The Large Consequences of a Small Shock*

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Abstract

We exploit a small, transitory and sector-specific shock in Thailand and find that it has large, heterogeneous and long-lasting effects by inducing permanent *sectoral reallocation*. Such temporary and negative demand shock pushes out permanently the worst sorted and less wealthy, turning into a "gift" to the stayers, who gain larger income and market power after the shock. By looking at the education outcomes, however, we find that the shock is a "gift" to the education of the young in the leavers' family. We also provide evidence of causal *spillover* effects to the rest of the economy. Combining the EU ban on black tiger shrimp with detailed household data from the Townsend Thai Project, we investigate the resource reallocation within and across sectors, changes in sectoral productivity and welfare within Thailand. In future work, we will use these findings to inform a novel dynamic model of sectoral reallocation.

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1 Introduction

Sectoral reallocation is one of the main channels through which economic shocks can be smoothed out. The economic literature has mostly studied the costs and the welfare implications of changing sector in the short-run, for instance, due to an increase in import competition. Curiously, despite the large interest in this topic, little is known about how sectoral reallocation serves to propagate to the long-run, even small and temporary, shocks. In particular, what are consequences and the spillover effects of a small, transitory and sector-specific demand shock? Who benefits and gets hurt? And what are the implications for future generations?

Answering this set of questions has been a very challenging task for economists in different fields. The obstacles include, first, identifying a clean and isolated exogenous variation and, second, having data at granular level with a long-time horizon to study it. Recently, many advancement have been done to analyze the role of exogenous demand shocks on firms outcomes (e.g., Atkin et al. 2014, Giroud and Mueller 2015, Greenstone et al. 2014, Lee 2016, Tahbaz-Salehi et al. 2017). Most of these shocks are large enough to generate simultaneous aggregate consequences, which are hard to disentangle from the consequences of the shock itself and they do affect multiple sectors simultaneously. Also the literature on international trade has estimated the costs and the welfare consequences of sectoral reallocation due to a trade shock (e.g. Artuç et al. 2010). However, in the existing set-ups only permanent shocks might have long-lasting effects and there are no concerns on future generations. Such models might bias the current estimated of sectoral reallocation and the, therefore, welfare.

In this paper, we bridge this gap by using a temporary import ban as a natural experiment to evaluate the long term impact, not only of those directly affected, but also of the others indirectly exposed. Thailand has been a key producer in the global aquaculture market, in particular, for shrimp. Until 2002, Thailand was the largest exporter of black tiger shrimp, constituting about 49% of all marine product exports in Thailand at its peak in 2000. In May 2002, while regulations on health in the European Union (EU) were becoming stricter, machines were better, and under concerns that products from Asian countries contained antibiotics, EU banned the imports of black shrimp from Thailand. In September 2002, shrimp producers in Southern US started anti-damping measures. This led to increasing the restrictions on imported shrimp. The price of black tiger shrimp plummeted by more than 50% and their production in few years went close to zero.

This paper consists of 4 parts. In the first part we document three facts that suggest the strength of the import ban and we describe the data. We find that: (i) the production value of black shrimp fell precipitously, (ii) the input expenditure share of the farmers for black tiger shrimp overtime declined to zero after the ban was implemented, (iii) in the period before the ban was implemented, the sectoral reallocation rate of the shrimp/fish industry was similar to the ones of the other industry but after the ban, only 35% of the farmers and 36% of the entrepreneurs stayed in the fishing sector.

In the second part of the paper, we run an event study to quantify the effect of the ban. To do so, we use a difference-in-difference estimation using the Townsend Thai Monthly Survey data since they have a rich set of controls. We find that after the ban the share of income from shrimp declined on impact and kept declining substantially and never recovered even after controlling for observable demographics at the household and national levels. At the same time, the total income of households/farmers producing shrimp declined on impact, stayed lower than the income of the households in other sectors, and after 4-5 years went back to pre-ban level. This supports our descriptive findings that the ban force households to seek alternative outcome elsewhere through sectoral reallocation at a cost.

In order to confirm our hypothesis that the ban affected sectoral reallocation, we run the event study using the probability of switching sector as the dependent variable. Our results suggest that when the ban took place, the probability of switching sector for shrimp farmers is 14% higher than the ones for farmers in other sectors. Moreover, this effect increases over time, peaking in the third year after the ban, where it reaches almost 40%. After 11 years from the ban, the probability is still higher and equivalent to 30%, approximately. These findings strongly support our original hypothesis that a temporary demand shock may have a long lasting impact on the sectoral reallocation of the economy. We then look into mechanisms that might have pushed shrimp farmers to switch to other sectors. We find that after the ban, shrimp farmers sell more fixed assets, home fixed assets and agricultural assets but they accumulate business assets. Therefore, even when in 2004 the ban was over, it would be costly to move back to the shrimp's sector.

In the third part of the paper, we look at the spillover effects of the ban on non-shrimp farmers. In particular, we identify households that do not work in shrimp's production but are exposed to the shrimp farming since they live in the same villages. We compare these households to the ones that are not exposed to the ban. We find that the business and livestock income of these households drop of 50% for about 3 years. Moreover, we find that they sell livestock assets and they accumulate land assets.

In the fourth and last part of the paper, we look at the determinants and the long-term outcomes for those that stayed in the shrimp farming and those that left. Overall, we find that stayers, who were originally richer, were placed on a higher income profile than before after the ban was lifted. Leavers instead, despite the fact that they did not suffer the ban so much, did not have an increase in income by leaving the sector. When we look at the educational outcomes of the young members of the shrimp households. We find that young members in households that left the shrimp production had higher long term education than members of households that stayed. Therefore, the negative demand shock turned into a "gift" for the income of stayers but also into an intergenerational "gift" for the education of young leavers.

The remainder of the paper is organized as follows. Section 2 makes a brief summary of the literature to which this paper is connected. Section 3 covers the data and evidence of the shock. Section 4 analysis the impact of the shock on income and sectoral reallocation and investigates the mechanisms behind the permanent effect. Section 5 runs an event study to look at the spillover effects of the ban on non-shrimp farmers exposed to the shock. Section 6 looks into the determinants and the heterogeneous consequences of those that stayed and those that left the shrimp sector. Section 7 concludes with a brief summary and future directions.

2 Literature review

This paper relates to several strands of economics literature. It closely relates to the work on propagation and amplification of demand shocks. Tahbaz-Salehi et al. (2017) and Boehm et al. (2017) study the impact of the Japanese earthquake in 2005 and its propagation to the local and international economy, respectively. This work complements these two in several dimensions. First, we look at a very small shock in just one sector. This allows us to isolate one unique channel and avoid aggregate changes. Second, using the farmer microdata, we focus on the role of demand changes and structural transformation to see how the shock propagates to the economy. Third, we are able to look at the effect of the shock on the workers affected indirectly and find causal estimates of the spillover effects of it.

It also closely relates to recent studies using import ban as a source of exogenous variation. Etkes and Zimring (2015) study the welfare consequences of the blockade imposed on the Gaza Strip between mid-2007 and mid-2010. They find a substantial decrease in welfare due to resource reallocation and labor productivity. Other papers analyze historical episodes of autarky, such as Bernhofen and Brown (2005) who examine Japan's sudden shift to international trade in the 1850s, find an upper bound of 8% for gains through the channel of comparative advantage. Irwin (2005) explores the self-imposed "Jeffersonian Embargo" in the U.S. between December 1807 and March 1809, and concludes that losses from the embargo in the U.S. amounted to 5% of 1806 GDP. However, none of this paper focuses on the ban of a single product, especially from the largest producer. The closest paper to ours in this literature is Brambilla et al. (2012), which looks at a catfish import ban in Thailand and finds results consistent with ours when looking at income. This paper builds on top of it by looking at sectoral reallocation and heterogeneous effects by having a more detailed panel dataset.

A single product ban allows us to better isolate the effect of trade restriction on allocation devoted to that sector. In this way we can identify how firms, entrepreneurs, and workers in the affected sector respond to the exogenous shock. Our prediction is that a whole "embargo" may have different economic implications than a product ban. We think that while an embargo will almost surely impact welfare negatively, the import ban of a single product could actually have opposite results. If the ban was imposed on an inferior product, then producers may switch to products that may be more productive. In fact, this may induce producers to switch to sectors that are more productive. This speeds up the sectoral transition for an economy and increases aggregate productivity. Hence, the welfare implications may be quantitatively different or even have the opposite consequences than the ones of a national embargo. The black tiger shrimp import ban from the EU on Thailand offers a natural experiment to look at an exogenous demand decline for an export product. We can use standard models to predict the effect of demand shock on the economy given that physical capital, know-how and specific expertise will be lost. Our paper speaks also to the recent and growing literature on the impact of demand shock on firms outcomes using quasi-natural experiment settings. For instance, Atkin et al. (2014), Giroud and Mueller (2015) and Lee (2016) look at how changes in the demand affect productivity and employment outcomes. Also, there is a branch of the literature that looks at how changes in input prices, such as labor or capital, bring firms to shrink or expand (Chodorow-Reich 2014, Doran et al. 2014, Greenstone et al. 2014). None of these papers, however, focuses on the impact of a negative demand shock on sectoral reallocation.

Another branch of the literature this paper is related to is measuring the cost associated with sectoral reallocation. In particular, recent study from Walker (2013) studies the effect of environmental regulations on the cost of reallocating workers to other sectors. Other papers look at the short run costs associated with it and also unemployment consequences (Abraham and Medoff 1984, Gibbons and Katz 1991, Jacobson et al. 1993, von Wachter et al. 2011). In addition to cost associated to job losses, we also look at cost associated with sectoral reallocation from farmers and entrepreneurs.

3 Data and Evidence of The Shock

We mainly use the Townsend Thai Monthly Survey household level data. Several features of this dataset, such as the detailed amount of controls, make it ideal for our study. We also run some robustness tests with firm-entrepreneur data, which allow us to capture the short and long run impact of the demand shock in two different dimensions. This section presents a brief background on the survey and descriptive statistics of the variables we analyze. A more detailed description of the survey and additional descriptive statistics can be found in Samphantharak and Townsend (2013). The Townsend Thai Monthly Survey is an on-going monthly survey initiated in 1998 in 16 villages in four provinces of Thailand. Chachoengsao and Lopburi are semi-urban provinces in a more developed central region near the capital city, Bangkok. Buriram and Sisaket provinces, on the other hand, are rural and located in a less developed northeastern region by the border of Cambodia. In each of the four provinces, the survey is conducted in four villages. This monthly survey began with an initial village-wide census. Every structure and every household was enumerated and the defined household units were created based on sleeping and eating patterns. Further, all individuals, households, and residential structures in each of the 16 villages can be identified in subsequent, monthly responses. From the village-wide census, approximately 45 households in each village were randomly sampled to become survey respondents. The survey itself began in August 1998 with a baseline interview on initial conditions of sampled households. The monthly updates started in

September 1998 and track inputs, outputs, and changing conditions of the same households over time. In this paper, we use a total of 210 months starting from August 1998.

In our study we use a balanced panel of 482 households over 135 months (around 12 years) across 16 villages in 4 provinces. We define shrimp farmers as households whose main sector is shrimp farming.

While the Townsend Thai Monthly Survey gives us a perfect setting to study sectoral reallocation across households/farmers, it is not nationally representative and it does not allow us to look at larger firms rather than small farmers. Therefore, we use a unique source of data from Banternghansa (2016), which compiled a novel dataset on multi-firms entrepreneurs. This dataset contains a 13-digit identifier number, name, registration and exit information of all new registered firms in Thailand since 1999 and any surviving registered firms before 1999. There is a total of 1,292,322 firms and out of those, 61.5% are private limited. Banternghansa (2016) defines "entrepreneur" at the family level. This is because entrepreneurs, especially in developing countries, tend to operate in family firms and decision making is taken at the family level. This is suitable to our study and our analysis using Townsend Thai data is also at the family level. A more detailed explanation of the dataset and of the summary statistics of the variables can be found on Banternghansa (2016).

3.1 Evidence of the Ban in the Data

Figure 1 summarizes the effect of the ban on the value of shrimp productions. Between 2002 and 2006, the production value of black shrimp fell precipitously from 1500 million dollars to 44 million dollars, corresponding to about 50% decrease annually. In contrast, the production value of white shrimp went from 139 million dollars in 2002 to 2342 million dollars in 2012. It is clear that the ban created a huge and lasting effect on the shrimp industry, and it was not until 2009 that the value of white shrimp production finally reached the same value of black shrimp production in 1999 but the value of the black tiger Thai shrimp never recovered after the ban was lifted.

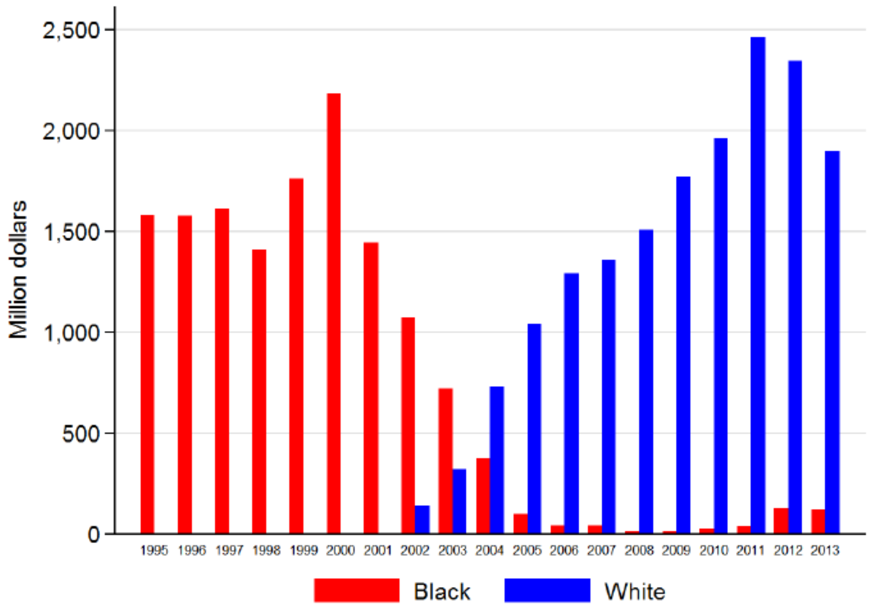
Second, in addition to the large time variation, we also document cross-sectional variation at the provincial-level. The data on shrimp farm at province-level is from the Department of Fisheries in Thailand. Figure 2 shows the change in value of shrimp production before and after the ban.[1] We see that while 11 provinces experience a decrease in value of production, about 13 experience an increase. Because the ban has differential impact on each province, we can exploit the cross-sectional variation in identifying the effect of the ban at the provincial level.[2]

Third, using household level dataset, we document that the input expenditure share of the farmers for black tiger shrimp overtime declined to zero after the ban was implemented. In addition, while input share of white shrimp started to pick up, it never reached the same levels as that of

[1]We compute the change by subtracting the mean value of production between 1999 to 2001 from the mean value of production between 2002 to 2012, which we then normalize to get a standard deviation of one.

[2]In future work, we plan to obtain municipality level data on shrimp farms which will provide us with more detailed spatial variation.

Figure 1: shrimp's Production Before and After the Import Ban

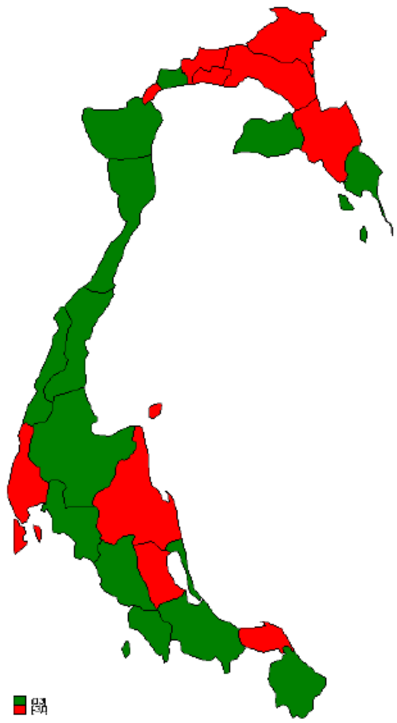


Note: The blue bars represent the value in million dollars of the production of black tiger shrimp. The red line represent the value of the white shrimp. Data drawn from the National Statistics.

the black tiger shrimp before the pre-ban period. Figure 3 plots the aggregate expenditure of black and white shrimp inputs from the household dataset around the time of the EU ban. The blue line is the polynomial fit of black shrimp as inputs used by households. Before the shock, aggregate expenditure of black shrimp was slightly below 10,000 dollars per month. After the ban, expenditure of black shrimp went virtually to zero. On the other hand, the expenditure of white shrimp as inputs, as illustrated by the smooth red line, started to increase after the EU ban of black shrimp took place. Thus, at the village level, households substitute from black to white shrimp, but at an expenditure level, households spend far smaller compared to the level before the ban. This supports our hypothesis that the black tiger import ban from the EU had a permanent effect on production even after the ban was lifted.

The three findings above show that the import ban, despite being a small shock, affected permanently the shrimp industry in Thailand after May 2002. The shock has a massive impact to the whole sector such that the entire production came to a halt and asymptotically went to 0. This setting provides us with a clean quasi-natural experiment and exogenous variation in time and space to look at the implication of the import ban on sectoral reallocation.

Figure 2: Change in value of shrimp production by province



Note: In red, we plot the area of the Thai provinces where the production of shrimp increased. In red, we plot the ones where the production decreased.

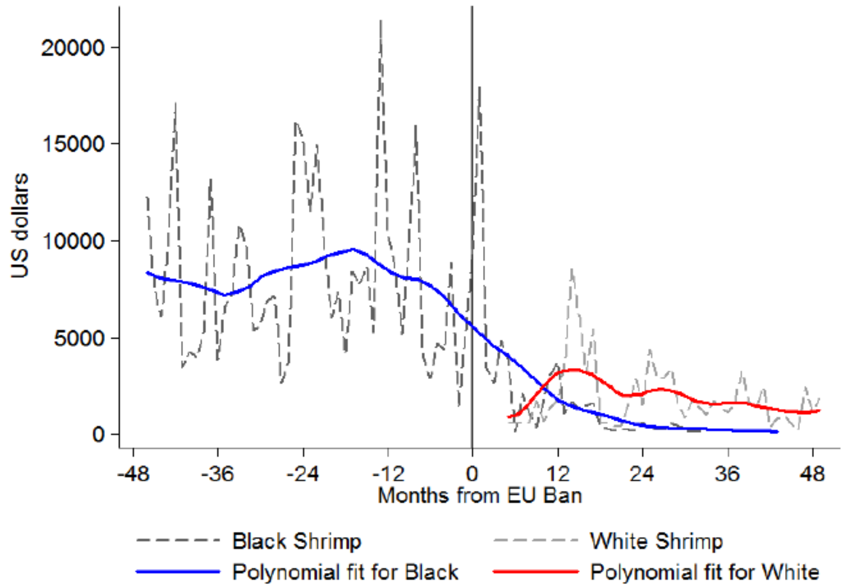
3.2 Sectoral Changes

We have documented that the EU ban has a large exogenous effect on the production of black, firms and provincial level. Based on this novel source of intertemporal and spatial variation, there is a wide range of outcomes variables we analyze in the rest of the paper. As a preliminary inquiry, we look at the sectoral transition of shrimp farmers and firms over time. First, we establish that the import ban has an impact on the effect on the sectoral reallocation both for farmers and entrepreneurs in the short and in the long run. Second, we run an event study in which we check whether, after controlling for observables, we find an impact of the import ban on sectoral reallocation for the farmers.[3]

In the Townsend Thai Monthly Survey household-level data, we define sector based on the share of net income in the periods before and after the ban. We observe that more than half of the shrimp farmers switch to other sectors. As shown in Table 1, there were 36 shrimp farmers between 1999 and March 2002. After the ban, between April 2002 and August 2006, there were only 15 shrimp farmers. This is a decrease of 58%. In Table **??**, we build the transition matrix to show in

[3]It would be very interesting to run the same level of study also for the firms, however, due to the lack of controls at the entrepreneur level, we focus only on farmers.

Figure 3: Expenditure on Shrimp inputs in Production



details the reallocation among sectors. We observe that households whose main sector was fish and shrimp switched out significantly. Among shrimp farmers before the ban, 28% went to cultivation, 11% opened up their own business, 22% went to supply labor and about 36% remained as fish and shrimp farmers, a similar transition probability compared to shrimp entrepreneurs. We note that the probability of staying as a shrimp/fish farmer is much smaller than staying in the other sectors. For instance, the probabilities of staying as cultivators, businessmen or labor workers are 80%, 70% and 62% respectively. The EU ban reduced the demand substantially and, as a result, explains why shrimp and fish farmers switched to other sectors at a much higher rate compared to other sectors.

As a placebo test, we construct the same transition matrix before the ban to capture potential trends. We report the results in table 3. We find that between 1999 and 2002, 71% of the farmers stayed in the fishing sectors. This number falls in the range of business (55%) and livestock (79%). This suggests that there was no trend that affected the outcome post-ban.

As an extra robustness test, we investigate the changes in sectors for households for which fishing was not their primary sector. In the Townsend Thai Monthly Survey, households are asked how much income they get from different sectors. In this way, we can rank their sectors from 1 to 5, where an sector is ranked with a 1 if it is the source of primary income, 2 if it is the secondary source, so on and so forth until 5. In table 4, we find that the difference between the rank of the shrimp's sector decreased significantly before and after the ban with a t-stat of -2.92. Instead, it stayed constant for cultivation, livestock and business. It only increased for labor supplied. Our finding suggests that the shrimp ban not only affected farmers whose main sector is aquaculture, but also on farmers whose incomes are derived from aquaculture.

Table 1: Main Sector Changes Before and After the Ban

Sector	Before ban (1999-03/2002)	After ban (04/2002-08/2006)	Change
Cultivation	234	266	14%
Livestock	37	33	-11%
Fish and Shrimp	36	15	**-58%**
Business	54	97	80%
Labor	254	204	-20%
Total number of household	615	615	

Table 2: Transition Matrix of main sectors for households

		After Ban (04/2002-08/2006)				
		Cultivation	Livestock	**Fish/Shrimp**	Business	Labor
Before Ban (1999 – 3/2002)	Cultivation	0.80	0.01	0.01	0.06	0.11
	Livestock	0.27	0.57	0.00	0.08	0.08
	Fish/Shrimp	0.28	0.03	**0.36**	0.11	0.22
	Business	0.09	0.04	0.00	0.70	0.17
	Labor	0.21	0.02	0.00	0.15	0.62

Table 3: Transition Matrix of main sectors for households before the Import Ban

		04/2002				
		Cultivation	Livestock	**Fish/Shrimp**	Business	Labor
(1999)	Cultivation	**0.89**	0.02	0.00	0.03	0.19
	Livestock	0.24	**0.79**	0.03	0.03	0.15
	Fish/Shrimp	0.42	0.09	**0.71**	0.03	0.09
	Business	0.22	0.10	0.06	**0.55**	0.16
	Labor	0.37	0.02	0.01	0.07	**0.78**

Table 4: Secondary Sectoral Changes Before and After the Ban

Average Sectoral Ranking (1=highest, 5=lowest)			
Sector	Before Ban (1999 – 3/2002)	After Ban (04/2002 – 08/2006)	t-stat of diff.
Cultivation	1.89	1.78	0.41
Livestock	3.47	3.56	-1.18
Fish/Shrimp	2.97	3.19	**-2.92**
Business	2.66	2.54	1.28
Labor	1.84	2.17	-5.26

Note: Sector is rank by the source of income, with rank 1 as the largest source of income and 5 as the smallest. If rank is increasing over time, it means that that source of income has become relatively less important.

4 Event Study I: Impact of the Ban and Channels

The analysis above provides descriptive evidence that the import ban had an effect both for entrepreneurs and households. However, to quantify the impact of the ban, in this section we run an event study using a difference-in-difference estimator (DD). In particular, we use the following specification

$$Y_{jt} = \sum_{k=-m}^{M} \beta_k \left[o_j^p \times 1(\tau_t = k) \right] + X_{jt} + \chi_j + g_t + \epsilon_{jt} \tag{1}$$

where j are the households and t are years.[4] o_j^p equals to one if the household's main Sector[5] was selling shrimp prior to the ban, and zero if the household's main sector was not in the shrimp business. The regression coefficient β_k is the reduced form impact of the ban on households at time k whose main sector was shrimp before the ban. X_{jt} are time-variant household characteristics which include cash-on-hand and net wealth in the previous period, family size, and the total number of jobs that household has. In other words, β_k(for $k \in [-m, M]$) delivers the event-study regression estimation corresponding to the differential paths of employment and income in the years before and after the ban took place. We also include time-invariant household characteristics, denote as χ_j. To capture aggregate shocks, we include the log income level of Thailand, denoted by g_t. ϵ_{jt} represents unobserved household $\times$ time shocks to outcomes and is assumed to be uncorrelated with the independent variables. Equation 1 serves as the benchmark econometric framework for the rest of the analysis. The data suited best for this analysis is from Townsend Thai Monthly Survey since they have a richer set of controls.

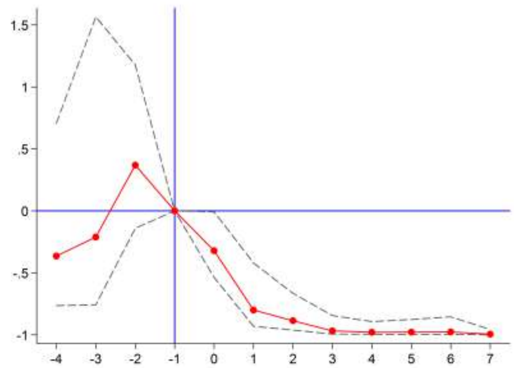
We run this specification for different dependent variables Y_{jt}. Specifically, Y_{jt} can be income level from shrimp business, share of income due to shrimp business, total income of the households and probability of switching sector. Figure 4 shows that household's income from fish and shrimp businesses shrink after the ban. On impact, the income from shrimp and fish fell by about 32%. Over time, the income from shrimp and fish fell to nearly 100% compare to the baseline year. Figure 5 shows the household's income due to shrimp and fish separately. As expected, the income share due to shrimp—shown in the left panel— decreased, from 15% on impact to about 60% after 7 years of the ban. However, we see that the income share due to fish—shown in the right panel of Figure 5— actually increase after the ban. The share of income due to fish rose to about 23% after 7 years. This suggests that even within the same business of fish and shrimp, there is substitution of product within the sector, albeit the overall income due to fish and shrimp decreases.

Next, we investigate whether the ban has an impact on the overall income of the household.

[4] Notice that the data are aggregated from monthly to yearly to avoid the volatility due to the seasonality of the products. This, however, came to the cost of power of the analysis.

[5] We define main sector if that sector is the largest source of income for that household prior to the ban. We use a total of 47 months (or almost 4 years) to calculate main sector. This way, we avoid monthly fluctuations in income when defining main sector before the ban.

Figure 4: Income from Fish and Shrimp business Before and After the Import Ban



Note: Plotted are the event-time coefficient estimates, where the dependent variable is the share of income from selling shrimp relative to total income from all business activities in a household × year. The first full year of the ban corresponds to year 0 in the graph. Coefficients are estimating using household level data from the Townsend Thai project. Standard errors are plotted at the 95% confidence interval.

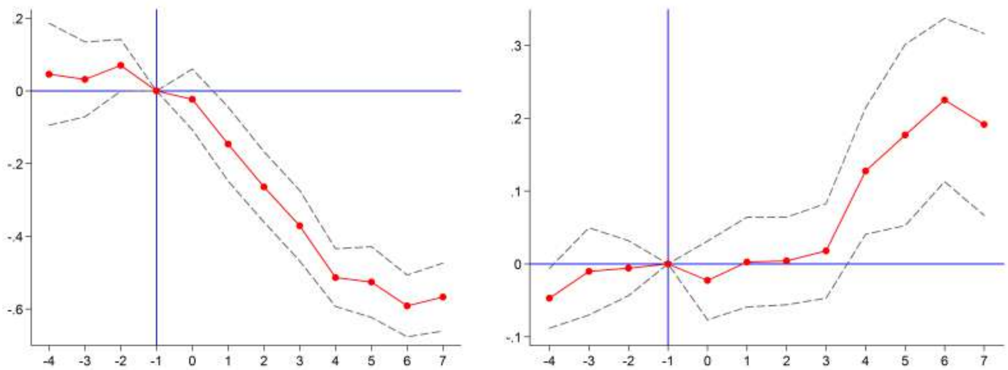
Figure 6 shows the total income from all jobs that the households earn. Unlike the income due to fish and shrimp, the total income drops temporarily and returns back to the pre-ban period after 5 years. While the effect is temporary, we find that total income drop to as low as 50% compared to the baseline, implying that the transitional cost is very large. This amounts to a loss of $10,500 for each shrimp farmer. The total loss for all the shrimp farmers in these villages add up to $315,000. These two figure taken jointly suggest that, while shrimp farmers suffer a negative shock in their income for up to five years, they respond to the ban by shifting their sector away from selling black shrimp such that their total income remains constant in the long run.

Our interpretation is supported by figure 7 which shows the probability of switching sector[6] for shrimp farmers relative to households with other sectors. The probability of switching sector increases by about 18% in the first year of the ban and as high as 40% after fourth year of the ban. Moreover, it remains positive relative to households with other businesses, indicating that the ban leads to an increased probability of transitioning out of the shrimp business compared to a household that has a different sector in the pre-ban period. Therefore, we conclude that while the ban was a temporary demand shock it had a permanent effect on the sectoral reallocation of the shrimp farmers.

Table 7 presents the findings using the share of income from shrimp as dependent variable in various version of equation 1. Each column in the table corresponds to a different regression where the dependent variable is share of income from shrimp. Results are presented for different

[6] We define that the household switches sector if the household's sector is different from its original sector in 1998 for at least 4 years.

Figure 5: Share of Income from Shrimp and Shrimp Before and After the Import Ban



Note: Plotted are the event-time coefficient estimates, where the dependent variable is the income earned from selling shrimp (left) and fish (right) in a household × year. The first full year of the ban corresponds to year 0 in the graph. Standard errors are plotted at the 95% confidence interval.

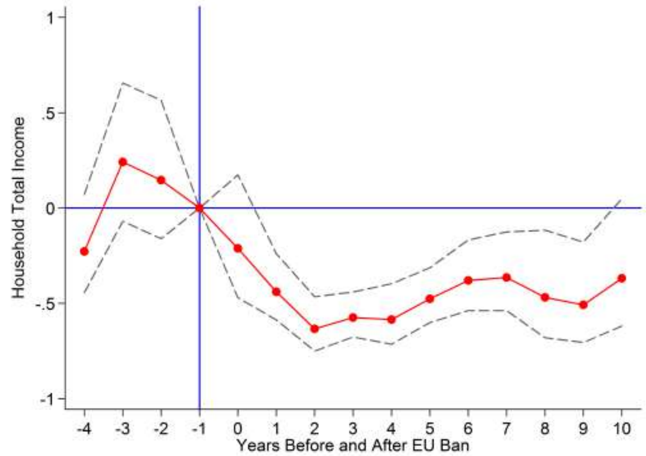
specifications that have different sets of controls. Column (1) presents the coefficients with no controls. In column (2), we add household characteristics as controls. In specific, we add initial wealth, initial cash, family size and number of household members that have jobs and do not live at home.[7] In column (3), we add aggregate controls, such as log GDP of Thailand. Finally, in column (4), we add also household fixed effects. The coefficients that we plot correspond to the ones of column (4).

Column (1) of table 7 suggests that the import ban lead to a reduction of share of income from shrimp for the households affected by it. This share decreased steadily over time and never recovered. After 7 years from the ban, the households that were in the shrimp's sector had a 57% decrease in share of income from shrimp with respect to the baseline in 2002. The R^2 is at 0.74. Column (2)-(4) suggest very similar results to column (1), the coefficients have very similar magnitudes. The R^2 is at 0.74 for column (2) and (3) but it goes to 0.83 in column (4).

Table 8 presents the findings using a dummy variable equal to 1 if the household changed primary sector as dependent variable in various versions of equation 1. We use the same controls as in table 7. In column (1), with no controls, we find that the probability of switching sector for shrimp's households is 23% larger than for the other households on impact and it increased over time reaching 45% after 3 years and staying stable there. However, in column (2), when we add household controls, we find that the probability of switching sector for shrimp's households is 22% larger than for the other households on impact and it increased over time reaching 44% after 3 years and staying stable there ending up to 43% over 7 years. In column (3), the magnitudes drop substantially. In specific, the probability of switching sector for shrimp's households is 16% larger than for the other households on impact and it increased over time reaching the peak to 33% after

[7]This last control capture remittances from other members of the household.

Figure 6: Household Level: Total Income Before and After the Import Ban



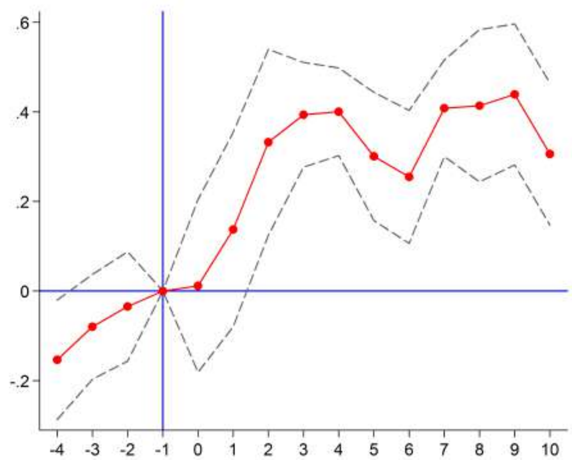
Note: Plotted are the event-time coefficient estimates, where the dependent variable is the total income earned from all business activities in a household × year. The first full year of the ban corresponds to year 0 in the graph. Standard errors are plotted at the 95% confidence interval.

3 years and stabilizing at 22% from the fifth to the seventh year. Finally, in column (4), when we add also individuals fixed effects, we find that, on impact, the probability of switching sector for shrimp's households is 17% larger than for the other households on impact and it increased over time reaching the peak to 33% after 3 years and stabilizing at 23% from the fifth to the seventh year. The R^2 for column (1) is quite low at 0.02 suggesting that lot is left unexplained. However, after adding the household fix effects the R square reaches 0.50 in column (4).

Table 9 presents the findings using the share of income from shrimp for household whose primary income is in shrimp and fish as dependent variable in various version of equation 1. We use the same controls as in table 7 and 8. All the columns report exponentiated coefficients from equation 1 using the translation $exp(\beta_k - 1)$. In column (1), we find that on impact shrimp producers are going to see a reduction of 15% in the share of income from shrimp. This effect grows over time, tipping after 4 years at a decrease of 39%. Then, it stabilizes around 35%. In column (2), when we add household controls, on impact the decrease drops to 22% and stabilizes at 43% after 7 years. Finally, in column (3) and (4), we find that the results have a substantially lower magnitude but they are still statistically significant. In particular, on impact, we observe, respectively, a 16% and a 17% decline. Instead, in the last 3 years of the sample, we observe, respectively, a 21% and a 23% decline. The R^2 is at 0.59 for column (1)-(3) and it reaches 0.76 in column (4).

The loss in income could be due to both the intensive and extensive margins. If a household moves, then his income due to shrimp becomes zero, which could explain why the income from shrimp after the ban is so low. To understand the effect of the intensive margin we report in the

Figure 7: Household Level: Probability of sectoral change before and after the Import Ban



Note: Plotted are the event-time coefficient estimates, where the dependent variable is the probability of sectoral change in a household × year. The first full year of the ban corresponds to year 0 in the graph. Standard errors are plotted at the 95% confidence interval.

Appendix the results of the event-study restricting the sample to *stayers* households that stayed in the shrimp's production.[8] The reason is that potentially, we may be biasing the results by not taking into account the exit of some of the households from the sector. When we compare the results with the ones in the Appendix, we find that the total income was not statistically different for households that stayed in the shrimp sector as reported in figure 18. Moreover, figure 19 the fraction of shrimp income decreased immediately but after 5 years, there is no statistical difference with the other sectors. The share of shrimp income decreased substantially, even after 7 years, approximately around 60% but decreased less than the one for the full sample as in figure 20. We also find that the share of income generated from the shrimp, for households that stayed in the fish and shrimp's sectors, kept decreasing for the first 4 years and started going back as in figure 21. After, 6 years, there was no significant effect. As a placebo test, in figure 23 we check how the probability of switching sector changes for "stayers" households. As expected, we find that the probability is not statistically significant. Overall, the results for the stayers indicate that, because the income did not increase as much as the entire group, there was selection for households that stayed in the fish and shrimp sectors even after the ban.

We also report the key results for the *stayers* in table 10, 11 and 12. In table 10, the dependent variable is the share of income from shrimp. We find that the results are very similar for all the

[8] We define *stayers* the households that from 1998 to 2010 changed sector less than the median household changed. Since the median household changed sector 4 times, we pick 3 as maximum number of times a household can have changed sector to be considered a *stayer*.

specifications in column (1)-(4). In particular, on impact, there is a reduction of 16% of share of income from shrimp with respect to the baseline in 2002. After 7 years, the decrease reaches 55%. These results are quantitatively very similar to the ones of the whole sample. The R^2 is at 0.84 for specifications (1)-(3) and it increases to 0.88 in specification (4).

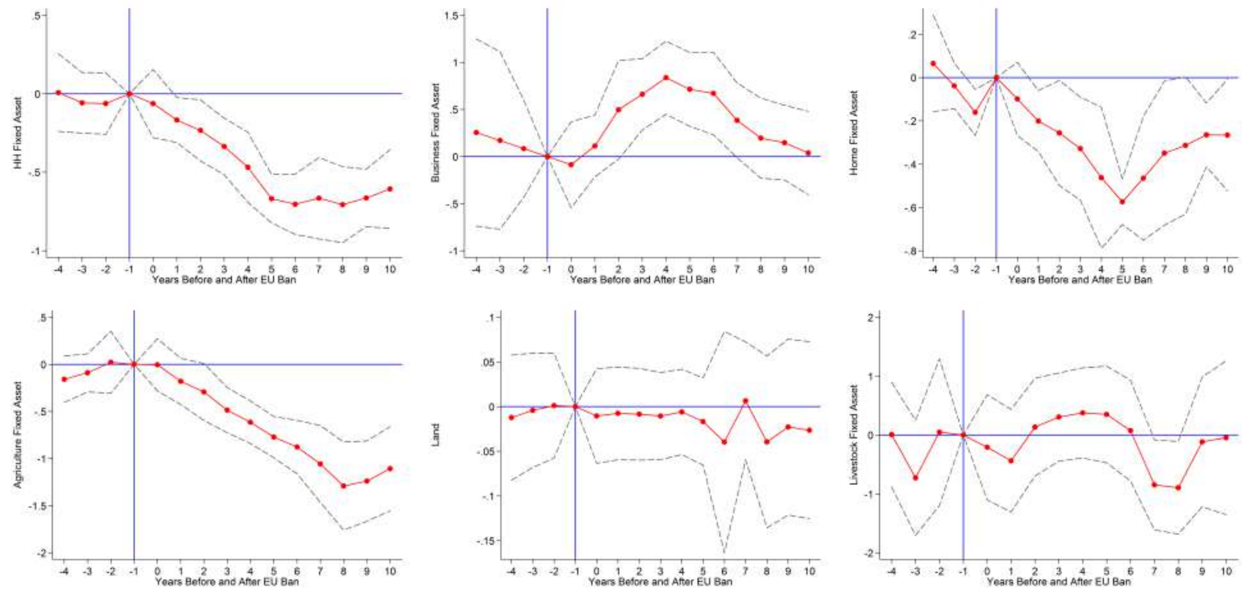
Instead, in table 11, we find that the probability of switching sector for stayers is not statistically significant in any of the regressions with the exception of very few cases, which could be due to spurious correlations in the data. We find this set of results very comforting since they suggest that the placebo test worked well. Table 12 reports the results of using the share of income from shrimp for households that work in fish and shrimp sectors. We find that on impact households get a 6% loss in income from shrimp with respect to the base year. Over time, the value decreases with a trough in the fourth year, where it reaches 34% drop. Afterwords it goes back and by the seventh year, the effect is not statistically significant anymore. The results are consistent for the four specifications we use in column (1)-(4). If we compare these results to the ones for the whole sample, and we find a strong difference. Specifically, the effect for the *stayers*, already lower on impact, reduces dramatically after after the fourth year. Instead, the effect for the whole sample is stronger and permanent. This finding suggests a selection effect for households that kept staying in the shrimp's production. The R^2 is quite low in column (1) at 0.01, it increases up to 0.15 in column (4) suggesting that lot is left unexplained.

4.1 How does the shock Propagates: Investigating Channels

How does the demand shock propagates to the rest of the economy? In this section, we look at several channels that might have affected the shrimp farmers and made them switch more to other sectors and not go back to the original sectors. We explore assets accumulation in other sectors, migration[9] out of the village and productivity. As we show in figure 8, we find that households shrimp farmers decrease their assets position in HH fixed assets starting the year after the shock and they keep decreasing their position. The same happens for home assets, although they recover after 5 years. The effect on other assets is not clear. In particular, we find some statistically significant differences for business assets and agricultural assets but they are only statistically significant 2 years after the ban happens. We do not find any statistically significant differences for land and livestock asset accumulation. Overall, this suggests that shrimp's households started accumulating more assets in other sectors, so even when the ban was released in 2004, they had paid a fixed cost inducing them to switch sector permanently. Therefore, it was quite costly to go back to the shrimp's production as it was before. We also look at the productivity evolution in each sector. We find that shrimp farmers become better after the shock in agriculture, but they become worse in business and in fish and shrimp. The first might be due to them switching more to agriculture. The decrease in business productivity is unclear. It is probably because they start learning in this

[9] We report the results for migration in the Appendix in section A.2 since we do not find any major results to discuss upfront.

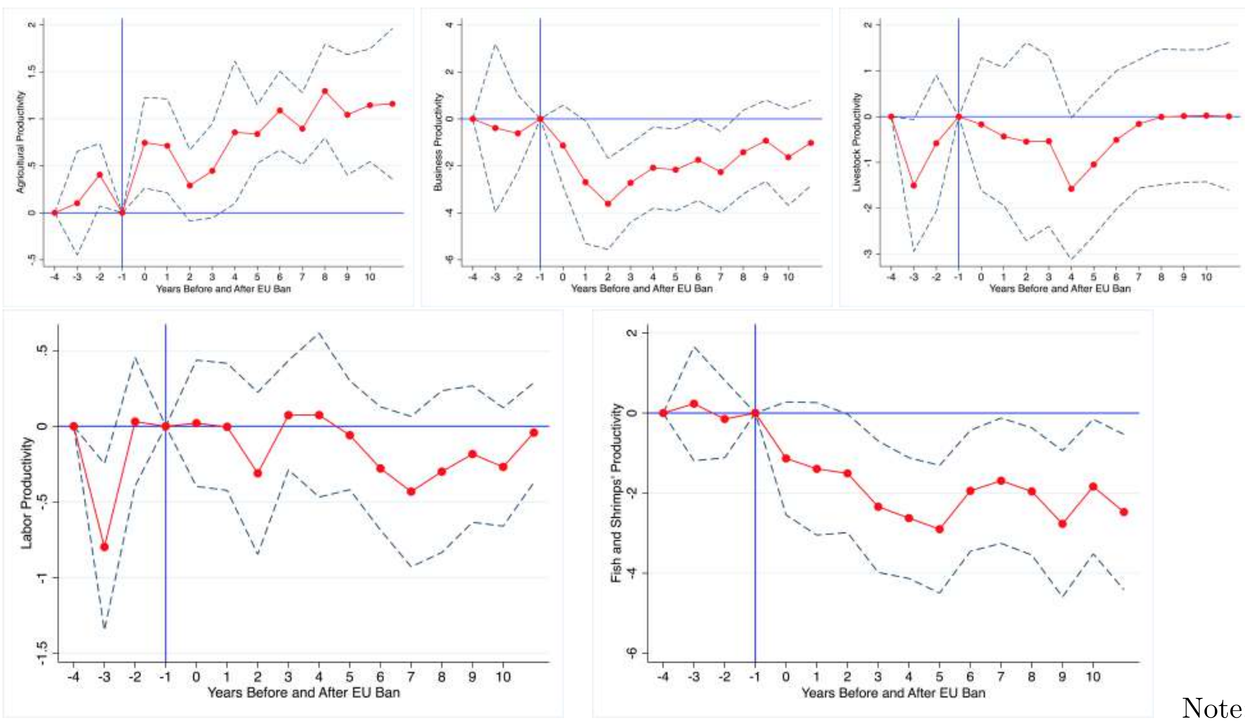
Figure 8: Household Level: Assets accumulation evolution



Note: Plotted are the event-time coefficient estimates, where the dependent variable is the quantity of assets of each type in a household year. The first full year of the ban corresponds to year 0 in the graph. Standard errors are plotted at the 95% confidence interval.

sector more than they used to do before. Finally they are less productive in fish and shrimp since they just produce less.

Figure 9: Household Level: Productivity evolution



Note: Plotted are the event-time coefficient estimates, where the dependent variable is the producitivity each type in a household year. The first full year of the ban corresponds to year 0 in the graph. Standard errors are plotted at the 95% confidence interval.

5 Event Study II: The Spillover Effects of the Ban

The ban might have had a spillover effect on the other households exposed to shrimp farmers.To quantify the impact of the ban on the non-shrimp farmers, we run an event study using a difference-in-difference estimator (DD) similar to the one in equation 1. In particular, we use the following specification

$$Y_{jit} = \sum_{k=-m}^{M} \beta_k \left[o_j^p \times 1(\tau_t = k) \right] + X_{jt} + \chi_j + g_t + g_i + \epsilon_{jt} \quad (2)$$

where j are the non-shrimp's households in village i and t are years.[10] o_j^p equals to one if the household's main sector[11] was not selling shrimp prior to the ban and being in one of the villages with a positive share of shrimp farmers, and zero if the household's main sector was not in the shrimp business and the household was not exposed to shrimp farming in his village. The regression coefficient β_k is the reduced form impact of the ban on households at time k whose main sector was different from shrimp farming before the ban and they were in villages exposed to shrimp farming. X_{jt} are time-variant household characteristics which include cash-on-hand and net wealth in the previous period, family size, and the total number of jobs that household has. In other words, β_k(for $k \in [-m, M]$) delivers the event-study regression estimation corresponding to the differential paths of employment and income in the years before and after the ban took place for households not directly affected by the bun but exposed to it. The rest of the description of specification 2 follows from specification in 1 including time span, data and control variables, just adding village fixed effects g_i. Equation 2 serves as the benchmark econometric framework for the rest of the analysis. We find that there a statistically significant reduction in the income deriving from Livestock for the the years of the year (2003-2004) and 2005. This is about a 50% drop in income. Moreover, there is a significant drop in business income for the ban years and 2005. The drop is about 50% of the income as well. Most likely, the business income drop is being derived by a lack in demand from the shrimp farmers. The drop in income for the livestock farmers could be also due to a lack of demand or to the increase competition since the shrimp farmers started producing more. In figure 12 we look at how the non-shrimp farmers changed sector over time. We find that non-shrimp farmers in shrimp's villages are less likely to change sector than non-shrimp farmers in non-shrimp's villages. Thsi suggests a crowding out effect on them.

[10]Notice that the data are aggregated from monthly to yearly to avoid the volatility due to the seasonality of the products. This, however, came to the cost of power of the analysis.

[11]We define main sector if that sector is the largest source of income for that household prior to the ban. We use a total of 47 months (or almost 4 years) to calculate main sector. This way, we avoid monthly fluctuations in income when defining main sector before the ban.

Figure 10: Household Level: Income Evolution for Non-shrimp farmers

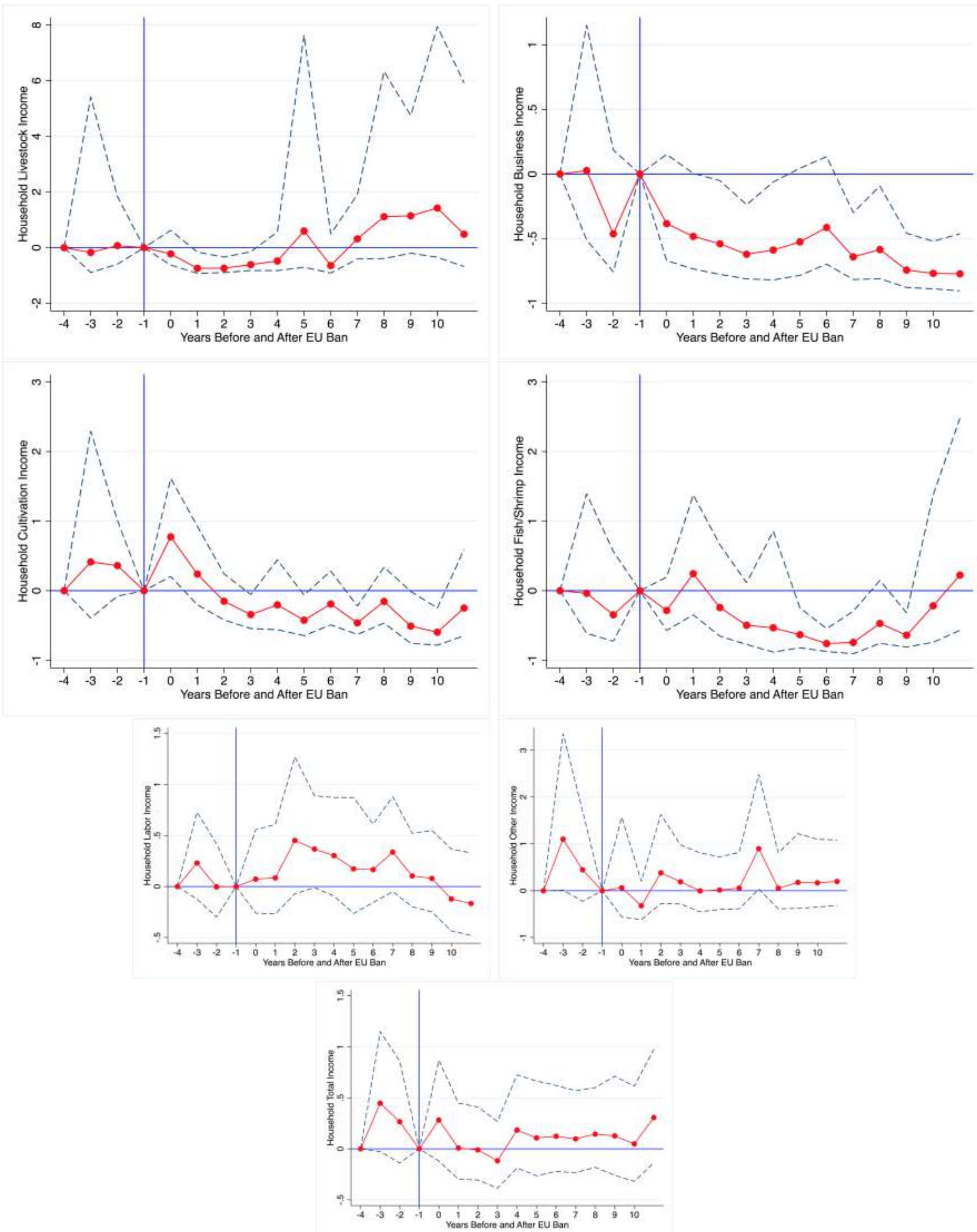


Figure 11: Household Level: Assets accumulation evolution for Non-shrimp farmers

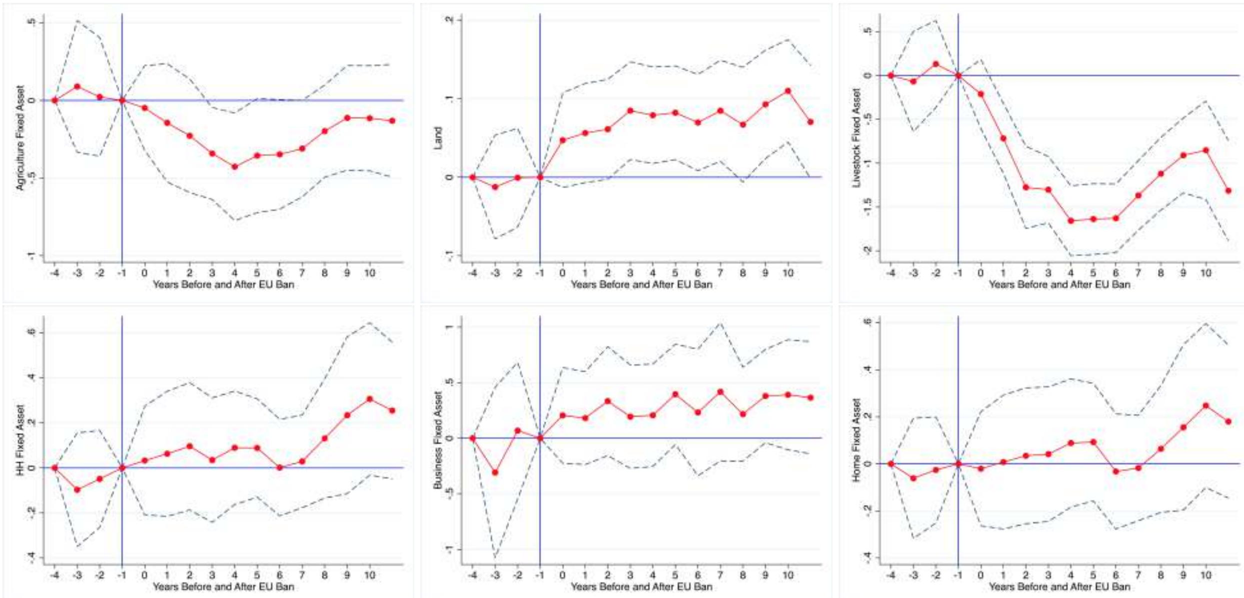
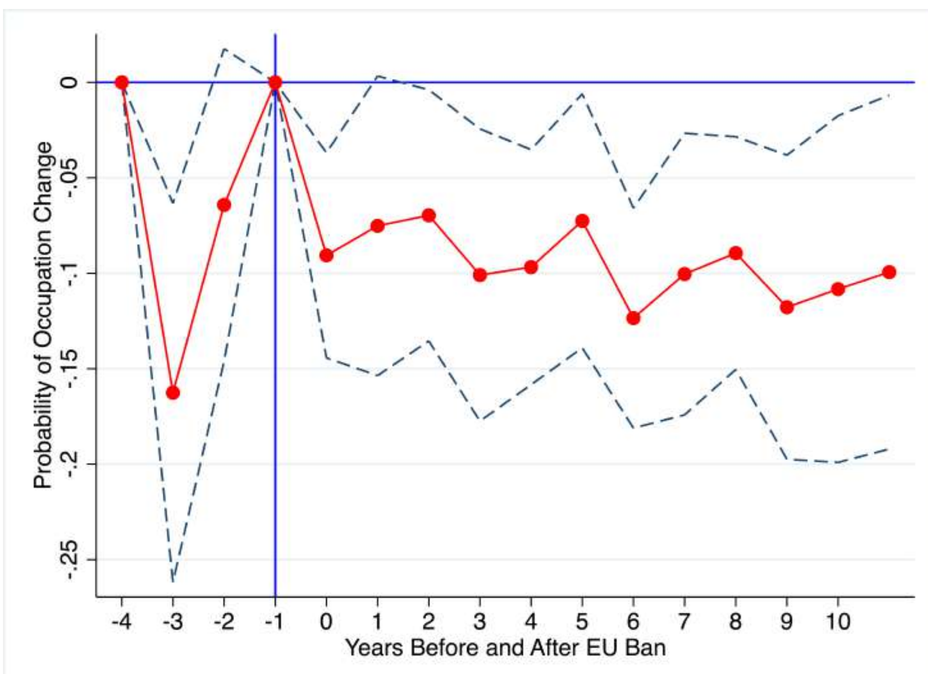


Figure 12: Sectoral Reallocation on Non-shrimp farmers



6 Event Study III: Stayers and Leavers: Determinants and Consequences

What are the determinants of shrimp farmers staying or leaving the sector? And, what are the long-term consequences on their households members in terms of education and income? We look at characteristics of stayers and characteristics of leavers before the ban. In table 5 we look at assets and productivity differences between stayers and leavers. We find that stayers have more wealth and more assets overall. Moreover, they are more productive in fish and shrimp, not controlling for anything else. Table 6 suggests that the difference in income between stayers and leavers was positive and statistically significant for total income. However, leavers have more labor and more other income than stayers. Moreover, when we look at household demographics, the only statistical significant different result in the education level. It suggests that leavers overall had higher levels of education. Overall, these findings suggest that wealth might have had an important component in the decision of leaving vs staying in the sector. Wealthier people could afford to wait that the ban was lifted. However, poorer people could not. They sold their shrimp's assets and went forward to other sectors. The ban can be seen as an opportunity for the farmers to re-optimize, therefore, we could see higher income later on. In the Figure 13 explores the evolution of total income for stayers and leavers and the overall gap. Overall, it looks like that income of the stayers drops much more than income of leavers, however, after the ban is lifted, the recovery is much faster for the income of the stayers, who end up on a higher long-term profile than they would have been otherwise. Income of leavers goes down a bit during the ban, but it goes back at the pre-ban level quite rapidly. However, the growth is not very steep.

In order to test what were the consequences of leaving the sector vs staying in the sector, we run an event study analysis for stayers and leavers. Clearly, different from the event study in the previous section, the treatment group is endogenous to the shock since stayers and leavers decide their action, or in other words, they are not forced. We run the following specification:

$$Y_{jit} = \sum_{k=-m}^{M} \beta_k \left[o_j^p \times 1(\tau_t = k) \right] + X_{jt} + \chi_j + g_t + g_i + \epsilon_{jt} \tag{3}$$

where o_j^p equals to 1 if the household's main sector was shrimp farming after the ban and before and equals to 0 if the household's main sector wasn't shrimp farming after the ban but it was before. As in the previous specifications, g_t and g_i are, respectively, time and individual fixed effects to capture other differences. Unfortunately, differently from the rest of the analysis, focusing only on

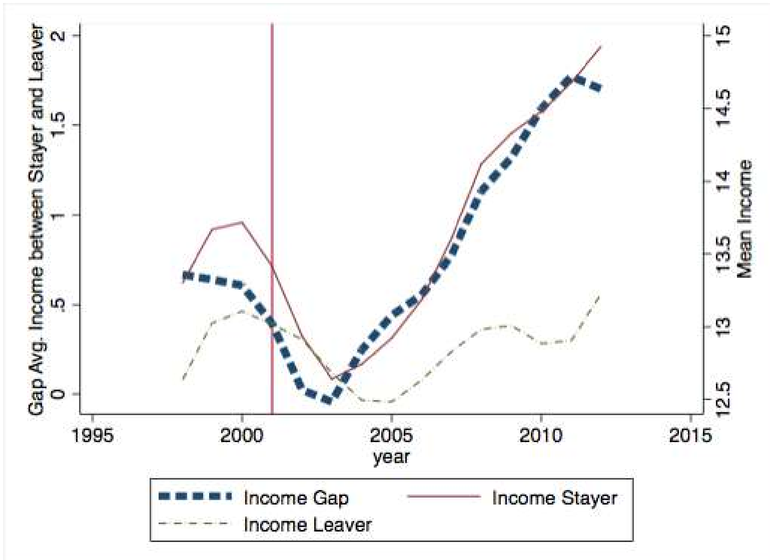
Table 5: Summary Statistics of Stayers vs. Leavers Before the Ban: Wealth and Productivity

Note: This table reports the summary statistics of wealth and productivity by sector both for stayers and leavers of the shrimp's sector before the ban.

Table 6: Summary Statistics of Stayers vs. Leavers Before the Ban: Income and Demographics

Note: This table reports the summary statistics of income by sector and demographics both for stayers and leavers of the shrimp's sector before the ban.

Figure 13: Income Gap



farmers in the shrimp sector does not give us enough power to estimate a coefficient every year. Therefore, we run the analysis by grouping the periods as follows: pre-ban (<2002), ban year (2002), during the ban (>2002 <2006) and after the ban (>2005). This gives us more power the estimate the coefficients of interest. In figure 14 we plot the estimated coefficients in the case that the dependent variable is income by sector and overall. We find that overall income is higher for stayer after the ban is lifted as the top plot shows. Agricultural income and fish and shrimp income are also higher for stayers after the ban is lifted. Instead, labor income are higher for stayers during the ban period. This suggests that stayers coupled with the negative demand shock by diversifying more. Figure 14 shows the estimated coefficients of regression 3 where the dependent variable is sex of the head of household. We find that the head of the household is more likely to be a man after the ban. Finally, in figure 16 and 17 we look at years of education of the young members of the households as dependent variable and probability of enrolling in university, respectively. We find that the education level is higher for the leavers than the stayers during and after the ban and probability of enrolling in university is higher for youngs in leavers families.

Figure 14: Stayers' Evolution

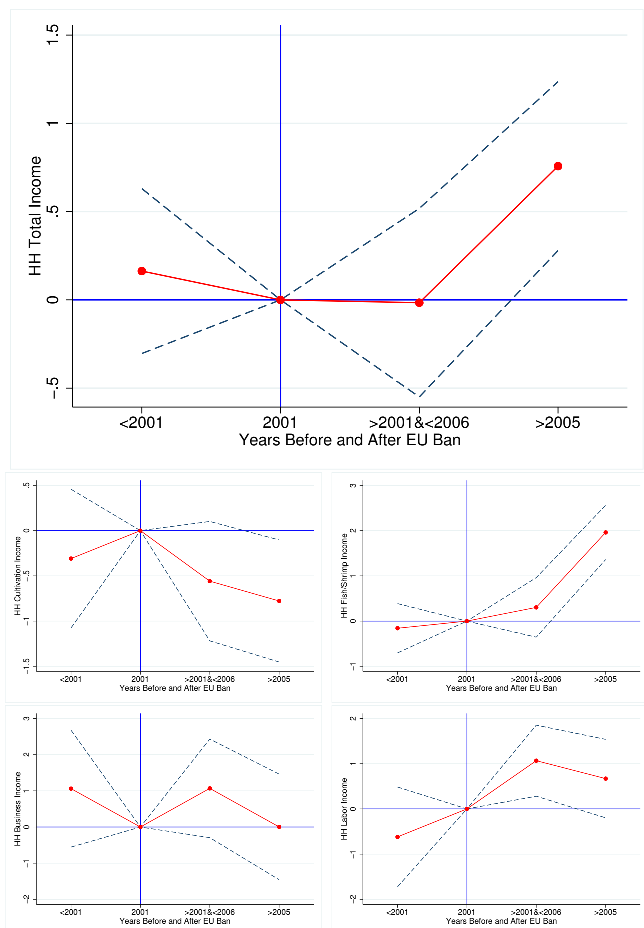


Figure 15: Sex

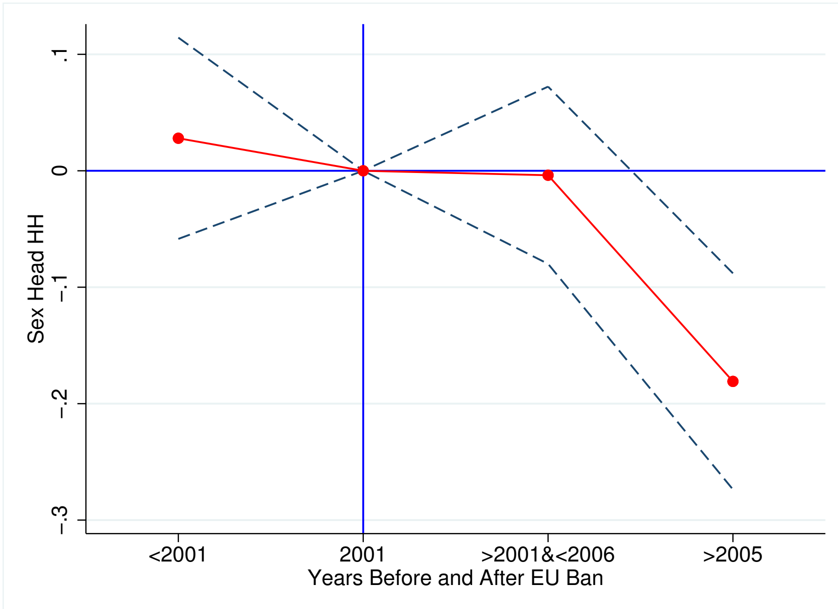


Figure 16: Years of Education

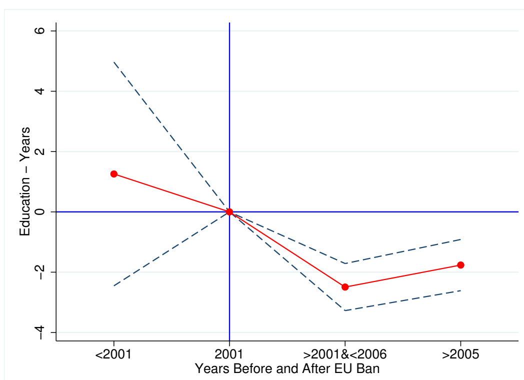
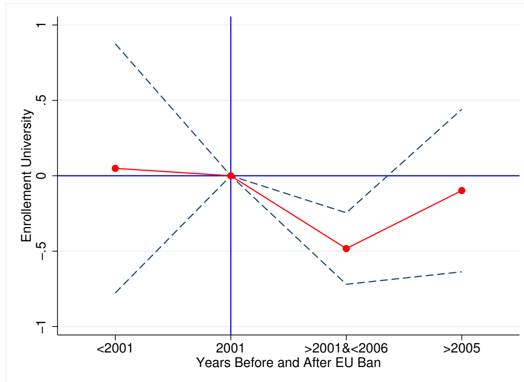


Figure 17: University Enrollment



7 Conclusion and Future Work

The black tiger shrimp import ban from the EU on Thailand offers a unique source of variation to look at the long-run consequences of an temporary demand shock through sectoral reallocation. The richness of our data allows us to look at outcomes in several dimensions. First, we find that both households/farmers and entrepreneurs left the sector substantially even in the long-run, despite the incentives given by the government to stay in the sector. Our findings are corroborated by the evidence of the event study that we run using the farmer/household data. We also find that the cost of the import ban is very large. On impact, households/farmers lose 60% of their income after 2-3 years. They only recover after 10 years. Moreover, the income they received from the shrimp's production declined permanently and never recovered. These two findings jointly suggest that the households shifted towards other sectors. This is corroborated by the fact that the probability of switching sector for households that were in the shrimp farming sector is very high, getting peak of 40% after 3 years and staying at 30% after 7 years. Overall, we can conclude that the ban was very costly for the economy in the short-run and it had long-run consequences by inducing to a reallocation of the sector. Second, by isolating the non-shrimp farmers, we identify a causal spillover effect of the demand shock on their income. We find that business income and livestock income were affected for the years of the ban and for a little longer. Third, we focus on the comparison between stayers and leavers of the shrimp industry. We find that stayers are wealthier and can cope with the shock for longer. In the long-run, the effect of the ban is very positive for the income of the stayers. We find that the mark-up in the shrimp' sector goes up substantially suggesting that the shrimp's farmer benefited substantially from the ban since it crowed out the farmers that could not afford to stay and could not come back since they sold the shrimp's assets. On the other hand, the consequences of the ban were very different in terms of education and future generations. The young members of the leavers' families had a boost in education that the young members' of the stayers families did not. This suggests that the opportunity cost of having kids in the production of the family business decreased. Therefore, at the end of the day future generations took advantage of such a shock. Overall, these findings suggest that models that estimate moving costs across sector and welfare gains as a response to trade shock, should take also into account: (i) that a temporary shock might still have long-run effects through fied costs of production; (ii) heterogeneity on the impact on future generations; (iii) effect trough changes on the market structure. Moreover, when looking at policy interventions, sectoral mobility seems to be a great buffer for shocks in developing countries, working better than geographical mobility to buffer shocks. A future version of this work will incorporate a Roys' model with sectoral choice informed by the findings aforementioned.

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A Appendix

A.1 Tables

Table 7: Share of Income from shrimp Before and After the Ban

	(1)	(2)	(3)	(4)
Ban (t-4)	0.05	0.05	0.05	0.05
Ban (t-3)	0.03	0.03	0.03	0.03
Ban (t-2)	0.07**	0.07**	0.07**	0.07*
Ban (t-1)	0.00	0.00	0.00	0.00
Ban (t+0)	-0.02	-0.02	-0.02	-0.02
Ban (t+1)	-0.15***	-0.15***	-0.15***	-0.15***
Ban (t+2)	-0.27***	-0.26***	-0.26***	-0.26***
Ban (t+3)	-0.37***	-0.37***	-0.37***	-0.37***
Ban (t+4)	-0.52***	-0.52***	-0.51***	-0.51***
Ban (t+5)	-0.53***	-0.53***	-0.53***	-0.53***
Ban (t+6)	-0.60***	-0.59***	-0.59***	-0.59***
Ban (t+7)	-0.57***	-0.57***	-0.57***	-0.57***
HH Controls		Yes	Yes	Yes
Aggr. Controls			Yes	Yes
Fixed Effects				Yes
Observation	5750	5750	5750	5750
R square	0.74	0.74	0.74	0.83

Note: This table reports regression coefficients from four separate regressions based on equation (2) where the dependent variable consists of income share from shrimp in a sector × year. See text for details. All of the regressions implicitly or explicitly control for households characteristics, aggregate controls, and household fixed effects. All the standard errors are robust and clustered at village-year level. T-stats are in parenthesis. ***, **, and *, represent statistical significance at 0.01, 0.5 and 0.1, respectively. The dependent variable in each regression is the share of income that come from shrimp.

Note: This table reports regression coefficients from four separate regressions based on equation (2) where the dependent variable consists of income share from shrimp in a sector × year. See text for details. All of the regressions implicitly or explicitly control for households characteristics, aggregate controls, and household fixed effects. All the standard errors are robust and clustered at village-year level. T-stats are in parenthesis. ***, **, and *, represent statistical significance at 0.01, 0.5 and 0.1, respectively. The dependent variable in each regression is the share of income that come from shrimp.

Table 8: Switching Sector from shrimp Before and After the Ban

	(1)	(2)	(3)	(4)
Ban (t-4)	-0.16**	-0.14**	-0.14**	-0.12*
Ban (t-3)	-0.06	-0.06	-0.07	-0.06
Ban (t-2)	-0.03	-0.03	-0.04	-0.04
Ban (t-1)	0.00	0.00	0.00	0.00
Ban (t+0)	0.03	0.03	0.00	0.00
Ban (t+1)	0.23**	0.22**	0.16*	0.17*
Ban (t+2)	0.39***	0.38***	0.29***	0.29***
Ban (t+3)	0.45***	0.44***	0.33***	0.33***
Ban (t+4)	0.45***	0.44***	0.28***	0.29***
Ban (t+5)	0.42***	0.40***	0.21**	0.22**
Ban (t+6)	0.45***	0.43***	0.21**	0.23**
Ban (t+7)	0.45***	0.43***	0.22**	0.23**
HH Controls		Yes	Yes	Yes
Aggr. Controls			Yes	Yes
Fixed Effects				Yes
Observation	5784	5784	5784	5784
R square	0.02	0.03	0.06	0.50

Note: This table reports regression coefficients from four separate regressions based on equation (2) where the dependent variable consists of a dummy equal 1 if the household changed sector from the base year, 1998, from shrimp to a sector × year. See text for details. All of the regressions implicitly or explicitly control for households characteristics, aggregate controls, and household fixed effects. All the standard errors are robust and clustered at village-year level. T-stats are in parenthesis. ***, **, and *, represent statistical significance at 0.01, 0.5 and 0.1, respectively. The dependent variable in each regression is the share of income that come from shrimp.

Table 9: Share shrimp's Income for Shrimp and Fish household Before and After the Ban

	(1)	(2)	(3)	(4)
Ban (t-4)	0.07	0.07	0.07	0.07
Ban (t-3)	0.02	0.02	0.02	0.02
Ban (t-2)	0.06*	0.06*	0.06*	0.06
Ban (t-1)	0.00	0.00	0.00	0.00
Ban (t+0)	-0.04	-0.04	-0.04	-0.04
Ban (t+1)	-0.15***	-0.14***	-0.15***	-0.15***
Ban (t+2)	-0.26***	-0.26***	-0.27***	-0.27***
Ban (t+3)	-0.36***	-0.35***	-0.36***	-0.36***
Ban (t+4)	-0.39***	-0.39***	-0.40***	-0.40***
Ban (t+5)	-0.36***	-0.36***	-0.37***	-0.37***
Ban (t+6)	-0.36***	-0.36***	-0.38***	-0.38***
Ban (t+7)	-0.35***	-0.35***	-0.36***	-0.36***
HH Controls		Yes	Yes	Yes
Aggr. Controls			Yes	Yes
Fixed Effects				Yes
Observation	5750	5750	5750	5750
R square	0.59	0.59	0.59	0.76

Note: This table reports regression coefficients from four separate regressions based on equation (2) where the dependent variable consists of the share of income from shrimp for household, whose primary sector is shrimp and fish. See text for details. All of the regressions implicitly or explicitly control for households characteristics, aggregate controls, and household fixed effects. Exponentiated coefficients are reported using the translation ($exp(\beta_k)-1$). All the standard errors are robust and clustered at village-year level. T-stats are in parenthesis. ***, **, and *, represent statistical significance at 0.01, 0.5 and 0.1, respectively. The dependent variable in each regression is the share of income that come from shrimp.

Table 10: Share of Income from shrimp Before and After the Ban for the *Stayers*

	(1)	(2)	(3)	(4)
Ban (t-4)	0.02	0.02	0.01	0.02
Ban (t-3)	0.06***	0.06***	0.06***	0.06***
Ban (t-2)	0.02	0.02	0.02	0.02
Ban (t-1)	0.00	0.00	0.00	0.00
Ban (t+0)	-0.05	-0.05	-0.05	-0.05
Ban (t+1)	-0.16*	-0.16*	-0.16*	-0.16*
Ban (t+2)	-0.22***	-0.22***	-0.22***	-0.22***
Ban (t+3)	-0.35***	-0.35***	-0.35***	-0.35***
Ban (t+4)	-0.54***	-0.54***	-0.54***	-0.54***
Ban (t+5)	-0.56***	-0.56***	-0.55***	-0.55***
Ban (t+6)	-0.63***	-0.63***	-0.63***	-0.63***
Ban (t+7)	-0.55***	-0.55***	-0.55***	-0.55***
HH Controls		Yes	Yes	Yes
Aggr. Controls			Yes	Yes
Fixed Effects				Yes
Observation	2872	2872	2872	2872
R square	0.84	0.84	0.84	0.88

Note: This table reports regression coefficients from four separate regressions based on equation (2) where the dependent variable consists of income share from shrimp in a sector $\times$ year. See text for details. All of the regressions implicitly or explicitly control for households characteristics, aggregate controls, and household fixed effects. All the standard errors are robust and clustered at village-year level. T-stats are in parenthesis. ***, **, and *, represent statistical significance at 0.01, 0.5 and 0.1, respectively. The dependent variable in each regression is the share of income that come from shrimp.

Table 11: Switching Sector from shrimp Before and After the Ban for the *Stayers*

	(1)	(2)	(3)	(4)
Ban (t-4)	0.00	0.01**	0.01***	0.01***
Ban (t-3)	0.08	0.09	0.08	0.07
Ban (t-2)	0.00	0.00	-0.01***	-0.01***
Ban (t-1)	0.00	0.00	0.00	0.00
Ban (t+0)	0.00	-0.00	-0.02***	-0.02***
Ban (t+1)	0.08	0.08	0.04	0.04
Ban (t+2)	0.08	0.08	0.02	0.02
Ban (t+3)	0.17	0.16	0.08	0.08
Ban (t+4)	0.33**	0.33**	0.22	0.22
Ban (t+5)	0.08	0.07	-0.06	-0.06
Ban (t+6)	0.08	0.07	-0.08	-0.08
Ban (t+7)	0.08	0.07	-0.07	-0.07
HH Controls		Yes	Yes	Yes
Aggr. Controls			Yes	Yes
Fixed Effects				Yes
Observation	2880	2880	2880	2880
R square	0.01	0.02	0.06	0.15

Note: This table reports regression coefficients from four separate regressions based on equation (2) where the dependent variable consists of a dummy equal 1 if the household changed sector from the base year, 1998, from shrimp to a sector $\times$ year. See text for details. All of the regressions implicitly or explicitly control for households characteristics, aggregate controls, and household fixed effects. All the standard errors are robust and clustered at village-year level. T-stats are in parenthesis. ***, **, and *, represent statistical significance at 0.01, 0.5 and 0.1, respectively. The dependent variable in each regression is the share of income that come from shrimp.

Table 12: shrimp's Income for Shrimp and Fish household Before and After the Ban for the *Stayers*

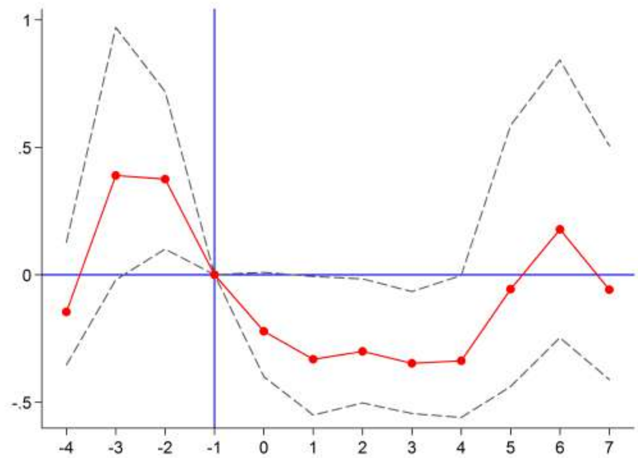
	(1)	(2)	(3)	(4)
Ban (t-4)	0.11***	0.11***	0.11***	0.11***
Ban (t-3)	0.03	0.03	0.03	0.03
Ban (t-2)	0.06***	0.06***	0.06***	0.06***
Ban (t-1)	0.00	0.00	0.00	0.00
Ban (t+0)	-0.06**	-0.06**	-0.06**	-0.06**
Ban (t+1)	-0.13***	-0.13***	-0.13***	-0.13***
Ban (t+2)	-0.17***	-0.17***	-0.18***	-0.18***
Ban (t+3)	-0.27***	-0.27***	-0.27***	-0.27***
Ban (t+4)	-0.34***	-0.34***	-0.34***	-0.34***
Ban (t+5)	-0.16**	-0.16**	-0.17**	-0.17**
Ban (t+6)	-0.14***	-0.14***	-0.15***	-0.15**
Ban (t+7)	-0.07	-0.07	-0.08	-0.08
HH Controls		Yes	Yes	Yes
Aggr. Controls			Yes	Yes
Fixed Effects				Yes
Observation	2872	2872	2872	2872
R square	0.82	0.83	0.83	0.88

Note: This table reports regression coefficients from four separate regressions based on equation (2) where the dependent variable consists of a dummy equal 1 if the household changed sector from the base year, 1998, from shrimp to a sector × year. See text for details. All of the regressions implicitly or explicitly control for households characteristics, aggregate controls, and household fixed effects. Exponentiated coefficients are reported using the translation $(exp(\beta_k) - 1)$. All the standard errors are robust and clustered at village-year level. T-stats are in parenthesis. ***, **, and *, represent statistical significance at 0.01, 0.5 and 0.1, respectively. The dependent variable in each regression is the share of income that come from shrimp.

A.2 Graphs for Stayers

sectionMigration Response to the Shock In figure 24 and 25, respectively, we report the estimates of the main specification equations 1 and 2 where the dependent variable is migration. In particular, we look at propensity of migrating of workers after the shock, we do not find any statistically significant effect, neither for the main event study nor for the spillover on the non-shrimp farmers. These findings are consistent with the findings of previous literature suggesting that in developing countries workers do not adjust through the migration margin. Although the estimates are extremely unprecise, just by looking at the estimates, we can see that the shrimp farmers are more likely to outmigrate, instead the non-shrimp farmers are less likely to outmigrate. developing countries workers do not adjust through the migration margin.

Figure 18: Household Level: Total Income Before and After the Import Ban



Note: Plotted are the event-time coefficient estimates, where the dependent variable is the total income of a household in shrimp production relative to the other households × year. The first full year of the ban corresponds to year 0 in the graph. Standard errors are plotted at the 95% confidence interval.

Figure 19: Household Level: Shrimp Income Share Before and After the Import Ban

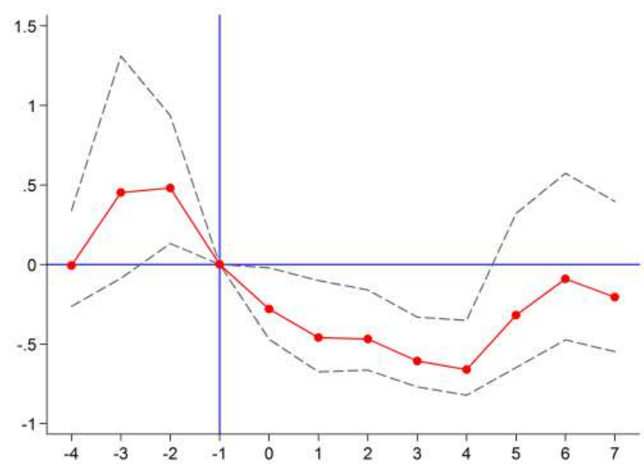


Figure 20: Household Level: Share of Shrimp Income Before and After the Import Ban

evt_share_shrimptay.png

Figure 21: Household Level: Share of shrimp Income for household on Shrimp and Fish Sector Before and After the Import Ban

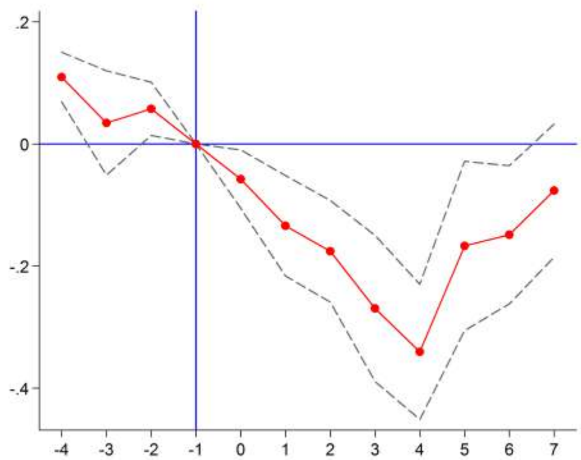
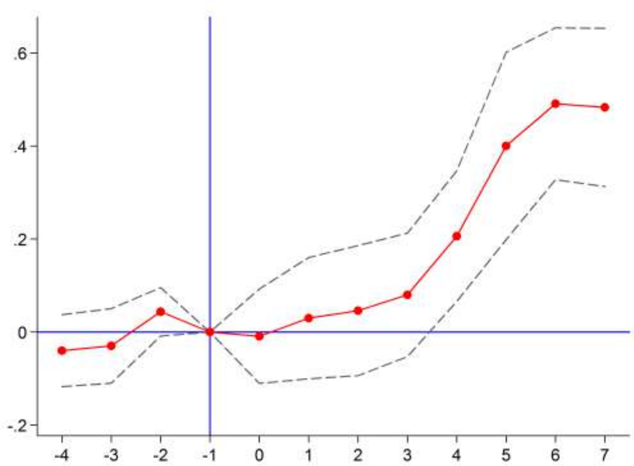
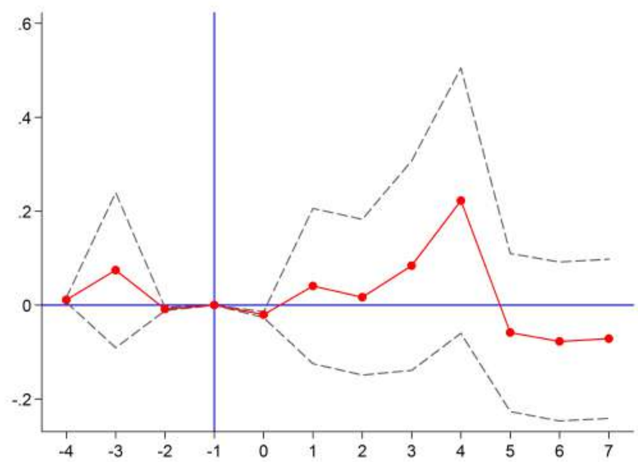


Figure 22: Household Level: Share of Non Shrimp Income for Household on Shrimp and Fish Sector Before and After the Import Ban



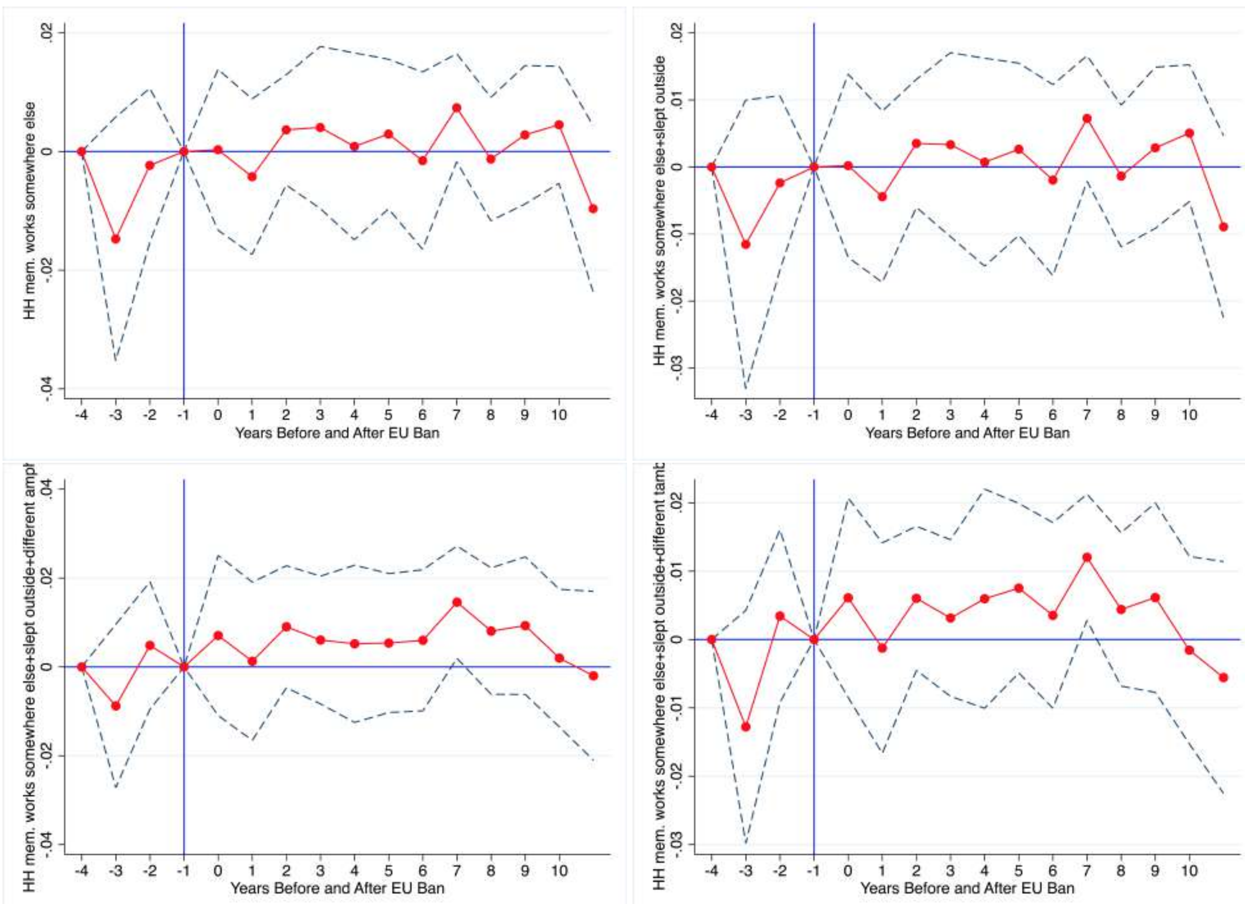
Note: Plotted are the event-time coefficient estimates, where the dependent variable is the share of income from fish for households that work in the fish and shrimp' sectors for *stayers*. The first full year of the ban corresponds to year 0 in the graph.

Figure 23: Household Level: sectoral Change Before and After the Import Ban



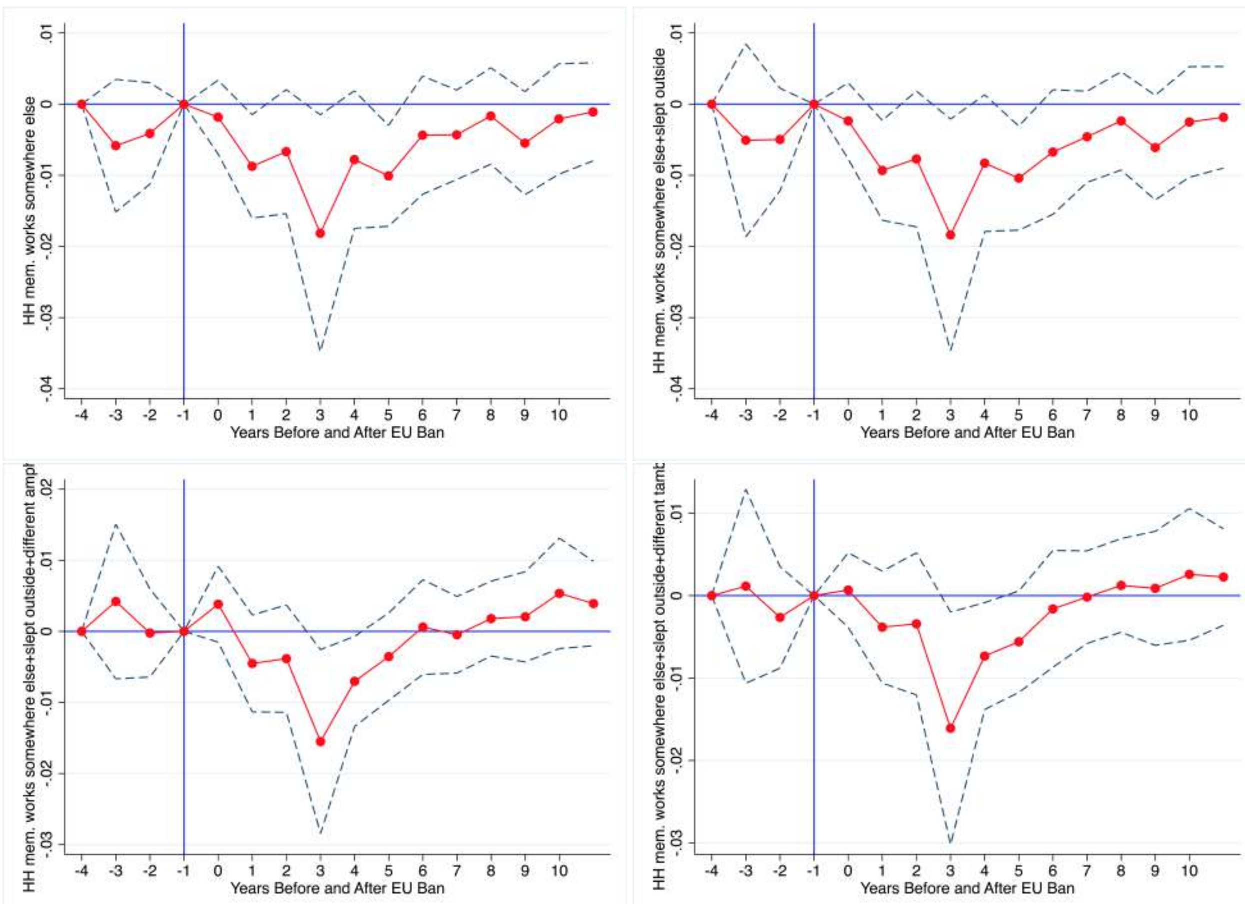
Note: Plotted are the event-time coefficient estimates, where the dependent variable is the probability of sectoral change in a household × year for *stayers*. The first full year of the ban corresponds to year 0 in the graph

Figure 24: Household Level: Migration evolution for Shrimp Households



Note: Plotted are the event-time coefficient estimates for the specification equation 1, where the dependent variable is the probability of migrating in a household year for stayers. The graphs have a slight different definition of migration for robustness, specified on the y-axis. The first full year of the ban corresponds to year 0 in the graph

Figure 25: Household Level: Migration evolution



Note: Plotted are the event-time coefficient estimates for the specification equation 2, where the dependent variable is the probability of migrating in a household year for stayers. The graphs have a slight different definition of migration for robustness, specified on the y-axis. The first full year of the ban corresponds to year 0 in the graph

B Sectoral Changes among Entrepreneurs

Using firm-level data we investigated family entrepreneurs that first enter in fish and aquaculture activities before the EU ban. Table 13 shows the sectoral transition for a balanced panel of 74 entrepreneurs who started their private limited companies in the fishing industry in 1999. We check in which sector, out of the 9 available, their main revenue is in 2013. Among the entrepreneurs, only 35% still derives their main source of revenue from fishing and aquaculture activities. We find that most of the entrepreneurs switched to manufacturing, construction and wholesale. We also find that twice the average number of firms closed in 2002 compared to the firms in other sectors.[12]

Table 13: Main Sector in 2013 for 74 entrepreneurs who started their businesses in Fishing and aquaculture activities before 2002

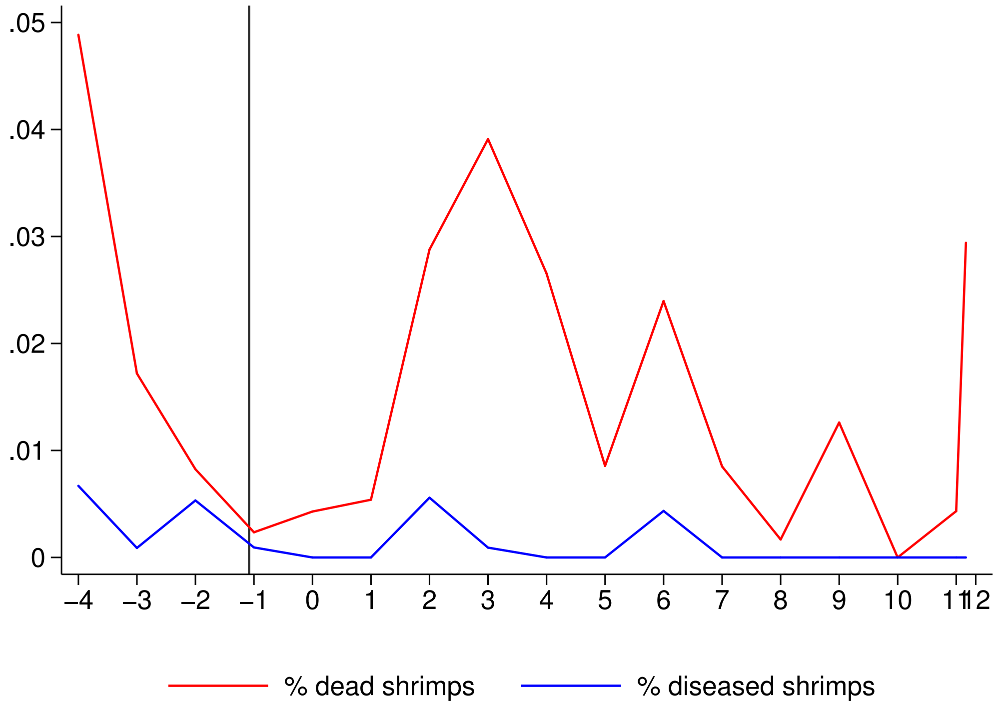
	Main Sector in 2013	Percent
Fishing	26	35%
Mining	1	1%
Manufacturing	11	15%
Construction	10	14%
Wholesale	14	19%
Hotels and Restaurants	2	3%
Transport	2	3%
Real Estate and other business activities	6	8%
Other activities	2	3%
Total	74	100%

C Robustness tests for "Sickness" of the shrimp

In this section, we test what it is probability of the shrimp being sick or dying before and after the ban. One of the main concerns with our identification strategy is that the whole "aquaculture" sector was shrinking before the ban. Therefore, our results may be driven by the fact that the decision of switching sector was not due to the ban, but it was due to the fact that the shrimp were getting easily sick and dying fast. Hence, the shrimp farmers would not see this business as profitable, therefore, they would drop from it permanently. This could explain why we observe our patterns in the data. In order to reassure that the main results are not driven by this fact, we plot the percentage of dies and sick shrimp over time in figure 26. We observe that the percentage of dead shrimp and percentage of *remaining* sick shrimp is not strictly larger in the period before the ban than in the later period. Moreover, there are only about 15% of sick shrimp on average, a relatively small number in order to shut down the entire sector. Figure 27 shows the percentage

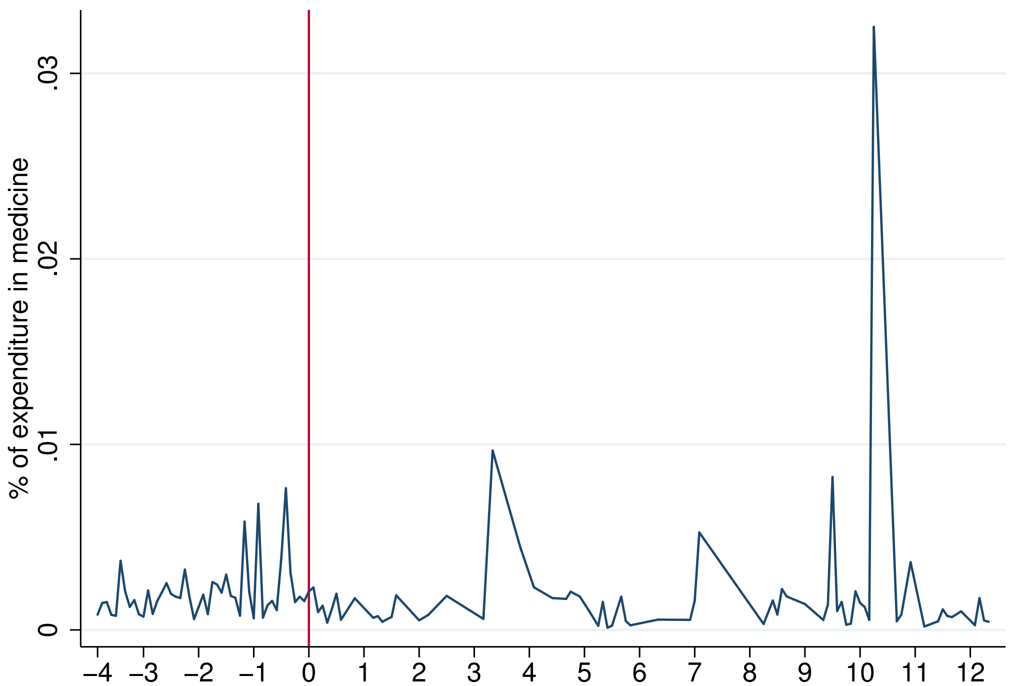
[12]In future analysis, we would like to further decompose the job-to-job transition and compare the growth rate of firms in fishing and aquaculture activities to firms in other sectors.

Figure 26: Percentage of sick and dead shrimp



of expenditure in medicine for the households producing shrimp. We observe that the households were spending less than 1% on medicine, but the value was increasing before the ban. The value, drops rapidly the year of the ban and it recovers it has few jumps in year 3, 4 7 and 10. But, overall, this suggests that the households responded to the bun by putting less medicine in their shrimp.

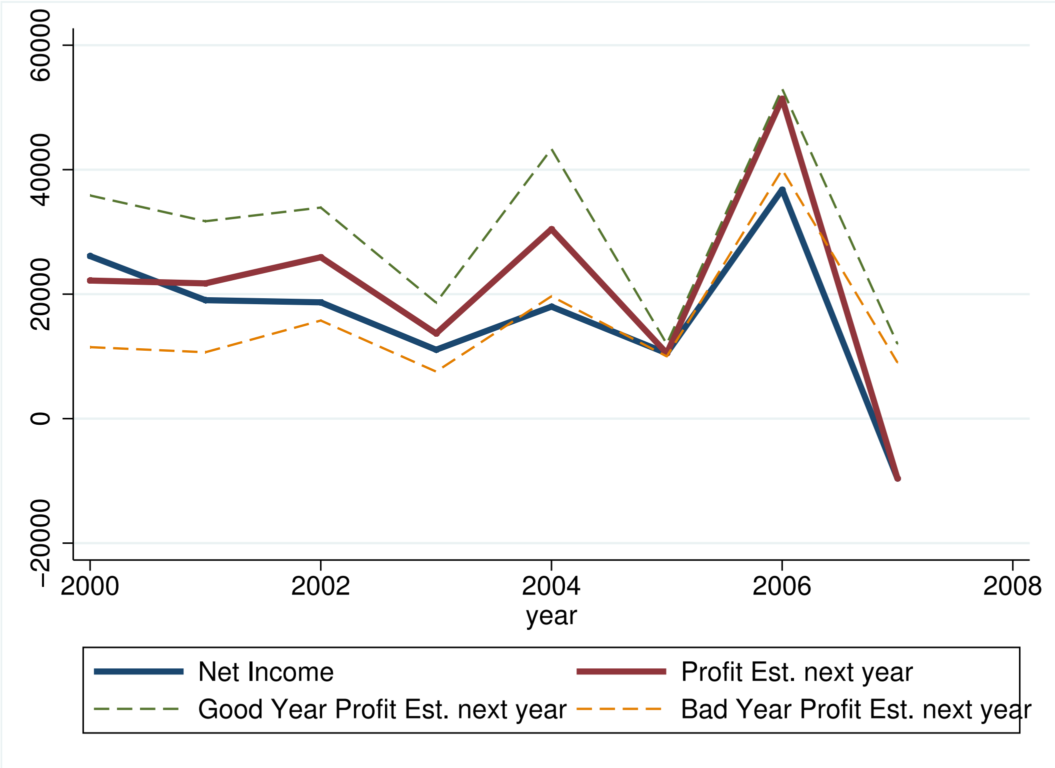
Figure 27: Percentage of Expenditure on Medicine



D Uncertainty

Part of the reasons why some farmers left in the sector might be the uncertainty about the length of the ban. Despite our intent to search for anecdotal evidence, we have not found evidence suggesting whether the ban was expected to be lifted or not. However, thanks to the large set of questions in the Townsend Thai Project data, the following questions were asked:

Figure 28: Expectations of future Profits



Using these questions, in figure 28 we check whether shrimp farmers had expectations for their income to be bad or good compared to their regular expectations. If they think that their future income are close to the lower bound, that would suggest that they expect the ban the ban to continue although it was lifted. This hints to more uncertainty for the future.