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Adjusting to Trade-Policy Changes in Export Markets

Evidence from U.S. Antidumping Duties on Vietnamese Catfish

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Abstract

A large literature studies the effects of trade policy changes on developing-country exports on household incomes, and recent contributions have increasingly addressed the effects of administered protection, such as anti-dumping duties. In 2003 the United States imposed anti-dumping tariffs on imports of catfish from Vietnam ranging from 37 to 64 percent. As a result, Vietnamese exports of catfish to the U.S. market declined sharply, thus providing a unique opportunity to study the effects of U.S. trade policy changes on Vietnamese families. Using data on Vietnamese households, the authors study the responses of catfish producers in the Mekong delta of Vietnam between 2002 and 2004. The evidence suggests that the rate of growth of income of households that depended on catfish sales was significantly affected. In addition, the anti-dumping duties triggered significant exit from catfish farming. Households adjusted by moving out of catfish aquaculture and into wage labor markets and agriculture, but not into other aquaculture activities. Finally, the evidence also suggests that households found it difficult to change their catfish production levels, and that performance in aquaculture affects other household economic activities.

This paper—a product of the a product of the Trade and Integration Team, Development Research Group—is part of a larger effort in the department to explore adjustments to trade policy in developing countries. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at gporto@worldbank.org.

Adjusting to Trade-Policy Changes in Export Markets: Evidence from U.S. Antidumping Duties on Vietnamese Catfish*

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1 Introduction

During the last two decades, there has been a significant increase in anti-dumping (AD) activity in the world economy. Prusa (2005) documents that the number of anti-dumping cases filed with the WTO tripled between the early 1980s and the late 1990s. Also, while two decades ago the overwhelming majority of AD cases was filed by the United States, the European Union, Canada and Australia, today India, Argentina, Mexico, Brazil, South Africa and New Zealand are additional heavy users. Figures from Zanardi (2004) show that 46 countries adopted AD laws between 1990 and 2001, which may yet lead to a further increase in anti-dumping activity in the near future.

The empirical literature on anti-dumping has traditionally focused on aggregate issues like changes in international equilibrium prices (Debaere, 2005; Prusa, 1997), pass-through to domestic prices (Blonigen and Haynes, 2002; Blonigen and Park, 2004), changes in trade volumes, trade deflection and trade depression (Bown and Crowley, 2007a; Staiger and Wolak, 1994; Prusa, 1997), impacts on aggregate welfare costs (Gallaway, Blonigen and Flynn, 1999), and retaliation and further trade liberalization (Blonigen and Bown, 2003).[1] In this paper, we are instead interested in exploring household adjustments to trade policy, in particular to anti-dumping measures. In light of the increasingly heavy use of AD, our estimates of these microeconomic impacts should become valuable additions to the set of current evaluations of AD policies.

We study the anti-dumping duties imposed by the United States on imports of catfish fillets from Vietnam in 2003. After the U.S. lifted the embargo on Vietnam in 1994, Vietnamese catfish burst into the U.S. market, which by 2002 became the main export destination and accounted for 50 percent of total production. However, while catfish farming is an important source of income for households in the Mekong delta in Southern Vietnam, it is also an important industry in the Southern United States (mainly in Mississippi, Arkansas, Alabama, and Louisiana). Faced with this increasing competition from cheaper Vietnamese catfish, the Association of Catfish Farmers of America (CFA) initiated a successful campaign

[1] This list refers only to empirical papers on anti-dumping. For an overview of this literature, see the survey in Blonigen and Prusa (2003).

to halt catfish imports. First, the CFA pursued a labeling campaign whereby Vietnamese products were forced to be sold as 'tra' and 'basa,' a different product from the American 'channel' catfish. Later, the CFA launched dumping allegations. In January 2003, the U.S. Department of Commerce (DoC) ruled in favor of the dumping claim of the CFA and established tariffs ranging from 37 to 64 percent on imports of frozen catfish (that is, tra and basa) from Vietnam. In July 2003, the U.S. International Trade Commission (USITC) ratified the DoC ruling. As a result, Vietnamese exports of catfish to the U.S. plummeted to the point of being almost completely shut down.

Our objective in this paper is to explore patterns of household adjustment to this AD shock among Mekong farmers in Vietnam. In world markets where export barriers abound (sometimes intertwined with export preferences), one of the main concerns with the trade policies of developed countries is how such policies affect welfare in trade partners in the developing world. For this reason, we focus here on adjustments in the process of generation of household income. We first establish the overall response of household income to the U.S. AD policy among catfish farmers in the Mekong. We also document how income adjustment takes place and whether there are intrahousehold spillovers from the activities directly affected by the trade shocks (catfish in our case) to other household occupations (like agriculture). To do this, we investigate whether the U.S. policy triggered exit out of catfish farming and into various other occupations, we establish whether there was an impact on the level of various sources of household income, and we inspect household adjustments in input decisions such as labor supply and investment in non-catfish activities.

Our identification strategy is based on the comparison of household outcomes before and after the U.S. AD intervention across catfish farmers with different levels of exposure to the shock. The Vietnamese catfish case is ideal for ex-post analysis. First, the 2003 U.S. decision is a trade shock which is arguably exogenous with respect to decisions taken by Vietnamese households. Second, the General Statistical Office in Vietnam collected two household surveys, the Vietnam Household Living Standard Surveys of 2002 and 2004, that span the period right before and after the U.S. trade policy. The combination of an exogenous policy change with ex-ante and ex-post data provides a unique opportunity to explore household responses to trade shocks. There are only few other studies that analyze ex-post the impact of trade policies on household income and production decisions. Edmonds and Pavcnik (2005) find that the increase in the price of rice that followed market integration in Vietnam led to declines in child labor, especially in households that were large net producers of rice. Topalova (2005) studies the impact on poverty and inequality of trade liberalization in India in the early 1990s. She finds that rural areas with industries more exposed to liberalization experienced less poverty reduction. Edmonds, Pavcnik, and Topalova (2007) analyze the impact of the same liberalization process on human capital investment. They find that areas with more concentration of protected industries saw a lower increase in schooling and a lower decline in child labor. McGaig (2008) studies the impact of the 2001 U.S.-Vietnam Bilateral Trade Agreement on poverty. He finds that areas more affected by U.S. tariff cuts experienced larger declines in poverty.

Our findings are as follows. We find that larger farmers suffered significantly larger losses than smaller ones, even in relative terms. The average catfish farmer faced an 11.3 percent decline in income relative to households with only marginal involvement in catfish production. However, while low-exposure farmers faced relative income losses of 6.2 percent the relative decline was 16.9 percent for high-exposure farmers.[2] The anti-dumping shock triggered significant exit out of catfish farming. On the one hand, the share of income derived from catfish farming decreased to a larger extent for those households heavily involved in aquaculture. On the other hand, full exit out of catfish was much more likely at low levels of exposure. Households adjusted by moving out of catfish aquaculture and into wage labor markets and agriculture (and not into other aquaculture activities like shrimp or mollusks, for instance). Moreover, we find evidence of adjustments costs and of spillovers into non-aquaculture household economic activities, with non-catfish income suffering relative declines as well. Also, not only investment in aquaculture declined, as expected, but aggregate investment in non-catfish activities declined as well. Overall, thus, our evidence is consistent with externalities, at the farm level, from catfish to non-catfish

[2]Because exposure is measured by the share of income derived from catfish prior to the U.S. intervention, our results provide evidence on the differential impact of the AD measure as a function of the level of exposure (rather than on the level effect of the AD). See Section 4.1

farming. These spillovers mostly affected activities such as animal husbandry, farm services, or silviculture, while leaving hours worked off-farm and investment in agriculture unchanged.

The rest of the paper is organized as follows. In section 2, we illustrate the timeline of the U.S. anti-dumping measures on Vietnamese catfish. In section 3, we describe the production of catfish in Vietnam and we characterize the catfish farmers of the Mekong delta. In section 4, we document the changes in household income and the pattern of household adjustment to the trade shock. Section 5 concludes.

2 The US anti-dumping Ruling on Vietnamese Catfish

Catfish is a fresh-water fish that thrives in large, flat rivers. In the U.S., catfish is raised in man-made ponds mainly in the states of Mississippi, Arkansas, Alabama, and Louisiana.[3] Farmers buy fingerlings (young fish) and feed them for approximately ten weeks. Processing plants purchase farm-raised catfish and market mostly fresh or frozen fillets in about equal parts. The catfish industry is by far the largest farm-raised fishing sector in the U.S. In 1999, it accounted for 80 and 64 percent of aquaculture production in volume and value, generating 440 million dollars of revenue (USITC, 2001). There are over 1,000 catfish farms and 25 processing plants in the Southeast. Most of the catfish produced in the U.S. is a high quality variety known as *channel catfish*, which, before the introduction of Vietnamese catfish, accounted for almost all domestic consumption (with total imports of less than 1 percent).

The Hau and Tien rivers in the Mekong region of South Vietnam also provide a good habitat for catfish. The Vietnamese varieties, known as *basa* and *tra*, are raised by small farmers in cages that are placed in the river itself and later processed in industrialized plants. While tra is of lower quality than basa in terms of flavor and texture, it is faster, easier, and less costly to raise and has become the most popular of the two species among Mekong producers.

In 1995, soon after the end of the U.S. embargo, Vietnam started exporting frozen fillets

[3]There is also some production of catfish in California, Florida, Georgia, Kentucky, Missouri, North Carolina, and Texas.

of basa and tra to the U.S. market.[4] As a first effort to popularize the Vietnamese products, more appealing names such as River Cobbler and China Sole were used to market the fish. Later on, retailers labeled basa and tra simply as catfish. They also adopted brand names that suggested a Mississippi-raised origin, such as *Cajun Delight Catfish*, and used packaging similar to the American channel catfish.

During the late 1990s and early 2000s, catfish exports from Vietnam increased significantly. By 2000-2002, approximately 50 percent of the total Vietnamese production of catfish was being sold to the U.S., and the volume market share in U.S. consumption reached 8.4 percent in 2000 and 19.6 percent in 2002. Vietnamese catfish served mostly food service distributors and chain restaurants—catfish available in supermarkets, on the other hand, is mostly fresh instead of frozen and thus of American origin. The average price of domestic catfish sold by U.S. processors fell by 18 percent between 2000 and 2002, from 2.75 to 2.25 dollars per pound. In turn, during the same time period, Vietnamese production capacity expanded by 100 percent (USITC, 2003).

The increasing popularity of Vietnamese catfish together with the decrease in domestic prices raised the concern of the Association of Catfish Farmers of America (CFA), a trade association of farmers and processors. At first, the CFA blamed the improper labeling of Vietnamese basa and tra as 'catfish' for the lower prices. The allegation was that even though Vietnamese catfish was a different product from American catfish, it was sold under misleading labels that allowed Vietnamese exporters to free ride on the significant commercial campaign and marketing efforts of domestic catfish producers.[5] Domestic producers launched a "raised in America" campaign to raise awareness among clients and consumers.

The CFA also lobbied in Washington. In October 2001, the U.S. House of Representatives adopted a new bill (H.R. 2964) which established the use of the label 'catfish' only for fishes of the *Ictaluridae* family (the American catfish), thus forcing Vietnamese exports to be labeled

[4]The embargo was lifted by the Clinton administration in February 1994 as a first step before re-establishing diplomatic relations in July 1995 and signing a bilateral trade agreement in December 2001. The 2001 trade agreement granted Vietnam Most Favored Nation (MFN) status.

[5]Strictly speaking, catfish refers to the order *Siluriformes*. There are 39 different families of catfish, including the family *Ictaluridae* and the family *Pangasiidae*. The American channel catfish (*Ictalurus punctatus*) is a species in the *Ictaluridae* family, while the Vietnamese basa (*Pangasius bocourti*) and tra (*Pangasius hypophthalmus*) are species in the Pangasiidae family.

as tra and basa. Subsequently, the 10-digit Harmonized System line corresponding to frozen catfish fillets, 0304.20.60.30, was split into three different lines: 0304.20.60.32 for catfish of the *Ictaluridae* family; 0304.20.60.33 for catfish of the *Pangasiidae* family (the Vietnamese catfish); and 0304.20.60.34 for all other *siluriformes*. The passing of the bill, however, did not lead to a significant recovery in prices. While public awareness increased, most Vietnamese catfish was being sold to American wholesale distributors, not final consumers, and a change in names was not enough to break the commercial networks that had already been established.[6]

In June 2002, the CFA filed a dumping lawsuit against Vietnam. A few months later, in January 2003, the U.S. DoC ruled in favor of U.S. farmers, arguing that Vietnamese exporters were dumping frozen fish fillets on U.S. markets by margins that varied by exporter and ranged from 37 to 64 percent of the "normal value."[7] When the exporting country is a "market economy," the DoC determines the normal value of an imported product using either the domestic price or an estimate of the cost of production in the country of origin. Vietnam, however, is considered as a "non-market economy" by the U.S. government, which implies the presumption that domestic prices are distorted. As a consequence, prices and costs in a surrogate country are used instead. In the case of Vietnamese catfish, the surrogate countries used by the DoC were Bangladesh and India. As the last step of the lawsuit, in July 2003, the USITC found that American catfish processors were materially injured by imports from Vietnam, confirming the application of anti-dumping import tax rates equivalent to the dumping margins of 37 to 64 percent.[8]

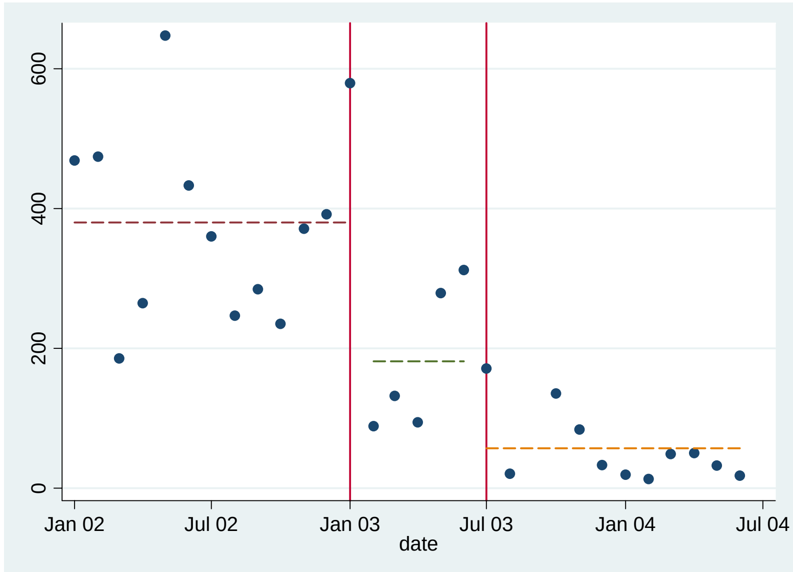
Figure 1 plots the time series of U.S. imports of tra and basa from Vietnam (in tons) between January 2002 and July 2004. Data are from the disaggregated monthly import series

[6]For more details on labeling issues and a general description of the evolution of imports of Vietnamese catfish see USITC (2003) and Seafood Business Magazine (2001).

[7]The DoC established margins of 36.84 percent for Vinh Hoan, 45.55 percent for Afiex, CAFATEX, Da Nang, Mekonimex, QVD, Viet Hai and Vinh Long, 45.81 percent for CATACO, 47.05 percent for Agifish, 53.68 percent for Nam Viet, and 63.88 percent of all other exporters.

[8]The USITC decided to exclude American catfish farmers from the investigation on material injury, and focused only on catfish processors. The argument was that the percentage of unprocessed domestic farm-raised catfish that was used as input for frozen fillets, which was about 50 percent, was not high enough.

Figure 1
US Imports of tra and basa from Vietnam
Monthly Quantities (tons)



Source: USITC. The two vertical lines correspond to the dates of the DoC announcement of AD tariffs (left) and of the ratification of the decision by the USITC (right).

at the 10-digit level of the Harmonized System.[9] The graph shows a striking drop in the imported quantities of tra and basa immediately following the DoC announcement in January 2003 (left vertical line). Average monthly imports dropped from nearly 380 monthly tons in 2002, to around 180 in the first semester of 2003, a more than 50 percent decline. After the ratification of the USITC in July 2003 (right vertical line), imports plummeted to a monthly average of 56 tons in the second semester of 2003, an 85 percent drop since 2002. These changes in import are consistent with the literature: Staiger and Wolak (1994) document similar drops in U.S. imports during the investigation phase in several anti-dumping cases and Prusa (2001) estimate overall drops of about 50 percent in U.S. AD-subject imports.

[9]See the USITC Interactive Tariff and Trade DataWeb, version 2.8.0. at `http://dataweb.usitc.gov`.

3 Catfish Farming in the Mekong

Fishing and aquaculture are prevalent all over Vietnam, a country with a dense river network and hundreds of kilometers of coastal areas. While marine fishing, both offshore and inshore, are important, our analysis focuses on small-scale aquaculture production by Vietnamese farmers. Within aquaculture, there are three major fishing activities in the country: freshwater aquaculture (river fishing), brackish water aquaculture (medium-salinity waters as in estuaries) and marine aquaculture (saltwater). Since catfish is a river fish, we will only study freshwater aquaculture.

To investigate the impact of the U.S. anti-dumping duties on Vietnamese farmers, we focus on households residing in provinces where catfish is the major source of aquaculture income. We will label these provinces, which are located in the Mekong region of South Vietnam, 'catfish provinces'. Data on fish production by species in Vietnam is not easily available to the public. In order to identify the catfish provinces, we must therefore follow an indirect approach consisting of two strategies. First, we examine the geography of the country and the ecological conditions needed for catfish production across regions. Second, we present supporting information on catfish production by provinces that we obtained from several scattered sources.

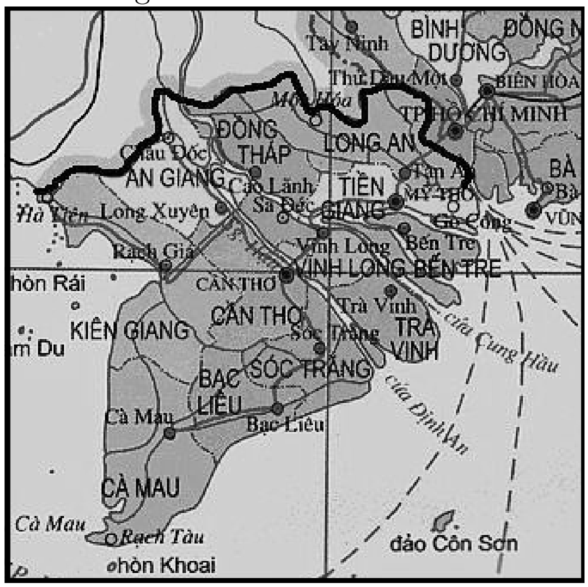
Within Vietnam, the production of catfish is geographically concentrated in the Mekong Delta. This is because catfish only develops in relatively flat rivers with sandy soils, a prevalent feature of the Mekong area. The Red River Delta, in North Vietnam, is instead a mountainous region not suitable for catfish, but rather for other fish like carp. The other regions specialize mostly in brackish and saltwater products. Table 1 supports this claim. Based on the description of the sector in World Bank (2005), a comprehensive report on Vietnam Aquaculture, we assembled evidence on region-specific forms of aquaculture. Two observations stand out. First, freshwater production is relevant in all North Vietnam and, within the South, only in the Mekong where 50 percent of the aquatic output comes from freshwater fishing. In addition, while the Mekong produces tra and basa (along with other fish like tilapia and barb) the North, and in particular the Red River, specializes in carp (common, Indian and Chinese). The main brackish aquaculture product is shrimp, particularly in the non-Mekong South, together with mollusks, crabs, mussels, scallops, and clams. Saltwater aquaculture involves mostly grouper and cobia. These observations establish that catfish is only produced in the Mekong region.

Even within the Mekong region, there is considerable heterogeneity in the composition of aquaculture production. While landlocked provinces specialize in freshwater aquaculture, coastal provinces tend to be more heavily engaged in brackish and saltwater aquaculture. Also, suitable river conditions for catfish farming are more prevalent in some provinces than in others. To see why, Figure 2 displays a map of the Mekong area and its provinces. Some Mekong provinces (Kien Giang, Ca Mau, Bac Lieu, Soc Trang, Tra Vinh, and Ben Tre) have extensive marine coastlines. Instead, the provinces of An Giang, Can Tho, Dong Thap, Vinh Long, Long An, and Tien Giang are mostly landlocked. The Mekong river, where catfish thrives, flows down from Cambodia and enters Vietnam at the border between An Giang and Dong Thap. The river then divides into the Hau branch, which crosses the Can Tho province, and the Tien branch, which crosses Tien Giang and Vinh Long provinces. The Mekong finally empties into the sea mostly in the provinces of Soc Trang and Tra Vinh. Clearly, the catfish habitat is concentrated in the provinces more heavily touched by the Mekong River.

Table 2 includes information on aquaculture production for each province in the Mekong region.[10] Columns 1 and 4 show the share of freshwater aquaculture in total aquaculture output in 2002 and 2003. In Dong Thap, An Giang, Vinh Long, and Can Tho, 100 percent of the aquaculture production is freshwater aquaculture. The share of freshwater aquaculture is much smaller in coastal provinces, where brackish and marine fishing is more relevant (columns 2 and 5). In particular, shrimp is prevalent in Bac Lieu, Ca Mau, and Kieng Giang, which are located on the Southernmost tip of Vietnam (columns 3 and 6). This confirms that landlocked provinces tend to be much more specialized in freshwater aquaculture than coastal provinces. Further, column 7 displays information on production levels of catfish in 2003, calculated from data on total catfish production in the Mekong region, as well as

[10]Data have been gathered from difference sources, which include the Ministry of Fisheries (`www.fistenet.gov.vn`) and seafood industry magazines such as Seafood from Vietnam Magazine (`www.seafoodfromvietnam.com.vn`) and World of Pangasius (`www.worldofpangasius.com.vn`).

Figure 2
Mekong Provinces in South Vietnam



Note: Map of the Mekong provinces.

on provincial production for the 6 major producers. The main producers of tra and basa in 2003 were An Giang, which accounted for 40.2 percent of total production, Dong Thap (15.8 percent) and Can Tho (35.5 percent). While Vinh Long and Tien Giang were relatively specialized in catfish, Soc Trang appeared to be only a marginal producer. All other provinces produced very little (around 1.6 percent) of tra and basa in that year.[11] Overall, these data confirm that catfish is indeed mostly produced in landlocked Mekong provinces.

In light of this evidence, our analysis focuses on the six 'catfish provinces' identified above, which we aggregate into two samples. Our core sample, which we call Mekong 4 (M4), comprises the landlocked provinces that almost fully specialize in catfish freshwater aquaculture, namely An Giang, Can Tho, Dong Thap and Vinh Long. For robustness, we also explore results using an alternative sample, which we call Mekong 6 (M6), that adds the provinces of Soc Trang and Tien Giang. These two latter provinces are also engaged in catfish but are diversified into brackish and marine aquaculture as well.

[11]The current structure of tra and basa production in the Mekong may have changed in recent years, but this is not relevant for our purposes in this paper.

3.1 The Household Survey Data

For the empirical analysis, we use panel data from the new Vietnam Household Living Standard Surveys (VHLSS). The first round of the VHLSS was carried out in 2001-2002, before the imposition of U.S. tariffs on catfish in 2003. The second round was carried out in August 2004, after the introduction of the trade barriers. The availability of ex-ante and ex-post panel data makes the AD on Vietnamese catfish an ideal case study.

The VHLSSs were conducted by The General Statistics Office of Vietnam (GSO) with technical assistance from UN Statistics Division, the World Bank and Statistics Sweden. In both surveys, GSO used a stratified two-stage sampling design. The primary sampling units were enumeration areas in urban areas, and supervisor areas in rural areas, identified in the 1999 Population and Housing Census. The surveys are representative at the national level. VHLSS'02 surveyed more than 74,000 households while VHLSS'04 surveyed over 44,000. A fraction of this sample forms a panel, with a total of 16,518 households surveyed in both years. The size of the panel is smaller than the initially planned figure of 20,000, both because of attrition and because errors in inputting household identifiers makes it impossible to match some panel households between the two rounds of the survey. Unfortunately, it is not possible to establish which or how many of the remaining 3,482 households are lost from the panel because of attrition or because of the miscoding.

The VHLSSs comprise several modules with information on demographics, education, employment, health, income and labor supply. There is also an expenditure module, which was however used only for a subsample of the interviewed households, 29,000 in VHLSS'02 and 9,000 in VHLSS'04. In practice, the expenditure module is not usable for our purposes because there are only a few dozen observations in the panel sample of aquaculture households in our focus Mekong provinces. Extensive modules record information on farm activities related to agriculture, livestock and aquaculture. Data include production, sales, input use and investment. The information on aquaculture activities distinguishes between raising and catching fish, shrimp, or all other aquaculture products (like mollusks). It must be emphasized that the data do not explicitly separate catfish from more general fish production. Hence, although in the rest of the paper we will refer to 'catfish income' and to 'catfish households', these are, strictly speaking, 'fish income' and 'fish households'. At the same time, we have shown that in the regions relevant for our analysis catfish represents a preponderant fraction of total catfish production, especially for M4 provinces.

Sample sizes and income levels on the panel sample are reported in Table 3. Panels A) and B) refer to households in the Mekong Delta in the target samples M4 and M6; Panel C) includes information on South Vietnam (excluding the Mekong), for comparison purposes.[12] The columns refer to fishing households, non-fishing rural households, and all households in the data, for both 2002 and 2004. Catfish production is widespread in the Mekong. There are 561 and 788 catfish households in the M4 and M6 panel samples, respectively. This is around half of the overall sample in the region and close to 60 percent of the total rural sample (more concretely, 63 percent in M4 and 56 percent in M6). These catfish households are the relevant population exposed to the AD shock on which we base our analysis.[13] Fishing is less prevalent in the rest of South Vietnam, where only 929 out of 6127 households (15 percent) are involved in fishing (mostly shrimp and marine aquaculture).

For each of the M4, M6, and South Vietnam (non-Mekong) regions, and for each set of households (fishing, rural, all), we report in Table 3 the median level of total annual per capita income (pci) in thousand Vietnamese Dong and in US PPP dollars. Income is defined as all sources of household income including earnings in agriculture (both for sale and home consumption), aquaculture, wages, livestock, silviculture, hunting, non-farm activities and transfers (see Appendix 1 for a description of the main variables). The median income levels are very similar for catfish households in the target samples M4 and M6 both in 2002 and 2004. In M4, median pci increases from 3,537 thousand Dong in 2002 to 4,224 thousand Dong in 2004, while in M6 it increases from 3,544 to 4,281 thousand Dong. Note that, despite the AD shock to catfish income, there is sizeable growth in total per capita income in the Mekong. These growth rates are, however, slightly lower than the average growth rate in pci at the national level based on VHLSS data. Catfish households are relatively better-off than

[12] We exclude North Vietnam from the analysis because of the striking differences in performance between the North and the South resulting from differences in the political environment up to the mid 1980s. We thank Quy-Toan Do for raising this issue in previous versions of our paper.

[13] We also conduct false experiments using fishing households in the non-Mekong South as a validation method.

the rest of the households in the Mekong. For instance, in 2002, the median pci of fishing households was around 27 percent higher than among non-fishing rural households and 8 percent higher than the overall median in the Mekong. Finally, an interesting results is that the median pci in both M4 and M6 is roughly the same as in the rest of South Vietnam.

To present an overview of the sources of income in the region, we report in Table 4 the share of income derived from different economic activities in the two target samples M4 and M6. Catfish households rarely specialize in fishing and are instead diversified into various economic activities, including wage labor, agriculture (both for sale in the market and for home consumption) and livestock (including poultry). At the same time, these households were only marginally involved in other aquaculture activities, such as shrimp or marine fishing. An important conclusion that emerges from Table 4 is that the share of catfish income declined in the Mekong area after the imposition of the anti-dumping duties in 2003. Before the AD shock, the average share of income derived from catfish in M4 was 11.2 percent. In 2004, the share dropped significantly by to 6.8 percent. Similarly, the share of catfish income in M6 decreased from 9.6 in 2002 to 6.5 in 2004. Such large declines in the weight of catfish income were accompanied by small increases in the role of income from several other sources such as wages.

4 anti-dumping Shock and Household Adjustments

In this section, we investigate whether households in the Mekong were affected by the U.S. anti-dumping shock. Specifically, our emphasis is in documenting the effects of the AD on the process of income generation of the household.

In order to illustrate the focus of our analysis and to clarify our empirical strategy, we introduce first a simple graphical illustration of the impact of the shock. We assume that a household h is engaged in two economic activities so that household income y_h is composed of catfish income, y_h^c, and agricultural income, y_h^a. We assume for simplicity that, in the initial situation before the AD shock, each household is endowed with fixed quantities of capital and labor $\bar{K}_h$ and $\bar{L}_h$. We also assume that inputs cannot be traded, so that the household's production problem is to maximize revenues (since production efficiency is a necessary condition for utility maximization).[14] Catfish income is the product of catfish farm-gate prices, p^c and catfish production, q^c_h. Similarly, agricultural income is the product of agricultural prices p^a and quantities q^a_h. Household income is then given by

$$(1) \quad y_h = p^c q^c_h(L^c_h, K^c_h) + p^a q^a_h(L^a_h, K^a_h),$$

where L^i_h, K^i_h denote the quantities of labor and capital allocated to the production of good $i, i = a, c$.

Figure 3 presents a schematic representation of the equilibrium in household production. At any point in time, the (fixed) inputs available to the household (capital, labor, etc.) define a production possibility frontier, represented by the curve ca, between catfish (denoted with c in the horizontal axis) and agriculture (denoted with a in the vertical axis). For given prices, efficiency in production requires tangency between the relative prices and the slope of this frontier. We assume that p^1 is the initial relative price of catfish and that, before the imposition of the tariff, inputs are allocated optimally, so that production is at point q^1.

The imposition of AD duties implies an exogenous change in the relative price of catfish. Keeping everything else constant, optimality requires tangency between the frontier ca and the new price vector. In Figure 3, when catfish prices decline to p^2, production allocation would shift to q^2. To study the welfare consequences of such a price change, differentiate (1) as follows:

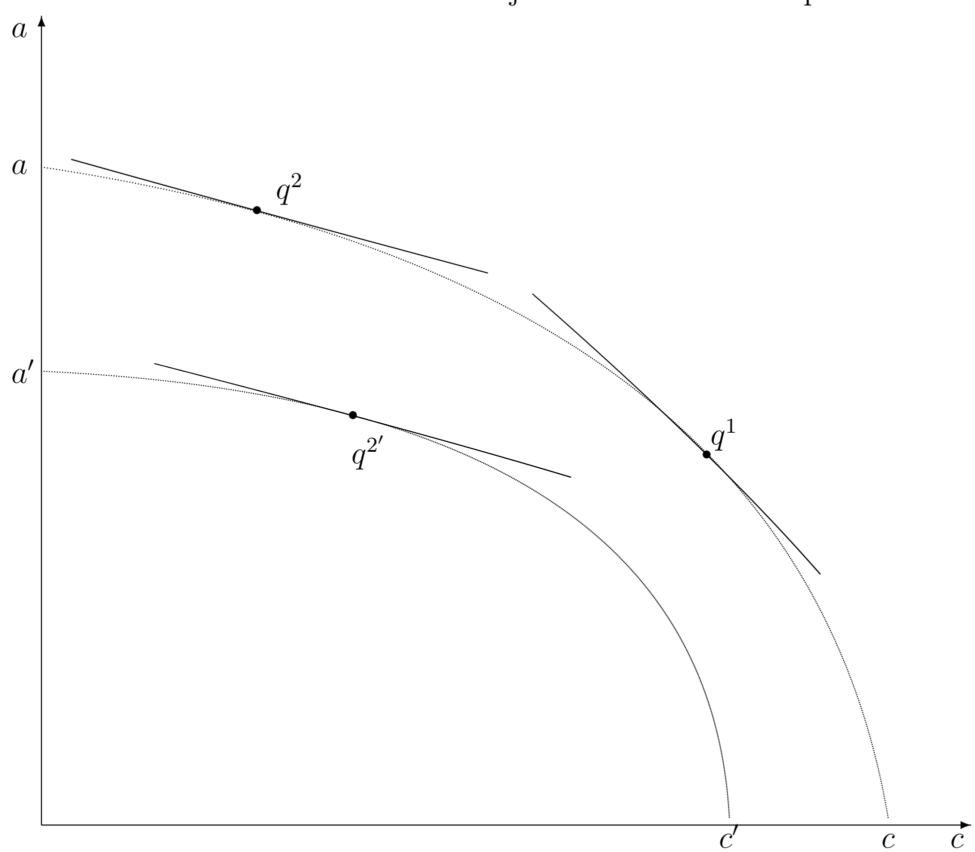
$$(2) \quad dy_h = dp^c q^c_h + p^c dq^c_h + p^a dq^a_h.$$

In a first best situation, and for a small price change, the last two terms cancel out because, with efficiency in production, $dq^a_h/dq^c_h = -p^c/p^a$. In such case, the welfare analysis can be based on the following first order approximation, popularized by Deaton (1989):

$$(3) \quad dy_h = q^c_h dp^c.$$

[14] See Benjamin (1992) or Singh, Squire and Strauss (1985) for full models of optimizing agricultural households.

Figure 3
Household Production With Adjustment Costs and Spillovers



Note: q^1 is the initial allocation. After a drop in catfish prices, q^2 would represent the first best allocation. Instead, with adjustments costs and spillovers in both aquaculture and agriculture, the equilibrium is $q^{2'}$.

This result follows from the envelope theorem: in an optimum, the resources released from the contraction of catfish activities cannot become idle and must be employed in agriculture. While the result holds for a sufficiently small price change, even with larger price changes a typical second order approximation is ordinarily (but not necessarily) small (the standard Harberger triangles).

There are various scenarios where the first order approximation in (3) can become inaccurate. In developing countries, distortions resulting from subsidies or taxes, or from the presence of missing markets in products, inputs, credit and insurance, are very common. Missing markets prevent the realization of the first best by affecting the shadow prices faced by the household (de Janvry, Fafchamps and Sadoulet, 1991). Another source of departure from the first order approximation is what we will refer to as "adjustment costs." Adjustment costs arise when the reallocation of resources from one activity to another (following a price change for instance) is costly. For example, know-how and other production inputs may be activity-specific, or start-up financing costs coupled with imperfections in credit markets may limit the ability to change the input allocation. Another scenario where the first order approximation may fail is when there are market imperfections that generate "intrahousehold spillovers," that is, when a decline in catfish prices not only affects the production of aquaculture but also of other household activities through externalities. For instance, if cash income earned for catfish sales is needed to finance investment, and if credit markets are imperfect, changes in catfish prices may affect input choices and then restrict the production possibilities in one or more seasons following the negative price shock.

Graphically, we can visualize the extent of the failure of the first order approximation by allowing the production frontier to shrink after the decline in catfish prices. This shift in the frontier represents the loss of resources due to costs of adjustment as well as due to spillovers in investment (possibly both in catfish and in agriculture). Our argument adapts the analysis in Atkinson and Stern (1974)—where taxation needed to provide a public good produces inefficiencies that shrink the production frontier—to a household production model. In Figure 3, the frontier shifts to $c'a'$ and, at changed prices p^2, the optimal allocation point q^2 is not feasible. With adjustment costs and intrahousehold spillovers, the equilibrium is instead at a point such as $q^{2'}$, an allocation characterized by declines in total income as well as in catfish and agricultural production.

We can also formalize this argument as follows. Suppose that the initial allocation of labor and capital is such that at initial prices p^1 the equilibrium q^1 is achieved. Instead of laying out a full dynamic model of household investment and production with adjustment costs and spillovers, we assume that the total amount of capital, $\bar{K}_h$, available to the farmer during the following season is a negative function of catfish prices. This simple idea formalizes the notion that when catfish prices decline, there is a loss of capital in the adjustment process from catfish to agriculture as well as lower overall investment. Differentiating (1) with respect to p^c, we get

$$(4) \quad dy_h = dp_h^c q_h^c + p_h^c \frac{\partial q_h^c}{\partial \bar{K}_h} d\bar{K}_h + p_h^a \frac{\partial q_h^a}{\partial \bar{K}_h} d\bar{K}_h,$$

where we now allow price changes dp_h^c to differ across households. The proportional change in household income is

$$(5) \quad d\ln y_h = s_h^c d\ln p_h^c + \left[s_h^c \epsilon_{K_h}^c + (1 - s^c)\epsilon_{K_h}^a \right] d\ln \bar{K}_h,$$

where s_h^c is the income share derived from catfish production and $\epsilon_{K_h}^i$ is the elasticity of the output of good i (catfish or agriculture) to the total capital stock of the household.[15] Notice that while (3) is an approximation to the change in welfare (real income) due to higher catfish prices, (5) is not because it does not take into account to cost of capital K. Our argument is that, in our setting, the loss of income can be higher than the savings in factor costs so that the decline in catfish prices can generate welfare losses beyond those captured by (3).

There are several insights from (5) that are useful for our empirical approach. First, the presence of adjustments costs implies the presence of the second term

[15] To derive equation (4), we used the optimality conditions in production that require equality in the value of the marginal products of each factor across sectors. Notice that this expression can be solved in general equilibrium as a function of the elasticity of substitution between factors, the factor intensity in the different sectors, and other technological parameters.

$\left[s_h^c \epsilon_{K_h}^c + (1-s^c)\epsilon_{K_h}^a\right] d\ln \bar{K}_h$ in the first order approximation (5), which can be sizeable. Second, the impact of the price change due to the AD policy should be expected to be heterogeneous across farmers and to depend on the exposure to the shock, measured in equation (5) by the income shares s_h^c. Note finally that the overall impact of the shock may be a non-linear function of those shares if $d\ln p_h^c$, $\epsilon_{K_h}^i$ and $d\ln \bar{K}_h$ are themselves functions of s_h^c. This may be the case if producers who differ in their reliance on catfish income also differ in their ability to bargain on the sale price to the catfish processing industry, in the magnitude of their adjustment costs, or in the extent of intrahousehold spillovers.

4.1 Empirical Strategy

In all our estimated regressions, we use only data from households involved in fish farming and residing in one of the provinces of the Mekong regions where catfish production is concentrated (the M4 and M6 samples defined above). In the absence of a randomized experiment, it is hard to find a suitable control group for catfish Mekong producers. Non-aquaculture households in the target samples are not suitable controls because of the likely self-selection into different economic activities. Also, non-aquaculture households may have been hit indirectly by the AD measure through general equilibrium effects. Aquaculture households in the rest of Vietnam are not a good control group either. On the one hand, the vast differences in trends and in recent history between North and South Vietnam prevent using the Red River delta region as a control. On the other hand, the non-Mekong South specializes in brackish and marine aquaculture, especially shrimp farming, and these activities are likely exposed to different trends relative to catfish farming. Our estimation strategy thus relies on comparing household outcomes before and after the introduction of the U.S. AD duties across households with different levels of exposure to the shock. Concretely, let Y_h be one of the outcomes that we explore below (income, income shares, sources of income, and input choices). We study the following model for the change in outcomes, $\Delta \ln Y_h$, from 2002 to 2004:

$$(6) \quad \Delta \ln y_h = \phi + \mathbf{\Delta x}_h' \beta + \gamma \ln y_h^{02} + g(s_h^c) + \epsilon_h,$$

where $\mathbf{x}_{ht}$ is a vector of household controls; $\ln y_h^{02}$ is the log of the initial level of household income; s_h^c is the initial share of income derived from catfish farming, our measure of exposure, and $g(\cdot)$ is a non-linear function that captures the impact of the AD policy; ϕ is an intercept which measures a year effect (recall that the equation is in first differences) and ϵ_h is an error term.

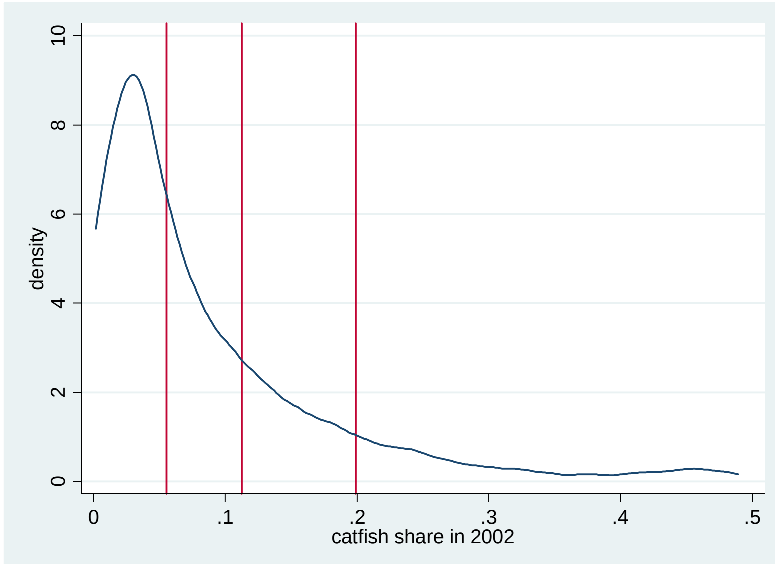
The model allows for the presence of year fixed effects, whose difference is represented by the intercept ϕ. The model also allows for the presence of household fixed effects which have been differenced out. The inclusion of a year effect controls for overall trends and aggregate shocks which may have hit all households. The household fixed effects absorb time-invariant unobserved heterogeneity at the farm/household level such as preferences, farming ability, land quality, or other pre-shock differences in aquaculture production. In addition, the household fixed effects embed regional, district or otherwise local effects. The vector $\mathbf{x}_{ht}$ includes household-specific controls such as household size, while time-invariant characteristics such as gender of the household head are differenced out. The inclusion of $\ln y_h^{02}$ among the regressors allows us to control for differences in trends that are a function of initial (log) income.[16]

Exposure to the AD shock is measured by the initial share of catfish income in total household income in 2002, s_h^c. Because we use initial shares in 2002, and since the 2003 price shock is due to anti-dumping duties imposed by the U.S., it is reasonable to postulate that this shock was exogenous to Vietnamese farmers (although it might have been affected by the behavior of the processors, especially if dumping indeed took place). In the estimation, even though we only use observations for which $s_h > 0$, we adopt the normalization $\lim_{s \to 0} g(s^c) = 0$. As a consequence, the estimates are a measure of the differential impact of the shock at different levels of exposure. An important implication of this caveat is that an estimated negative impact of s^c on the change in income does not literally indicate a predicted decline, but rather it should be interpreted as the impact on the rate of growth in income relative to households with a positive but marginal involvement in catfish farming.

Figure 4 plots an estimate of the distribution of initial catfish shares, using Gaussian

[16] A similar approach is adopted, for instance, in Banerjee et al. (2007) and Miguel and Kramer (2004).

Figure 4
Catfish Income Shares in 2002



Note: non-parametric estimates of the density of catfish income shares in 2002 using a Gaussian Kernel and the standard optimal bandwidth. The sample is M4, the Mekong provinces of An Giang, Can Tho, Dong Tha, and Tra Vinh. The vertical lines represent the median catfish share (the leftmost line), the mean share (the centerline) and the median share, conditional on producing more than the mean (the rightmost line).

Kernel methods, for sample M4 (the landlocked Mekong provinces of An Giang, Can Tho, Dong Tha, and Tra Vinh). The distribution of catfish shares is clearly unimodal and right-skewed. The mode is close to 0.025, while mean and median are respectively 5.5 and 11.2 percent.

4.2 The Impact on Household Income

We first estimate the impact of the AD shock on household income, using model (6).[17] We present separate results for total and per capita household income—measured including earnings from all economic activities, including home production and transfers—and for net income, which is calculated subtracting from total income the cost of inputs in farm activities

[17]As a reminder, expenditure-based indicators cannot be used as outcomes because the expenditure modules were responded by only a small sample of less than 50 observations in our panel of aquaculture households in the Mekong.

(see Appendix 1 for details). Our basic specification adopts a quadratic polynomial on the initial shares to estimate $g(\cdot)$. For robustness, we also estimate a more general and flexible partially linear semi-parametric model as in Robinson (1988).

To reveal different AD effects at different levels of exposure, we evaluate the estimated impact function $g(\cdot)$ for different values of s_h. For households in M4, we define three levels of exposure: low, at a level equal to the median share (5.5 percent); medium, at the mean level equal to 11.2 percent; high, for a level equal to the median share among farmers above the sample mean (a value close to 20 percent). The corresponding figures for M6, the extended Mekong catfish provinces (adding Sac Trong and Tien Giang) are 4.4 percent, 9.6 percent, and 16.9 percent respectively.

Results from our regressions are in Table 5. We report the impact on total household income for the M4 sample in column (1) and for the M6 sample in column (2). The corresponding results for per capita household income are in columns (3) and (4) and, for net income, in columns (5) and (6). Panel A) shows the estimates from the quadratic model. All our estimates, in both samples and for the three outcomes, are negative and statistically significant at the 5 percent level or below. As indicated in Section 4.1, the impacts are to be interpreted as relative to the marginal fish farmer with s_h approximately equal to zero. In the remaining of the paper we will refer to such differential changes as to "relative income losses".

In regions included in M4, a farmer with the median pre-shock share suffered a 6.2 percent relative income loss. A farmer with an average pre-shock share is predicted to have suffered instead a relative income loss of 11.3 percent. The relative losses for a high-exposure farmer are even higher at 16.9 percent. The impact on per capita income is very similar, 6.4, 11.7 and 17.6 percent, respectively. Instead, the impact on net income is slightly larger: 8.1 percent for low-exposure, 14.7 percent for average-exposure, and 21.7 percent for high-exposure.[18]

When the Mekong M6 sample is used instead, the impact on each outcome is smaller. This was to be expected, because farmers in the two new provinces included in M6 are less specialized in catfish and there is therefore less overall exposure to the shock. Total income

[18]While these differences are not statistically significant, we explore adjustments in input use below.

suffers relative declines of 4.7 percent for low-exposure farmers, 9.1 percent for the average farmer, and 13.9 percent for highly-exposed farmers. The relative per capita income losses are equal to 4.8, 9.4 and 14.3 percent, for low-, average-, and high-exposure households, respectively. Finally, the relative declines in net income are 6.2, 12.0, and 18.3 percent for the three exposure levels.

The semi-parametric estimates of $g(\cdot)$ are reported in Panel B). [19] Results are similar to those from the quadratic model. For instance, in Mekong 4 (M4), the impact on total household income change is 6.8, 12.4, and 17.9 percent, at low-, mean- and high-exposure respectively. In Mekong 6 (M6), the corresponding figures are 4.7, 9.7, and 15.2 percent. The estimated impact on the rate of growth of per capita and net income is also similar to the quadratic specification.

We next use our semi-parametric estimates to plot the overall shape of the function $g(\cdot)$. This reveals the different impact for households across all (relevant) catfish shares. The results are in Figure 5. Panel A) shows estimates for total income, Panel B) for per capita income, and Panel C) for net income. For each of these three income outcomes, the graph on the left is the estimate for the M4 sample while the one on the right refers to the M6 sample. Consistent with the estimates reported above, the shape of the function g is non-linear and well approximated by a quadratic model.

4.3 Discussion and False Experiments

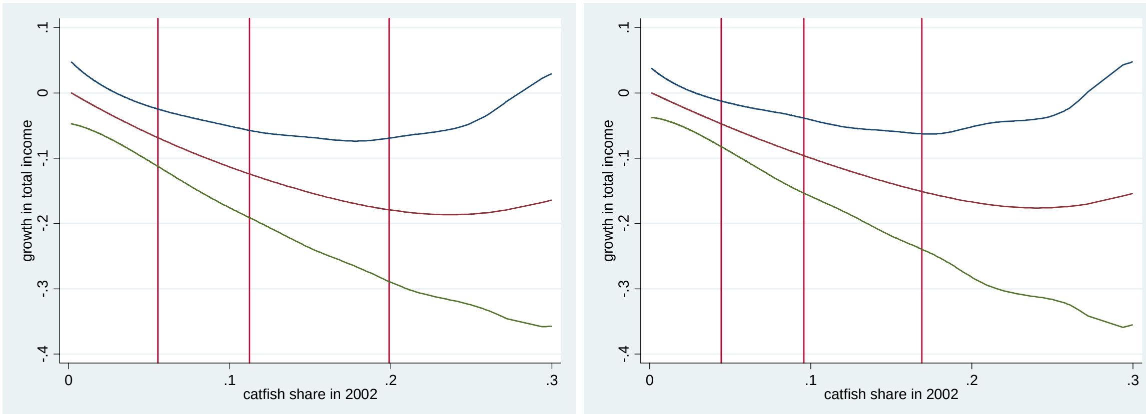
Our identification strategy assumes that, conditional on all other regressors, differences in the change of an outcome from 2002 to 2004 across households with different catfish income shares s_h^c can be attributed to a decrease in the price of catfish caused by the U.S. anti-dumping measures. The presence of household fixed effects and of a time trend will take care of most factors that could threaten this assumption. However, our strategy may be invalidated by the presence of other factors which could have affected in a systematically

[19] We estimate the partially linear model of Robinson (1988) with locally weighted non-parametric regressions. Since in this model the scale of the function $g(\cdot)$ cannot be recovered, we adopt the normalization $\lim_{s\to 0} g(s^c) = 0$, as in the quadratic specification. The standard errors are computed using the theoretical formulas reported in Pagan an Ullah (1999).

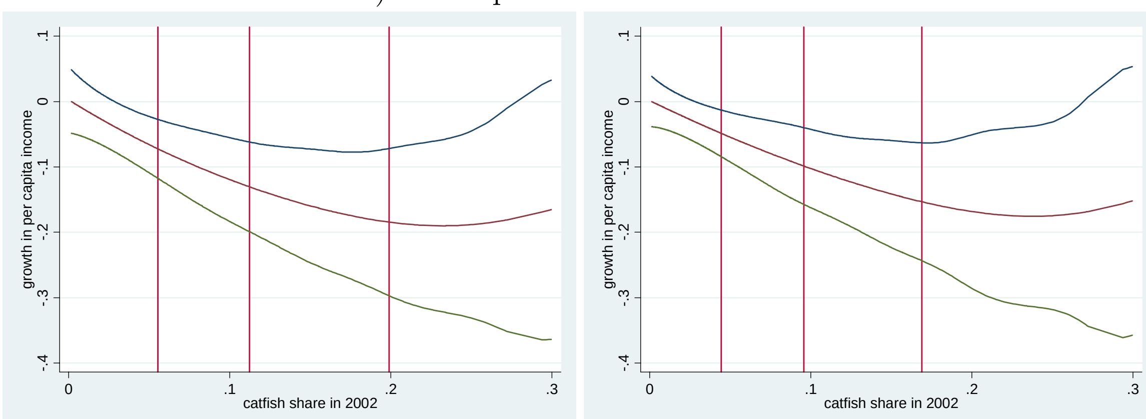
Figure 5

anti-dumping Impacts on Household Income

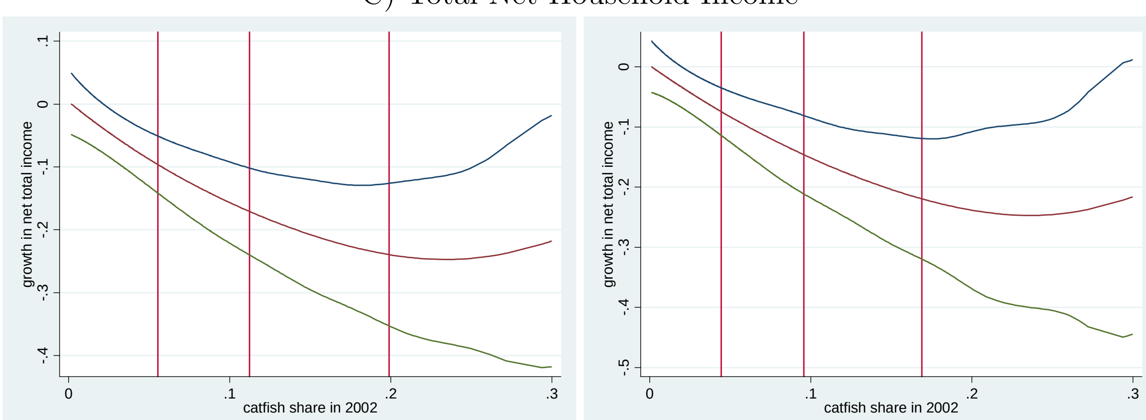
A) Total Household Income



B) Per Capita Household Income



C) Total Net Household Income



Note: Own calculations based on the panel of aquaculture households from the VHLSS (2002 and 2004). The estimates represent the relationship between the growth rate in total household income (panel A), per capita household income (panel B) and total net/disposable income (panel C) and the exposure to the U.S. anti-dumping shock (measured by the share of income derived from catfish) relative to a household with marginal exposure. The graphs on the left are estimated using the M4 sample (which includes the Mekong provinces of An Giang, Can Tho, Dong Thap and Vinh Long); the graph on the right uses instead the M6 sample (which adds Soc Trang and Tien Giang).

different way the livelihood of families relatively more involved in catfish production. One such factor is the outbreak of avian flu which hit the region in 2004. The outbreak led to large declines in the demand for poultry and to a corresponding significant increase in the demand for fish. This, however, is unlikely to be an important concern. While the initial outbreak of the avian flu in Vietnam took place in January 2004, it was an isolated episode while the epidemic only became sizeable after August 2004. Our data, instead, was collected in August 2004 with a recall period of one year, thus capturing data before the actual outbreak.

Additional evidence in support of our empirical strategy can be provided by performing a falsification experiment. If our identifying assumption holds, we should not observe any such impact for fishing households in non-Mekong regions. Based on the historical differences between North and South Vietnam pointed out before, the best candidates for this false experiment are the non-Mekong provinces of South Vietnam. We then estimate model (6) using the sample of fishing households in these areas, and using the same outcomes as in Table 5. The results, displayed in Table 6, show that in this sample, for all outcomes and for all levels of exposure, there is no evidence that the pre-AD shares are associated to the magnitude of the income change. Indeed all estimated coefficients are not only statistically not significant but also positive. We conclude that this falsification experiment helps validate our empirical strategy.

Even so, our estimates require to be further qualified. The estimates reflect the impact of the anti-dumping after allowing for different economy-wide responses to the shock. One important such response is trade deflection, that is, the shift of exports to other non-U.S. markets.[20] For Vietnamese catfish, trade deflection is hard to establish or to rule out, due to lack of data.[21] Some evidence is offered by COMEXT data on European Union imports, which indicate that imported quantities of tra and basa from Vietnam increased by 78 percent between 2002 and the first semester of 2004.[22] Another factor which may

[20]The empirical relevance of trade deflection in cases of anti-dumping is yet to be established. Bown and Crowley (2007a) find evidence of trade deflection in the case Japan; but Bown and Crowley (2007b) cannot find supporting evidence in the case of China.

[21]The Vietnamese government does not release export data on catfish, while publicly available data on COMTRADE is disaggregated up to the level of frozen fillets, but not specifically catfish.

[22]According to data released by the Vietnamese government, the European Union accounted for 29.6

have muted the negative impact of the U.S. tariffs is government policy. In July 2003, the Vietnamese ministry launched the Fund for Development of Aquaproduct Export Markets to support aquaproduct exporters of fish. Further, Agifish and other fish exporters launched a campaign to promote domestic consumption of *basa* and *tra* fish. Ultimately, these responses via trade deflection and government policy have likely dampened the impact of the price drop following the U.S. tariffs, so that our estimates can be seen as a lower bound for the direct impacts of the AD.

4.4 Household Adjustments: Exit from Catfish Farming

While households could adjust to the U.S. catfish anti-dumping in many different ways, here we only focus on patterns of adjustment in the generation of income. To begin, we first examine the dynamics out of catfish aquaculture by documenting whether households abandoned catfish farming, either partially or totally. In Table 4, we showed that the unconditional mean share of catfish in the M4 sample dropped from 11.2 percent in 2002 to 6.8 percent in 2004, a sharp decline of around 40 percent. The catfish income shares in the M6 sample dropped from 9.6 to 6.5, a smaller but still significant decline. Overall, there is evidence of a large decline in the share of income from raising catfish in the Mekong after the U.S. anti-dumping.

To investigate whether the pattern of switching out of aquaculture depends on the level of exposure, we run a regression model like (6) with catfish shares as the dependent variable (the right hand side of the model is the same as before). Results are in columns (1) and (2) of Table 7 for samples M4 and M6. We find a statistically significant decline in the share of catfish income at all levels of exposure. In M4, for instance, the drop in catfish income shares for low-exposure farmers is -0.018, which is equivalent to 33 percent of the low-exposure share in 2002 (5.5 percent). For the average farmer, the decline in shares is of 3.9 percentage points, roughly over 35 percent of the initial share in 2002 (11.2 percent). For a high-exposure farmer, the decline in shares is of 7.8 percentage points, which is equivalent to 39 percent of the share in 2002 (20 percent). Similar results are obtained in the M6

percent of Vietnamese catfish exports in 2004.

sample.

The estimated drop in catfish shares is consistent with switching out of aquaculture. But it may also be simply the consequence of the decline in catfish prices, regardless of whether households actually switched resources towards other economic activities.[23] To further explore the pattern of switching, we now study if the AD tariffs actually led to full exit from catfish production.

The data show substantial exit from fish farming. In the M4 sample, 145 of the 561 households involved in fish farming in 2002 have stopped the activity by 2004. This implies an exit rate of around 25 percent. Full exit is even stronger in sample M6. Out of 788 catfish farmers in the panel, 224 (almost 30 percent) fully abandoned fish farming. To explore if exit was related to the income shares from catfish, we estimate a model analogous to (6) but using, as dependent variable, a binary indicator that takes a value of 1 for farmers for whom $s_{h,2004}$=0. We estimate the regression using a Linear Probability Model, and as before we only include households who were involved in fish farming in 2002. The results are in columns (3) and (4) of Table 7. The pattern of full exit is negatively related to the initial shares, that is, smaller farmers are more likely to abandon all catfish activities than larger farmers. For instance, in sample M4, the probability of exit of the median farmer is 23.4, while it is 19.3 percent for the average farmer and 14.7 percent for high-exposure farmers. Similar patterns emerge in M6. Overall, these findings are consistent with a scenario in which it is easier for farmers who are relatively less involved in catfish farming to exit, even though exit is also observed among households with large values of s_h.

Given this decline in catfish shares, we now look at the changes in income shares from other economic activities among catfish households in our sample. We are interested in the response of other aquaculture activities and other major activities such as agriculture and wage labor (see Table 4 in section 3). For this purpose, we estimate model (6) using changes in different income shares as the dependent variable. While part of the estimated adjustment is just a mechanical response of the computation of the shares (if the share of catfish declines, then other shares will necessarily increase), the analysis can reveal interesting compositional

[23]In addition, if income shares follow a stationary time series process, then the sign of the estimated coefficients is mechanically negative.

changes in income shares.

We report the results in Table 8. The response of the share of income from other aquaculture activities is negative at all levels of exposure, but it is never statistically significant and it is always very small (columns 1 and 2). This is perhaps not surprising, given that in both M4 and M6, as documented in section 3, fishing activities involve almost exclusively freshwater aquaculture, while the opportunities to switch to shrimp, mollusks, and in general brackish or marine aquaculture, are very limited. The results in columns (3) and (4) indicate that the combined response of wage labor and agricultural activities (including both marketing and home-consumption) is positive and statistically significant at all levels of exposure. Also, note that the estimated adjustment in these income shares closely matches the drop in catfish shares of Table 7. In columns (5) and (6), we consider adjustment only towards purely market activities like wage labor and sales of agriculture produce. Here, our results show that only medium- to high-exposure farmers are able to adjust to the market. Smaller farmers tend to retreat more into agriculture for home consumption.

4.5 Adjustment Costs and Spillovers

We now explore whether the data reveal patterns of household behavior that are consistent with the existence of adjustment costs and spillovers, as illustrated in Figure 3. We begin by assessing the response of fishing income: we estimate model (6) using the change in (log) fishing income as the dependent variable. Results are in columns (1) and (2) of Table 9. The anti-dumping had a large impact on fish income at all levels of exposure and especially for high-exposed farmers. For instance, catfish income suffered a relative drop of 36.7 percent for the median farmer in M4, 57.7 percent for the average farmer, and 74 percent for the high-exposed farmer (the impacts in M6 are 33.8, 56.6 and 73.8 percent respectively).[24]

We can use the estimated changes in catfish income to predict the magnitude of the implied change in household income if all other sources of income remained unchanged (that is, if there were no adjustment costs in production or spillovers to other household economic activities). Let total income y_h be the sum of catfish income y_h^c and other incomes y_h^o so

[24]See Appendix 2 for a discussion of the changes in sample sizes in the regressions reported in this section.

that, keeping y_h^o constant, $d \ln y_h = s_h^c d \ln y_h^c$. By multiplying the estimated changes in catfish income in columns (1) and (2) of Table 9 by the pre-shock catfish shares, we get potential relative losses in total income y_h of 2.0, 6.5 and 14.8 percent for low-, average- and high-exposure farmers. These magnitudes are substantially smaller than the estimated relative losses in total income from Table 5 (equal to 6.2, 11.3, and 16.9 percent for the three levels of exposure). These differences can only be accounted for by changes in other sources of income that are also induced by the AD shock. We test this in columns (3) and (4) of Table 9. We run our standard regression (model (6)) with the log of total income, net of catfish income, as the dependent variable. We confirm that the AD shock caused relative declines in the rate of growth of non-catfish income equal to 8.7 percent, 14.5 percent and 18.5 percent for low-, average-, and high-exposure catfish farmers. These estimated impacts on non-catfish income caused by the AD provide additional evidence consistent with adjustment costs and intrahousehold spillovers.

To further explore this result, we now ask which non-catfish sources of income were most likely affected by the AD shock. We examine the two major sources of non-catfish income among Mekong farmers revealed in Table 4: agriculture and wage income, and other sources of income. The results in columns (5) and (6) show no differential impact on wages and agriculture income across exposure levels: all our estimates are positive but not statistically significant. Instead, in columns (7) and (8), we observe a relative decline in the other sources of income. This suggests that while households managed to maintain the income derived from wages and agriculture, they suffered additional relative income losses in other occupations (like livestock or farm services).[25]

Additional support for the existence of spillovers into activities different from fish farming can be derived from inspecting the impact of the AD shock on input choices, both in aquaculture and in non-aquaculture activities. Results are in Table 10. First, in columns (1) and (2), we see that investment in catfish aquaculture (that is, all type of expenditures in catfish activities like breeds, fish food, materials, repairs and maintenance and depreciation

[25] Notice also that the induced increase in the share of income derived from wages and agriculture (reported in Table 8) is due more to a relative decline in income from other sources than to a relative increase in income from wage labor and agriculture.

of fixed assets) suffered significant declines, from 28.3 percent for low-exposure farmers, to 46.4 percent for the average farmer, and to 61.9 percent for high-exposure farmers. The AD shock seemed to have caused households to heavily disinvest in catfish farming, a finding that is consistent with the large relative drop in catfish income reported above. Second, in columns (3) and (4), we see that hours worked for wages did not change. The results in columns (5) and (6) show instead that households more exposed to the shock increased significantly investment in agriculture relative to households only marginally involved in catfish farming. Finally, the last two columns of Table 10 confirm that total non-agricultural investment suffered relative declines.

It should be noted that there are differences in the samples used in different regressions within this section. This is because not all households in the core sample (i.e., the pre-shock aquaculture producers in 2002) report positive amounts for all the dependent variables analyzed in this section. An obvious example is fish income, which is not reported by pre-shock producers who abandoned the market the market before 2004. The differences in sample sizes raise concerns that our inferences from Tables 9 and 10 could be based on potentially non-comparable samples. In the Appendix we carry out a series of robustness checks and we argue that the results are not driven by different samples used in the regressions.

Overall, our results describe a household behavior that is consistent with both adjustments to trade policy (via choice of economic activities, and investment in aquaculture) and with spillovers from the activities directly affected by those policies to other household activities (via adjustments in input choices in non-aquaculture activities or in labor supply).

5 Conclusions

Following an anti-dumping lawsuit, the United States imposed tariffs on imports of catfish from Vietnam ranging from 37 to 64 percent. These tariffs led to sharp declines in Vietnamese exports of catfish to the U.S. market. Catfish constitutes an important source of income for thousands of households in the Mekong delta of South Vietnam. Using a panel data of

Vietnamese households, we explore the responses of those catfish producers between 2002 and 2004. We find that, over this period, the rate of growth of income was significantly lower among households relatively more involved in catfish farming in 2002. In addition, the anti-dumping shock triggered significant exit from catfish farming. Households adjusted by moving out of catfish aquaculture and into wage labor markets and agriculture but not into other aquaculture activities.

An important feature of our work is that we highlight the existence of adjustments costs in production and of spillovers of the anti-dumping measures into non-catfish household economic activities. First, there is evidence that households abandoned catfish farming and retreated into wage labor and agriculture. Second, households more involved in catfish farming suffered not only relative declines in aquaculture income, but also experienced relatively row rates of growth in non-catfish income, thus suggesting spillovers. Third, while households managed to maintain income from wage labor and agriculture relatively constant, they suffered relative losses in other sources of income (like livestock, silviculture or farm services)—further evidence of spillovers. Finally, households more exposed to the anti-dumping measure saw smaller rates of growth in investment in both catfish and aggregate non-catfish farming, while maintaining hours worked for wages relatively constant and increasing substantially agricultural investment.

Overall, our results make clear that trade policies such as these anti-dumping duties can affect households involved in the economic activities targeted by the interventions in complex ways. For instance, household can adjust to the intervention and, in the process, can incur adjustments costs and face intrahousehold spillovers. Neglecting these adjustments can bias the assessment of trade interventions.

Appendix 1: Definition of Variables

In this Appendix, we briefly describe the main variables used in the text, with an emphasis on the measurement of the different dependent variables.

1. Table 5:

Total household income: the sum of all sources of income (for home consumption and for sale) from the income modules of the VHLSS, including wages and salaries, agricultural production, livestock, farm services, silviculture, aquaculture, hunting, non-farm activities, and transfers.

Per capita household income: total household income per household member.

Net household income: total household income net of expenditures in inputs used in farm activities (seeds, maintenance, hired labor, depreciation) like agriculture, aquaculture, farm services, silviculture, hunting, and livestock.

2. Table 7:

   Probability of exit: dichotomous indicator equal to 1 if a farmer producing catfish in 2002 fully abandoned catfish farming in 2004.

3. Table 8

   Other aquaculture income: all other sources of income from aquaculture except catfish (shrimp, mollusks, marine aquaculture).

   Income from wages and agriculture: the sum of income from these two activities, including own consumption of agriculture and sales of agricultural output.

   Income from wages and agriculture sales: the sum of income from these two activities, only including the sales of agricultural output (and thus excluding own consumption).

4. Table 10

   Catfish investment: expenditures in catfish activities, including breeds, fish feed, non-durable items, energy and fuel, small repairs and maintenance, depreciations, rent of land, rent of machinery, hired labor, veterinary services, and interests.

   Hours worked off-farm: total number of hours of all household members out of the farm (for a wage or salary). Only reported by those members that earned wage income. Each household member reports his/her hours worked in "the most time consuming activity among wage/salary activities." Since the "industry" categories are aggregates (for instance, all agriculture in condensed into only one code), the measure used in the regression is the total number of hours worked by all members (so that sample sizes become large enough for regression analysis).

Appendix 2: Robustness to Different Samples

In most of the regressions reported in section 4.5, sample sizes change. This is because not all households in the core sample (i.e., the pre-shock aquaculture producers in 2002) report positive numbers for all the variables analyzed. An obvious example is fish income, which is not reported by pre-shock producers that exited the market in 2004. These differences in sample sizes raise concerns that our inferences from Tables 9 and 10 are based on potentially non-comparable samples. We therefore re-estimate the model for changes in income (total, per capita, and net) for the various (selected) sample sizes in Tables 9 and 10 and we compare the results with those for the core sample (from Table 5). If these results are similar across samples, then we can claim that our inferences based on the selected samples are unlikely to be driven by the differences among the samples. After performing this exercise, we find in general that the impacts on total income, per capita income and net income are indeed similar for all alternative samples. As an example, we report the results for total income, net of input purchases, in Table 11, for samples varying by sources of income, and Table 12, for samples reporting various input purchases. Clearly, the impacts on income are very similar across samples, perhaps with the exception of the sample of household reporting income from "wages and agriculture," for which the impacts appear to be somewhat weaker.

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Table 1
Vietnam Aquaculture: Main Species by Region

Region	Freshwater Aquaculture (share 2002)	Main Species	
		Freshwater	Brackish & Marine
Mekong	48.2	tra, basa (catfish) Common carp, tilapia, barb	shrimp crabs, mollusks
South East	33.7	common carp	shrimp, mollusks, lobster grouper, cobia
South Central	15.7	common carp, grass carp snakeheads	shrimp mollusks, pearls, mussels, scallops grouper, cobia lobster
North East	59.6	common carp	grouper, cobia shrimp, mollusks pearls oysters, seaweed
Red River	73.9	Chinese and Indian carp	—
North Central	66.4	Chinese and Indian carp	shrimp seaweed, clams, bivalves grouper, cobia, red drum

Note: The table documents the main fish species produced in Vietnam, by region, based on information in World Bank (2005). The share of freshwater aquaculture by region in 2002 is from the Ministry of Fishing, Vietnam (`www.fistenet.gov.vn`).

Table 2
Vietnam Aquaculture by Province in the Mekong

Province	Share in 2002			Share in 2003			Catfish Production
	Freshwater	Brackish & Marine		Freshwater	Brackish & Marine		
		total	shrimp		total	shrimp	2003
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Long An	76.7	23.3	19.7	69.2	30.8	28.1	–
Dong Thap	100.0	0.0	1.8	100.0	0.0	1.5	15.8
An Giang	100.0	0.0	0.3	100.0	0.0	0.3	40.2
Tien Giang	38.9	61.1	6.4	43.0	57.0	9.3	6.4
Vinh Long	100.0	0.0	0.7	100.0	0.0	0.3	7.4
Ben Tre	7.6	92.4	16.2	13.5	86.5	20.7	–
Kien Giang	33.2	66.8	45.9	28.3	71.7	49.3	–
Can Tho	100.0	0.0	0.3	100.0	0.0	0.2	35.5
Tra Vinh	48.9	51.1	13.1	49.5	50.5	19.9	–
Soc Trang	29.3	70.7	67.4	29.6	70.4	69.0	3.1
Bac Lieu	2.2	97.8	76.4	0.8	99.2	76.3	–
Ca Mau	6.4	93.6	68.6	7.3	92.7	67.6	–

Source: Ministry of Fisheries (`www.fistenet.gov.vn`) and Seafood from Vietnam Magazine (`www.seafoodfromvietnam.com.vn`). For 2002 and 2003, the figures show the shares of total aquaculture production from freshwater, brackish & marine, and shrimp aquaculture. The last column reports the fraction of total catfish (tra and basa) production from each province in the Mekong region, calculated from data on total production as well as production by province. Provinces for which the fraction is not reported account for 1.6 percent of total production in the Mekong region.

Table 3
Vietnam Household Living Standards Survey: Panel Sample
Average Annual Household Income
(in thousand Vietnamese Dong & PPP U.S. dollars)

	Fishing Households		Rural Households		All Households	
	2002	2004	2002	2004	2002	2004
Mekong 4 (M4)						
observations	561	561	334	334	1113	1113
total income	3537	4224	2769	3507	3278	3883
in PPP U$S	1247	1489	976	1237	1156	1352
Mekong 6 (M6)						
observations	788	788	614	614	1706	1706
per capita income	3544	4281	2856	3598	3262	3881
in PPP U$S	1250	1509	1007	1269	1150	1368
South Vietnam (non-Mekong)						
observations	929	929	3560	3560	6127	6127
per capita income	3711	4107	3038	3736	3253	3873
in PPP U$S	1309	1448	1071	1317	1147	1366

Note: Own calculations based on the panel sample of the Vietnam Household Living Standard Surveys, 2002 and 2004. Mekong 4 (M4) and Mekong 6 (M6) refer to two sets of Mekong provinces that specialize in catfish production: M4 includes An Giang, Can Tho, Dong Thap and Vinh Long, and M6 adds Soc Trang and Tien Giang.

Table 4
Vietnam Household Living Standards Survey
Sources of Income
Panel Sample

	Mekong 4 (M4)		Mekong 6 (M6)	
	2002	2004	2002	2004
Catfish	11.2	6.8	9.6	6.5
Other Aquaculture	1.0	1.0	1.2	1.3
Wages	26.7	28.1	25.7	27.4
Agriculture	42.5	43.2	44.3	43.4
sales	33.5	33.2	35.6	34.5
own	9.0	10.1	8.7	8.9
Livestock	9.5	10.4	10.6	11.6
Sylviculture	0.6	0.6	0.6	0.5
Farm Services	0.7	0.6	0.7	0.6
Other	7.8	9.3	7.4	8.8

Note: Own calculations based on the panel sample of the Vietnam Household Living Standard Surveys, 2002 and 2004. Mekong 4 (M4) and Mekong 6 (M6) refer to two sets of Mekong provinces that specialize in catfish production: M4 includes An Giang, Can Tho, Dong Thap and Vinh Long, and M6 adds Soc Trang and Tien Giang.

Table 5
Average Impact of Anti-Dumping on Income
Mekong Provinces

	Total Income		Per Capita Income		Net Income	
	M4	M6	M4	M6	M4	M8
	(1)	(2)	(3)	(4)	(5)	(6)
A) Quadratic Model						
Low Exposure	-0.062^{**}	-0.047^{**}	-0.064^{**}	-0.048^{**}	-0.081^{***}	-0.062^{***}
($s^c = 0.055$)	(0.031)	(0.022)	(0.030)	(0.022)	(0.030)	(0.021)
Mean Exposure	-0.113^{**}	-0.091^{**}	-0.117^{**}	-0.094^{**}	-0.147^{***}	-0.120^{***}
($s^c = 0.112$)	(0.054)	(0.042)	(0.053)	(0.041)	(0.052)	(0.040)
High Exposure	-0.169^{**}	-0.139^{**}	-0.176^{**}	-0.143^{**}	-0.217^{***}	-0.183^{***}
($s^c = 0.200$)	(0.078)	(0.062)	(0.077)	(0.061)	(0.074)	(0.059)
Observations	561	788	561	788	561	788
R^2 (within)	0.162	0.194	0.155	0.190	0.158	0.188
B) Partially Linear Model						
Low Exposure	-0.068^{***}	-0.047^{***}	-0.072^{***}	-0.049^{***}	-0.096^{***}	-0.074^{***}
($s^c = 0.055$)	(0.022)	(0.018)	(0.023)	(0.018)	(0.023)	(0.020)
Mean Exposure	-0.124^{***}	-0.097^{***}	-0.131^{***}	-0.099^{***}	-0.171^{***}	-0.147^{***}
($s^c = 0.112$)	(0.034)	(0.029)	(0.035)	(0.030)	(0.035)	(0.033)
High Eaxposure	-0.179^{***}	-0.152^{***}	-0.184^{***}	-0.154^{***}	-0.239^{***}	-0.220^{***}
($s^c = 0.200$)	(0.056)	(0.045)	(0.057)	(0.046)	(0.058)	(0.051)
Observations	561	788	561	788	561	788

Note: Estimates of a growth equation for total household income (columns 1 and 2), per capita household income (columns 3 and 4), and net income (columns 5 and 6). Panel A) reports results from the quadratic model at three different levels of exposure measured by the pre-shock fish shares: the median (low exposure), the mean (average exposure), and the median share for farmers with shares above the mean (high exposure). Panel B) reports results from a partially linear model. Mekong 4 (M4) and Mekong 6 (M6) refer to two sets of Mekong provinces that specialize in catfish production: M4 includes An Giang, Can Tho, Dong Thap and Vinh Long, and M6 adds Soc Trang and Tien Giang.
Robust standard errors within parenthesis: $*$, $**$, $***$, significant at 10%, 5%, and 1% level, respectively.

Table 6
False Experiments
Average Impact of Anti-Dumping on Income
non-Mekong South Provinces

	Total Income (1)	Per capita Income (2)	Net Income (3)
Low-Exposure	0.009	0.010	0.034
	(0.026)	(0.026)	(0.024)
Mean	0.032	0.035	0.117
	(0.086)	(0.084)	(0.081)
High-exposure	0.071	0.077	0.233
	(0.157)	(0.154)	(0.157)
Observations	384	384	384
R^2 (within)	0.331	0.306	0.315

Note: Estimates of a growth equation for total household income (column 1), per capita household income (column 2), and net income (column 3). Results from the quadratic model at three different levels of exposure measured by the pre-shock catfish shares: the median (low exposure), the mean (average exposure), and the median share for farmers with shares above the mean (high exposure). The false experiments are run on the sample of fishing households in non-Mekong South Vietnam.
Robust standard errors within parenthesis.

Table 7
Catfish Income Shares and Exit
Mekong Provinces

	Changes in Catfish Shares (all farmers)		Prob of Exit (all farmers)	
	M4	M6	M4	M6
	(1)	(2)	(3)	(4)
Low-Exposure	-0.018^{**}	-0.017^{***}	0.234^{***}	0.292^{***}
	(0.008)	(0.006)	(0.069)	(0.051)
Mean	-0.039^{***}	-0.038^{***}	0.193^{***}	0.237^{***}
	(0.014)	(0.012)	(0.074)	(0.055)
High-exposure	-0.078^{***}	-0.072^{***}	0.147^{*}	0.172^{***}
	(0.022)	(0.018)	(0.080)	(0.063)
Observations	561	788	561	788
R^2 (within)	0.457	0.384	0.292	0.314

Note: Estimates of dynamics out of catfish farming. Columns (1) and (2) refer to the changes in the share of catfish income for all farmers (staying or exiting). Columns (3) and (4) use a discrete indicator of exit equal to 1 if a catfish producer in 2002 fully left catfish farming in 2004. Mekong 4 (M4) and Mekong 6 (M6) refer to two sets of Mekong provinces that specialize in catfish production: M4 includes An Giang, Can Tho, Dong Thap and Vinh Long, and M6 adds Soc Trang and Tien Giang.
Robust standard errors within parenthesis: $*$, $**$, $***$, significant at 10%, 5%, and 1% level, respectively.

Table 8
Average Impact of Anti-Dumping on Income Shares
Mekong Provinces

	Other Aquaculture		Wages and Agriculture		Wages and Agriculture Sales	
	M4 (1)	M6 (2)	M4 (3)	M6 (4)	M4 (5)	M6 (6)
Low-Exposure	−0.004	−0.004	0.023**	0.024**	0.019	0.019**
	(0.003)	(0.003)	(0.012)	(0.008)	(0.012)	(0.009)
Mean	−0.008	−0.009	0.048**	0.053**	0.041*	0.042**
	(0.005)	(0.006)	(0.021)	(0.017)	(0.022)	(0.017)
High-exposure	−0.012	−0.013	0.090***	0.094***	0.078**	0.076**
	(0.008)	(0.009)	(0.033)	(0.027)	(0.034)	(0.027)
Observations	561	788	561	788	561	788
R^2 (within)	0.030	0.023	0.130	0.115	0.112	0.094

Note: Estimates of income shares for other aquaculture, wages and agricultural income, and wages and agricultural sales. Mekong 4 (M4) and Mekong 6 (M6) refer to two sets of Mekong provinces that specialize in catfish production: M4 includes An Giang, Can Tho, Dong Thap and Vinh Long, and M6 adds Soc Trang and Tien Giang.
Robust standard errors within parenthesis: ∗, ∗∗, ∗ ∗ ∗, significant at 10%, 5%, and 1% level, respectively.

Table 9
Average Impact of Anti-Dumping on Income Sources
Mekong Provinces

	Catfish Income		Non-Catfish Income		Wages and Agriculture		Other Income	
	M4	M6	M4	M6	M4	M6	M4	M6
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Low-Exposure	-0.367^{***}	-0.338^{***}	-0.087^{**}	-0.062^{**}	0.005	0.015	-0.129^{*}	-0.130^{**}
	(0.042)	(0.090)	(0.035)	(0.025)	(0.028)	(0.021)	(0.071)	(0.052)
Mean	-0.577^{***}	-0.556^{***}	-0.145^{**}	-0.112^{**}	0.021	0.041	-0.223^{*}	-0.241^{***}
	(0.051)	(0.039)	(0.062)	(0.048)	(0.052)	(0.043)	(0.120)	(0.092)
High-exposure	-0.740^{***}	-0.736^{***}	-0.185^{**}	-0.148^{**}	0.070	0.094	-0.313^{*}	-0.345^{***}
	(0.047)	(0.037)	(0.090)	(0.072)	(0.083)	(0.070)	(0.165)	(0.125)
Observations	416	564	560	787	532	753	521	730
R^2 (within)	0.202	0.203	0.228	0.248	0.282	0.264	0.035	0.039

Note: Estimates of income sources: catfish income, non-catfish income, wages and agriculture, other sources of income (livestock, silviculture, farm services). Mekong 4 (M4) and Mekong 6 (M6) refer to two sets of Mekong provinces that specialize in catfish production: M4 includes An Giang, Can Tho, Dong Thap and Vinh Long, and M6 adds Soc Trang and Tien Giang.
Robust standard errors within parenthesis: $*$, $**$, $***$, significant at 10%, 5%, and 1% level, respectively.

Table 10
Average Impact of Anti-Dumping on Inputs
Mekong Provinces

	Catfish Investment		Hours Worked Off-Farm		Agriculture Investment		Non-Agriculture Investment	
	M4	M6	M4	M6	M4	M6	M4	M6
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Low-Exposure	-0.283^{***}	-0.248^{***}	-0.006	-0.018	0.105^{*}	0.097^{**}	-0.277^{***}	-0.265^{***}
	(0.058)	(0.045)	(0.032)	(0.023)	(0.065)	(0.048)	(0.063)	(0.046)
Mean	-0.464^{***}	-0.436^{***}	-0.014	-0.038	0.219^{*}	0.213^{**}	-0.456^{***}	-0.462^{***}
	(0.080)	(0.068)	(0.060)	(0.046)	(0.132)	(0.104)	(0.088)	(0.088)
High-exposure	-0.619^{***}	-0.595^{***}	-0.028	-0.065	0.400^{*}	0.385^{**}	-0.613^{***}	-0.623^{***}
	(0.086)	(0.076)	(0.093)	(0.072)	(0.224)	(0.182)	(0.096)	(0.074)
Observations	411	548	560	785	399	583	460	636
R^2 (within)	0.105	0.117	0.175	0.157	0.100	0.073	0.104	0.139

Note: Estimates of input choices: investment in catfish, hours worked off-farm, investment in agriculture, and investment in non-agriculture activities (livestock, farm services, etc.). Mekong 4 (M4) and Mekong 6 (M6) refer to two sets of Mekong provinces that specialize in catfish production: M4 includes An Giang, Can Tho, Dong Thap and Vinh Long, and M6 adds Soc Trang and Tien Giang.
Robust standard errors within parenthesis: $*$, $**$, $***$, significant at 10%, 5%, and 1% level, respectively.

Table 11
Impacts on Net Income
Alternative Samples

	Catfish Income		Non-Catfish Income		Wages and Agriculture		Other Income	
	M4	M6	M4	M6	M4	M6	M4	M6
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Low-Exposure	-0.071^{**}	-0.056^{**}	-0.084^{***}	-0.064^{***}	-0.046^{*}	-0.040^{**}	-0.095^{***}	-0.077^{***}
	(0.032)	(0.023)	(0.030)	(0.021)	(0.025)	(0.018)	(0.032)	(0.022)
Mean	-0.131^{**}	-0.110^{**}	-0.151^{***}	-0.124^{***}	-0.085^{**}	-0.078^{**}	-0.169^{***}	-0.148^{***}
	(0.055)	(0.043)	(0.052)	(0.040)	(0.044)	(0.035)	(0.053)	(0.041)
High-exposure	-0.197^{***}	-0.168^{***}	-0.222^{***}	-0.187^{***}	-0.130^{**}	-0.120^{**}	-0.245^{***}	-0.221^{***}
	(0.077)	(0.064)	(0.074)	(0.059)	(0.063)	(0.052)	(0.075)	(0.059)
Observations	416	564	560	787	532	753	521	730
R^2 (within)	0.239	0.264	0.159	0.189	0.262	0.271	0.166	0.200

Note: Estimates of income sources: catfish income, non-catfish income, wages and agriculture, other sources of income (livestock, silviculture, farm services). Mekong 4 (M4) and Mekong 6 (M6) refer to two sets of Mekong provinces that specialize in catfish production: M4 includes An Giang, Can Tho, Dong Thap and Vinh Long, and M6 adds Soc Trang and Tien Giang.
Robust standard errors within parenthesis: $*$, $**$, $***$, significant at 10%, 5%, and 1% level, respectively.

Table 12
Impacts on Net Income
Alternative Samples

	Catfish Investment		Hours Worked Off-Farm		Agriculture Investment		Non-Agriculture Investment	
	M4	M6	M4	M6	M4	M6	M4	M6
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Low-Exposure	−0.065**	−0.059**	−0.081***	−0.062***	−0.068**	−0.053**	−0.082***	−0.067***
	(0.033)	(0.025)	(0.030)	(0.021)	(0.033)	(0.024)	(0.031)	(0.022)
Mean	−0.120**	−0.114**	−0.146***	−0.122***	−0.122**	−0.102**	−0.149***	−0.130***
	(0.056)	(0.047)	(0.052)	(0.040)	(0.057)	(0.044)	(0.053)	(0.041)
High-exposure	−0.182**	−0.175***	−0.216***	−0.185***	−0.178**	−0.152**	−0.222***	−0.197***
	(0.079)	(0.067)	(0.074)	(0.059)	(0.080)	(0.065)	(0.073)	(0.059)
Observations	411	548	560	785	399	583	460	636
R^2 (within)	0.230	0.254	0.159	0.189	0.315	0.320	0.236	0.257

Note: Estimates of input choices: investment in catfish, hours worked off-farm, investment in agriculture, and investment in non-agriculture activities (livestock, farm services, etc.). Mekong 4 (M4) and Mekong 6 (M6) refer to two sets of Mekong provinces that specialize in catfish production: M4 includes An Giang, Can Tho, Dong Thap and Vinh Long, and M6 adds Soc Trang and Tien Giang.
Robust standard errors within parenthesis: $*$, $**$, $* * *$, significant at 10%, 5%, and 1% level, respectively.