$ 150 million in 2008, which was about 5% of total exports. Despite signs that the stock may collapse (Pitcher and Bundy, 1995; Mkumbo et al, 2002), landings have been maintained at an annual level of about 500,000 tons since the early 1990s (see figure 1) despite declining stocks and thanks to increasing effort.

“Our assessment gives a direct and dramatic indication that increasing effort at the rate of the late 1980s could soon lead to a catastrophic stock collapse”

(Pitcher and Bundy, 1995, p. 176)

Figure 1. Nile perch landings in Lake Victoria 1977-2008

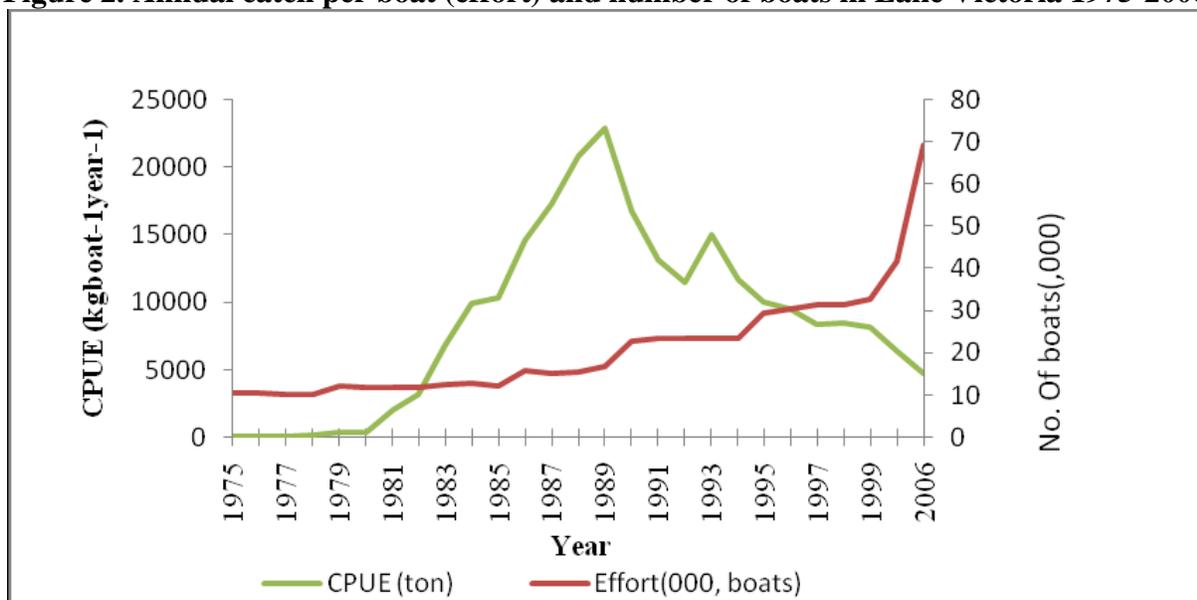


(FAO FishStat, 2010)

During the 1980s the Nile perch provided a new source of inexpensive protein for people around the Tanzanian shoreline and fishers called it the *mkombozi*, saviour in Kiswahili, (Reynolds, Gréboval and Mannini, 1992). Later on, a growing share of the Nile perch catch has been exported, primarily to Europe. 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. Recent estimates show that Nile perch, dagaa and Nile tilapia constitute 45%, 40%, and 8% respectively of Tanzania’s total Lake Victoria landings (Balirwa et al, 2003).

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. Owners of the boats are commonly involved in beach activities, e.g. selling the catch, and in some cases are onboard in their vessel as ordinary crew. There are two dominant types of fishing units on the Lake: Nile perch/Tilapia gill nets and Dagaas nets. Nets are placed in the late afternoon and retrieved in the morning. Because of the concern with theft, fishers often stay out with the net, sleeping in their boats. Dagaas are fished at night when the moon is dark using pressure lamps to attract them, which limits fishing to 15 days a month. Dagaas are usually caught with gillnets, but illegal short purse seines and mosquito nets are also used. In addition, some fishers use longlines, usually baited with dagaas, haplochromis or other small fish, which enables them to catch Nile perch that are too large to be caught by gillnets. Tilapias are sometimes caught with hooks and lines but in most cases small-mesh gill nets. Entry into the Lake Victoria fisheries is open to anyone with enough capital and the necessary skills, there is no catch limit, thus participating fishers can catch as much as they can, given the stock level and their vessels capacity. Fishing requires an annual license fee, which approximately equals the gross revenues from two days of fishing but do not function as a limited access policy (Eggert and Lokina, 2010). Hence, Lake Victoria fisheries provides a classic example of open access where theory predicts that effort increases up to a level where total revenue equals total cost and the resource rent is completely dissipated (Gordon, 1954). From the mid 1980s effort, measured as number of boats fishing in the lake, has increased dramatically. Until 1989 annual catch per boat had increased but then started to decline. In order to compensate boat owners increased the amount and length of gill nets used which indicate that the reduction in catch per unit effort (cpue) in Figure 2 may be slightly underestimated. Personal communication with Tanzanian fishers on site indicate that the average crew size from 1985 to 2005 was reduced from a total of five to three, which give a rough estimate of 60,000 fishers in 1985 that had increased to almost 200,000 in 2006.

Figure 2. Annual catch per boat (effort) and number of boats in Lake Victoria 1975-2006



(Warui, 2007)

Measuring welfare changes in the Tanzanian lake region 1993-2008

Our aim with this study is to measure the welfare changes among the Tanzanian population by the lake over the last 20 years. In addition we would like to know whether development by the lake is similar or different to the rest of the country. To be able to test in a robust statistical way we should ideally have panel household data collected at least in the beginning and at the end of the period. No such data exist to our knowledge. A second alternative would be to collect household data and ask respondents to also provide recall data of conditions 15 years ago. However, such a long time frame would add substantial uncertainty which is hard to control for. As an alternative we found World Bank data. In 1993 the Population and Human Resources Division of the East Africa Department of World Bank carried out a household survey, HRDS (1996). This study included about 520 households from the regions Mwanza and Mara by the lake and we used the questionnaire from the 1993 survey to design a survey in the same regions, which would provide us with comparable data from 1993 and 2008. The sample from 1993 was made by two-stage cluster sampling, which implies that the village weights should be used in the final analysis. 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 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. We note a minor increase of the fraction of large households, five or more in a household, during the period but at the same time the average household size has slightly decreased in both rural and urban areas.

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

A crude but simple measure of the level of human capital is the education of the household head. Dercon and Krishnan (1998) found for Ethiopian farmers that increased educational level of the household head implied lower poverty levels, reduced fluctuations in poverty over season and increased the chances of getting better off over time. In 1964, by the time of independence Tanzania had extremely poorly educated population. Sarris and Tinios (1995) found increases in 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 where *No education* is down from 21.9/14.5% in 1993 to

5.8/3.4% in 2008 and *Some or complete secondary* has increase from 5.4/16.9% in 1993 to 6.2/22.6% in 2008.

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

	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 & Other	1.5	4.2	1.2	4.2
Nonstated or missing	1.1	1.9	4.3	1.5

In order to adjust for differences in household sizes we use the calorie based equivalence scales developed by WHO (Dercon and Krishnan, 1998) where individuals are divided into females and males and then into 13 different age classes and given weights in the range of 0.33 – 1.14. Adjusting for inflation is another requisite for comparison. We used the IFS data base CPI (IMF, 2010), which is available both on monthly and 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 Tanzanian shillings. Income increases are small but statistically significant both for rural and for urban areas. We also find that on average there is a substantial improvement with respect to the food share of total consumption over the period. The average share was 75.9% in 1993 while the corresponding figure for 2008 was 65.6%. Both for 1993 and 2008 we have assessed prices on staple food like rice, corn, meat, fish etc. from some village leaders. We noted large price variations within the sample years, but also confirmed the dramatic food price increases for 2007-2008. In addition we noted that real price increases for meat and fish were substantial, resulting in some substitution for other sources of protein by the households. Hence, our results indicate that on average the population in Mwanza and Mara are better off in 2008 compared to the situation in 1993. However, it is possible that increases in mean are mainly due to income increases for the richer part of the population. In order to say something about the poorer fraction we need additional measures. The National Bureau of Statistics in Tanzania have carried out household budget surveys for the country in 1991/92, 2000/01 and 2007, which both provide a baseline of the general development of household welfare in Tanzania but also figures of basic poverty needs in Tanzanian shillings. We used the levels calculated in the HBSs from 91/ 92 and 2007 respectively, deflated by the IFS CPI (IMF, 2010), and then calculated the corresponding figures for our samples. The results provide a useful guide of the trend. They also 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 HBS surveys reported the fraction of population living below the basic needs line for three categories; Dar es Salaam, other urban areas and rural areas. We compare our samples with *other urban* and *rural areas*. The HBS results for *other urban* areas were 28.7/25.8/24.1% and the corresponding figures for *rural areas* were 40.8/38.7/37.6%, indicating only modest but continuous reduction in incidence and depth of poverty in Tanzania. Our samples have substantially lower fractions, but again we caution about direct comparisons, but more importantly we can compare development for the poorest in the lake area regions, see table 3. In

rural areas there is a reduction in poverty but it is so small that it is 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 eighteen to eight percent. Sarris and Tinios (1995) showed how sensitive comparisons are regarding particularly adjustments for inflation when assessing welfare development in Tanzania. Our results indicate that the development for population in rural areas of Mwanza and Mara are at least at par with rural population in the rest of the country, while those living in urban areas of the lake region have had a more beneficial period compared with the population in other urban areas maybe with the exception for Dar es Salaam.³

Table 3. Distribution of the poor in Mwanza and Mara

		1993	2008	t-stat
Weighted mean	Rural	740,000	770,000	-5.1
Exp per adult equiv in 2008 TShs	Urban	1,040,000	1,160,000	-12.2
Average food share of total consumption per hh		75.9%	65.6%	
Basic Needs based on deflated levels from HBS 1991 or 2007	Rural	15.0%	14.0%	1.2
	Urban	17.9%	8.1%	17.7

Another approach to measure welfare development, sometimes referred to as poverty mapping, based on combining data from household surveys and census data has been developed in recent years (Hentschel et al., 2000; Minot, 2000; Elbers et al., 2003). The point of departure is to estimate the relationship between poverty and household characteristics, where the latter are collected at various points in time. 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 do not imply any improvement in analyzing our data per se as we have income data collected for both occasions, but we can explore whether our data actually have significant socio economic variables explaining income. We ran ordinary least squares (OLS) regressions on the two data sets. For the 2008 data we also have distance variables for the samples, which we use to construct two alternative dummy variables indicating whether the sampled households are either within 2 or 10 km from the beach of the lake. In table 4 we report the summary statistics of the variables used in the regression. The samples are fairly similar with mean household head age of 44 years, about 15% of heads are female and about 50% have farm work as main income. Heads having fishing as main income are less than a handful in each sample. For the 2008 sample we note that 64% of the households are situated 10 km or less from the lake.

³ 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 4. Summary statistics of 1993 and 2008 sample used for income regression.

	2008		1993	
	Mean	Std Dev	Mean	Std Dev
R_household_count_adultequiv	5.22	2.07	5.35	3.01
R_household_count_adultequiv_sq	31.5	21.9	37.6	54.1
R_head_age	44.3	14.2	43.6	13.2
R_head_female	0.16		0.15	
R_head_activity_farmwork	0.46		0.51	
R_head_activity_lookingforwork	0		0.002	
R_head_activity_fishing	0.006		0.004	
R_head_activity_paidemp	0.12		0.26	
R_head_activity_farmwork	0.30		0.17	
R_head_activity_other	0.07		0.04	
R_head_activity_missing	0.02		0.02	
R_head_educ_none	0.05		0.18	
R_head_educ_primary	0.72		0.65	
R_head_educ_secondary	0.14		0.11	
R_head_educ_postsecondary	0.03		0.01	
R_head_educ_adult	0		0.01	
R_head_educ_other	0.04		0	
R_head_educ_missing	0.02		0.03	
W_village_lake_10km	0.64			
W_village_lake_2km	0.31			

^a 1993 price variables adjusted for inflation using IFS series 73864ZF CPI urban areas (all families) (IMF 2010) from date of survey to October 2008. Level of significance: * $p < 0.01$, ** $p < 0.05$, *** $p < 0.01$

In table 5 we report the results of the regressions where the dependent variable is log of expenditures per adult equivalent. Larger households are poorer than smaller but the negative effect of a larger household is decreasing in size, while neither age nor gender for household head has an impact on income per adult equivalent. If the major activity for the household head is other productive work, including all kinds of self-employed activities, the household is better off than the average farmer household. The same applies for fishermen in the 1993 sample, but note that the number is less than a handful. More importantly, the effect of education on income is striking. Compared to the reference alternative, head with some or completed primary schooling, heads with no education earn substantially less while heads with secondary or post secondary education earn substantially more, which is in line with results of Minot (2007). We also 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, which is in line with a previous study. Geheb et al. (2008) found substantially lower rates of child malnutrition in households within 25 km of the lake compared to those in the range 25-35 km from the lake.

Table 5. OLS Regression on Income measured as log expenditure per adult equivalent.

	2008		1993
	Model 1	Model 2	Weighted
R_household_count_adultequiv	-0.350***	-0.325***	-0.162***
R_household_count_adultequiv_sq	0.022***	0.006***	0.006**
R_head_age	0.023	0.001	-0.001
R_head_gender	-0.055	-0.074	-0.074
R_head_activity_farmwork	Ref.	Ref.	Ref.
R_head_activity_lookingforwork	Dropped	dropped	0.296
R_head_activity_fishing	0.340	0.335	0.878**
R_head_activity_paidemp	0.168	0.184**	0.275***
R_head_activity_otherprod	0.195***	0.217**	0.459***
R_head_activity_other	0.105	0.118	0.116
R_head_activity_missing	Dropped	dropped	0.129
R_head_educ_none	-0.451***	-0.466***	-0.040
R_head_educ_primary	Ref.	Ref.	Ref.
R_head_educ_secondary	0.739***	0.753***	0.425***
R_head_educ_postsecondary	0.800***	0.813***	0.395*
R_head_educ_adult	Dropped	dropped	-0.196
R_head_educ_other	-0.323**	-0.289*	dropped
R_head_educ_missing	Dropped	dropped	0.621***
W_village_lake_10km	0.157***		
W_village_lake_2km		0.190**	
_cons	14.10***	14.06***	14.10***
N	502	502	515
adj. R2	0.270	0.273	0.317

^a 1993 price variables adjusted for inflation using IFS series 73864ZF CPI urban areas (all families) (IMF 2010) from date of survey to October 2008. Level of significance: * $p < 0.01$, ** $p < 0.05$, *** $p < 0.01$

Discussion and Conclusions

This paper assesses the welfare development for two samples of household surveys carried out in 1993 and 2008 in the two Tanzanian regions Mwanza and Mara by the Lake Victoria. The ultimate purpose was to shed light on whether the booming fish industry in Lake Victoria during the same period had impacted welfare development in the regions using a micro level perspective.

Our results indicate that average income in 2008 Tanzanian shillings 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 were 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 a better development than in Tanzanian *other urban areas* on average 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 confirmed the significant impact of education on household income. We also found that households on average are better off when situated close to the lake. Clearly our results indicate that if having an impact of the welfare on the population by the lake, there is more support in our data that the fish boom has had a positive effect rather than the opposite on the well being of those residing in Mwanza and Mara.

As shown in Figure 1, Nile Perch landings have been quite stable in the study period. Despite biological warnings we cannot say for sure that catches will decline in the future, which may lead to a corresponding decline in welfare. Moreover, welfare as we measure it in our survey is of course affected by a multitude of factors: education level, changes in capital stock, openness to trade in other sectors etc. Clearly, these effects could dominate an unidentified negative effect from increased export of Nile Perch. Thus, even though our analysis does not confirm the Brander and Taylor story, we cannot dismiss that a decline in welfare will eventually occur due to increased harvesting resulting from trade liberalization. Béné et al. (2010) characterize the debate about international fish as two opposing views where advocates promote the view that export and trade liberalization is pro-poor, while critiques claim that fish export imply food insecurity. The same dispute has occurred concerning the Nile perch export oriented fishery in Lake Victoria (Abila, 2003; Abila and Jansen, 1997; Bokea and Ikiara, 2000). Béné et al. (2010) study the issue on a macro perspective using national data for countries in sub-Saharan Africa and their results fail to give support to any of these polarized views. Geheb et al. (2008) have a more micro level approach using health data on occurrence of malnutrition, and strongly reject the claim that there is a direct linear relationship between Nile perch export and the high frequency of malnutrition among population in lake regions of all three countries surrounding the lake. They also stress that exporting food does not imply taking away the food per se, “It is cash and the way this is distributed within households that matters...” (Geheb et al., 2008, p.88), further they found that fishermen unanimously held that factories had been beneficiary for their business and had lead to higher prices. 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 dagaa⁴, which in turn implies changing fishing patterns. Brown et al. (2005b) also discuss how changing fishing patterns may have a strong gender effect as females are much more involved in catching and handling dagaa and haplochromis, compared with Nile perch fishing which primarily imply work for males. Geheb et al. (2008) also focus on the gender issue and hold that it is a major reason for the high frequency of malnutrition around the lake, household income have increased but is more unequal within households. Smith et al. (2003) is another study emphasizing the gender aspect, which claim that improving the status of women vis-à-vis men likely improves nutrition of children.

In this study we have quantitatively assessed the welfare development in the Tanzanian Lake Victoria regions, Mwanza and Mara. Our results add to the empirical studies that reject the claim that the dramatic upsurge in Nile perch export has lead to food shortage and deteriorating conditions for the local population, a narrative widespread outside the scientific community inter alia due to the documentary “Darwin’s Nightmare” (for a critical analysis of the film, see Molony et al., 2007). Still, there is certainly room for improvement. The bargaining power between fishermen and process factories is strongly uneven, a fact reinforced by the open access conditions which also imply suboptimal use of the fish resources. There are unacceptable high

⁴ Mkumbo et al. (2002) confirm recovery of Haplochromis and other prey species as the Nile perch stock has been reduced.

numbers of children malnourished around the lake, and in the case of Tanzania figures are higher than average for the whole country. Recommending policies is beyond the scope of this study. Geheb et al. (2008) provide an insightful discussion in favour of improving the status and income of women, while Béné et al. (2010) primarily promote the development of regional trade (Africa-to-Africa) as a means of improvement.

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